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SCIENCE DEPARTMENT OF DAUGAVPILS UNIVERSITY

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Zinātnisko rakstu krājumā *Daugavpils Universitātes 62. starptautiskās zinātniskās konferences rakstu krājums = Proceedings of the 62nd International Scientific Conference of Daugavpils University* apkopoti 2020. gada 28.–29. maijā konferencē prezentētie materiāli.

Daugavpils Universitātes 62. starptautiskās zinātniskās konferences rakstu krājums tiek publicēts 3 daļās: A. daļa. *Dabaszinātnes*; B. daļa. *Sociālās zinātnes*; C. daļa. *Humanitārās zinātnes*.

The annual scientific conferences at Daugavpils University have been organized since 1958. The themes of research presented at the conferences cover all spheres of life. Due to the facts that the conference was of interdisciplinary character and that its participants were students and outstanding scientists from different countries, the subjects of scientific investigations were very varied – in the domains of natural sciences, health care sciences, humanities and art, and social sciences.

The results of scientific investigations presented during the conference are collected in the collection of scientific articles *Proceedings of the 62nd International Scientific Conference of Daugavpils University*.

Proceedings of the 62nd International Scientific Conference of Daugavpils University are published in three parts: part A. *Natural sciences*; part B. *Social Sciences*; part C. *Humanities*.

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VESELĪBAS APRŪPES ZINĀTNE / HEALTH CARE SCIENCE

COSMETICS EFFECT ON MILD FORMS OF ACNE VULGARIS

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Abstract

Cosmetics effect on mild forms of Acne vulgaris

Key Words: *Acne vulgaris, cosmetics, bacterial resistance, topical therapy*

Introduction Acne vulgaris [AV] is commonly considered a problem that occurs in adolescence, an increasing number of patients over 25 years of age. According to the European guidelines for the management of acne, the treatment options differ according to the severity and clinical type of acne and can involve topical as well as systemic therapy. Bacterial resistance to antibiotics is a clinically relevant concern globally. Therefore, therapeutic options that reduce the need for topical and oral antibiotic therapy for acne are welcome.

Materials and Methods Forty-one individual with comedonal and mild papulopustular AV according to European Dermatology Forum and American Academy of Dermatology guidelines was enrolled in the study.

The study participants were randomly split into two groups. The first group (N=17) used a test product 1 with active substances including Salicylic Acid 2%, Ilex Paraguariensis Leaf Extract 1%, Zinc PCA 0.50%, Cetraria Islandica Extract 0.03%, Usnea Barbata Extract 0.03%, Juniperus Communis Callus Culture Extract 0.02%. The second group (N=17) used test product 2 without active substances. Thus, each group of participants used a test product with or without active substances in the morning and before going to sleep. The severity of facial acne of each participant was captured during the initial visit before applying the test product as well as during the follow up visit after 6 weeks. Images were taken from 3 perspectives: frontal and sagittal from both sides. Images were evaluated for relative changes of inflammatory and non-inflammatory lesion count. Data statistical analysis Mann Whitney U test was used to compare results from both groups and Wilcoxon Signed test was used to compare acne severity before and after 6 weeks.

Results The study revealed that the quantity of inflammatory lesions decreased in both groups, respectively, by -39,56, SD=82,37% in the group using test product 1, and by -2,16, SD=61,0% in the group using test product 2. The results between both groups differed significantly ($p=0,013$). The percentage changes in the quantity of non-inflammatory lesions did not reveal a statistically significant difference.

In absolute numbers inflammatory lesion count decreased significantly (from 4,71, SD=2,23 to 2,29, SD=2,14, $p=0,011$). For non-inflammatory elements no statistically significant difference was revealed.

Conclusions Topical cosmetic formulations can have a significant impact on the severity of mild acne.

Kopsavilkums

Kosmētikas iedarbība uz vieglām Acne vulgaris formām

Atslēgvārdi: *Acne vulgaris, kosmētiskie līdzekļi, antibakteriālā rezistence, lokāla terapija*

Ievads Acne vulgaris [AV] ir plaši izplatīta problēma pusaudžu vidū un virs 25 gadu vecuma. Pēc Eiropas dermatologu asociācijas vadlīnijām terapija tiek nozīmēta atkarībā no AV smaguma pakāpes un klīniskā tipa. Atkarībā no tā tiek piemēlēta lokāla vai sistēmiska terapija. Baktēriju rezistence pret antibiotikām ir globāla problēma, tādēļ terapija, kura ļautu samazināt nepieciešamību pēc lokāliem un sistēmiskiem antibiotiskiem līdzekļiem ir ļoti būtiska.

Materiāli un metodes Pētījumā tika iekļauti 41 pacients ar komedonu un vieglas smaguma pakāpes papulopustulozu AV atbilstoši *European Dermatology Forum* un *American Academy of Dermatology* vadlīnijām kas nejauši tika iedalīti divās grupās. Pirmā grupa (N=17) saņēma kosmētisku līdzekli ar aktīvām vielām – testēšanas produkts 1 (Salicilskābe 2%, *Ilex Paraguariensis* lapu ekstrakts 1%, Cinks 0.50%, *Cetraria Islandica* ekstrakts 0.03%, *Usnea Barbata* ekstrakts 0.03%, *Juniperus Communis Callus* ekstrakts 0.02%)., savukārt otra grupa (N=17) saņēma kosmētisko līdzekli bez aktīvām vielām – testēšanas produkts 2. Pētījuma dalībnieki produktu lietoja no rīta un pirms gulētiešanas. Katrs pacients tika bildēts pirmās vizītes laikā un 6 nedēļas pēc produkta lietošanas. Fotografijas tika uzņemtas frontāli un sagitāli no abām pusēm. Bildēs tika izvērtēts iekaisīgo un neiekaisīgo element skaits. Datu statistiskā analīzē tika izmantots *Mann Whitney U* un *Wilcoxon Signed test*.

Results Pētījumā pierādījās, ka abās grupās samazinājās iekaisīgo element skaits, proti, -39,56, SD=82,37% grupā lietojot testa produktu 1 un par -2,16, SD=61,0% grupā lietojot testa produktu 2. Starp abām grupām tika konstatēta

statistiski nozīmīga atšķirība ($p=0,013$). Starp neiekaisīgajiem elementiem abās grupās netika konstatēta statistiski nozīmīga atšķirība.

Absolūtos skaitļos iekaisīgo elementu skaits statistiski nozīmīgi samazinājās (no 4,71, $SD=2,23$ uz 2,29, $SD=2,19$ un $p=0,011$). Starp neiekaisīgajiem elementiem statistiski nozīmīga atšķirība netika konstatēta.

Secinājumi Lokālo kosmētisko līdzekļu kombinācija uzlabo ādas stāvokli ar vieglas smaguma pakāpes AV.

Introduction

Acne vulgaris [AV] is commonly considered a problem that occurs in adolescence, an increasing number of patients over 25 years of age are seeking dermatological help for this condition [12]. Epidemiological studies have demonstrated that acne is most common in post-pubescent teens, with boys most frequently affected particularly with more severe forms of the disease [9,14]. The prevalence of adult acne is 3% in men and between 11% and 12% in women, with a significant decline from 45 years of age and onwards [12].

According to the European guidelines for the management of acne, the treatment options differ according to the severity and clinical type of acne and can involve topical as well as systemic therapy. There is paucity of investigations concerning treatment of comedonal acne, there is also lack of consensus on the initiation treatment of comedonal acne among experts [1]. American Academy of Dermatology mentions treating milder forms by facial washes, creams and pads; their primary active ingredients are benzoyl peroxide, salicylic acid, sulfur, sodium sulfacetamide, and resorcinol. This class of products is generally helpful for patients with mild acne to minimize the side effects of topical treatments. Commonly used topical acne therapies include antibiotics, e.g., clindamycin 1% solution or gel or erythromycin in 2% concentration as a cream, gel or lotion and combination of antibiotics with benzoyl peroxide. Furthermore, retinoids – such as tretinoin (0.025-0.1% in cream, gel, or microsphere gel vehicles), adapalene (0.1%, 0.3% cream, or 0.1% lotion 73,74), and tazarotene (0.05%, 0.1% cream, gel or foam) are used. Also topical treatment of AV may include retinoid with benzoyl peroxide, retinoid with antibiotic, azelaic acid, and sulfone agents [5; 16]. Bacterial resistance to antibiotics is a clinically relevant concern globally. Therefore, therapeutic options that reduce the need for topical and oral antibiotic therapy for acne are welcome [6].

Topical or systemic treatments frequently cause adverse effects related to impairment of the skin barrier, and cosmetics must therefore be used in combination to help protect the skin barrier [11].

When treating milder forms of acne the beneficial effects of separate active substances used in cosmeceutical on the severity of acne has been studied. Salicylic Acid, Ilex Paraguariensis Leaf Extract, Zinc PCA, CetrariaIslandica Extract, Usnea Barbata Extract, JuniperusCommunis Callus Culture Extract are all have been observed to improve the condition of skin in patients with acne. On the other hand, the synergic effect of applying multiple active substances is not so much studied.

Therefore, the goal of this study is to evaluate the synergistic effects of active substances in a cosmetic product on mild forms of acne.

Materials and Methods

The study had been approved by the Ethics Committee of Riga Stradins University (Nr.6-3/3/15 (28.03.2019.)). Forty-one individual with comedonal and mild papulopustular AV according to European Dermatology Forum and American Academy of Dermatology guidelines was enrolled in the study [1,4]. Exclusion criteria were:

- acne with indication for topical or systemic treatment,
- allergic reaction to cosmetic substances,
- local infection on the skin, such as herpes simplex,
- patients systemically treated with isotretinoin in the last 6 months,
- patients with other treatment of Acne vulgaris in the last 2 months,
- patients who had a superficial face peeling during the last 4 weeks,
- patients that had used any kind of antibiotics in last 4 weeks,
- lactation or pregnancy.

The study participants were randomly split into two groups. The first group (N=17) used a test product 1 with active substances including Salicylic Acid 2%, Ilex Paraguariensis Leaf Extract 1%, Zinc PCA 0.50%, Cetraria Islandica Extract 0.03%, Usnea Barbata Extract 0.03%, Juniperus Communis Callus Culture Extract 0.02%. The second group (N=17) used test product 2 without active substances. In the first group the average age was 25,59 (SD=7,06), and for the second 26,47 (SD=5,62). All participants were women. Thus, each group of participants used a test product with or without active substances in the morning and before going to sleep. Before applying test product participants would cleanse the face and in the morning would apply a moisturizer. The severity of facial acne of each participant was captured during the initial visit before applying the test product with Canon 6D camera and Canon EF 50 mm 1:1,4 lense), as well as during the follow up visit after 6 weeks. Images were taken from 3 perspectives: frontal and sagittal from both sides. Images were evaluated for relative changes of inflammatory and non-inflammatory lesion count. Data statistical analysis Mann Whitney U test was used to compare results from both groups and Wilcoxon Signed test was used to compare acne severity before and after 6 weeks.

Results

The study revealed that the quantity of inflammatory lesions decreased in both groups, respectively, by -39,56, SD=82,37% in the group using test product 1, and by -2,16, SD=61,0% in the group using test product 2. The results between both groups differed significantly ($p=0,013$) (Figure 1). The percentage changes in the quantity of non-inflammatory lesions did not reveal a statistically significant difference.

In absolute numbers inflammatory lesion count decreased significantly (from 4,71, SD=2,23 to 2,29, SD=2,14, p=0,011) (Figure 2). For non-inflammatory elements no statistically significant difference was revealed.

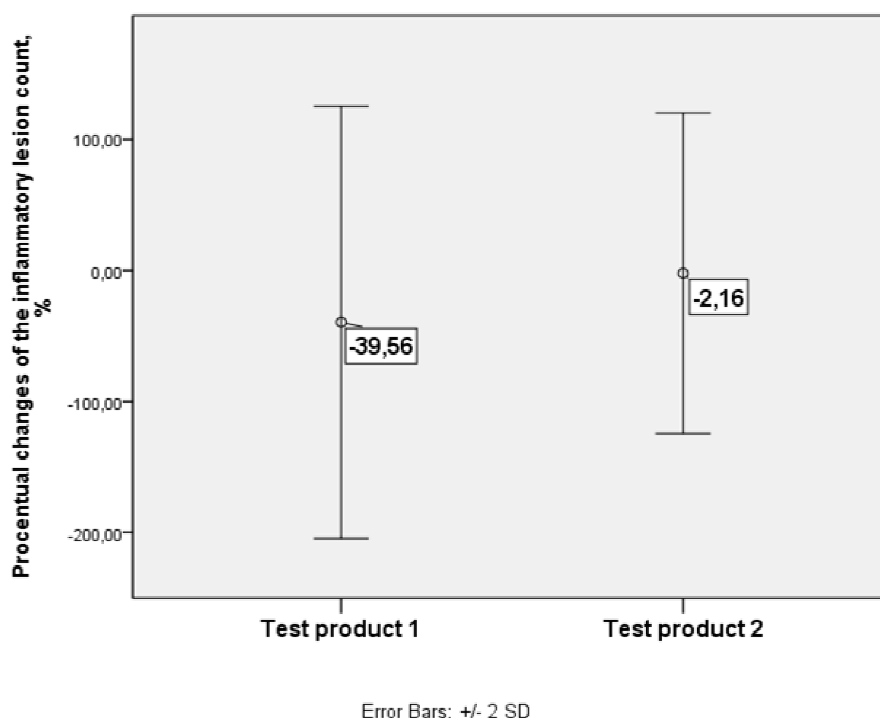


Figure 1. Comparison of the decrease in inflammatory lesions between groups

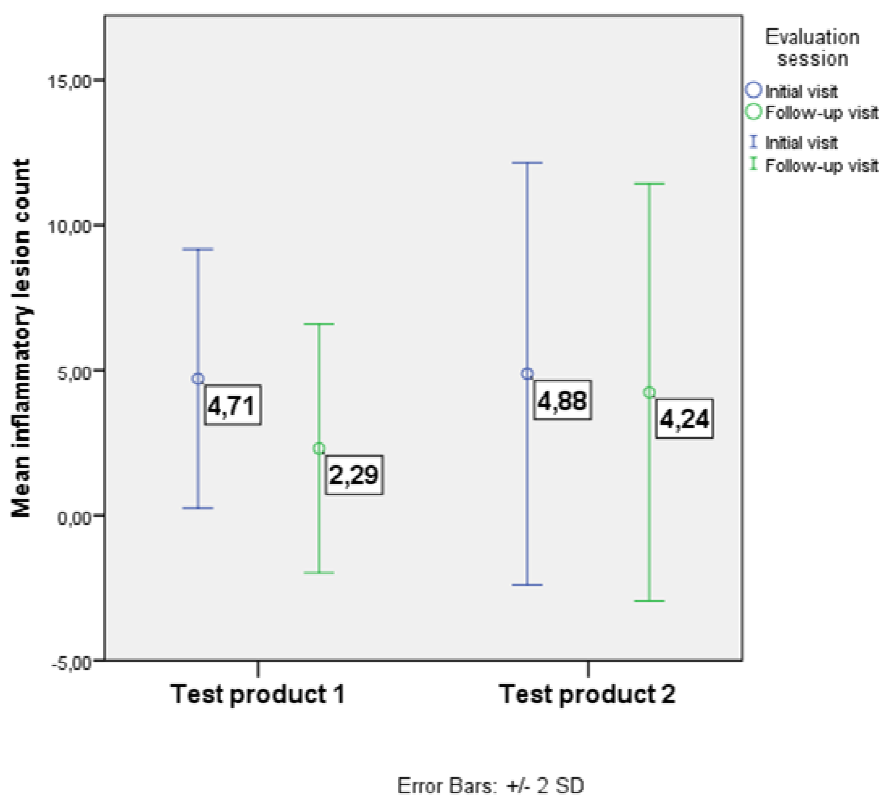


Figure 2. Mean inflammatory lesion count in both groups at the initial and follow-up visits

Discussion

Whereas effect of applying separate active substances when treating acne vulgaris is studied more sufficiently, there is paucity of publications on the clinical effects of applying multiple active substances at the same time.

Salicylic acid is a comedolytic agent that is available over the counter in 0.5% to 2% strengths for the therapy of AV. Both wash-off and leave-on preparations are well tolerated. Clinical trials demonstrating the efficacy of salicylic acid in acne are limited [16]. Combining active ingredients targeting multiple components of acne pathogenesis may yield optimal outcomes. A study investigates the safety and efficacy of an antioxidant optimized topical salicylic acid 1.5% cream containing natural skin penetration enhancers in combination with antioxidant activity for treatment of facial acne [15].

The preponderance of evidence suggests zinc as a compound with antibacterial and anti-inflammatory effects and that it may decrease sebum production [3]. Zinc inhibits chemotaxis of polymorphonuclear cells. It also inhibits 5 α -reductase and TNF- α and stimulates antiradical enzyme systems, mainly superoxide dismutase. A zinc based preparation is used for skin ailments and wound healing formulations. The inhibitory effect of zinc and its compounds on P. acne induced inflammation has been reported in several studies [13].

There is a study reporting of anti acne properties of Yashadabhasma, mainly comprising of zinc, individually, and in combination with tankana. Yashadabhasma plays an important role in the normal functioning of skin in vitro [13].

Research on the effects of *Ilex paraguariensis* (Yerba mate extract) and juniper berries show similar effects in health and disease like antioxidant, anti-inflammatory, antimutagenic and lipid-lowering activities [2]. Juniper berries also have antifungal and genoprotective properties [2,7].

The antioxidant activity, reducing power, superoxide anion radical scavenging and free radical scavenging activities of the aqueous extract of *Cetraria islandica* were studied [4].

Usnea species have been used as antimicrobial agents in many countries and were being developed as a modern pharmaceutical just prior to the advent of the penicillin antibiotics. During the 1980s, interest in usnic acid as an antimicrobial was renewed because of increasing experience of multidrug resistance caused by overuse of synthetic antibiotics. It has been shown that both the optical enantiomers of usnic acid are active against Gram-positive bacteria and mycobacteria, and several research studies and clinical trials have confirmed the antibacterial properties of usnic acid [10].

The current research demonstrates that combining several active substances with antioxidant, antifungal, anti-comedogenic and anti-inflammatory properties can be effective in particular pathogenic stage of AV and has, therefore, high potential in treating milder forms of acne.

The product with active substances has anti-inflammatory and comedolytic effects but does not impact comedogenesis due to basic nature of comedogenesis during follicular enlargement and hyperkeratinization, which is largely associated with sebocyte formation. Recent work suggests that the formation of sebocytes is regulated by several molecular pathways (e.g. Lef-1, Blimp1, Wnt, C-myc) and that sebocyte activity is controlled via a range of cellular pathways and hormones in addition to androgens including, for example, peroxisome proliferator-activated receptors, substance P receptors, α -melanocyte-stimulating hormone, insulin-like growth factor, corticotropin-releasing hormone, vitamin D and ectopeptidases. As sebum and keratinocyte debris accumulate in the microcomedon, larger, clinically visible closed or open comedones are developing.

Evolving comedone facilitates colonization of the infra-infundibulum of follicles by *P. acnes* and the release of inflammatory mediators into the surrounding perifollicular dermis together with the attraction of immunocompetent cells. At this point test products 1 unfolds anti-inflammatory effect [8].

Conclusions

Topical cosmetic formulations can have a significant impact on the severity of mild acne.

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BOTANICAL INGREDIENTS IN COSMETICS: IMPACT OF NOVEL FORMULATION CONTAINING BETULA ALBA (BIRCH) SAP ON BIOPHYSICAL PARAMETERS OF THE SKIN

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Abstract

Botanical ingredients in cosmetics: impact of novel formulation containing betula alba (birch) sap on biophysical parameters of the skin

Key Words: dermatology, hydration, viscoelasticity, *Betula alba*, birch sap

Introduction. Gradual accumulation of different factors can disturb epidermal barrier function, corneocyte differentiation, lead to disintegration of collagen and elastic fibers, increase transepidermal water loss, reduce hydration and elastic recoil leading to dryness, laxity and reduced healing capacity of the skin. Active substances found in birch sap (organic and amino acids, betulin, micro- and macroelements) possess its use as ingredient with antioxidant, anti-inflammatory, cell stimulating and water-replacing properties improving wound healing, epidermal barrier function and hydration.

Aim of the study. The aim of this study was to evaluate impact of novel cosmetic formulation containing birch sap on biophysical parameters of the skin.

Materials and Methods. Participants were asked to apply the test product on inner aspect of the left forearm twice a day. The right forearm was considered a control site. Instrumental assessment of hydration and viscoelasticity (R2, R5, R7) parameters was made using Corneometer CM 825 and Cutometer dual MPA580 (Courage & Khazaka, Germany) accordingly. Parameters were evaluated four times (before application as well as 1 hour, 5 days and 4 weeks after daily use of the product). Paired and independent sample T-test was used for analysis of collected data with $p < 0.05$ considered statistically significant.

Results. Statistically significant improvement in skin hydration level was observed regarding the experimental site when compared with the control site after 1 hour and 4 weeks (39.83 SD=30.86% vs. 0.83 SD=15.14%, $p < 0.001$). There was statistically significant increase in moisture levels of both sites after 5 days, though percentage increase was significantly higher on the left site.

Conclusions. Daily use of *Betula alba* sap containing cosmetics leads to good immediate as well as long term outcome providing marked improvement in moisture level of the skin.

Kopsavilkums

Augu izcelsmes vielas kosmētikā: Jauna *Betula alba* (bērza) sulu saturoša pagatavošana ietekme uz ādas biofizikālajiem parametriem

Atslēgvārdi: dermatoloģija, hidratācija, viskoelasticitāte, *Betula alba*, bērzu sula

Ievads. Pakāpeniska dažādu faktoru kumulatīvā darbība var traucēt epidermas barjerfunkciju, korneocītu diferenciāciju, novest pie kolagēna un elastīgo šķiedru dezintegrācijas, palielināt transepidermālo ūdens zudumu, samazināt hidratāciju un elasticitātes parametrus, veicinot tādējādi ādas sausumu, ļenganumu un samazinātu ādas atjaunošanās kapacitāti. Bērza sulā esošās aktīvās vielas (organiskās un aminoskābes, betulīns, mikro- un makroelementi) padara iespējamu tās izmantošanu dažādos pagatavojumos ar antioksidantu, pretiekaisuma, šūnas stimulējošām un ūdeni aizstājošām īpašībām, tādējādi veicinot brūču dzīšanu, uzlabojot epidermas barjerfunkciju un hidratāciju.

Mērķis. Pētījuma mērķis bija izvērtēt jauna bērzu sulu saturoša kosmētiskā pagatavošana ietekmi uz ādas biofizikālajiem parametriem.

Materiāli un metodes. Pētījuma dalībniekiem tika lūgts aplicēt testa produktu uz kreisā apakšdelma iekšējās virsmas divreiz dienā. Labais apakšdelms tika uzskatīts par kontroles pusi. Hidratācijas un viskoelasticitātes (R2, R5, R7) parametru izvērtējums tika veikts, izmantojot Corneometer CM 825 un Cutometer dual MPA580 (Courage & Khazaka, Vācija). Parametri tika izvērtēti četras reizes (pirms aplikācijas, kā arī 1 stundu, 5 dienas un 4 nedēļas pēc produkta izmantošanas ik dienas). Datu analīzei tika izmantots divu atkarīgu un neatkarīgu izlašu T-tests. Par statistiski ticamu tika atzīta p vērtība mazāka par 0,05.

Rezultāti. Statistiski nozīmīgas hidratācijas līmeņa izmaiņas tika novērotas eksperimenta pusē, salīdzinot ar kontroles pusi, pēc 1 stundas un pēc 4 nedēļām (39.83 SD=30.86% pret 0.83 SD=15.14%, $p < 0.001$). Statistiski nozīmīgs mitruma līmeņa pieaugums tika novērots abās pusēs pēc 5 dienām, tomēr procentuālais pieaugums statistiski ticams bija tikai kreisajā pusē.

Secinājumi. *Betula alba* sulu saturošu kosmētisko līdzekļu izmantošana ikdienā raksturojas ar labiem tūlītējiem un ilgtermiņa efektiem, nodrošinot ievērojamu ādas mitruma līmeņa pieaugumu.

Introduction

Integrity of the skin as a protective barrier is crucial in maintenance of internal homeostasis as well as wellbeing and self-esteem of a person. Different harmful stimuli can disrupt structural integrity of the skin making it prone to infection, reduce laxity of the skin and quality of the skin in general and be esthetically disfiguring thus different chemical substances that can induce wound healing, improve quality and viscoelastic properties of the skin by improving elastic recoil and hydration parameters as well as inducing synthesis of collagen fibers are of great interest in medicine as well as in cosmetic industry especially those substances that can be derived from plants and other botanicals thus being described as phytomedicines (Ebeling *et al.*, 2014).

Triterpenes found in birch bark are bioactive compounds that have been used in folk medicine for years for example in traditional medicine of North American Indians as a natural remedy to improve wound healing (Ebeling *et al.*, 2014). Although botanical substances and bioactive compounds of different plants have been firstly described long time ago only very small percentage (approximately 15%) of them have been studied phytochemically (Muceniece *et al.*, 2016). It has been scientifically established that they have a positive impact on re – epithelialization and migration of keratinocytes thus promoting new tissue formation and restoration of skin barrier integrity (Ebeling *et al.*, 2014). Other useful and healing properties of triterpenes include, for example, anti – inflammatory, anti – oxidative, cytotoxic, anti – bacterial, anti – viral, anti – diabetic (lupine group triterpenoids have an impact on glucose metabolism, insulin secretion and progression of diabetic angiopathies thus being promising substance in management of diabetes), gastro – and hepatoprotective activity (Chudzik, Korzonek-Szlacheta and Król, 2015; Dehelean *et al.*, 2012; Ebeling *et al.*, 2014; Muceniece *et al.*, 2016). Nowadays they are being studied as promising antineoplastic and anticancer agents that can be used in the future with their mechanism of action based on anti-inflammatory properties decreasing incidence of occurrence of malignant growths and metastatic processes (Dehelean *et al.*, 2012).

The group of triterpenes units wide range of different substances including squalene, betulinic acid, lupeol, lupane, ursane and others (Chudzik, Korzonek-Szlacheta and Król, 2015).

Betulin is botanical compound, pentacyclic triterpene derived mainly from the outer bark of *Betula* species (Barret *et al.*, 2017); however, it can be also found in other plants (Dehelean *et al.*, 2012).

Beneficial physical, chemical, and pharmacological properties of betulin are being investigated in many researches showing that betulin is a promising compound in different cosmetic and medical preparations. It accelerates wound healing by induction of re – epithelialization providing faster wound closure and thus preventing the wound from pathogen contamination and development of wound site infection and as a sequelae also better aesthetic results and appearance

of the skin (Barret *et al.*, 2017). Nevertheless, it has positive impact on regulation of inflammatory mediators acting as modulator and differentiation of skin cells (Barret *et al.*, 2017) as well as induction of interferon pathway (Dehelean *et al.*, 2012; Schwieger-Briel *et al.*, 2019).

Nevertheless, oxidative processes induce the transformation of betulin in betulinic acid – more potent and chemically active substance (Dehelean *et al.*, 2012; Muceniece *et al.*, 2016).

It has been scientifically estimated that currently available technologies and synthesis techniques allows at least 70% of active compound betulin to be extracted from outer bark of *Betula* species (Dehelean *et al.*, 2012); however, the amount of the substance extracted varies from one *Betula* specie to another, the soil and climate as well as the fact that proper extraction techniques need to be used in order to achieve the best result with minimal waste of active substances. These facts are of great importance especially when large production for commercial purposes is planned (Dehelean *et al.*, 2012; Muceniece *et al.*, 2016).

Materials and Methods

Cosmetic formulations used in this research were developed in private enterprise according to currently valid normative acts and regulations. Assessment of safety of the product was made and approval of Riga Stradins University Ethics Committee was obtained.

The aim of the study was to evaluate impact of novel cosmetic formulation containing birch sap on biophysical parameters (viscoelasticity and hydration) of the skin.

Participants (N = 30) meeting inclusion criteria (no current pregnancy or breastfeeding, no acute inflammation or exacerbation of preexisting dermatological condition, intolerability or allergic reactions for any of the ingredients of test product) were enrolled and asked to apply the test product on inner aspect of the left forearm twice a day. The right forearm was considered a control site. Volunteers who did not meet aforementioned inclusion criteria were excluded from the research.

Instrumental assessment of hydration and viscoelasticity (R2, R5, R7) parameters was made using Corneometer CM 825 and Cutometer dual MPA580 (Courage & Khazaka, Germany) accordingly. Measurement of the hydration was performed with use of a probe consisting of two oppositely charged electrodes thus being able to create an electromagnetic field and to provide measurement of electric capacity and dielectricity of the stratum corneum of the skin (GmbH, 2000). Cutometer, in turn, provided measurements of viscoelastic properties of the skin with help of an optic system by measuring deformation of the skin caused by constant negative pressure created inside the cutometer probe (GmbH, 2017).

Hydration level and viscoelastic parameters of the skin were evaluated four times (before application as well as 1 hour, 5 days and 4 weeks after daily use of the product).

Relative air humidity level of 40–60% and room temperature of 23° C was maintained during the time of the research.

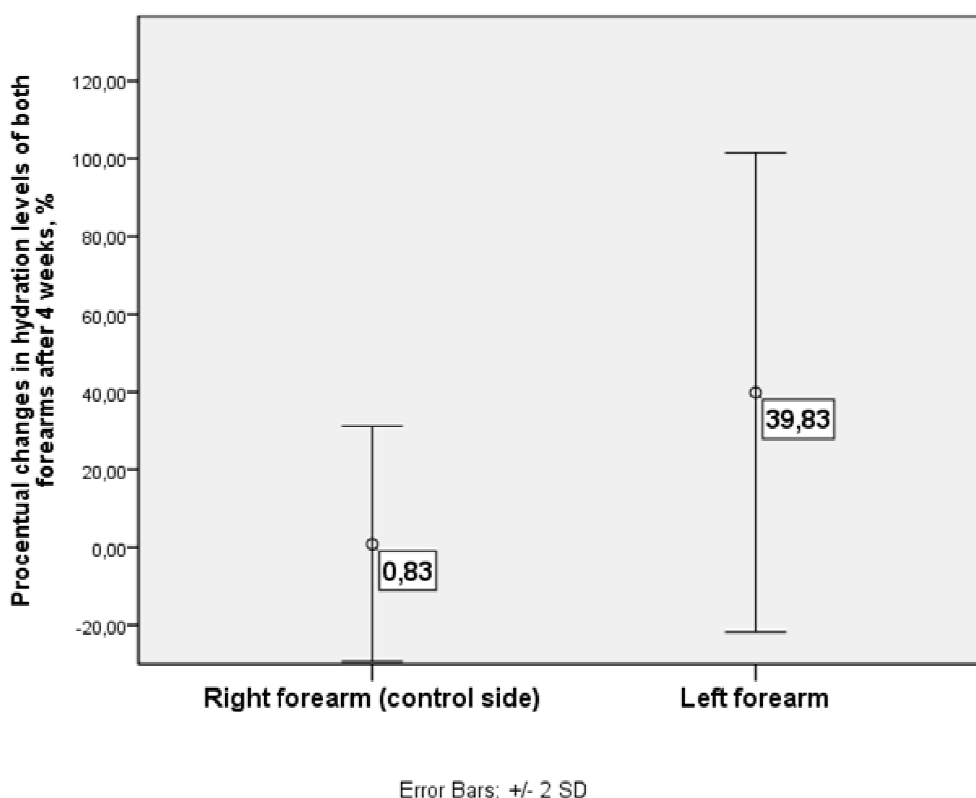
Paired and independent sample T-test was used for analysis of collected data with p value less than 0.05 considered statistically significant.

Results

Statistically significant improvement in skin hydration level regarding the experimental site when compared with the control site after 1 hour and 4 weeks (39.83 SD=30.86% vs. 0.83 SD=15.14%, $p < 0.001$) was observed (graph 1).

There was statistically significant increase in moisture levels of both control as well as experimental sites after 5 days, though percentage increase in hydration level was significantly higher on the left site.

No statistically significant changes in viscoelastic parameters of the skin were found comparing changes in elasticity after 1 h, 5 days and 4 weeks as well as comparing right and left forearm.



Graph 1. Procentual changes of the hydration level of both forearms after 4 weeks

Discussion

Statistically significant improvement in skin hydration level shows that novel cosmetic formulation containing *Betula alba* (birch) sap possesses immediate as well as long term cumulative impact on moisture content of the skin; however in order to obtain more precise data additional use

of other measurement devices for example Tewameter (Courage & Khazaka, Germany) with estimation of transepidermal water loss would be advised in further researches. It would help assess barrier functions of the skin thus providing better understanding about impact of the topically applied substance on the quality and integrity of the skin especially in correlation with water capacitance measurements being done with Corneometer.

Nonetheless, regression testing can be used in order to assess not only impact of active substances on the skin directly when applied but also after discontinuation of the use of preparation – it allows the researcher to evaluate, how long does it take for biophysical parameters to return to their pre – application state, which means – analysis of longevity of achieved results.

As for viscoelastic properties, obtained results lead to a conclusion that botanical ingredients in *Betula alba* (birch) sap does not provide enough impact on elastic properties of the skin. There were no statistically significant improvements in each of the parameter that has been analysed (R2, R5 or R7), which means that neither viscous nor fibrous components of the dermis were influenced with no instrumentally detectable changes. Longer observation period can be advised, e.g. 8–12 weeks, to assess possible changes in the fibrous components of the dermis.

Although methodology of current research was developed according to all the advices given by manufacturer of Cutometer and Corneometer (Courage & Khazaka, Germany) in users manual of both devices and generally accepted practice used in scientific publications it is possible to emphasize some factors that could be ameliorated and influence results of conducted study.

Current research almost completely relies on compliance of participants involved – whether they have followed all of the instructions they have been given or not, as well as whether they have applied other moisturizing products on test area of their skin or not. Nevertheless, daily activities of participants such as sunbathing or physical activities could have had an impact on obtained results as well. Thus pointing to necessity to improve research methodology not only by using regression test but also with help of defined preparation period during which no topical preparations are allowed in order to precondition skin of all of the participants.

Control groups and bigger sample sizes are another factor to improve in order to achieve better and more reliable and reproducible results.

Conclusions

Botanical compounds found in *Betula alba* sap show wide range of beneficial properties that can be used in preparation of novel botanical cosmetic formulations.

Daily use of *Betula alba* sap containing cosmetics leads to good immediate as well as long term outcome providing marked improvement in moisture level of the skin; however further researches need to be conducted to evaluate impact of birch sap on viscoelastic properties of the skin.

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COMPARISON OF THE ANALGESIC EFFECT OF ESP AND TEA AFTER THORACOTOMY

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Abstract

Comparison of the analgesic effect of ESP and TEA after thoracotomy

Key Words: TEA, ESP, thoracotomy, analgesia, lung surgery, pain

Background. ESP block is an interfascial plane block where a local anaesthetic is injected in a plane below the erector spinae muscle. Investigations indicated its likely site of action is at the dorsal and ventral rami of the thoracic spinal nerves. The ESP block holds a promise for thoracic analgesia in acute postsurgical, posttraumatic pain and chronic neuropathic pain.

Aim. Evaluate ESP analgesic effect after thoracotomy to TEA and compare mean opioid consumption in 48h after surgery for each regional block.

Methods. A prospective study was conducted in the Hospital of Tuberculosis and Lung diseases in Latvia between January 2020 and March 2020. 10 patients with block randomization were divided in 2 groups: 5 patients had ESP block with 15 ml 0,25% *S. Bupivacaini* and 5 patients had TEA block with 0,1 ml/kg 0,25% *S. Bupivacaini*. Both groups had the same systemic analgesics for first 24h after surgery: *S. Ketorolaci* 60 mg, *S. Acetaminofeni* 4g, *S. Metamizoli* 4 g and *T. Etoricoxibi* 90 mg. Pain score was evaluated from 1 to 10 (numeric rating scale – NRS). Postsurgical pain after thoracotomy was assessed during first 48 hours. If patient had pain > 4, one of opioids were added: *S. Tramadol* 100 mg i/m or *S. Fentanyl* 0.05 mg i/v. Both drugs were converted to morphine milligram equivalent.

Results. The study included 10 randomized patients after thoracotomy. ESP group had 5 men and 1 woman, mean age M=57.20, TEA group had 3 men and 2 women, mean age M = 69.40, SD=3.78; mean BMI=28.10 kg/m². Results showed statistically significant differences in pain reduction between both groups (p<0,05). ESP worked better as an analgesic than TEA. Mean opioid consumption during 48h in ESP group was 52 mg but in TEA group – 60mg. Consumption is not statistically significant between both groups. (p=0.45).

Conclusion. Study indicates that it can provide adequate and fast analgesia with gradual pain decrease. However, TEA did not reduce the pain as good as ESP and pain constantly persisted <4.

Kopsavilkums

ESP un TEA pretsāpju efekta salīdzinājums pēc torakotomijas

Atslēgvārdi: TEA, ESP, torakotomija, analgēzija, plaušu operācija, sāpes

Ievads. ESP blokāde ir starpfasciju blokāde, kur lokālais anestētiķis tiek injicēts plāknē zem erector spinae muskuļu grupas. Pētījumi norāda, ka tā darbības vieta ir mugurkaula krūšu daļas dorsālie un ventrāli spinālie nervi. ESP blokādei ir liels potenciāls torakālo sāpju atsāpināšanā pēc operācijām, pēctraumatiskām sāpēm un hronisku sāpju ārstēšanā.

Mērķis. Noskaidrot ESP analgētisko efektu pēc torakotomijas, salīdzinot ar TEA un salīdzināt vidējos opioīdu lietošanas daudzumus 48h pēc operācijas katrā grupā

Metodes. Pētījuma dizains bija prospektīvs, kas tika veikts Plaušu slimības un Tuberkulozes centrā Latvijā starp 2020.gada janvāri un 2020. gada martu. 10 pacienti tika randomizētā veidā sadalīti 2 grupās: 5 pacientiem bija ESP blokāde ar 15 ml 0,25% *S. Bupivacaini* un 5 pacientiem – TEA blokāde ar 0,1 ml/kg 0,25% *S. Bupivacaini*. Abas grupas saņēmu vienādu sistēmisko analgēziju pirmās 24 stundas pēc operācijas: *S. Ketorolaci* 60 mg, *S. Acetaminofeni* 4g, *S. Metamizoli* 4 g and *T. Etoricoxibi* 90 mg. Sāpes tika novērtētas no 1–10 pēc ciparu sāpju vērtēšanas skalas. Postķirurģiskās sāpes pēc torakotomijas tika novērtētas pirmās 48h. Ja pacientam sāpes bija > 4, tad viens no opioīdu preparātiem tika pievienots: *S. Tramadol* 100 mg i/m vai *S. Fentanyl* 0.05 mg i/v. Abi medikamenti tika konvertēti uz morfīna miligramu ekvivalentu.

Rezultāti. Pētījumā tika iekļauti 10 randomizēti pacienti pēc torakotomijas. ESP grupā bija 5 vīrieši un 1 sieviete, vidējais vecums M=57.20; SD=8.11; vidējais BMI=25.79 kg/m². TEA grupā bija 3 vīrieši un 2 sievietes, vidējais vecums M = 69.40, SD=3.78; vidējais BMI=28.10 kg/m². Rezultāti norādīja statistiski ticamu atšķirību sāpju samazinājumā starp abām grupām (p<0.05). ESP darbojas labāk nekā TEA. Vidējais opioīdu lietošanas daudzums pirmo 48h laikā ESP grupā – 52 mg, bet TEA grupā – 60 mg. Starp abām grupām nav statistiski ticama atšķirības. (p=0.45).

Secinājumi. Pētījums norāda, ka ESP spēj nodrošināt adekvātu un ātru analgēziju ar graduālo sāpju samazinājumu. Taču, TEA nesamazināja sāpes tik pat cik labi, kā ESP un sāpes konstanti saglabājās <4.

Introduction

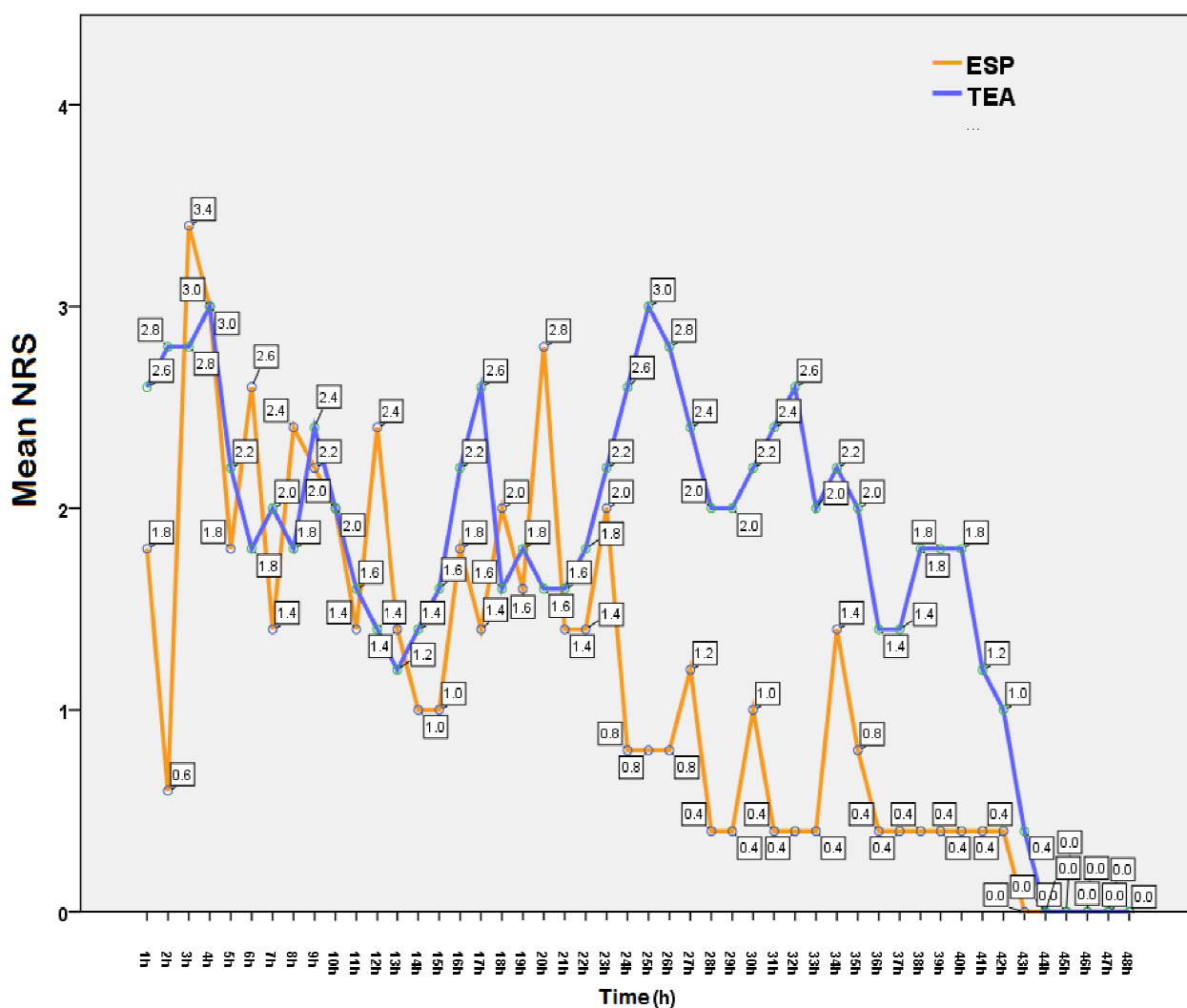
Thoracotomy is considered the most painful of surgical procedures and providing effective analgesia is the goal for all anaesthetists. Ineffective pain relief impedes deep breathing, coughing, and remobilization culminating in atelectasis and pneumonia. The multifactorial nature of acute thoracotomy pain precludes the use of any single analgesic technique to block all the pain afferents described above. (Forero et al., 2016) Success is more likely with a multimodal approach that targets multiple sites along the pain pathway and incorporates regional anaesthesia with non-steroidal anti-inflammatory drugs (NSAIDs), opioids, and other parenteral adjuncts. TEA is a widely used analgesic technique for thoracotomy but is technically harder. The needle is placed in T5-T6. ESP site of action is at the dorsal and ventral rami of the thoracic spinal nerves. The novel interfascial plane block was first described in 2016. Benefits of ESP compared to TEA are less opioid consumption which means fewer side effects from opioids, technically simple and safe, equal efficacy with fewer complications and less painful procedure. (Forero et al., 2016) There have not been reported complications after this procedure in 2016 and 2017. First complication was announced in 2018 which was pneumothorax. Possible complications might be puncture of artery and hematoma. ESP action Duration of analgesic effect of ESP is not well known. Some studies suggest it works for 12 to 36 hours. The best effect is achieved when administered continuously. ESP is a new technique and holds promise as simple and safe for thoracic analgesia in acute postsurgical or posttraumatic pain as well as chronic neuropathic pain as good as thoracic epidural analgesia (TEA).

Material and Methods

This is a prospective study which was conducted in the Hospital of Tuberculosis and Lung diseases in Latvia between January 2020 and March 2020. In total 10 patients who accepted to participate in this study were randomized and divided in 2 groups: 5 patients had ESP block with 15 ml 0,25% S. Bupivacaini after thoracotomy and 5 patients had TEA block with 0,1 ml/kg 0,25% S. Bupivacaini. Catheters for TEA method was inserted under ultrasound guidance. Patients read the information about this study and confirmed their participation with a signature. Both groups had the same systemic analgesics for first 24h after surgery: S. Ketorolaci 60 mg, S. Acetaminofeni 4g, S. Metamizoli 4 g and T. Etoricoxibi 90 mg. Each hour patients were examined and asked to rate their pain. Pain score was evaluated from 1 to 10 (numeric rating scale – NRS). 1 – as there is almost no pain at all and 10 as extremely painful. Postsurgical pain after thoracotomy was assessed during first 48 hours. If a patient had pain > 4 NRS, one of opioids were added: S. Tramadol 100 mg i/m or S.Fentanyl 0.05 mg i/v. Both drugs were converted to morphine milligram equivalent. We used descriptive statistics and t independent test to investigate statistically significant association between both techniques.

Results

This study included 10 randomized patients after thoracotomy. Both blocks were mainly used after thoracic surgeries for different lung conditions. Each group had 5 patients. Patient age range was from 44 years old to 74 years old. In general, 7 men and 3 women took part in this study. ESP group had 5 men and 1 woman, mean age $M = 57.20$, $SD = 8.11$; mean body mass index (BMI) = 25.79 kg/m^2 . TEA group had 3 men and 2 women, mean age $M = 69.40$, $SD = 3.78$; mean BMI = 28.10 kg/m^2 . Results showed statistically significant differences in pain reduction between both groups ($p < 0.05$). As it could be seen in the diagram below, ESP worked better as an analgesic than TEA and subjective pain at ESP was lower after 2 h, 25 h, 28 h, 31 h, 32 h (mean numeric rating pain scale respectively after 2 hours = 0.6; mean NRS after 25h=0.8; m=0.4; m=0.4; m=0.4; m=0.4) compared to TEA (m=2.8; m= 3.0; m=2.0; m= 2.0; m= 2.4; m= 2.6). ESP as analgesic works faster and the pain drop is steeper than TEA. On the other hand, TEA works slower and analgesic effect is more smoothly. Mean opioid consumption during 48 h in ESP group was 52 mg but in TEA group – 60 mg. Consumption is not statistically significant between both groups. ($p = 0.45$).



1. diagram. Mean numeric rating pain scale during 48h in both groups

Discussion

Thoracic epidural and paravertebral blocks have been commonly used for relieving acute or chronic pain for cervical, thoracic, or abdominal surgeries. (Mesbah et al., 2016) ESP block has emerged as an effective novel regional technique with effective analgesia with less opioid requirements, along with simplicity and safety. (Joshi et al., 2008) It is supposed to work at the origin of spinal nerves, based on cadaveric and contrast studies. When dye was injected into the interfascial plane deep to erector spinae muscle bilaterally, craniocaudal spread of injectate from C7 to T8 was noticed in the paraspinous gutter with lateral spread till the transverse processes at all levels. (Jain et al., 2018) The injectate was also noticed slightly beyond the costotransverse junctions at levels T3 to T6 on the right and T4 to T8 on the left. Cadaveric studies have showed that block at T5 level is enough to have unilateral multidermatomal sensory block ranging from T1 to L3. This block serves the purpose of a paravertebral block without risk of pleural injury, therefore it is a safer method. Study showed that the optimal plane for injection in the ESP block is deep to the erector spinae muscle rather than superficial to it, as this will deposit local anesthetic closer to the dorsal and ventral rami. The erector spinae muscle extends along the length of the thoracolumbar spine, and thus, this plane permits extensive cranio – caudal spread and coverage of multiple dermatomes. The most significant advantage of the ESP block is its simplicity and safety. The sonoanatomy is easily recognizable, and there are no structures at risk of needle injury in the immediate vicinity. The technique also lends itself well to insertion of an indwelling catheter, which can be used to extend the duration of analgesia as needed. It may be therefore proved to be a useful intervention in thoracic neuropathic pain where more conventional therapies have had limited success. In addition, there is clearly potential for its application in a much wider range of conditions, including acute pain after thoracic surgery or trauma.

Conclusion

Study concluded that it can provide adequate, fast and gradual pain decrease. Although, TEA did not reduce the pain as good as ESP and pain constantly persisted <4, it also worked as good as ESP in pain reduction. Most of the patients reported no pain or very low pain after 43h in both groups.

Acknowledgement

The authors certify that they have obtained all appropriate patient consent forms. The patients understand that their names and initials will not be published, anonymity can be guaranteed. There was no financial support or sponsorship. There are no conflicts of interest.

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ROLE OF EXTERNAL CEPHALIC VERSION IN REDUCING THE CESAREAN DELIVERY RATE

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Abstract

Role of external cephalic version in reducing the cesarean delivery rate

Background. Although term breech presentation is relatively rare, it continues to be one of the indications for the cesarean section. Risk of complications may be increased for both mother and fetus in such a situation. External cephalic version (ECV) may reduce the number of breech presentations and cesarean sections.

Aim. To evaluate the effectiveness of this obstetric manoeuvre to increase the proportion of vertex presentation among fetuses that were formerly in the breech position near term, so as to reduce the cesarean section rate.

Methods. A retrospective study was conducted in Riga Maternity Hospital. The ECV data was reviewed over a period of 4 years at Riga Maternity Hospital between 2016 and 2019. 160 women were enrolled who accepted to perform ECV (age range 16–45 years old). Data was analyzed by descriptive statistics and frequencies. Women were divided into 2 groups: successful and non-successful ECV. A p-value of <0.05 was considered significant. Association was calculated by Pearson chi-square and Independent samples t-test. Logistic regression was used to predict the effectiveness and complication rate.

Results. Mean age of women was M=30.16; SD=5.15 years, gestational age at ECV M= 261 (37+2 weeks); SD=6.61 days. The success rate of the procedure was 45.6% (n=73). ECV near term was associated with a reduction in non-cephalic presentation and cesarean section (OR= -2.89; 95% CI: 0.02-0.13) (p=0.01). Regression showed only the number of parity as a significant factor for prognosing vaginal birth. The risk for cesarean delivery decreases in 57% with every number of vaginal birth (p=0.03). It also showed 78% chances to predict delivery using collected data from this study which is not significant. 49.4% had a vaginal delivery, 28.1% had an emergency cesarean after a successful version. Complications at delivery after successful ECV were in 17.50% and in 25% unsuccessful. There is no association between complications and external version (p=0.33). There was an association with complications: neonate in ITU 3.68 (95%CI: 1.11-12.11) (p=0.02), blood loss (p=0.01) and Apgar score in 1st minute (p=0.01). There was no association with present meconium at birth (p=0.96), postpartum bleeding (p=0.29), uterine dysfunction (p=0.29), fetal distress (p=0.11), premature membrane rupture (p=0.65) or placental abruption (p=0.66) after version.

Conclusion. The external cephalic version is a safe and effective manoeuvre reducing the risks cesarean section. Complications are not associated with the external version. There are multiple factors which impact the result of delivery and only prognostic factor was parity.

Introduction

The presence of the fetus in the breech presentation during pregnancy is not clinically relevant. In the absence of disturbing circumstances, but up to recital 36 related to spontaneous fetal self-circulation. 7% of different ways of insecure. And afterwards it is decided whether take further actions or not. One of the actions – performs the external circulation of the fetus by an ultrasonic controller, which has proven to support and correct the method used in practice. As a second solution, childbirth fetal pelvic or planned caesarean section (Rezeberga, 2016).

Initially, a planned caesarean section was recognized as an effective solution in the case of breech presentation, but later on the number of caesareans increased and the maternal morbidity associated with anesthesia and surgical intervention increased (Hannah et al., 2002). Both ACOG and RCOG recommended the use of external fetal ECV as the first-line method to reduce caesarean section. A successful external fetal circulation is considered to be when the anterior part of the fetus is the head. The efficiency of the method is high (reduces the number of births in the breech position by 62%, but the number of caesarean sections by 45%) (Rezeberga, 2016).

The external fetal ECV procedure is offered to pregnant women at 36–40 weeks of gestation, for whom no contraindications are found during ultrasonography and for whom the anterior part of the fetus is not the head. Absolute contraindications to ECV are contraindications for vaginal births, fetal abnormalities, uterine bleeding, ruptured fetal membranes and multiple pregnancy. Risk factors for ineffective external fetal ECV include nulliparity, low AI, localization of the placenta in the anterior / lateral wall, adiposity of the pregnant woman, the fetus facing the maternal spine, tense maternal abdominal muscles, incomplete breech presentation, membrane rupture, palpable fetal head.

Material and Methods

The study design is a retrospective cross-sectional study. The participants of the study were selected according to the numbers of the history of childbirth, for which an external fetal ECV test was performed and which were born at the Riga Maternity Hospital (RDN) in the period from 2016 to 2019 (included). In total, the data obtained are for a period of 4 years. By compiling records of the performed ECV in the database of the RDN Ultrasonography Cabinet, initially about 300 pregnant women with a ECV attempt were obtained. The birth history numbers of these pregnant women were checked in a patient database to obtain a sample of pregnant women who performed both turnover manipulation and childbirth at RDN. There were 160 pregnant women. The collection of the required data from childbirth histories in the Statistics Division of the RDN was performed in the period from April 10th to December 10th of year 2019 according to the attached sample.

Statistics were processed with IBM SPSS Statistics Base Grad Pack 22.0 software. Microsoft Office Word 16 was used to create the tables. The paper uses generally accepted statistical parameters in medical research: central tendencies (arithmetic means), data scattering variables (standard deviation), etc. The participants of the study were divided into two groups: successful and unsuccessful attempt at ECV. Manipulation was considered successful if the anterior part of the fetus was the head after the ECV. The Chi-Square Test was used to assess the association between the two groups with nominal values. The results of each test were considered statistically significant if the statistical reliability is $p < 0.05$. The nonparametric Mann Whitney U criterion was used to compare the rank averages of the two independent groups. The logarithmic regression test was used to obtain the percentage reduction in caesarean section risk after successful ECV.

The research protocol was developed in accordance with the general protocol of the Research Ethics Commission of the Medical Institute of the University of Latvia, and it was approved by the Research Ethics Committee of the University of Latvia (Approved on 03.04.2019). The development of further research was approved at the Riga Maternity Hospital with the permission of the Ethics Committee (No. V-42/2019. Approved on 09.04.2019).

Results

The women in the study ranged in age from 16 to 45 years, with a mean age of 30.16 (SD = 5.15; median = 30.00; mode = 29). There were 73 women with a successful external fetal cephalic version, mean age M = 31.37 (SD = 5.04; median = 30.00; mode = 27). There were 87 women with an unsuccessful external fetal cephalic version, mean age M = 29.15 (SD = 5.06; median = 30.00; mode = 29). The mean age of women did not differ statistically between the two groups ($p = 0.08$). External fetal cephalic version was successful in 45.6% of pregnant women and unsuccessful in 54.4%.

Significant influencing successful ECV factors. The number of pregnancies significantly affected the results of the external fetal cephalic version. Women with a higher number of pregnancies (3 and more) are more likely to have a successful external fetal cephalic version ($p = 0.002$). Overall, women with the first pregnancy participated the most in the study ($N = 79$; 49.4%), moreover 60.9% of cases ($N = 53$) women with first pregnancy had an unsuccessful ECV. Consequently also 60.0% ($N=96$) of respondents had a first childbirth and 74.7% ($N = 65$) of pregnant women had unsuccessful ECV and first childbirth. Pregnant women with at least one and more births have a higher probability of a successful external fetal cephalic version ($p = 0.001$). After data processing of anterior part of the fetus before ECV, it is concluded that the anterior part of the fetus greatly influences the results of the procedure of the external cephalic version of the fetus ($p = 0.032$). Incomplete breech presentation was the most common in the fetal presentation study (76.3%; $N = 122$) and reduces the likelihood of successful ECV than full Breech presentation and transverse lie.

Partially influencing successful ECV factors. Analyzing the data with the *Chi-Square* Test, there is a tendency that the body mass index before ECV determines a partial effect on the result of the external fetal cephalic version procedure, but the data do not differ significantly between groups ($p = 0.08$). In this sample of data, successful ECV was observed in 69.9% ($N = 51$) of women with normal weight and 23.3% ($N = 17$) of overweight women. Only 6.8% ($N = 5$) of pregnant women had successful manipulation of underweight and none of the study participants had successful manipulation of obesity. The mean BMI values of both groups before birth and in childbirth did not differ significantly ($p = 0.10$).

The type of abortion partially influences the result of a successful external fetal cephalic version procedure ($p > 0.05$). Pregnant women without a history of abortion are more likely to have a successful ECV, which was 67.1% in the study ($N = 49$). Overall, 72.5% ($N = 116$) of the participants had no abortions of any kind, 12.5% ($N = 20$) had legal abortions and 6.9% ($N = 11$) had miscarriages.

The results obtained for the fetal water index (FTI) indicate that this factor partially influences the outcome of the manipulation, but there are no statistically significant differences between the groups ($p = 0.64$). Less likely for successful ECV if $FTI < 10$ cm than $FTI > 10$ cm.

Placental location partially determines the results of the ECV procedure, but there is no statistically significant difference between the study groups ($p = 0.32$).

Analyzing the data, both fetal pathologies ($p = 0.08$) and umbilical cord wrap around the neck ($p = 0.24$) partially influence the turnover results, but the data are not statistically different between the studied groups.

Analysis of childbirth results after manipulation of ECV. The study participants who had a successful ECV have a longer gestation time after ECV manipulation – on average 281 days (40 + 1 weeks) than the study participants who had an unsuccessful ECV manipulation, i.e. 279 days (39 + 6 weeks)). The average difference in days from the time of turnover to childbirth for study participants with a successful manipulation result is larger, i.e. 19.5 days, than with an unsuccessful result – 18.3 days. The obtained data on the time of gestation during childbirth do not correspond to the normal distribution. Therefore, the nonparametric *Mann Whitney U* test was used to determine statistically significant differences between the two independent samples. The results indicate that there are statistically insignificant differences between the two groups ($p = 0.09$) In the course of the study, the efficiency of ECV was analyzed. The obtained results indicate that spontaneous vaginal and induced vaginal births are more pronounced in patients who had a successful ECV ($p = 0.001$). In contrast, acute and elective caesarean section are more common in patients with unsuccessful ECV ($p = 0.001$). The obtained data are statistically reliable ($p < 0.05$).

Discussion

The result of successful ECV turnover is approximately 40–60%, based on various literature sources. There are studies that indicate a 58% probability, but in another study, 49% – that collected 2,614 cephalic versions (Melo et al., 2019). There are also studies that achieve 70% efficiency (Lau et al., 1997). In the 2016 study, RDN was 36.6% successful ECVs (Vedmedovska et al., N.d.). In the author's work, the ECV efficiency is 45.6%, which is among the average results of worldwide research, thus the probability of the fetus turning to the head is on average 50%. Such a recommendation is also provided in the RCOG guidelines (“External Cephalic Version and Reducing the Incidence of Term Breech Presentation,” 2017). The RDN ECV rate was most likely to be influenced by the large number of nulliparous pregnant women included (60%).

A 2009 study identified 3 key parameters for successful manipulation that can be determined by ultrasonography, including placental placement in the posterior wall of the uterus, $FTI > 10$ cm, and a full breech presentation (M. Kok et al., 2009). The obtained results in the research work do not coincide with the data obtained in another study. The author gains a greater predominance for a

successful result if the anterior part of the fetus is the fetal pelvis (72.6%), rather than the full breech supine – the pelvis and feet (13.7%). Comparing the two samples with a statistical test, a statistically significant difference ($p = 0.03$) is obtained, which indicates that the type of anal sleep is an important factor for successful ECV.

Placental placement in the anterior wall is considered a risk factor for unsuccessful manipulation (Ben-Meir et al., 2008). In turn, the placement of the placenta in the posterior wall improves the outcome (M. Kok et al., 2009). The data of other studies coincide with the results of the author. Among the successful total ECVs in 45.2% of cases the placenta in the uterine cavity was localized in the posterior wall and high, 30.1% in the anterior wall and high, 9.6% in the posterior wall and fundus, 8.2% in the fundus, 5.5% in the posterior wall and low, etc.

Studies show that multiparous women are more likely to give birth vaginally than nulliparous women after successful ECV (El-Toukhy et al., 2007). In one study, 40% of nulliparous and 64% of multiparous women had a successful ECV (Melo et al., 2019). Also in the author's study, pregnant women with a history of at least one birth had a higher number of successful ECVs, respectively, the number of unsuccessful ECVs third – 4.6% and 17.8%, in the fourth – 0.0% and 6.8%. This may be due to late fetal fixation in the small pelvis and loss of anterior abdominal muscle elasticity after several pregnancies. The situation is similar with the number of pregnancies, although other studies have not sought an association between the number of pregnancies in the history and the outcome of ECV, the author accepted it as one of the possible prognostic parameters. According to the obtained data, it can be concluded that starting from the third pregnancy, the probability of successful ECV increases. It should be noted that according to statistical data, this factor is statistically reliable and significant ($p = 0.002$), but unfortunately not all pregnancies have a history of childbirth. A woman is also at risk of missed or miscarriage, for example, a patient is in her fifth pregnancy, but only her first birth is planned. In this case, the number of pregnancies may not be the determining prognostic factor, so each case is individual. The RCOG guidelines state: “The result of turnover depends on multiple indicators. Each individual case affects the probability of each patient.” (“External Cephalic Version and Reducing the Incidence of Term Breech Presentation,” 2017). The author mentioned intrauterine diagnosed fetal pathology and umbilical cord wrap around the neck before manipulation as predictive factors for predicting the outcome of the manipulation. Both of these indicators did not show a statistically reliable association ($p = 0.24$ and $p = 0.15$), but evaluating the data obtained as a percentage, it can be concluded that a higher probability of successful ECV is without fetal pathologies and umbilical cord wrap.

Conclusions

1. The efficiency of the external fetal cephalic version (ECV) is 45.6%, which is ensured by at least one birth in the patient and the location of the fetus in the incomplete breech or transverse position.
2. Partly influencing factors for successful ECV are a pregnant woman with normal or overweight and FTI > 10 cm, localization of the placenta in the posterior wall of the uterus, fetal without pathologies and umbilical cord wrap around the neck.
3. The most common reasons for unsuccessful external fetal cephalic version were strong fetal fixation in the small pelvis, relative dehydration, fetal immobility, and pain during manipulation.
4. Women with successful external fetal cephalic version have a longer gestational time on the day of birth and the average number of days from the day of manipulation to childbirth; spontaneous vaginal or induced vaginal births are more common, birth complications are more common and neonates were more likely to have an intensive care.
5. The most important reasons for acute caesarean section after successful manipulation are primary uterine dysfunction, acute fetal distress and secondary uterine dysfunction. The risk of an acute caesarean section in the front of the head is 8%.
6. Successful external fetal cephalic version reduces the risk of caesarean section by 91.8%.

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DEPRESSION, BIPOLAR AND ANXIETY DISORDERS AMONG LYME DISEASE PATIENTS IN LATVIA

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Abstract

Depression, bipolar and anxiety disorders among lyme disease patients in Latvia

Key Words: *Borreliosis, borrelia, Lyme disease, depression, anxiety, cysts, round bodies, biofilms*

Background. Lyme disease or Borreliosis is tick-borne disease widespread all around the world. Latvia as a part of North Europe is located in the main endemic area.

Objective. The aim of the study was to evaluate a mental health of Borreliosis patients.

Materials and methods. Cross-sectional study was conducted in Lyme disease support group in Facebook. 223 respondents filled out the questionnaire. The answers were collected using Google survey functionality and data was statistically analysed in IBM SPSS Statistics 22. The questionnaire has been adapted from M.D. Robert Bransfield's "The Neuropsychiatric Assessment of Lyme Disease" assessment form (Bransfield 2018). Respondents filled 6-point (0 – no symptoms, 5 – max symptoms) or 2-point (yes, no) Likert scale of ordinal data.

Results. The questionnaire has been filled by 192 women (86.1%) and 31 men (13.9%). Mean age = 43.6; SD = 11.58; Min = 18; Max = 72 years. There was a serious tendency among respondents to gravitate towards positive answer in depression scale (Median = 3.00, $n = 48$, 21.5%) and the same tendency was explorable for bipolar disorder (Median = 3.00, $n = 46$, 20.6%), the same pattern described data with lesser extent in Obsessive compulsive disorder (OCD) scale (Median = 2.00, $n = 49$, 22%) and for General anxiety disorder (GAD) (Median = 2.00, $n = 38$, 17%). There was a statistically significant ($p = 0.01$) non-parametric Spearman's rho correlation between depression and bipolar disorder ($r = 0.687$) and even higher between OCD and GAD ($r = 0.713$).

Conclusions. Depression, bipolar disorder, OCD and GAD are common in the sample group of Lyme disease patients in Latvia. The statistical tests showed high comorbidity between bipolar disorder and depression and between OCD and GAD. The broader investigation of mental spectrum disorders is advisable among Lyme disease patients.

Kopsavilkums

Depresija, bipolāri traucējumi un trauksmes spektra traucējumi starp Laimas slimības pacientiem Latvijā

Atslēgvārdi: *Boreliozē, borēlija, Laimas slimība, depresija, trauksme, cistas, apaļās formas, biofilmas*

Ievads: Laimas slimība jeb boreliozē ir ērcu pārnēsāta slimība, kas ir izplatīta visa pasaulē. Latvija ir Ziemeļeiropas daļa, kura lokalizējas galvenajā endēmiskajā zonā.

Mērķis: Pētījuma mērķis bija izvērtēt boreliozes pacientu mentālo veselību.

Metodes: Pētījumam bija šķērsgriezuma dizains, kas norisinājās aptaujas formā Laimas slimnieku atbalsta grupā Facebook vietnē. 223 respondenti aizpildīja aptauju. Atbildes tika savāktas izmantojot Google aptaujas funkcionalitāti un dati tika statistiski apstrādāti IBM SPSS Statistics 22. Aptauja tika adoptēta no Dr. Roberta Bransfielda aptaujas formas (Bransfield 2018). Aptaujas dalībnieki aizpildīja 6 punktu (0 – nav simptomu, 5 – maksimālie simptomi) vai 2 punktu (0 – nē, 1 – jā) Likerta ordinālo datu skalu.

Rezultāti: Aptauju aizpildīja 192 sievietes (86.1%) un 31 vīrietis (13.9%). Vidējais vecums 43.6 gadi, standartnovirze 11.58 gadi, minimālais vecums 18 gadi, maksimālais vecums 72 gadi. Depresijas simptomu skalā bija vērojama nopietna tendence atbildēm sliekties uz pozitīvo pusi (Median = 3.00, $n = 48$, 21.5%) un līdzīga tendence tika novērota starp bipolāriem traucējumu simptomiem (Median = 3.00, $n = 46$, 20.6%), ar nedaudz zemāku pozitīvo atbilžu dominanci izpaudās obsesīvi kompulsīvo traucējumu atbildes (Median = 2.00, $n = 49$, 22%) un ģeneralizētas vispārējas trauksmes atbildes (Median = 2.00, $n = 38$, 17%). Starp depresijas un bipolāro traucējumu simptomiem tika novērota statistiski ticama ($p = 0.01$) cieša Spīrmana korelācija ($r = 0.687$) un vēl ciešāka starp obsesīvi kompulsīvu traucējumu simptomiem un vispārējas trauksmes simptomiem ($r = 0.713$).

Secinājumi: Depresijas, bipolāro traucējumu, obsesīvi kompulsīvo traucējumu un ģeneralizētas vispārējas trauksmes simptomi ir vispārīzplatīti Laimas slimības slimnieku vidū. Statistiskie testi uzrādīja augstu komorbiditāti starp bipolāriem traucējumiem un depresiju un starp obsesīvi kompulsīviem traucējumiem un ģeneralizētu vispārēju trauksmi. Plašāka spektra pētījumi starp Laimas slimības pacientiem ir vēlami.

Introduction

The clinical symptoms of Lyme disease manifest as a multisystemic inflammation affecting various tissue forms that in its early (localized) stage mainly affects the skin, and in later

disseminated or persistent stages affects the joints, nervous system, and, to a lesser extent, the heart, muscles, or other organs (Zimering et al. 2014). By increasing numbers of patients facing ongoing or relapsing symptoms, Lyme disease has emerged as the most common vector-borne disease in the United States and Europe (Johnson et al. 2014). Every year 300 000 new cases appear in the United States and 500 000 in Europe and the most dramatic tendency is an unknown number of unreported cases, Lyme disease has been acknowledged as a significant health issue (Stricker and Johnson 2013).

Borrelia spirochetes, which are motile and able to survive in various conditions, transform upon harsh and hectic environmental changes into latent forms, undergoing at the same time genotypic and phenotypic changes (Brorson et al. 2009). In such forms, they can survive even decades corrupting and evading the host immune system (Miklossy et al. 2008). Latent rounded forms are living forms with a low metabolic rate. Unlike spirochetes, they are not motile, but they can transform back to the living form and induce inflammation with symptomatic manifestation. They are morphologically diverted into granular form (dot-like spirochetes), cell wall deficient (CWD) form (spheroplast, L-form, bleb-like spirochete), or cystic form (round body/form) (Sapi et al. 2011). Biofilm, on the other hand, is a thin-layered agglomerate of bacteria covered with self-produced extra-polysaccharide substance (EPS) usually called as alginate formed for protection from severe and harsh conditions. Biofilm may contain a heterogeneous population of spirochetes and rounded forms with distinct genetic and protein profiles. *Borrelia* in the biofilm is much more difficult to eliminate as well and can be even up to 1,000 times more resistant to antibiotics because of limitation in their distribution and dissemination (Sapi et al. 2012).

Lyme disease is a multifactorial systemic disease causing a debilitating condition in different organ groups depending on individual tissue tropism (Sapi et al. 2012). The neuropsychiatric aspects of Lyme disease have not yet investigated in Latvia. It is important to identify the broad spectrum of neuropsychiatric symptoms to explore the current situation in Latvia. Neuropsychiatric disturbances are not well recognised in Latvia among Lyme disease patients, they affect patient's mood, cognition and social interactions.

Aim

To investigate and identify neuropsychiatric aspects among Lyme disease patients, conducting an anonymous survey to find out how many Lyme disease patients suffer from disorders and what their characteristics are. To fulfill the aim the four consecutive tasks have been carried out:

- To overview borreliosis patients
- To identify and characterise spectrum of neuropsychiatric symptoms
- To determine correlations among mood disorders, anxiety disorders, cognition and social functioning

- To determine foundation symptoms and to clarify whether there are group differences among these symptoms depending on the factors like sex, known/unknown infection time and noticed/unnoticed erythema migrans.

Materials and methods

Cross-sectional study was conducted in Lyme disease support group in Facebook. 223 respondents filled out the questionnaire. The answers were collected using google survey functionality and data was statistically analysed in IBM SPSS Statistics 22. The questionnaire has been adapted from M.D. Robert Bransfield's "The Neuropsychiatric Assessment of Lyme Disease" assessment form. Respondents filled 6-point (0 – no symptoms, 5 – max symptoms) or 2-point (yes, no) Likert scale of ordinal data. Statistical significance level is $p < 0.05$

Results

The survey was completed by 192 women (86.1%) and 31 men (13.9%). Mean age is 43.6, SD = 11.58; Min = 18; Max = 72 years There is serious tendency among responders to gravitate towards positive answer in depression scale (Median = 3.0, n = 48, 21.5%), and the same tendency is explorable for bipolar disorder (Median = 3.0, n = 46, 20.6%). There was a statistically significant ($p < 0.01$) Spearman $r_s = 0.69$ correlation between these two symptoms. There was a more equal distribution in the spectrum of obsessive-compulsive disorder (Median = 2.0 n = 49, 22%) and general anxiety disorder (Median = 2.0, n = 38, 17%). There was an even closer Spearman $r_s = 0.71$ correlation between these sets of symptoms. A similar picture was observed in relation to reduced social functioning (median = 3.0, n = 39, 17.5%), which was closely correlated with lowered performance at school / university ($r_s = 0.698$), a moderate correlation was observed between several mental symptoms ($r_s = 0.54 - 0.57$) social phobia, loss of control, slowness, weakness and inaccuracy regarding thinking and depression.

Discussion

Table 1 shows a comparison between my survey and Dr. Robert Bransfield's investigation – a leading American research psychiatrist in the field of disseminated borreliosis. The Bransfield's study was a retrospective study of 100 Lyme disease case histories selected in 2 groups of 50 patients, 50 aggressive and 50 non-aggressive (Bransfield 2018). 44% of patients were male and 56% – female, age (mean = 42, min. = 8, max = 67), median time to diagnosis and treatment was around 8 years (92% patients were misdiagnosed).

Depression In the Bransfield study was 87% of patients, and the results of my research survey showed a lower prevalence of overall depressive symptoms – 52.5%. This can be explained by the fact that in the Facebook survey, patients may have had an easier course and duration of the disease. At the same time, Bransfield's study mainly addresses late forms of neuroborreliosis. Interestingly, in Latvia depression was accompanied by an increase in anger, aggression, eruptions – 54.2%,

which could indicate a type of agitated depression, as well as accompanying eating disorders – overeating (48%), weight gain with increased eating (46.8%) and disruption in circadian rhythm (40.5%).

Bipolar disorder is also almost twice as common in the Bransfield study, which is also due to more severe cases and the inclusion of aggressive patients in the study which have much more severe psychic symptoms. Decreased social functioning is an issue that is only 10 percent lower in the Facebook group (54.7%), which could be explained by the fact that moderate depressive episodes can reduce social functioning in the same way as depersonalization, which in the Bransfield study is almost 2.5 times higher than in a Facebook study.

Generalized anxiety disorder is 20 percent higher in the Bransfield study (68%), suggesting that anxiety disorders are also a severe problem for Facebook participants who can be addressed with adequate psychiatric treatment and antibacterial therapy to eradicate the etiological causative agent *B. burgdorferi*.

Table 1. Comparison between the author’s investigation and Dr. Bransfield’s

	Prevalence %	
	Bransfield’s research (n=100)	Author’s research (n=223)
Depression	87	52.5
Bipolar disorder	80	44
Decreased social functioning	64	54.7
General anxiety disorder	68	48.5
Obsessive-compulsive disorder	42	35.7
Post traumatic stress disorder	30	34.4
Addictions	22	24.3
Legal problems	23	7.5
Dissociative episodes	25	16.8
Derealization	31	24.6
Depersonalization	62	26.9
Aggressive intrusive thoughts	39	24.5
Paranoia	62	47.6
Hypervigilance	69	63.4
Nightmares	70	44.4
Suicidal thoughts	72	26.9

Quite similar rates (+ -6%) were found in other anxiety spectrum disorders – obsessive compulsive-disorder, post-traumatic stress disorder, hypervigilance, and also addictions, which is a sign of an indirect way how to mitigate anxiety spectrum disorders.

The Branfield study showed 3 times higher rate in deviant behaviour – problems with the law (23%). Dissociative episodes and derealization were only slightly higher in the Bransfield study. As

the Bransfield study included 50 participants (half) from the study with particularly aggressive events (some had committed murders), aggressive thoughts of an intrusive nature are almost twice as high as in the Facebook group (24.5%). Although only ¼ patients suffer from aggressively obsessive thoughts, I believe that this is a high indicator in the Latvian population as well.

The prevalence of paranoia and nightmares are also higher in the Bransfield study leaving 44–47% slightly behind for Latvian population.

The rates of suicidal thoughts are almost 3 times lower in the Facebook group, which indicates that depression does not go as badly as in the patients included in the Bransfield study.

In general, there is a tendency for neuropsychiatric symptoms to be more severe in the Bransfield study, where different pathophysiological pathways may be involved while Facebook may have a predominant inflammatory process related to cytokine cascades outside of CNS. There may be a sufficient explanation to justify the fact that the results in some areas are almost equivalent. This topic should be explored further in the future.

Of course, the area of aggressive thoughts and problems with the law is dominated by the Bransfield study, which also provided a compelling explanation that particularly aggressive states with murderous tendencies are explained by metabolic cascades of pathophysiology involving co-infection *T.Gondii* (Bransfield 2018), which would open another exciting aspect – Lyme disease co-infections in the Latvian population.

Conclusions

Depression of various intensities prevailed in 51.7% of respondents, bipolar disorder – 50.1%, obsessive-compulsive disorder – in 35.4% of respondents, general anxiety disorder in 48.2%, lowered social performance in 54.4% of respondents. Among all psychiatric symptoms depression had the highest prevalence of 2.4% before onset of borreliosis. Thus, it can be concluded that a large number of patients have acquired debilitating psychiatric illnesses during the course of Lyme disease, which etiological factor is *B. Burgdorferi* or a complication resulting from the illness. The treatment results depend on the timely involvement of a psychiatrist.

There was a strong correlation ($r_s > 0.6$) between depression and bipolar disorder, general anxiety disorder and obsessive-compulsive disorder, suggesting a spectrum of comorbidity tendencies worth considering for a patient examination in an endemic area. It must be acknowledged that the same pattern of comorbidities can occur with other neuroinfections that would give a similar bio-signature.

There were statistically significant differences ($p < 0.05$) in the answers between men and women in the questions about peripheral vision, sudden mood swings, crying and a headache, in all four questions women showed higher mean ranking scores.

Sleep as an important preventive condition of mood disorders is disturbed in 75.3% of respondents who do not feel awake / rested during the day. The Mann-Whitney U test with conditionally divided groups (known infection time, unknown infection time) and (noticed *erythema migrans* or undetected *erythema migrans*) revealed an interesting fact that in both cases there is statistically significant ($p < 0.05$) difference between the groups directly in the question “Do you have vivid nightmares”, showing a higher mean rank in the group with unknown time of infection or undetected erythema migrans.

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RARE CASE OF ASYMPTOMATIC CUTANEOUS LEIOMYOMATOSIS IN 65-YEAR-OLD PATIENT

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Abstract

Rare case of asymptomatic cutaneous leiomyomatosis in 65-year-old patient

Key Words: dermatology, leiomyomatosis, smooth muscle, tumor, leiomyoma cutis

Introduction. Cutaneous leiomyomas are rare solitary or multiple benign intradermal neoplasms arising from smooth muscle cells in adolescence or early adulthood. Multiple leiomyomas appear as superficial firm papules or nodules that form clusters in linear or dermatomal distribution. Majority of leiomyomatosis patients have fumarate hydratase gene mutation associated with early-onset cutaneous and uterine lesions (Reed's syndrome) and early-onset renal cell cancer. Over time cutaneous leiomyomas may develop painful paroxysms that appear spontaneously or are induced by physical or emotional stimuli. Leiomyomatosis should be differentiated from a broad spectrum of benign and malignant lesions such as leiomyosarcoma and cutaneous metastases.

Case description. A 65-year-old woman presented to the dermatologist's office with a 10-year history of slowly growing, painless, firm lump on her left breast. Patient's medical history was not significant except breast augmentation surgery 30 years ago. On examination solid, nodular, well-demarcated, painless tissue mass, approximately 1.5 cm in diameter was seen on the left breast and multiple small nodules of similar structure arranged in zosteriform distribution were seen on patients left trunk and back. An excisional biopsy was performed with histopathological findings consistent with the suspected clinical diagnosis of leiomyomatosis.

Conclusions. Excisional biopsy is relatively safe treatment method for solitary lesions, however gradual increase in tumor size and quantity can lead to disfiguring appearance of the skin and declining surgical treatment efficacy.

Summary. This report presents a rare case of an asymptomatic patient with multiple cutaneous leiomyomas. Thorough evaluation (genetic testing, gynaecological examination and renal imaging) needs to be performed in order to exclude Reed's syndrome and hereditary leiomyomatosis and renal cell cancer.

Kopsavilkums

Rets asimptomātiskas ādas leiomiomatozes klīniskais gadījums 65 gadus vecai pacientei

Atslēgvārdi: dermatoloģija, leiomiomatoze, gludā muskulatūra, audzējs, ādas leiomioma

Ievads. Ādas leiomiomas ir reti solitāri vai multipli labdabīgi intradermāli jaunveidojumi, kas veidojas no gludās muskulatūras šūnām pusaudžu vai agrīnā pieaugušo vecumā. Multiplu leiomiomu gadījumā redzamas virspusējas, cietas papulas vai mezgliņi, kas veido klasterus lineārā vai dermatomālā izvietojumā. Lielākajai leiomiomatozes pacientu daļai tiek atrasta fumarāta hidratāzes gēna mutācija, kas saistīta ar agrīna sākuma ādas un dzemdes veidojumiem (Rīda sindroms) un agrīna sākuma nieru šūnu vēzi. Laika gaitā ādas leiomiomas var dot klīnisko simptomātiku sāpīgu paroksismu veidā, kuri rodas spontāni vai kurus inducē dažādi fizikāli vai emocionāli stimuli. Leiomiomatozi ir nepieciešams diferencēt no plaša labdabīgu un ļaundabīgu veidojumu spektra, par piemēru minot leiomiosarkomu un ļaundabīgu audzēju ādas metastāzes.

Klīniskā gadījuma apraksts. 65 gadus veca sieviete vērsusies dermatoloģijas klīnikā ar sūdzībām par lēni augošu, nesāpīgu, blīvu veidojumu uz kreisās krūts pēdējo 10 gadu laikā. Citādi pacientes anamnēze bez patoloģijas, tomēr zināms, ka pirms 30 gadiem pacientei veikta krūšu palielināšanas operācija. Objektīvajā apskatē redzama solida, nodulāra, labi norobežota, nesāpīga audu masa, ap 1,5 cm diametrā uz kreisās krūts, kā arī multipli līdzīgas struktūras sīki mezgliņi, kas novietojas zosteriformi uz pacientes rumpja kreisās puses un muguras. Tika veikta veidojuma ekscīzijas biopsija ar klīniskajai ainai atbilstošu histopatoloģisko atradni, apstiprinot leiomiomatozes klīnisko diagnozi.

Secinājumi. Ekscīzijas biopsija ir relatīvi droša solitāru veidojumu ārstēšanas metode, tomēr pakāpeniska veidojuma augšana un multiplu veidojumu parādīšanās var novest pie kroplojoša ādas izskata un mazināt ķirurģiskās ārstēšanas efektivitāti.

Kopsavilkums. Dotais ziņojums apraksta retu klīnisko gadījumu asimptomātiskai pacientei ar multiplām ādas leiomiomām. Rīda sindroma un hereditāras leiomiomatozes un nieru šūnu vēža diferenciāldiagnostikai nepieciešams veikt rūpīgu un vispusēju pacientu izvērtēšanu, kas sevī ietver ģenētisko testēšanu, ginekoloģisko izmeklēšanu un nieru izmeklēšanu ar attēldiagnostikas metodēm.

Introduction

Cutaneous leiomyomas are relatively uncommon (5% of all leiomyomas) solitary or multiple benign dermal based smooth muscle cell tumors that occur equally in both men and women of all races with onset mainly during the second or third decade of life (Anderson, 2012; Kudur, 2013; Palle and Mancini, 2016; Patterson, 2021). Three main types of cutaneous leiomyomas can be distinguished: pilar (nevoid or hamartomatous) leiomyoma, solitary angioleiomyoma and genital leiomyoma arising from m. arrector pili, the media of blood vessels and smooth muscles of genital skin and nipples accordingly (Billings, 2018).

Clinically leiomyomas manifest as circumscribed, nonencapsulated, firm, papules or nodules with hyperpigmentation or red-brown or pearly color of overlying skin (Anderson, 2012; Müller and Kutzner, 2019; Palle and Mancini, 2016). Multiple lesions accounting up to several hundred can disseminate or arrange in blaschkoid, segmental or zosteriform pattern giving the skin cosmetically disfiguring appearance with formation of large plaques (Anderson, 2012; Kudur, 2013; Müller and Kutzner, 2019).

Dermatoscopic features of leiomyoma include central hypopigmentation with pigment network on the periphery with some lesions showing hyperpigmented structure inside the central part of the lesion (Patterson, 2021).

Although leiomyomas can occur anywhere main predilection sites include trunk, extensor surfaces of the extremities, face, and neck (Anderson, 2012; Kudur, 2013).

Cutaneous leiomyomas, mainly solitary piloleiomyomas can be asymptomatic, they are rarely painful thus remaining undiagnosed for a long time (Müller and Kutzner, 2019; Patterson, 2021). However, they can become painful with paroxysmal, spontaneous pain or pain induced by cold, tactile or emotional stimuli being considered characteristic symptom in patients with multiple leiomyomas (Kudur, 2013) in turn rubbing of the lesion can provoke twitch or fasciculation known as pseudo-Darier's sign (Anderson, 2012). Pathogenesis of pain is not completely understood, however local pressure, muscle contraction with activation of sympathetic nervous system and influx of calcium ions has been proposed as possible causes (Kudur, 2013).

Size of leiomyomas can vary from 1 to 2 cm in diameter with solitary lesions being slightly larger than multiple reaching size even bigger than 2 cm in diameter (Anderson, 2012; Müller and Kutzner, 2019). Vulvar and scrotal tumors usually are bigger measuring up to 5 cm and 14 cm in diameter accordingly (Müller and Kutzner, 2019).

Both solitary and multiple lesions can be associated with underlying heterozygous mutation in the Krebs cycle protein fumarate hydratase gene located in chromosome 1q42.3-43 with an autosomal dominant pattern of inheritance; however more likely it is seen in multiple leiomyomatosis with detection rate 75 – 100% in affected patients (Anderson, 2012; Müller and

Kutzner, 2019; Walsh *et al.*, 2020; Menko *et al.*, 2014). Fumarate hydratase is mitochondrial enzyme that plays important role in aerobic metabolism. It is being known for converting fumarate to malate as well acting as tumor suppressor gene. Inactivation of enzyme leads to increase in intracellular fumarate concentration suppressing activity of hypoxia – inducible factor prolyl hydroxylase thus leading to increased hypoxia – inducible factor levels and disruption of normal endogenous metabolic pathways (Walsh *et al.*, 2020) thus playing an important role in induction of tumorigenesis and malignant transformation (Kulkarni *et al.*, 2019). Nevertheless increase in intracellular fumarate concentration causes upregulation of factors such as hypoxia-inducible factor and glucose transporter type 1 and changes in glucose and lactic acid metabolism. These findings show connection occurring between Krebs's cycle and oncogenesis however further researches need to be conducted (Linehan *et al.*, 2007).

Many types of mutations have been found thus being responsible for different manifestations of the disease (Anderson, 2012; Müller and Kutzner, 2019). In women cutaneous lesions seen in approximately 50% of patients are associated with early-onset uterine fibroids also known as Reed's syndrome with approximately 90% of women with known fumarate hydratase gene mutation having uterine leiomyomata (Kamihara, Schultz and Rana, 2006 [Updated 2020]) as well as early onset renal cell carcinoma also known as hereditary leiomyomatosis and renal cell cancer (Kudur, 2013; Müller and Kutzner, 2019). However, it is supposed that leiomyomas by itself have no or little malignancy potential (Müller and Kutzner, 2019).

Lesions that are not associated with underlying genetic conditions are pathogenetically connected with idiopathic proliferation of myocytes (Anderson, 2012). Mechanical stretching in large, saggy breasts has been proposed as possible factor in development of leiomyomas on the breast (Patterson, 2021).

Histopathology of the lesions show ill defined tumor located in the dermis with densely packed intersecting smooth muscle fascicles consisting of spindle cells with cigar-shaped nuclei surrounded by eosinophilic cytoplasm without connective tissue in the central parts of the lesion and with irregular mixing with the surrounding fibers and nearby pillar muscles. No signs of atypia, mitosis or necrosis is seen (Anderson, 2012; Billings, 2018; Müller and Kutzner, 2019).

In cutaneous lesions there are no characteristic histological features specific for patients with aforementioned fumarate hydratase gene mutation, however specific traits (eosinophilic macronucleoli, halos and cytoplasmic inclusions) have been found in uterine and renal lesions. In addition to this immunohistochemical marker 2-succinocysteine that forms as a consequence of altered fumarate metabolism has been found facilitating diagnostic of genetic conditions (Patterson, 2021).

Differential diagnosis includes a broad spectrum of benign and malignant intradermally localised lesions such as angioliipoma, dermatofibroma, smooth muscle hamartoma, dermal melanocytic nevus, leiomyosarcoma or metastases of tumors of different locations (Kudur, 2013; Müller and Kutzner, 2019). Clinical, dermatoscopic and histological evaluation with use of immunohistochemistry staining of the tissue sample can help differentiate between broad spectrum of conditions leading to correct diagnosis and treatment.

Surgical excision is considered treatment of choice for cutaneous lesions, especially for those being symptomatic or those being of cosmetic concern. Alternative therapy includes CO₂ laser ablation, cryotherapy, and electrosurgery (Müller and Kutzner, 2019). Nevertheless, conservative therapy using medications is available for the sake of alleviation of symptoms with alpha adrenoblockers being most frequently used. Use of gabapentin and botulinum toxin as well as calcium channel blocker nifedipine has also been reported (Anderson, 2012). However, in the case of multiple lesions, treatment becomes more challenging and high incidence of recurrence after surgical excision is seen (Palle and Mancini, 2016).

Substances with antitumor activity (bevacizumab, 17 – allylamino – 17 – desmethoxygeldanamycin and others) are being evaluated in treatment of hereditary leiomyomatosis and renal cell cancer syndrome targeting different metabolic pathways such as hypoxia – inducible factor and heat shock protein 90 accordingly that are being disrupted by genetically caused increase in intracellular fumarate concentration (Linehan *et al.*, 2007).

Combination of immunotherapy and targeted therapy was approved as a first – line treatment for patients presenting with advanced renal disease thus it needs to be taken into consideration also for hereditary leiomyomatosis and renal cell cancer syndrome patients. That is of great importance especially because patients with type 2 papillary renal cell carcinoma often are unresponsive to currently available treatment options such as chemotherapy, radiotherapy and immunotherapy (Feng *et al.*, 2020).

Case description

A 65-year old otherwise healthy woman presented to the dermatology clinic in November 2018 with complaints of a slowly growing, painless, firm lump located on her left breast, which firstly appeared 10 years ago. The patient had no other complaints.

Patient's medical history was not significant except breast augmentation surgery performed 30 years ago.

On examination solid, nodular, well-demarcated, painless tissue mass, approximately 1.5 cm in diameter was seen on the left breast. Multiple small nodules of similar structure arranged in zosteriform distribution were seen on patient's left trunk and back.

As for this patient an excisional biopsy was performed with histopathological evaluation of biopsy sample showing tumor with locally infiltrative growth consisting of smooth muscle fibers arranged in bundles, nuclei of the cells were without any signs of atypia, mitotic activity and necrosis – finding consistent with diagnosis of leiomyoma cutis.

At the follow-up visit in December 2018 no complications were observed.

Discussion

More than thirty different autosomal dominant germline mutations in fumarate hydratase gene (Linehan *et al.*, 2007) located in 1q42.3-q43 are known leading to development of different genetic syndromes such as Reed's syndrome manifesting as cutaneous and uterine lesions with low malignization rate of uterine leiomyomas as well as renal collecting duct carcinoma and type II papillary renal cell carcinoma. Specific G354R mutation is known for being responsible for predisposition to uterine lesions without skin involvement (Patterson, 2021).

Uterine leiomyomatosis usually is characterized by symptomatic lesions leading to hysterectomy in approximately one half of affected women before the third decade of life (Linehan *et al.*, 2007).

Aforementioned patient did not have any other complaints at the moment of presentation to dermatologist office; however common genetic defects in multiple leiomyomatosis patient makes it necessary to conduct a thorough systemic examination. Thus, early genetic screening may help reduce the risk of severe and potentially life-threatening disease (Anderson, 2012). It is estimated that lifetime risk of development of renal cancer in patients with deficient fumarate hydratase protein is approximately 15% (Müller and Kutzner, 2019). However, there is no evidence of correlation between type of certain fumarate hydratase gene mutation and lifetime tumorigenesis risk (Menko *et al.*, 2014). Prognosis for these patients tend to be poor because of them presenting to specialists office only on advanced stages of the disease (Netto and Epstein, 2019). In addition renal tumor in hereditary leiomyomatosis and renal cell cancer syndrome manifests itself extremely aggressive, with early spreading of the disease in comparison with renal cancer in other hereditary syndromes for example Von Hippel – Lindau, Birt – Hogg – Dubé and hereditary papillary renal carcinoma syndrome (Linehan *et al.*, 2007) with 10 – 16% of patients presenting at advanced stages of the disease (Müller and Kutzner, 2019) presenting with weight loss, back pain and hematuria with life expectancy not exceeding five years after the diagnosis is made in most of the patients (Feng *et al.*, 2020).

Genetic testing for fumarate hydratase gene mutation is recommended for all patients with multiple leiomyomas and especially when systemic involvement is present. Nevertheless, a regular screening for systemic involvement is indicated for all patients with already diagnosed fumarate hydratase gene mutation with computed tomography and magnetic resonance imaging being

advised for renal and uterine lesions accordingly (Walsh *et al.*, 2020). Chest and abdominal computed tomography scan needs to be performed in order to exclude metastatic disease (Feng *et al.*, 2020).

Multidisciplinary approach involving dermatologist and other healthcare professionals is essential in providing thorough examination of patients state of health with use of the best possible treatment options thus improving outcomes and quality of life (Adams *et al.*, 2017).

Conclusions

Cutaneous leiomyomatosis is considered being benign skin condition with intradermal smooth muscle proliferation in different body sites of the patient; however possible systemic involvement needs to be kept in mind by every healthcare professional dealing with leiomyomatosis patient. It is important to take into account all of complaints patient is having when presenting to specialist office and to perform thorough systemic examination as well as genetic testing if any signs of systemic involvement are seen especially in patients with multiple lesions.

Excisional biopsy is relatively safe treatment method for solitary lesions; however gradual increase in tumor size and quantity can lead to disfiguring appearance of the skin, declining surgical treatment efficacy and need to use less efficient, symptomatic treatment options.

Summary

This case report presents a rare case of an asymptomatic patient with multiple cutaneous leiomyomas. Thorough evaluation (genetic testing, gynecological examination and renal imaging) needs to be performed in order to exclude Reed's syndrome and hereditary leiomyomatosis and renal cell cancer because of aggressive nature and poor prognosis in patients with fumarate hydratase gene mutation related genetic syndromes.

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THE PREVALENCE OF MUSCULOSKELETAL PAIN AMONG IT AND COMPUTER SCIENCE STUDENTS

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Abstract

The prevalence of musculoskeletal pain among IT and computer science students

Key Words: *musculoskeletal pain, students, ergonomic factors, IT workers*

Introduction: Although computers ease everyday life, the use of it is accompanied by risk factors, like, repetitive movements, prolonged sitting in awkward and static postures, that can contribute to the occurrence of musculoskeletal disorders. IT and computer science students may be at greater risk for the development of musculoskeletal symptoms due to the intensive computer use that takes an essential part of their studies.

Aim: To assess the prevalence of musculoskeletal pain among computer science and IT students.

Materials and methods: This cross-sectional study was conducted using an anonymous online questionnaire. Analysis of data was performed using the Microsoft Excel and SPSS version 20 programs.

Results: The highest prevalence of pain, which was associated with computer use was in the neck region 48% (N=72), back 59% (N=89), where the frequency of pain in the lower back and upper back was respectively 35% and 42%. According to the upper limb pain was reported by 59% (N=89), the most affected regions were the wrist and hands (36,7%) and shoulders 31%. The least common reported body area of pain was lower extremities (15%).

Conclusion: Overall, 87,3% of students reported experiencing musculoskeletal pain in at least one body part.

Kopsavilkums

Muskuloskeletālo sāpju izplatība IT un datorzinātnes studentu vidū

Atslēgvārdi: *muskuloskeletālas sāpes, studenti, ergonomiskie faktori, IT nodarbinātie*

Ievads: Lai arī dators atvieglo ikdienu, tā lietošana ir saistīta ar tādiem riska faktoriem, kā atkārtotas kustības, ilgstoša sēdēšana neērtās un statiskās pozās, kas ilgtermiņā var veicināt muskuloskeletālo slimību attīstību. IT un datorzinātņu studenti iespējams ir pakļauti lielākam muskuloskeletālās sistēmas simptomu un traucējumu riskam, intensīvākas datora lietošanas dēļ, kas saistīta ar studiju specifiku.

Mērķi: Izpētīt muskuloskeletālo sāpju prevalenci datorzinātņu un IT studentu vidū.

Materiāli un metodes: Šķērsgriezuma pētījuma dati tika savākti izmantojot anonīmu tiešsaistes anketa. Datu analīze tika veikta, izmantojot Microsoft Excel un SPSS 20 programmas.

Rezultāti: Visaugstākā sāpes izplatība, kas saistīta ar datora lietošanu, bija kakla rajonā – 48% (N = 72), muguras – 59% (N = 89). Sāpju biežums muguras lejasdaļā bija 42%, savukārt muguras augšdaļā 35%, augšējās ekstremitātēs 59% (N = 89), īpaši plaukstu locītavās un plaukstās (36,7%) un plecu joslā (31%). Visretāk pētījuma dalībnieki izjuta sāpes apakšējās ekstremitātēs (15%).

Secinājumi: Kopumā 87,3% no studentiem izjūt sāpes vismaz kādā no ķermeņa daļām.

Introduction

Musculoskeletal pain (MSP) represents a widespread issue with a significant impact on the quality of life; in addition, it is one of the most frequent work-related problem across Europe (Eurofound 2017). Additionally, there is a significant impact on social and health care systems with notable economic loss. According to OSHA data on compensations for work-related musculoskeletal disorders, employers spend approximately \$20 billion per year not taking into account indirect costs which could make up to five times more than direct (OSHA 2014). The MSP aetiology possesses a multifactorial nature including individual features and psychosocial factors, work organizational and environmental conditions. Exposure to certain occupational risk factors is a significant promoter to the development of the disorders. Work on a computer includes risk factors that can contribute to an occurrence of pain, like repetitive movements for the forearm, wrist, and

finger areas and prolonged sitting in an abnormal and static posture more for the neck, back, shoulder, and elbow regions (Cho 2012). During the last decade, the field of IT has grown tremendously, and it only continues to grow so do demands for specialists; according Taulbee Survey between the year 2006 and 2015 the number of undergraduates majoring in computer science has increased by 291% (National Academies of Sciences, Engineering, and Medicine 2017: 57). As IT and computer science (CS) studies requires intensive work on the computer they might be at the greater risk for earlier musculoskeletal pain development. Therefore, the aim of the study was to assess the prevalence of musculoskeletal pain among CS and IT students.

Materials and methods.

This was a cross-sectional study where target population was students of IT and CS programs without the history of experiencing a musculoskeletal injury, trauma, disorder or operation within the past years before the study. Study was conducted using anonymous online questionnaire, which contained questions about demographic data, computer use and musculoskeletal pain existence. Further on all data was collected and analyzed via MS Excel and SPSS 20 programs. Due to the low number of participants, the factors with continuous data were dichotomized for statistical analysis. Logistic regression test was used to determine an association between MSP and individual factors. The level of statistical significance was set at $P < 0.05$

Results

Final study included 150 IT and CS students, there was predominance of right-handed (88%) participants. Of all students 68% (N=102) were male and 32% (N=48) were women. Median age of participants was 22,8 years (range 18–42). Regarding students' physical state 65,3% of respondents were within normal weight, 25,3% overweight and 6% obese. Study estimates that 38% of participants were doing sports one to two times per week, while 34,7% reported not doing sport at all.

The mean duration of computer use among the students was 8,89 hours (range 2–16h), 14,7% (N=22) of students admitted that averagely use computers less than six hours, while majority 85,3% (N=128) reported that work on the computer for more than six hours. The rest break for at least once in two hours was taken by 66% (N=99) of participants. Also, sixty-six percent of participants reported that take a rest break for five to ten minutes.

Overall, 87,3% students (93,8% of women and 84,3% of men) reported to experience MSP in at least one body part. The highest prevalence of pain, which was associated with computer use was in the neck region 48% (N=72), back 59% (N=89), where the frequency of pain in the lower back and upper back was respectively 35% and 42%. According to upper limb, pain was reported by 59% (N=89), the most affected regions were the wrist and hands (36,7%) and shoulders 31% (Figure1). Also, there wasn't any association found between the dominant hand and side of the affected upper

limb, as in most of the time students reported of having pain in the both sides. The least common reported body area of pain was lower extremities (15%). Forty-nine percent of students experienced pain three and more times weekly, where only 3,4% has pain daily.

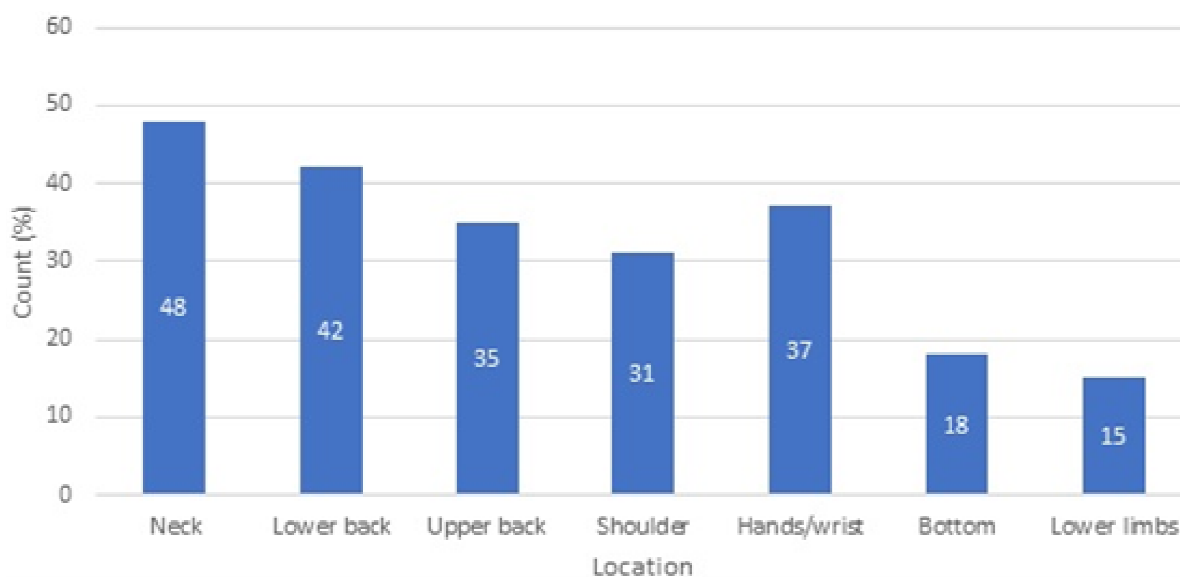


Figure 1. Musculoskeletal pain prevalence

This study found that there is significant association between female gender and MSP, particularly in the neck, *bottom, lower back (p<0.001) and shoulder, hands/finger (p<0.05)*. *Study also found association between being physically inactive and neck and lower back pain (p<0.02)*. For lower back pain was found association with break duration less than 6 minutes (p<0.02) and computer work duration without brakes more than for two hours (p<0.03).

Discussion

The study supported previous literature about the high prevalence of musculoskeletal pain among university students (Jenkins et al., 2007; Menéndez et al., 2009; Schlossberg et al., 2004). In this study the overall prevalence of computer-related pain was high – 87,3%. Several risk factors seem to be associated with the frequency and extent of MS in the neck and back. This Study data suggested that being female, being physically inactive and working with computers more than 2 h without break has a significant risk factor. There wasn't obtained significant difference between pain occurrence and type of the used computer, BMI and age.

This study was limited by its cross-sectional design as the reliability of information relies heavily on memory and the answers may be subjective. We cannot exclude the possibility if the self-reported physical discomfort, if actually related to computer use, has any etiological significance in terms of musculoskeletal pain, although exclusion factors were used cannot be ruled out health conditions about which participants wasn't aware. Nor did we collect detailed

information about activities outside studies, except exercising, and ergonomic risk factors and mental health of participants that might have contributed to symptoms. As other research has shown association between psychological distress (e.g. anxiety, depression, and high levels of stress) and increased pain development (Oha et al. 2014; Vargas-Prada et al., 2015). Additional large prospective longitudinal research is essential to increase basic understanding.

Nevertheless, majority of students 72,3% at the time when study was conducted estimated pain as slight and in 55,6% pain lasted less than for 30 min further exposure may presage future problems. Reduction occurrence of the MSP and therefore improving quality of life is important among prospective computer professionals and overall population. It's essential to increase awareness about computer-related musculoskeletal risks starting from younger pupils of primary school, as later literature report that millennial uses visual unit devices from a young age, becoming more sedentary and screen-oriented, what in perspective may lead to an increased rate of musculoskeletal problems (Owen et al. 2010). Interventions to consider include effective educational training in proper work behavior, such as adequate posture maintenance and rest break taking coupled with ergonomic workstation setup and appropriate equipment available (e.g., adjustable furniture and ergonomic keyboards and mouse) (Mani 2018).

Conclusions

MSP was prevalent in studied IT and CS students. Overall, 87,3% of students reported experiencing MSP in at least one body part. Pain was experienced mostly in the neck and lower back region. Pain significantly affects life quality, therefore, the high prevalence of pain reported by students suggests identifying preventive measures that will reduce symptom occurrence and worsening.

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DIGITAL EYE STRAIN: PREVALENCE OF SYMPTOMS AND ITS ASSOCIATED FACTORS

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Abstract

Digital Eye Strain: Prevalence of Symptoms and Its Associated Factors

Key Words: digital eye strain, computer vision syndrome, duration of computer use, ocular symptoms

Objectives. Computers and other visual display devices have become an essential part of our daily life. It's estimated that at the end of 2019, 53,6% of the global population used the Internet. With the increased use, digital eye strain has become an important occupational health problem of the 21st century. The aim of this study was to define the prevalence of digital eye strain among computer users and explore its association with duration of computer use, workstation arrangement and other factors.

Materials and methods. The study design is a cross-sectional study. The data was gathered using the structured questionnaire based on Computer Vision Syndrome Questionnaire and VSP Computer Vision Questionnaire. Chi-square test, Mann-Whitney U test and probit regression were used to determine the association between two variables. Data analysis was performed using IBM SPSS Statistics 22 and MS Excel.

Results. A total of 247 subjects participated in this study. Dryness, headache and blurred vision were the most common reported symptoms of CVS with prevalence of 73,3%, 72,9%, and 70,4%, respectively. Females were found to be at a higher risk for development of burning sensation, ($p=0,008$), headache ($p=0,017$), dry eyes ($p=0,026$) and coloured halos around objects ($p=0,034$). Burning sensation was strongly associated with duration of computer use ($p=0,036$) and each hour of computer use increased the prevalence of the symptom by 3,8%.

Conclusion. High prevalence of vision and ocular related symptoms were noted among participants. Factors such as mean duration of daily computer use, pre-existing eye disease, taking breaks, workstation arrangement were not significantly associated with the prevalence of CVS or its severity. Females were at a higher risk for development of digital eye strain, however, further studies are needed to determine factors associated with digital eye strain.

Kopsavilkums

Digitālā acu spriedze: simptomu izplatība un ar to saistītie faktori

Atslēgvārdi: digitālais acu sasprindzinājums, datora redzes sindroms, okulārie simptomi, datora lietošanas ilgums

Ievads: Datora un citu vizuālo displeju lietošana ir kļuvusi par būtisku mūsdienu dzīves sastāvdaļu. Tiek lēsts, ka 2019. gadā 53,6% pasaules iedzīvotāju izmantoja internetu. Pieaugot digitālo ekrānu izmantošanai, digitālais acu sasprindzums ir kļuvusi par nozīmīgu 21. gadsimta darba vides problēmu.

Mērķis: Noteikt datora redzes sindroma prevalenci vizuālo displeju termināļu (VDT) lietotāju vidū un izpētīt tādu faktoru, kā vecuma, dzimuma, VDT lietošanas ilguma, jau esošas acu slimības, ekrāna spilgtuma, kontaktlēcņu lietošanas un darba stacijas iekārtojuma, ietekmi uz datora redzes sindroma attīstību.

Metodes: Šķērsriezuma pētījums, kas veikts, izmantojot strukturētu anketu, par pamatu ņemot datora redzes sindroma anketu (*Computer Vision Syndrome Questionnaire*) un VSP datora redzes anketu (*VSP Computer Vision Questionnaire*). Saistība starp datora redzes sindromu un ar to asociētajiem faktoriem tika noteikta, izmantojot chi-square testu, Mann-Whitney U testu un probit regresiju. Datu apstrāde veikta ar SPSS 20.0 un MS Excel.

Rezultāti: Starp 247 VDT lietotāju datora redzes sindroma (DRS) prevalence bija 74,9%. Biežāk novērotie simptomi bija sausuma sajūtu acīs (73,3%), galvassāpes (72,9%) un miglaina redze (70,4%). Galvassāpju ($p=0,017$), halo zonas ap objektiem ($p=0,034$), sausuma sajūtas acīs ($p=0,026$) un acu dedzināšanas ($p=0,008$) prevalence bija augstāka sievietes vidū, parādot statistiski nozīmīgu saistību starp sievietes dzimumu un šo simptomu attīstību. Acu dedzināšana bija cieši saistīta ar pie datora pavadīto laiku ($p=0,036$) un katra pie datora pavadītā stunda palielināja simptoma prevalenci par 3,8%.

Secinājumi: VDT lietotājiem tika novērota augsta DRS simptomu prevalence. Sievietēm bija lielāks risks noteiktai DRS simptomu attīstībai. Faktori, kā datora ekspozīcijas laiks, acu slimības anamnēzē, atpūtas pauzes, darba stacijas iekārtojums, nebija statistiski nozīmīgi saistīti ar DRS izplatību vai tā simptomu intensitāti.

Introduction

Prolonged use of computers, smartphones and tablets is a common cause of eye discomfort. As the exposure of digital displays has increased in recent decades the number of people suffering from vision related symptoms has raised. American Optometric Association defines digital eye

strain (DES) also called computer vision syndrome (CVS) as the complex of eye and vision problems related to near work which are experienced during or related to computer use.

DES is the main occupational risk factor and its symptoms such as eye redness, blurred vision, diplopia, eye pain, eye fatigue and headache affect 64–90% of computer users. In the United States, about 80% of adults use digital devices for more than two hours a day and nearly 67% use two or more digital devices at the same time. The main risk factors of DES are duration of visual display terminals use, poor lighting, glare, screen brightness, pre-existing eye diseases.

In the last decade the use of digital devices has rapidly increased in all age groups. According to the International Telecommunication Union data, in 2019, 53.6% or 4.1 billion of world population used the Internet on a daily basis. Researches reveal that the main problems associated with DES are reduced productivity, increased error rates at work, reduced job satisfaction and impaired vision.

Material and Methods

Study design

A cross-sectional study conducted between December 2019 and January 2020.

Study population

The study included people over 18 years of age. Inclusion criteria – participants use at least one of the visual display terminals such as computer, smartphone and / or tablet on a daily basis. Sample size was calculated using the Cochran formula.

Methods

The data was gathered using the structured questionnaire based on Computer Vision Syndrome Questionnaire and VSP Computer Vision Questionnaire. The questionnaire included questions about general population data such as age, gender, preexisting eye diseases in medical history. Intensity and frequency of 16 symptoms related with DES were evaluated (see Table 1).

Table 1. Evaluation of intensity and frequency of DES symptoms

Frequency		Intensity	
	Points		Points
Never- the symptom does not occur at all	0	Mild/ Moderate	1
Occasionally- sporadic episodes or once a week	1	Intense	2
Often/ Always- 2 or 3 times a week or almost every day	2	-	-

The result of “Frequency x Intensity” was recoded as: 0 = 0; 1 or 2 = 1; 4 = 2. If the total score was ≥ 6 points, the participant was considered to suffer with DES.

Analysis of data

Analysis of data was performed using Microsoft Excel and the Statistical Package for Social Sciences (SPSS) version 20. Chi-square test, Mann-Whitney U test and probit regression were used to evaluate the association between DES and its risk factors. Level of statistical significance was set at $P < 0.05$.

Results

A total of 247 VDT user participants were included in this study. The median age of the study group was 28,2 years (range 18–70 years). 67,6% (N=167) were females 33,4% (N=80) were males (see Fig. 1). 41,3% (N=102) of participants had pre-existing eye disease. Most common reported eye diseases were – myopia (27,9%), hypermetropia (7,7%), dry eye syndrome (7,3%), astigmatism (5,7%), strabismus (2,3%).

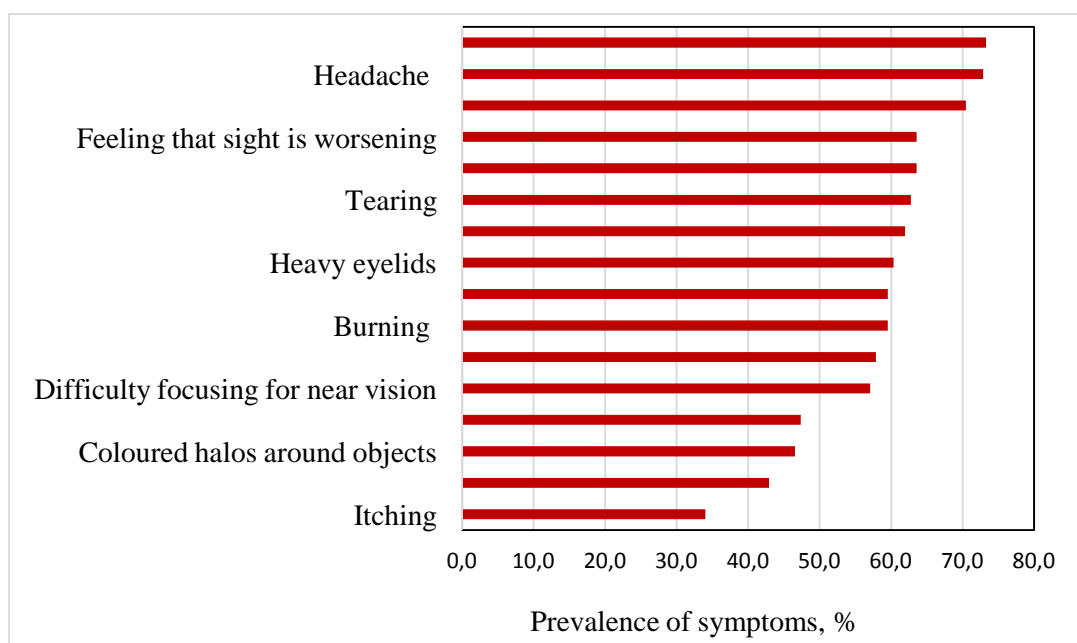


Figure 1. Number of participants by gender

The prevalence of DES was 74,9%. Among women, the prevalence of DES was 78,4%, among men – 67,5%. The most commonly reported symptoms were dry eyes (73,3%), headaches (72,9%) and blurred vision (70,4%). 95,5% (N = 236) of participants indicated that experience at least one of the symptoms of DES (see Fig. 2).

The prevalence of headache ($p = 0.017$), coloured halos around objects ($p = 0.034$), dry eyes ($p = 0.026$) and eye burning ($p = 0.008$) was higher among women, showing a statistically significant association between female gender and the development of these symptoms.

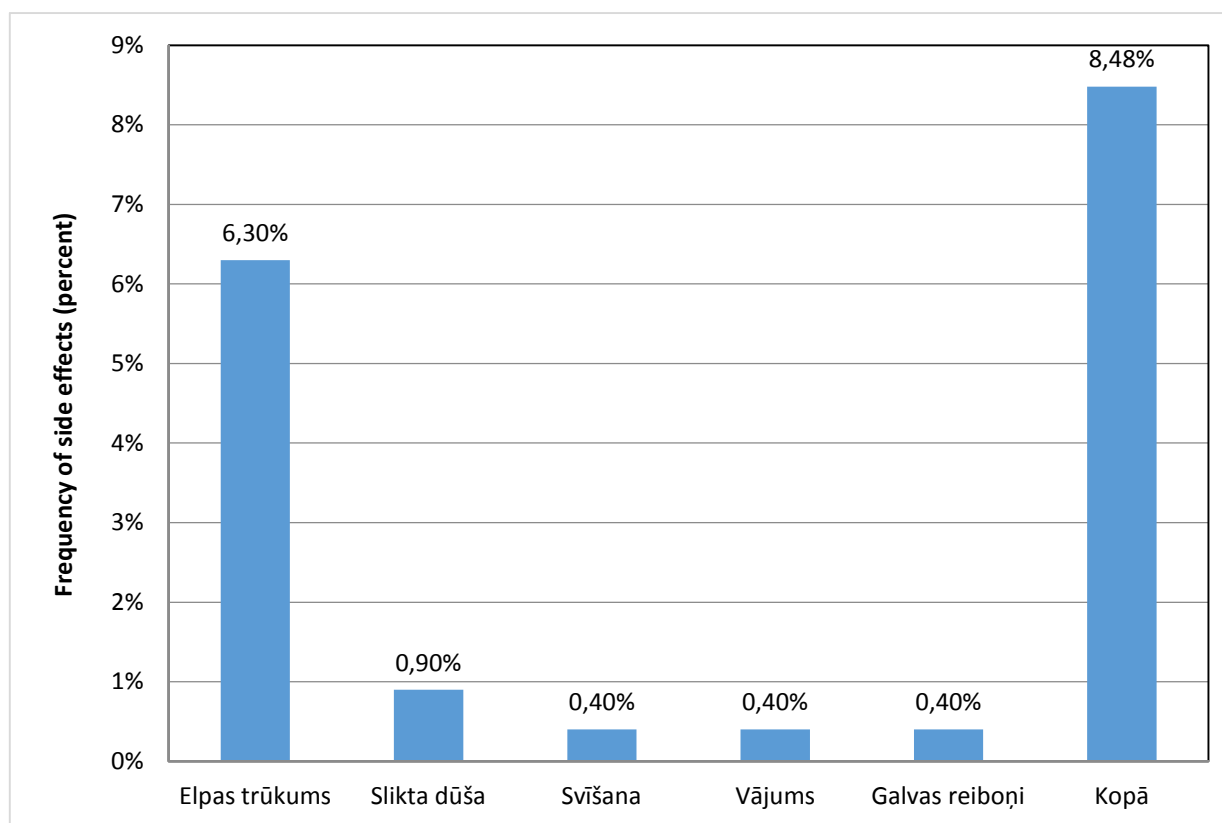


Figure 2. Prevalence of DES symptoms among computer users (%)

Further on, all participants are separated in two groups – group 1, where CVSQ score was less than six points, group 2, where CVSQ score was more than six points.

The majority (49,4%) of participants in group 2 indicated that they spend two to four hours a day at the computer screen (see Table 2).

Table 2. Hours spent at the computer screen in a day

	<1 h n (%)	1–2 h n (%)	2–4 h n (%)	4–6 h n (%)	6–8 h n (%)	>8 h n (%)
Group 1	9 (14,5)	13 (20,1)	14 (22,6)	12 (19,4)	6 (14,3)	8 (12,9)
Group 2	28 (15,1)	17 (9,2)	42 (49,4)	38 (26,2)	32 (17,3)	28 (15,1)

This study found that there is a significant association between female gender development of headache ($p=0,017$), coloured halos around objects ($p=0,034$), eye dryness ($p=0,026$) and burning sensation ($p=0,008$).

Time spent at the computer was statistically significantly associated with development of burning sensation. Each hour spent at the computer increased the prevalence of the symptom by 3.8% ($p = 0,036$).

A statistically significant association was found between DES and age ($p = 0,018$). The mean age in group 2 was 27,6 years (9.2 SD), while in group 1 it was 31,1 years (1.4 SD). Probit

regression analysis revealed that as the mean age increases by one year, the risk of development of DES decreases by 1.5 pp. 75.5% of all DES cases were in the 18–30 age group (see Table 3).

Table 3. Association between individual and computer use related factors and DES

Factors	p value
Age	0,018
Gender- female	0,063
• Headache	0,017
• Halos around objects	0,034
• Dryness	0,026
• Burning	0,008
Pre-existing eye disease	0,284
Contact lenses	0,133
Wearing glasses	0,284
Time spend on computer	0,102
• Burning	0,036
Time spend on tablet/ smart phone	0,343
Taking breaks	0,464
Brightness of computer screen	0,584
Distance to keyboard	0,890
Distance to computer screen	0,284
Position of the top line of the screen	0,212

Discussion

The study explored the prevalence of DES among digital display users and investigated the associations between DES and its risk factors.

The results of the study showed that the prevalence of DES is 74.9%. Similar results were obtained in other studies – 73% in Ethiopia, 72% in the United Arab Emirates, 73.9% in Brazil, 74.3% in Spain. In contrast, in Malaysia and India, the prevalence of DES was higher – 89.9% and 81.9% respectively.

Several factors have been associated with the development of DES. The association of CRS prevalence with VDT use has been reported in the literature. In several studies, a significant increase in risk of DES was observed after two to eight hours of computer use. The controversial results of the studies may be related to the difficulty in accurately quantifying the duration of daily use of VDT.

The study concluded that if the age increases by 1 year, the risk of DES decreases by 1.5 pp. Possible explanations of this relationship are related to the mean age of the study group, which was

28.2 years. The age distribution of the study group does not represent the average age of the population, which is 43.9 years in Latvia. Too small study sample in the over-40 age group (10.5%) could explain why there is no statistically significant relationship between DES and increasing age.

Similar to Ranasinghe et al. and Reddy et al. studies significant association between rest breaks and the prevalence of DES was not found. Other authors report a significant reduction of DES risk by taking five-minutes break every 20 minutes and 60 minutes of computer use. In this study, it was not shown that the position of the monitor and the distance to computer screen affect the development of DES. The obtained results could be related to inaccurate distance and time measurements reported by the respondents

This study was conducted as a cross-sectional study, such design does not allow to generalized conclusions about cause-and-consequences relationships over time, but outlines the relationship between the DES and its risk factors. The results of the study shows that DES is a major public health problem affecting more than 70% of VDT users. Education about DES provoking factors and the principles of proper ergonomics of computer use would be essential to reduce eye symptoms and improve work productivity.

Conclusions

- 1) The prevalence of CVS among computer users is high. In this research it was 74.9%
- 2) There was no statistically significant correlation between computer exposure time, pre-existing eye disease, taking breaks, workstation arrangement and the prevalence or intensity of CVS.
- 3) Female gender could be a significant risk factor for CVS as the higher prevalence of certain symptoms were reported in this group.

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COMPLICATIONS AND SIDE EFFECTS ASSOCIATED WITH DOBUTAMINE STRESS ECHOCARDIOGRAPHY AT RIGA EAST CLINICAL UNIVERSITY HOSPITAL

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Abstract

Complications and side effects associated with dobutamine stress echocardiography at the Riga East clinical university hospital

Key Words: dobutamine, stress echocardiography, side effects, complications

Introduction. Dobutamine stress echocardiography (DSE) is a widely used pharmacologic stress testing with simultaneous echocardiographic visualization of cardiac structures for the diagnosis and evaluation of coronary artery disease.

Aim. To determine the incidence of DSE complications and side effects at the Riga East Clinical University Hospital.

Materials and methods. Retrospectively, 224 (104 female, 120 male) patients with DSE protocols performed at RAKUS in 2019 were analyzed and the incidence of complications and side effects were assessed. The mean age of the study group is 65.69 ± 9.8 years old. In 46.40% of cases, atropine was used. Attaining target heart rate – 89.70%. Data were statistically processed using IBM SPSS Statistics.

Results. The overall incidence of side effects caused by DSE is 74.1%. No serious complications such as death, asystole, ventricular fibrillation, persistent ventricular tachycardia, myocardial infarction were observed. Chest pain occurs in 21% of cases, ventricular extrasystoles – 33%, supraventricular extrasystoles – 15.60%, nonsustained ventricular tachycardia – 10.30%, paroxysmal supraventricular tachycardia – 4.50% and paroxysmal atrial fibrillation – 1.30%. Hypotension was observed in 12.50% and severe hypertension in 1%. Left ventricular outflow tract obstruction was observed in 17% and left ventricular mid-cavity obstruction in 2.20%. Among non-cardiac side effects, the most commonly observed was dyspnea – 6.30%.

Conclusion. No life-threatening complications were observed. Non-cardiac complications are rare. The most common of arrhythmias are ventricular and supraventricular extrasystoles.

Kopsavilkums

Ar dobutamīna stresa ehokardiogrāfiju asociētas komplikācijas un blakusefekti Rīgas Austrumu klīniskajā universitātes slimnīcā

Atslēgvārdi: dobutamīns, stresa ehokardiogrāfija, blakusefekti, komplikācijas

Ievads: Dobutamīna stresa ehokardiogrāfija (DSE) ir plaši pielietots medikamentozs slodzes tests ar vienlaicīgu sirds struktūru ehokardiogrāfisku vizualizāciju koronāro artēriju slimības diagnostikai, novērtēšanai.

Mērķis: Noteikt DSE komplikāciju un blakusefektu biežumu Rīgas Austrumu klīniskajā universitātes slimnīcā.

Matēriāli un metodes: Retrospektīvi tika apskatīti 224 (104 sievietes, 120 vīrieši) pacientu DSE protokoli, kas 2019.gadā veikti RAKUS, un tika analizēts izmeklējuma komplikāciju, blakusefektu biežums. Vidējais pētāmās grupas vecums sastāda $65,69 \pm 9,8$ gadus. Dati tika statistiski apstrādāti ar *IBM SPSS Statistics* palīdzību.

Rezultāti: Kopējais DSE izraisīto blakusefektu skaits sastāda 74,1%. Nopietnas komplikācijas kā nāve, asistolija, kambaru fibrilācija, noturīga kambaru tahikardija, miokarda infarkts novērotas netika. 21% gadījumos novēro sāpes krūtīs. No aritmijām visbiežāk sastop ventrikulārās ekstrasistolēs – 33%, retāk supraventrikulārās ekstrasistolēs – 15,60%, nenoturīgas kambaru tahikardijas – 10,30%, supraventrikulārās tahikardijas paroksismus – 4,50% un ātriju fibrilācijas paroksismus – 1,30%. Hipotensiju novēro 12,50%, izteiktu hipertensiju – 1%. Kreisā kambara izejas trakta obstrukciju novēro 17%, kreisā kambara vidusdaļas obstrukciju – 2,20%. No nekardiālām blakusefektiem visbiežāk atzīmējams elpas trūkums – 6,30%.

Secinājumi: Dzīvībai bīstamas komplikācijas novērotas netika. Nekardiālās komplikācijas ir retas. Biežākās no aritmijām ir ventrikulārās un supraventrikulārās ekstrasistolēs.

Introduction

Dobutamine stress echocardiography is a drug stress test with simultaneous echocardiographic visualization of cardiac structures. The clinical use of dobutamine stress

echocardiography has been known since the mid-1980s (Sicari et al, 2009). This pharmacological stress test has increasingly been used to diagnose coronary artery disease in patients who are unable to adequately bare the exercise (Mertes et al, 1993). The sensitivity of the test is 86% and the specificity is also 86% (Picano et al, 2008). It has similar diagnostic accuracy and prognostic significance as radionuclear load methods, but at the same time dobutamine stress echocardiography has lower costs, it is safe for the environment and does not cause radiation exposure to either the patient or the doctor (Pellikka et al, 2010; Sicari et al, 2009).

This test is used to assess inducible ischemia, myocardial contractile reserve, or viability, as well as to assess the severity of valve pathology in asymptomatic patients. During exercise, left ventricular regional contractility and hemodynamic parameters are evaluated echocardiographically. Contractility disorders in at least two adjacent segments indicate exercise-induced ischemia. During the examination, the drug load is gradually increased, according to the protocol, until the age-appropriate submaximal pulse is reached, the maximum allowable drug dose, positive test signs on echocardiography, severe chest pain or positive test signs on electrocardiography (ST segment deviation more than 2 mm). If the cessation criteria are not met, atropine is added to the test (Sicari et al, 2009).

Dobutamine stress echocardiography is considered a safe method of examination, but there is a risk of complications and side effects, including life-threatening complications (Geleijnse et al, 2010).

The incidence of mortality is less than 0.01%, cases of ventricular fibrillation and cardiac rupture have been reported. Cardiac rupture incidence <0.01%. The incidence of myocardial infarction is 0.02%, it is observed in patients with unstable plaques, increased heart rate and contractility, plaque rupture and thrombosis, as well as dobutamine has the ability to induce platelet activation, aggregation and vasoconstriction through alpha1 adrenoreceptors. Cerebrovascular event incidence <0.01%. Hemorrhagic stroke can be caused by an increased heart rate and an increase in blood pressure caused by the administration of dobutamine in the presence of an aneurysm in the blood vessel wall. Ischemic stroke or transient ischemic attack may follow the mechanisms already described for myocardial infarction. Hypotension can provoke a stroke in high-grade carotid artery stenosis or a left ventricular thrombus. The incidence of asystole is as low as 0.01% and is based on sinus bradycardia syndrome with or without hypotension. Such a response may be provoked by myocardial infarction of the lower wall and cardio-inhibiting vagal reflex. The incidence of ventricular fibrillation is 0.04% and is mainly observed in patients with structural heart disease. Incidence of persistent ventricular tachycardia 0.15%. Dobutamine has an effect on QRS, QT length, can increase intracellular calcium levels, thus increasing ventricular automatism. Beta-adrenoreceptor stimulation reduces plasma potassium levels, which may predispose to ventricular

arrhythmias. Incidence of supraventricular arrhythmias: supraventricular extrasystoles – 7.8%, supraventricular tachycardia – 1.3%, atrial fibrillation – 0.9%. Arrhythmia predictors are left atrial enlargement and pressure increase, as well as old age. The incidence of hypotension is 1.7%, resulting in an inadequate increase in cardiac output to the expected reduction in systemic vascular resistance or a disproportionate decrease in systemic vascular resistance, or inadequate release due to insufficient contractility due to dynamic left ventricular obstruction. There are also a number of non-cardiac side effects such as nausea, vomiting, headaches, tremors, shortness of breath, etc (Arruda-Olson, 2020; Geleijnse et al, 2010; Sicari et al, 2009).

Dobutamine stress echocardiography test side effects, complications have been studied and are known worldwide. It is important to collect data on the complications of this test in Latvia, Riga East Clinical University Hospital, their frequency, reliability of the method in order to be able to evaluate the benefits of the test with possible consequences.

The aim

To determine the frequency of complications and side effects of dobutamine stress echocardiography in Riga East Clinical University Hospital.

Materials and methods

Data collection

DSE protocols of 224 (104 women, 120 men) patients performed in 2019 at Riga East Clinical University Hospital were reviewed retrospectively, and the frequency of examination complications and side effects was analyzed. In the course of the study, differences in complications, side effects between the sexes and patients who received atropine during the test and who underwent this study without the addition of atropine were evaluated.

Stress protocol

Dobutamine was administered intravenously starting at a dose of 5 to 10 $\mu\text{g} / \text{kg}$ per minute and increased by 10 $\mu\text{g} / \text{kg}$ every 3 minutes up to a maximum of 40 $\mu\text{g} / \text{kg}$ per minute. Atropine was added at a dose of 0.25 mg to 1 mg, at a dose of dobutamine of 40 $\mu\text{g} / \text{kg} / \text{min}$ if the end point of the test was not reached. Blood pressure, heart rate and clinical symptoms were monitored during the study. An electrocardiogram of 12 leads was obtained at the beginning of the study, at the beginning of the dobutamine infusion, and at the end of each 3-minute interval. Echocardiographic images were obtained at rest, during the dobutamine infusion, and during the recovery period.

Termination of the test

Stress induction was stopped when 85% of the age-predicted heart rate was reached or at the maximum dose, or severe chest pain, or ST segment abnormalities on the electrocardiogram of more than 2 mm, or recurrent left ventricular contractility abnormalities in two adjacent segments as well as when significant side effects were identified.

Definition of side effects

Cardiac complications are defined as chest pain, left ventricular and mid-cavity obstruction, arterial hypotension and hypertension, and minor and major heart rhythm disorders. Life-threatening complications are defined as asystole, ventricular fibrillation, persistent ventricular tachycardia, and myocardial infarction. Life-threatening arrhythmias (asystole, ventricular fibrillation, persistent ventricular tachycardia) were defined as major arrhythmias. Minor arrhythmias are defined as supraventricular or ventricular extrasystoles, supraventricular tachycardia paroxysms, or nonsustained ventricular tachycardia episodes. Severe arterial hypotension was defined as a decrease in arterial pressure ≥ 40 mmHg and the presence of symptoms. Severe hypertension was defined as systolic pressure above 220 mmHg and diastolic pressure above 120 mmHg.

Non-cardiac adverse reactions were defined as headache, dizziness, nausea, dyspnoea, sweating, and weakness during the study.

Statistical analysis of data

Data were statistically processed using IBM SPSS Statistics. The continuous variables were described by the arithmetic mean and standard deviation. Qualitative variables were characterized by percentage frequency. Categorical variables were compared with the Pearson Chi2 test or Fisher's exact test according to the test conditions. The significance level was chosen to be $p < 0.05$.

Results

Characteristics of the patient group

The mean age of the study group is 65.69 ± 9.8 years, the minimum age is 32 years, the maximum is 87. Women 46% ($n = 104$), men 54% ($n = 120$). The mean age was 68.07 ± 9.07 years for women and 63.63 ± 10.10 years for men. Atropine was used in 46.40% ($n = 104$) cases. The submaximal heart rate reaches 89.70% ($n = 201$).

Complications and side effects

The total number of side effects caused by dobutamine stress echocardiography is 74.1%. Percentage of cardiac complications – 70.53%, frequency of non-cardiac complications – 8.48%. No life-threatening complications such as asystole, ventricular fibrillation, persistent ventricular tachycardia, myocardial infarction were observed. No fatalities were observed. Chest pain was observed in 21% ($n = 47$) of cases. No major arrhythmias were observed. All observed arrhythmias are classified as minor arrhythmias. Of these arrhythmias, the most common are ventricular extrasystoles (VES) – 33% ($n = 74$), less common supraventricular extrasystoles (SVES) – 15.60% ($n = 35$), nonsustained ventricular tachycardia (NSVT) – 10.30% ($n = 23$), paroxysmal supraventricular tachycardia (PSVT) – 4, 50% ($n = 10$) and atrial fibrillation (Afib) paroxysms – 1.30% ($n = 3$). Hypotension is observed in 12.50% ($n = 28$), marked hypertension in 1% ($n = 2$).

Left ventricular tract obstruction (LVOTO) was observed in 17% (n = 38), left ventricular mid-cavity obstruction (LVMCO) – 2.20% (n = 5) (Fig. 1). Among the non-cardiac side effects, the most common are shortness of breath – 6.30% (n = 14), less commonly nausea – 7.1% (n = 2) and sweating, weakness, dizziness – 0.4% (n = 1) (Fig. 2).

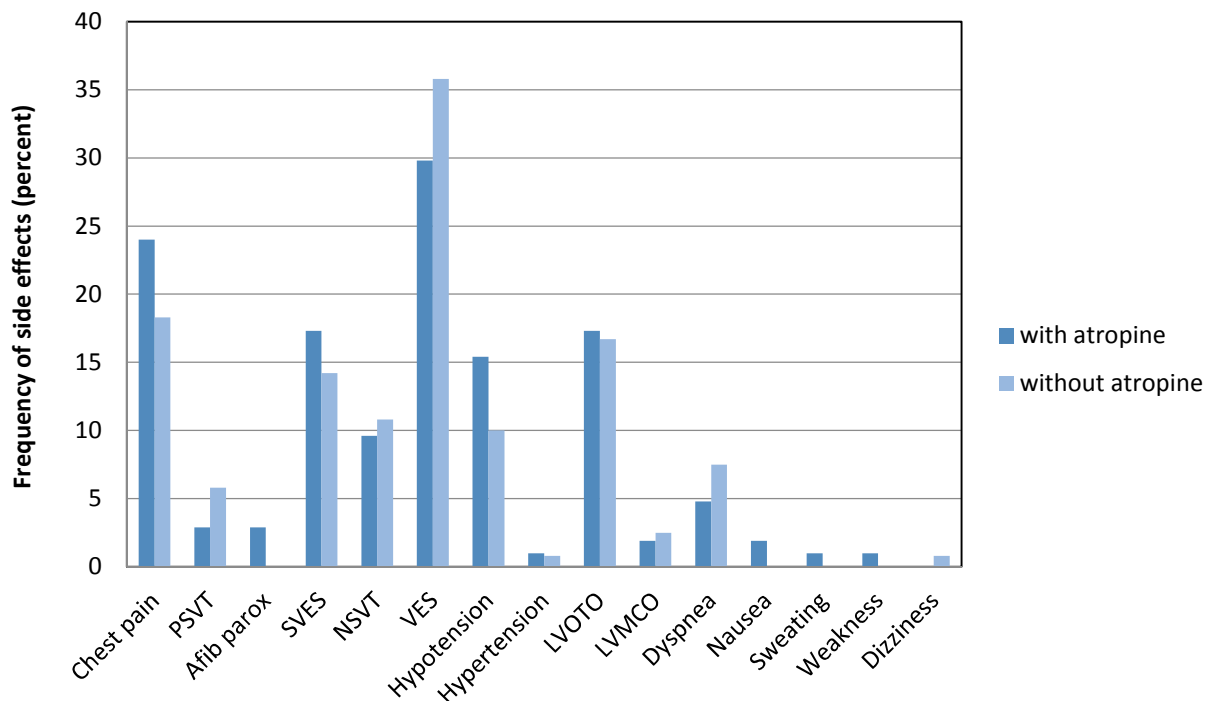


Figure 1. Cardiac complications

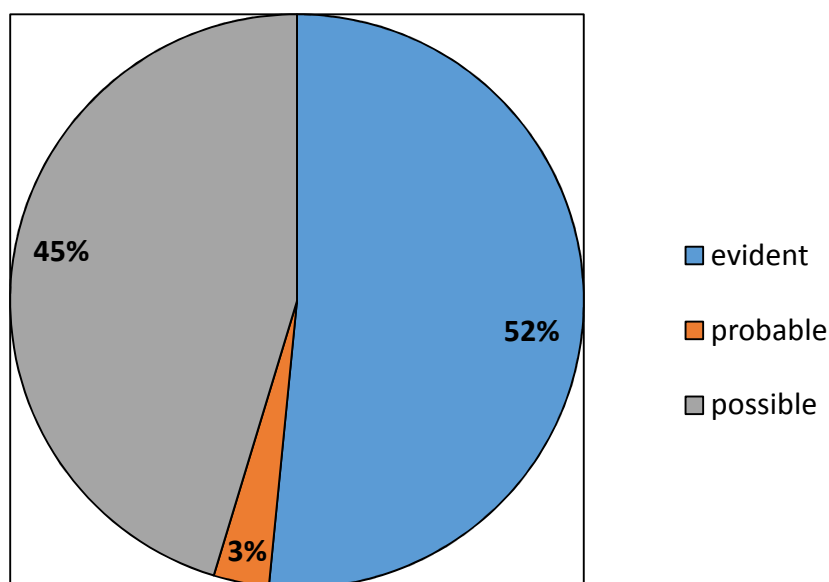


Figure 2. Non-cardiac complications

When evaluating the incidence of adverse reactions separately in women (n = 104) and men (n = 120), a statistically significant difference was observed only in the incidence of ventricular extrasystoles (26% (n = 27) in women, 39.2% (n = 47) in men, p = 0.036) and the incidence of

nonsustained ventricular tachycardia (2.9% (n = 3) for women, 16.7% (n = 20) for men, p = 0.001). In both cases, these arrhythmias are more common in men (Fig. 3).

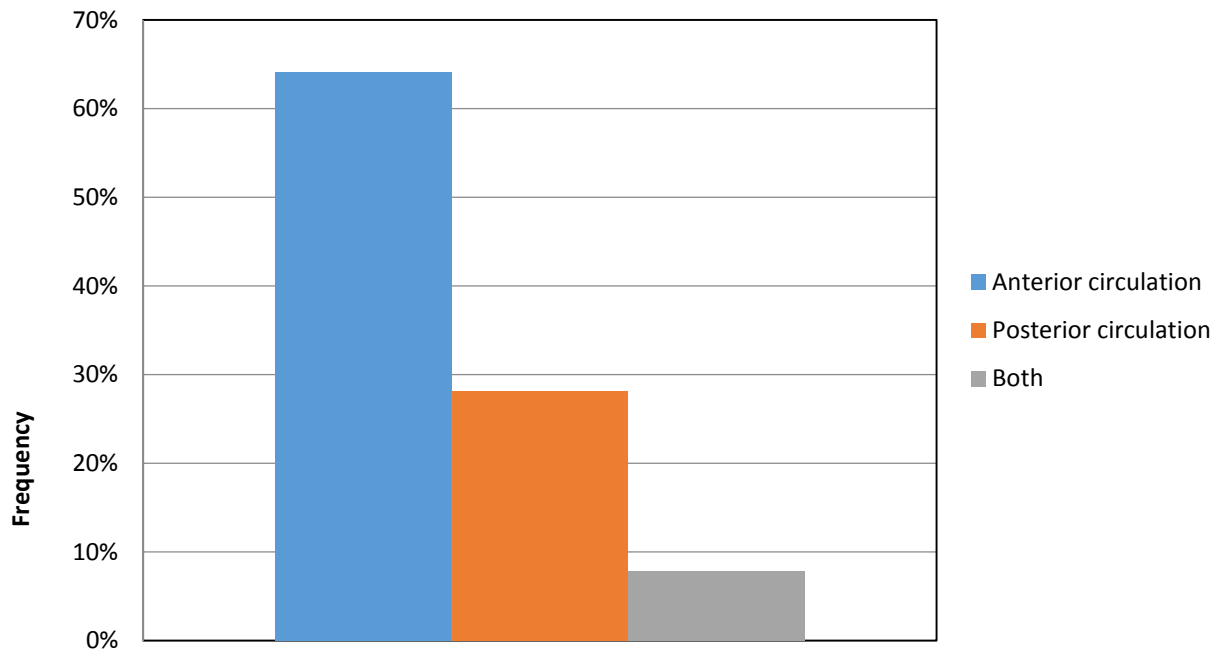


Figure 3. Differences between women and men in side effects

No statistically significant differences in complications, side effects were observed between the atropine group of patients (n = 104) and those receiving dobutamine stress echocardiography without the addition of atropine (n = 120). P values above 0.05 (Fig. 4).

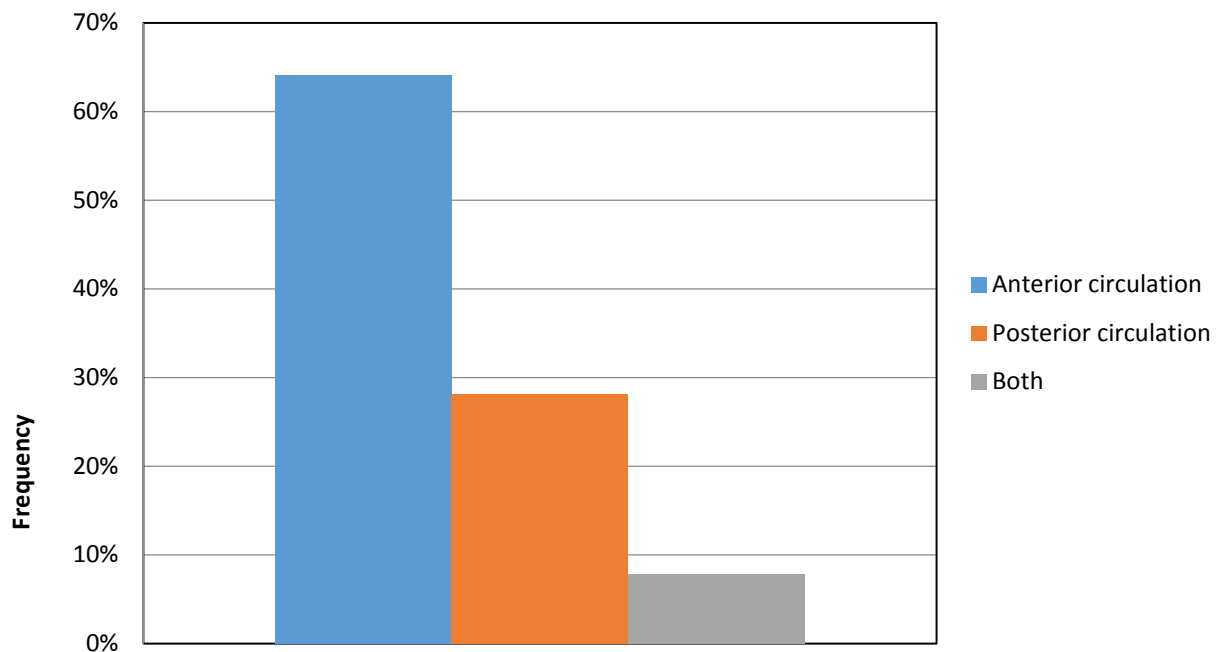


Figure 4. Differences in side effects between the atropine group and the group without the addition of atropine

Discussion

Dobutamine stress echocardiography is a safe method of examination. According to the literature, life-threatening complications are rare in 0.18% (Arruda-Olson, 2020). In the present study, life-threatening complications such as asystole, ventricular fibrillation, persistent ventricular tachycardia, and myocardial infarction were not observed in any of the 224 patients who underwent examination at Riga East Clinical University Hospital. No fatalities were observed.

The total number of complications is 70.53% and is very close to that described in the literature, which is 76% (Mahmarian et al, 2014). The most common are so-called small arrhythmias associated with beta 1 receptor stimulation, dobutamine-induced decreases in ventricular refractory period, or dobutamine-induced decreases in plasma potassium (Fennich et al, 2013; Geleijnse et al, 2010). The most common arrhythmias were ventricular extrasystoles, the frequency of which was 33%, the frequency of this complication in the literature varies from 0.5% to 43.6% (Geleijnse et al, 2010). The second most common arrhythmia was supraventricular extrasystoles, the frequency of which is 15.60%, the frequency described in the literature is from 0.7 to 27.8% (Geleijnse et al, 2010). Less common arrhythmia was nonsustained ventricular tachycardia – 10.30%, the frequency of which in Riga East Clinical University Hospital is higher than described in the literature (0.5–7.3%) (Geleijnse et al, 2010). Similar to the literature, supraventricular tachycardia paroxysm was found in 4.50% of cases and atrial fibrillation paroxysm was found in 1.30% of cases, left ventricular output tract obstruction in 17% and mid-cavity obstruction in 2.20%. Blood pressure above 220/120 mmHg was rarely observed in only 1% of cases, arterial hypotension was more common in 12.50%, and reported in the literature up to 20% (Fennich et al, 2013). The mechanism of the hypotensive reaction during the dobutamine infusion is still unclear. The prognostic significance is widely discussed, with no significant association with cardiac complications reported in most studies, while Dunkelgrun et al. in a retrospective study of 3381 patients showed that severe hypotension during dobutamine infusion is an independent predictor of cardiac death and non-fatal myocardial infarction (Fennich et al, 2013).

Chest pain is observed more frequently than described in the literature, the incidence in this study was 21%, in the literature up to 11% (Arruda-Olson, 2020). Non-cardiac complaints are rare and test discontinuation was not affected.

When comparing the incidence of complications, side effects between the sexes, ventricular extrasystoles and nonsustained ventricular tachycardia were more common in men.

Co-administration of atropine in dobutamine stress echocardiography is a safe and effective strategy. Early injection of atropine during dobutamine stress echocardiograms has been shown to reduce the duration and dose of dobutamine infusion, reducing dobutamine-induced side effects while maintaining similar diagnostic accuracy (Fennich et al, 2013). In this study, the addition of atropine was not associated with a higher incidence of complications or side effects.

Conclusions

No life-threatening complications were observed. Non-cardiac complications are rare. The most common arrhythmias are ventricular and supraventricular extrasystoles. Ventricular extrasystoles and nonsustained episodes of ventricular tachycardia are more common in men. The addition of atropine during stress echocardiography is not associated with a higher incidence of complications or side effects.

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CARDIOEMBOLIC ISCHEMIC STROKE IN A GROUP OF YOUNG PATIENTS

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Abstract

Cardioembolic ischemic stroke in a group of young patients

Key Words: cardioembolia, ischemic stroke, young patients

Introduction. Among young patients cardioembolism is one of the most common causes of stroke.

Aim. To identify the most common sources of cardioembolism for ischemic stroke in young patients.

Materials and Methods. A retrospective study was carried out among 64 patients younger than 55 years old, who were hospitalized at Riga East Clinical University Hospital with a diagnosis of cardioembolic stroke. The frequency of cardioembolism sources were analyzed in patients of ≤ 55 , ≤ 49 and 50–55 years old. The causal relationship of the patent foramen ovale (PFO) to stroke was assessed using the Risk of Paradoxical Embolism (RoPE) Score. The data was analyzed using SPSS.

Results. Patients younger than 55 years old: 32,8% had atrial fibrillation (AF), 20,3% – PFO, 15,6% – dilated cardiomyopathy, left ventricular hypertrophy, 7,8% – mechanical valves, 4,7% – left ventricular thrombus, atrial septal aneurysm with PFO, 3,1% – paroxysmal AF, recent myocardial infarction and left ventricular wall motion abnormalities, 1,6% – left atrial thrombus, left ventricular aneurysm without thrombus, congestive heart failure with EF $< 30\%$, apical akinesia and ventricular septal aneurysm. Comparing 2 age groups (≤ 49 years old ($n = 31$) and > 49 years old ($n = 33$)), PFO (41,9%) is the leading source of cardiac embolism in patients of ≤ 49 years old, in contrast, in patients of > 49 years old, the leading source of cardioembolism is AF – 54,6%, while no PFO is detected in any of the patients in this group. All patients with PFO on the RoPE score have a score of ≥ 7 , indicating a high likelihood of stroke association with pathology.

Conclusion. The most common source of cardioembolism in patients younger than 55 years old is AF. PFO plays a leading role in patients under 49 and AF – over 50 years old.

Kopsavilkums

Kardioembolisks išēmisks insults gados jaunu pacientu grupā

Atslēgvārdi: kardioembolisms, išēmisks insults, jauni pacienti

Ievads. Jaunu pacientu vidū kardioembolisms ir biežākais insulta cēlonis.

Mērķis. Noteikt biežākos kardioembolijas avotus išēmiskam insultam gados jauniem pacientiem.

Materiāli un metodes. Retrospektīvi tika analizēti 64 kardioemboliskas ģenēzes cerebrāli infarkti (CI), pacientiem, kas jaunāki par 55 gadiem un ar diagnozi CI tika hospitalizēti Rīgas Austrumu klīniskajā universitātes slimnīcā. Kardioembolijas (KE) avotu biežums tika analizēts vecumā ≤ 55 , ≤ 49 un 50–55 gadiem. Persistējošās ovālās atveres (PFO) cēloniska saistība ar insultu tika vērtēta, izmantojot paradoksālās embolijas riska novērtēšanas skalu (RoPE). Dati statistiski apstrādāti ar SPSS.

Rezultāti. Pacientiem jaunākiem par 55 gadiem: ātriju fibrilācija (AF) 32,8%, tad seko PFO 20,3%, dilatācijas kardiomiopātija, kreisā kambara hipertrofija 15,6%, mehāniskie vārstuļi 7,8%, kreisā kambara trombs, ātriju starpsienas aneirisma ar PFO – 4,7%, paroksizmālā AF, nesens miokarda infarkts un kreisā kambara kustības traucējumi – 3,1%, kreisā priekškambara trombs, kreisā kambara aneirisma bez tromba, hroniska sirds mazspēja ar izsviedes frakciju $< 30\%$, apikālā akinēzija un kambaru starpsienas aneirisma bija sastopamas visretāk – 1,6%. Salīdzinot 2 vecuma grupas (≤ 49 gadiem ($n=31$) un > 49 gadiem ($n=33$)), konstatē, ka pacientiem ≤ 49 gadiem vadošais KE avots ir PFO (41,9%) un AF konstatē tikai 11,9%, savukārt, pacientiem vecumā > 49 gadiem vadošais KE avots ir AF 54,6%, un nevienam no pacientiem šai grupā PFO nekonstatē. Visiem pacientiem ar PFO pēc RoPE skalas novērtējums ir ≥ 7 punktiem, kas norāda par augstu varbūtību insulta saistībai ar patoloģiju.

Secinājumi. Biežākais KE avots pacientiem jaunākiem par 55 gadiem ir AF. Vecumā zem 49 gadiem vadošā loma ir PFO, bet vecumā virs 50 gadiem – AF.

Introduction

Despite awareness of risk factors for stroke and improved primary prevention, stroke ranks second of causes of death and is a leading cause of severe long-term disability (Katan et al, 2018).

In about 10% of cases, stroke affects patients under 55 years of age. In addition, young patients have a disproportionate economic impact of stroke compared to the elderly group, disabling people in their productive years of life. (Rolfes et al, 2013; Smajlović, 2015). There is no uniform criterion to define the entity “stroke in the young”. Previously published studies and registries commonly define young adults as those younger than 45, 49, and 55. (Putala, 2016; Rolfes et al, 2013; Smajlović, 2015).

Cardioembolism is one of the major causes of stroke in both young and elderly patients. Cardioembolism is not only important, but also one of the most effectively preventable causes of stroke. Cardioembolic strokes are strokes with a poor prognosis, the most severe of the subtypes of cerebral infarction, characterized by high mortality and severe disability (Kamel et al, 2017; Smajlović, 2015).

More than 20 specific cardiac pathologies can cause cerebral embolism. It is clinically useful to classify these cardiac sources into high and low risk categories. High-risk sources have a relatively high risk of primary and recurrent stroke, which is strongly associated with the cardioembolic mechanism. Low-risk sources are common in the general population and the associated risk of primary and recurrent stroke is low or uncertain. If a patient with cerebral ischaemia has a low-risk source of cardioembolism, the etiological role should be assessed skeptically and other diagnostic information considered in the context (Schneck, 2015).

The incidence of sources of cardioembolism varies in different age groups. In young patients, one of the most common causes of cardioembolism is a patent foramen ovale. A persistent oval opening (patent foramen ovale, PFO) is a congenital opening in the atrial septum (Ebrahimi et al, 2011; Smajlović, 2015). In the fetal period, foramen ovale is a very important heart structure that ensures that the body is supplied with oxygenated blood. About 25% of the general population do not close the foramen ovale. In the physiological state, the pressure in the left atrium exceeds the pressure in the right atrium, ensuring passive closure of the PFO. However, increasing pressure in the right atrium, which may occur during a normal cardiac cycle, during the Valsalva maneuver, coughing, sneezing, and in pathologies such as severe tricuspid regurgitation, myocardial infarction in the right ventricle, pulmonary artery thromboembolism, may result in right-to-left shunt and in the systemic circulation passage of thrombi. Most people with PFO do not have problems, although blood flows from the right atrium to the left. Problems occur when thrombi appear in the blood. A source of thrombus is required to create a paradoxical embolism. If there is a shunt between the right and left atria, thrombi can bypass the lung barrier and enter the brain, causing a stroke (Caswell, 2011). In ischemic stroke patients who are diagnosed with PFO, in 1/3 of cases, the association of stroke with PFO is accidental. The relationship depends on the patient's age, the presence of traditional risk factors and the subtype of cerebral infarction. To determine the role of

PFO in the etiology of stroke, Kent et al developed the Risk of Paradoxical Embolism (RoPE) scale (Bang et al, 2015). A high RoPE in a patient with cryptogenic ischemic stroke and PFO, and without other convincing etiology, is highly likely to indicate that the causal relationship of the stroke is PFO-related. The more points on the RoPE scale, the more likely a stroke is to be associated with PFO (Kent et al, 2013; Mas et al, 2001).

Atrial fibrillation (AF), which affects 33 million people worldwide, may also be a cause of cardioembolism among young patients. Although atrial fibrillation is less common in young patients, it increases the risk of stroke by 3 to 5 times. The prevalence of atrium fibrillation increases rapidly from 0.1% to 55 years of age and to almost 10% in people over 80 years of age (Kamel et al, 2017). Dilatation cardiomyopathy (DCM) is associated with an increased risk of thromboembolism due to low ejection fraction, blood stasis and altered coagulation (Kozdag et al, 2008). Prosthetic heart valves are a source of high risk of cardioembolism, and bioprosthetic valves have a lower risk of stroke than mechanical ones, especially in the long term (Kamel et al, 2017). Infectious endocarditis affects about 1 in 10,000 individuals. This is a relatively rare risk factor for stroke. About one in five cases of endocarditis is complicated by stroke (Kamel et al, 2017). The prevalence of left ventricular thrombus in the general population is low, occurring at 7 per 10,000 patients. Thrombus formation is promoted by reduced wall contractility, local myocardial trauma, and hypercoagulation / blood flow stasis (Habash et al, 2017). Systolic heart failure affects approximately 26 million people worldwide (Kamel et al, 2017). The incidence of thromboembolism in the chronic heart failure population ranges from 2.7% to 22% (Kozdag et al, 2008). Left ventricular hypertrophy (LVH) is common in hypertensive patients and increases the risk of stroke by 64%. The specific mechanism that explains the link between LVH and increased risk of stroke is unclear. Some authors explain this by the fact that LVH increases myocardial oxygen consumption, which can lead to an imbalance between oxygen demand and myocardial supply, thereby causing myocardial ischemia and inducing small areas of hypokinetic myocardium. These areas can cause small blood clots to form and provoke the development of a stroke (Tadic et al, 2014).

Although the sources of cardioembolism are known in the world, it is important to assess the frequency of their occurrence in Latvia – Riga East Clinical University Hospital, especially in the group of young patients who are a socially and economically active part of the population. Analysis and reporting of results helps to think about possible causes of stroke in young patients and thus, by choosing the right stroke prevention, provides an opportunity to reduce the incidence of stroke or the risk of stroke recurrence.

The aim

To determine the most common sources of cardioembolism for ischemic strokes in a group of young patients at Riga East Clinical University Hospital.

Materials and methods

Data collection

64 strokes of cardioembolic genesis were retrospectively analyzed in patients under 55 years of age with a diagnosis of cerebral infarction hospitalized at Riga East Clinical University Hospital. The sources of cardioembolism were identified based on the CCS (Causative Classification of Ischemic Stroke) classification. The significance of the patent foramen ovale in the etiology of ischemic stroke was determined using the Risk of Paradoxical Embolism (RoPE) scale.

Diagnostic definitions and criteria

The following vascular risk factors were identified from the medical records: arterial hypertension, diabetes, atherosclerosis, dyslipidemia, smoking. Criteria for arterial hypertension – a patient with a history of arterial hypertension or a patient taking antihypertensive medication. Criteria for diabetes mellitus – data in the medical records for pre-existing diabetes mellitus (type I or II) or fasting glucose above 7.0 mmol / l or glucose above 11.1 mmol / l. Criteria for dyslipidaemia – total cholesterol > 5.0 mmol / l, LDL > 3.0 mmol / l, TG > 1.7 mmol / l, HDLH in women < 1.2 mmol / l, men < 1.0 mmol / l or use of hypolipidising drugs. Criteria for atherosclerosis – data on atherosclerotic process in intra- or extracranial blood vessels are recorded in medical documentation with ultrasonography, CTA, MRA or digital subtraction angiography. Smoking is classified into two groups – active smokers and non-smokers. The vascular area affected by cerebral infarction was divided into three groups – CI in the anterior cerebral circulation, CI in the posterior cerebral circulation, and CI affecting both anterior and posterior circulation. The incidence of cerebral infarction subtypes and sources of cardioembolism were analyzed in patients under 55 years of age. It was further compared by dividing the study population into two subgroups corresponding to another common age range of young patients – 49 years.

Data analysis

Data were statistically processed using IBM SPSS Statistics 21.0 and Microsoft Office Excel 2010 program. The continuous variables were described by the arithmetic mean and standard deviation. Qualitative variables were characterized by percentage frequency. Categorical variables were compared with Pearson's χ^2 test or Fisher's exact test under test conditions. The significance level was chosen to be $p < 0.05$.

Results

In the group of young patients, cardioembolic stroke accounts for 23.1% ($n = 64$) and is the most common cause in this group (Fig. 1). In the group of stroke of cardioembolic genesis, the

mean age of patients was 46.98 ± 7.94 years, minimum age 27 years, maximum 55 years. In this group, a strong male dominance is observed in 68.7% (n = 44), women make up 31.3% (n = 20).

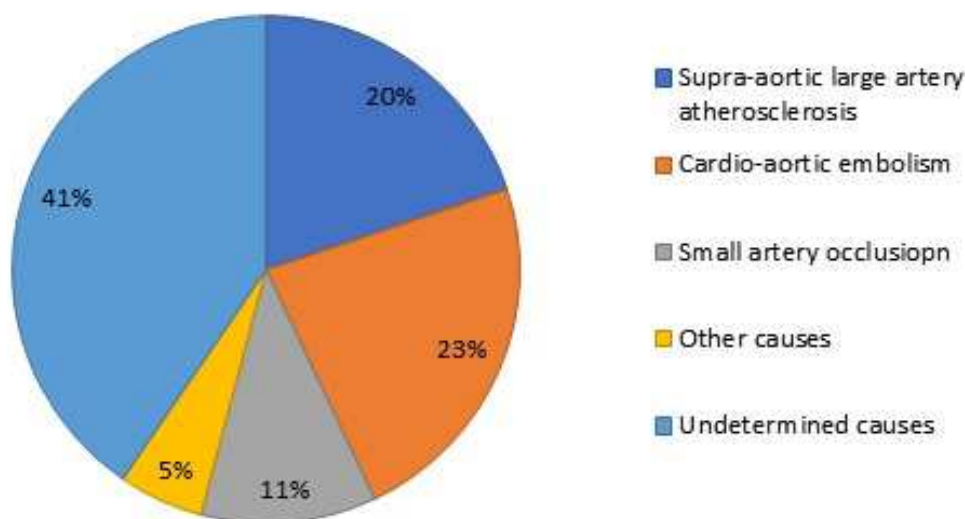


Figure 1. Stroke etiology

From the cardioembolic stroke subgroup according to CCS classification in 51.6% (n = 33) cases cardioembolic genesis can be stated as evident, 3.1% (n = 2) – probable, 45.3% (n = 29) – possible (Fig. 2).

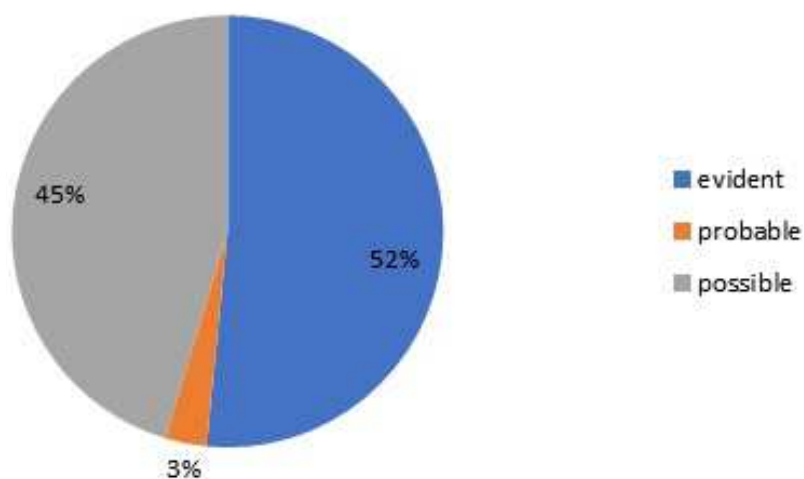


Figure 2. Cardioembolic stroke subgroups

Typical risk factors for stroke are observed in the cardioembolic genesis stroke group: arterial hypertension 60.9% (n = 39), dyslipidemia 50.0% (n = 32), smoking 42.2% (n = 27), atherosclerosis 40.6% (n = 26). Diabetes mellitus is less common in 12.5% (n = 8) (Fig. 3). Stroke affects the anterior cerebral circulation in 64.1% (n = 41) cases, and posterior cerebral circulation in 28.1% (n = 18) cases, and affects both the anterior and posterior circulation in 7.8% (n = 5) cases (Fig. 4).

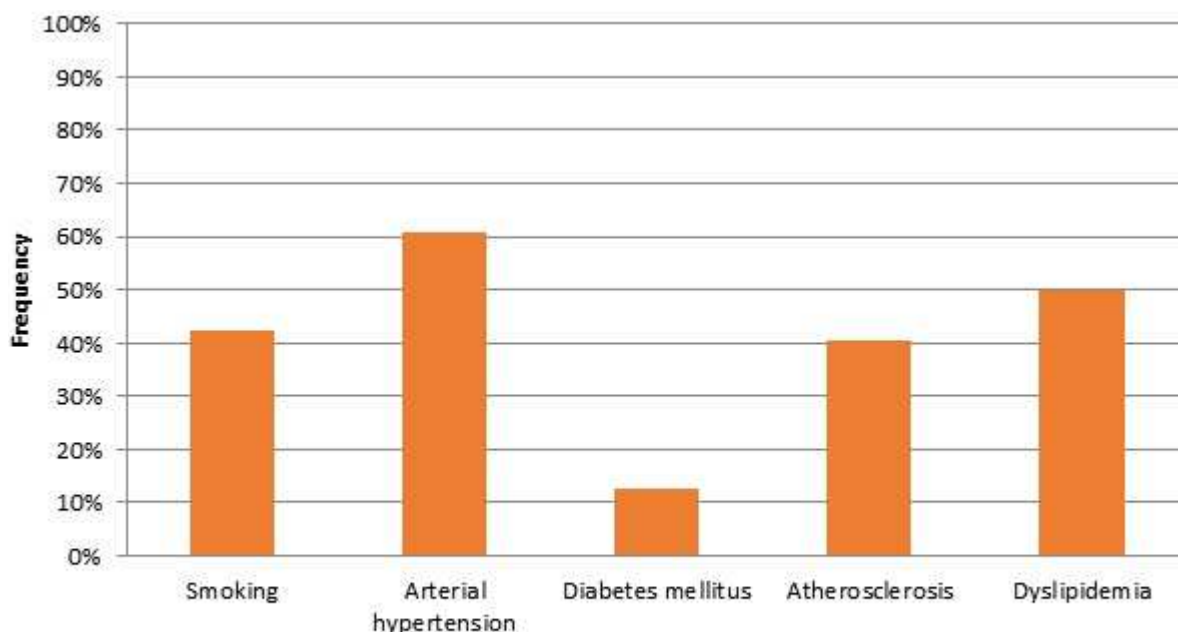


Figure 3. Stroke risk factors

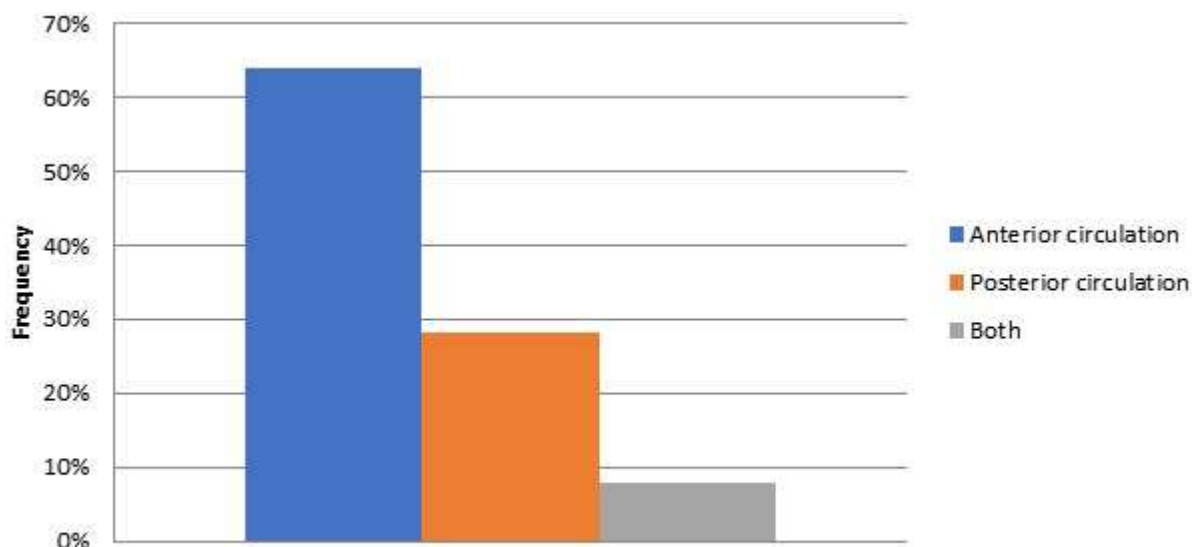


Figure 4. Cerebral vascular territories

In the cardioembolic cerebral infarction group of patients under 55 years of age, the most common source of cardioembolism is permanent atrial fibrillation 32.8% (n = 21), followed by patent foramen ovale 20.3% (n = 13), dilated cardiomyopathy, left ventricular hypertrophy 15.6% (n = 10), mechanical valves 7.8% (n = 5), left ventricular thrombus, atrial septal aneurysm with patent foramen ovale – 4.7% (n = 3), paroxysmal atrial fibrillation, recent myocardial infarction and left ventricular wall motion abnormalities – 3.1% (n = 2), left atrial thrombus, left ventricular aneurysm without thrombus, congestive heart failure with ejection fraction <30%, apical akinesia and ventricular septal aneurysm are the least frequent – 1.6% (n=1) (Fig. 5).

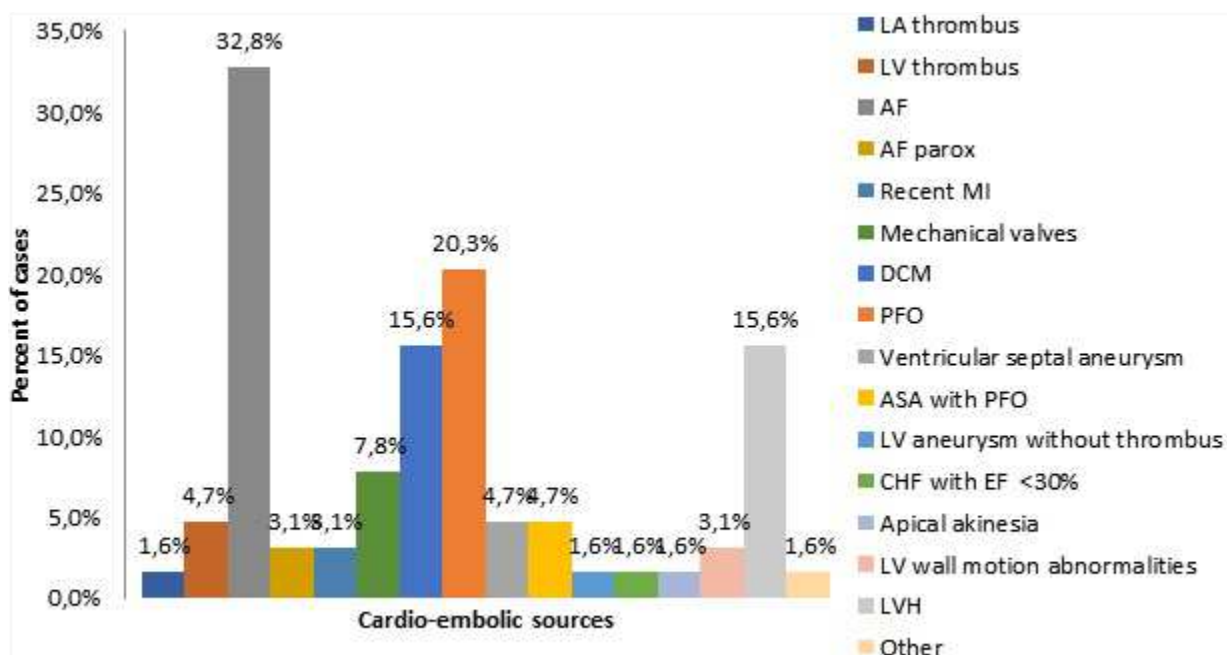


Figure 5. Cardioembolism sources (<55 years of age)

Comparing the two age groups (≤ 49 years ($n = 31$) and > 49 years ($n = 33$)), a statistically significant difference was observed for permanent atrial fibrillation and PFO. Atrial fibrillation in the permanent form under the age of 49 makes up 16.1% ($n = 5$), aged 50–55 g. 48.5% ($n = 16$), $p = 0.006$. PFO under the age of 49 makes up 41.9% ($n = 13$), aged 50–55 g. there is no case of PFO (0%), $p < 0.001$. In patients under 49 years of age, the leading source of cardioembolism is PFO 41.9% ($n = 13$) and atrial fibrillation (permanent form) is detected in only 16.1% ($n = 5$), while in patients aged 50–55 years the leading source of cardioembolism is atrial fibrillation: permanent form – 48.5% ($n = 16$), paroxysmal – 6.1% ($n = 2$), and none of the patients in this group showed PFO (Fig. 6).

After evaluating patients on the RoPE scale, seven patients score seven points, corresponding to 72%, three patients have eight points, corresponding to 84%, and three patients have nine points, corresponding to 88%. Therefore, all patients with patent foramen ovale have a RoPE score of ≥ 7 , indicating a high likelihood of association between the stroke and the pathology (Fig. 7).

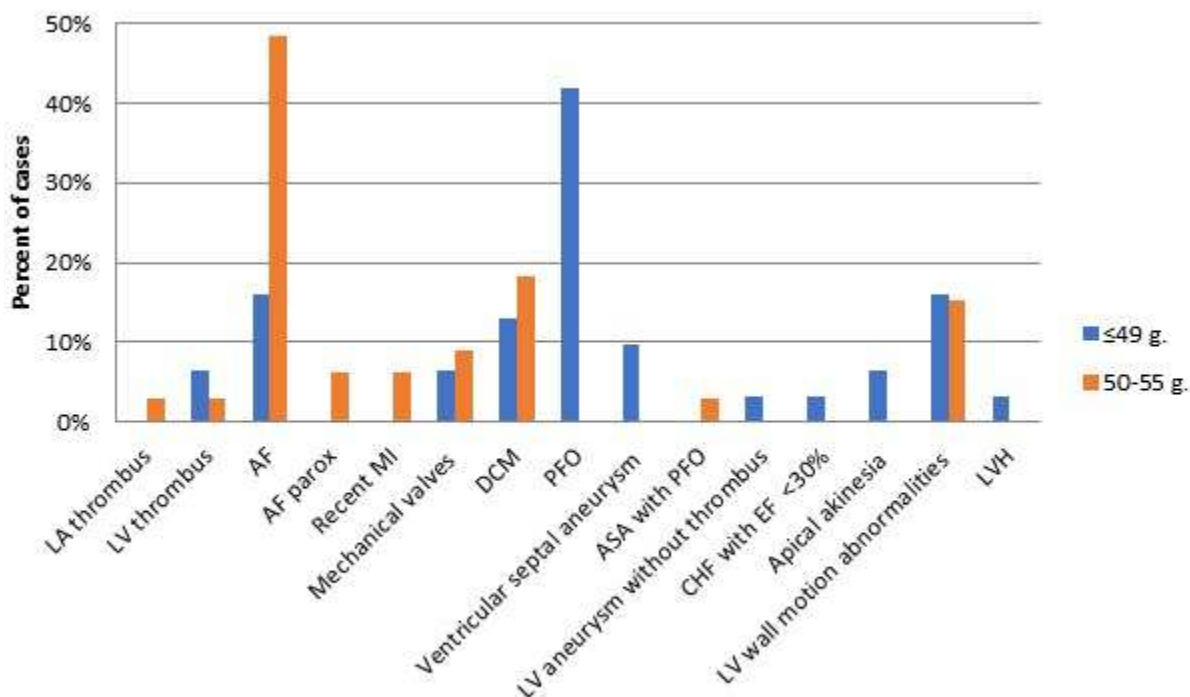


Figure 6. Cardioembolism sources (<49 years and 50–55 years)

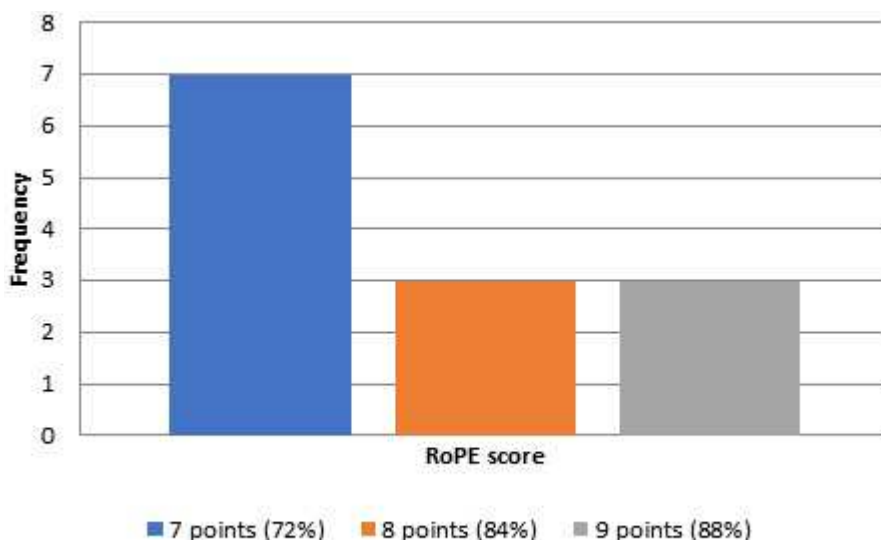


Figure 7. RoPE score

Discussion

According to the literature, the main source of cardioembolism in stroke-typical age patients is atrial fibrillation, which has an incidence of about 50% (Kamel et al, 2017), while in young patients, according to a study by Putaala J., et al. 37%, but the incidence of atrial fibrillation is only 14% (Putaala et al, 2000).

According to the results of this study, the leading source of cardiac embolism in Riga East Clinical university hospital for patients under 55 years of age is atrial fibrillation 32.8%, followed by PFO 20.3%. The incidence of atrial fibrillation increases with age (Kamel et al, 2017), so the high proportion of atrial fibrillation in the study group can be explained by the high age limit of

young patients, which was defined as 55 years of age. In a subgroup analysis where the age limit was defined as 49 years, atrial fibrillation accounted for only 16.1% of patients under 49 years of age, with PFO being the leading source of cardioembolism at a rate of 41.9%. All patients with patent foramen ovale have a RoPE score of ≥ 7 , indicating a high likelihood of association between the stroke and the pathology. At 50–55 years, the incidence of atrial fibrillation is 48.5% and no cases of PFO have been reported in this age group.

From the resulting results and data in the literature, it can be concluded that the age limit adopted to define new patients is of great importance. Perhaps a more accurate definition of the age group of young patients would be up to 49 years.

Cardioembolic stroke plays an important role in young patients, and differences in the incidence of sources of cardioembolism are observed, reinforcing the importance of PFO in this age group.

Conclusions

The most common source of cardioembolism in patients under 55 years of age is permanent atrial fibrillation (32.8%), followed by patent foramen ovale (20.3%). Patent foramen ovale plays a leading role under the age of 49 years (41.9%), but permanent atrial fibrillation (48.5%) occurs over the age of 50 years, and no patients with patent foramen ovale were found in this group. All patients with a patent foramen ovale score on the RoPE scale score ≥ 7 points ($\geq 72\%$), indicating a high probability of stroke being directly associated with the pathology.

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EMOTIONAL WELLBEING AMONG HEALTH CARE SPECIALISTS DURING COVID-19 PANDEMIC

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Abstract

Emotional wellbeing among health care specialists during Covid-19 pandemic

Key Words: COVID-19, health care, depression, anxiety

Introduction. In January 2020 the World Health Organisation declared the outbreak of a new coronavirus disease. A study in China represents that during Covid-19 pandemic among health care workers 50,4% have symptoms of a depression and 44,6% – symptoms of anxiety.

Aim. To investigate the prevalence of depression and anxiety during Covid-19 infection pandemic among health care specialists.

Method. A cross-sectional study. An online survey that consisted of a hospital anxiety and depression scale.

Results. In total there were 107 respondents, the median age was 28 years. Out of all respondents 2,8% were extremely worried about pandemic, 38,3% were worried, but not so much, 37,4% were worried only a little and 21,5% were not worried at all. Out of all respondents depressive sensations were found with 11,2% of people, border depression status were found with 8,4%. An anxiety was found with 19,6% and border anxiety – 13,1%.

Conclusions. Anxiety is more prevalent than depression among health care specialists. One-third of respondents have border anxiety or anxiety, and one-fifth have border depression or sensation of depression. Around two-fifths of the respondents are worried about the current situation. In most cases people worry about the ambiguity of their future, the health of their relatives or selves and their financial situation.

Kopsavilkums

Emocionālā labsajūta veselības aprūpes speciālistu vidū COVID-19 pandēmijas laikā

Atslēgvārdi: COVID-19, veselības aprūpe, depresija, trauksme

Aktualitāte. 2020. gada janvārī Pasaules Veselības organizācija izsludināja jauna veida koronavīrusa izplatīšanos. Ķīnā veikts pētījums veselības aprūpes speciālistu vidū uzrāda, ka 50,4% no dalībniekiem ir depresijas simptomi un 44,6% ir trauksmes simptomi.

Mērķis. Noskaidrot depresijas un trauksmes prevalenci veselības aprūpes speciālistu vidū COVID – 19 pandēmijas laikā.

Metode. Šķērsriezuma pētījums. Tā bija tiešsaistes anketa, ko veidoja hospitālā trauksmes un depresijas skala.

Rezultāti. Analizētas 107 anketas. Vidējais vecums bija 28 gadi. No respondentiem 2,8% bija ļoti noraizējušies par pandēmiju, 38,3% uztraucās, bet ne tik daudz, 37,4% bija noraizējušies tikai nedaudz un 21,5% atzīmēja, ka neuztraucas nemaz. No visiem respondentiem depresijas sajūtas tika konstatētas 11,2%, robeždepresijas stāvoklis – 8,4%. Trauksme tika konstatēta 19,6% un trauksmes robežstāvoklis – 13,1% dalībnieku.

Secinājumi. Veselības aprūpes speciālistu vidū trauksmes izplatība novērojama biežāk kā depresija. Vienai trešdaļai dalībnieku ir trauksmes robežstāvoklis vai trauksme un vienai piektdaļai ir depresijas robežstāvoklis vai depresīvs garastāvoklis. Aptuveni divas piektdaļas no dalībniekiem ir noraizējušies par pašreizējo situāciju. Lielākoties respondenti raizējās par neskaidrību par nākotni, pašu un tuvinieku veselības stāvokli un finansiālo situāciju ģimenē.

Introduction

In January 2020 the World Health Organisation (*WHO*) declared the outbreak of a new coronavirus disease – COVID-19 and in March 2020, *WHO* made the assessment that it can be characterised as a pandemic (*WHO*, 2020).

As of writing this document (June 25, 2020) coronavirus has infected 9 229 049 people and there have been 477 269 deaths worldwide and the numbers are still growing. (*WHO*, 2020). In Latvia right now there are 1111 cases and 30 deaths (European centre for disease prevention and control, *ECDC*, 2020).

The outbreak of a disease, especially a pandemic, can be stressful for people and can cause a fear and anxiety. As the coronavirus pandemic spreads across the world very fast, it is inducing a considerable degree of worry and concern in the population at large. It mostly affects older adults, care providers and people with chronic disease. (Centres of disease control and prevention, *CDC* 2020). There are different methods people use to cope with situations like this. WHO recommends that some of the ways to reduce the stress could be talking to ones closest friends and work colleagues, maintaining healthy lifestyle, limiting worry and agitation and focusing on hobbies (WHO, 2020). There are opinions out there that predict – the global pandemic could rise the risk of suicide. During COVID–19 pandemic most common risk factors include social isolation, economic recession, stress, anxiety and pressure in medical healthcare professionals (Thakur et al., 2020).

Challenges for those who work in health care are the increased workload, fear of getting infected, working with personal protective equipment, caring for patients who are infected and caring for colleagues who have also fallen ill (Walton et al., 2020).

A study in China represents data on depression and anxiety levels among health care workers during Covid-19 pandemic. The results show that 50,4% of respondents have symptoms of a depression and 44,6% have symptoms of anxiety (News RX 2020).

Another study in China shows that anxiety symptoms are more likely to happen to people under 35 years of age and those who extensively focus their thinking on the outbreak. In comparison with other professions, healthcare workers show higher risks for poor sleep quality (Yeens Huang et al., 2020).

Professionals working directly with the patients with COVID-19 are showing significant work-related psychological pressure and frequent somatic symptoms (Barello et al., 2020).

It is important to notice that at the time of the pandemic, people with pre-existing mental illnesses are more likely to develop symptoms (Groover et al., 2020).

Aim: To investigate the prevalence of depression and anxiety during COVID-19 infection pandemic among health care specialists.

Material and Methods

This was a cross-sectional study. The online survey was distributed using social networking service Facebook. The questionnaire consisted of demographic questions and a hospital anxiety and depression scale (HADS). HADS is commonly used to determine the levels of anxiety and depression that a person is experiencing. The HADS was devised 30 years ago by Zigmond and Snaith to measure anxiety and depression in a general medical population of patients (Stern et al., 2014) It has become a popular tool, for clinical practice and research. The HADS is a fourteen point scale – seven for anxiety and seven for depression and takes 2–5 min to complete. It is one of the National Institute for Health and Care Excellence (NICE) recommended tools for diagnosis of depression and anxiety.

An analysis of the data was performed using MS Excel and IBM SPSS – descriptive statistics.

Results

In total there were 107 respondents, out of them 88 (82,2%) were women and 19 (17,8%) – men. The median age was 28 years, age group 22 up to 62 years old.

Out of all respondents 93 (86,9%) live in a city, 8 (7,5%) in a small town and 6 (5,6%) in the countryside. Out of all respondents 3 (2,8%) were extremely worried about COVID-19 pandemic and the possible resulting situations, 41 (38,3%) were worried, but not so much, 40 (37,4%) were worried only a little and 23 (21,5%) were not worried at all.

A life companion (61%), close friend (46%), parents (44%) and work colleague (37%) are closest people respondents share their thoughts and feelings with. Also, participants mentioned sister or/and brother (31%), other family member (15%) and psychotherapists (4%). 99,1% noted they were worrying about something during this time. The most common topics that cause worries are ambiguity about the future situation (67%), worries about relative or own health (66%) and financial situation (36%). Some respondents also worry about restrictions in health care availability (39%), own university education (31%), travel restriction (20%), self-realization (17%) and restriction to go to the store (12%). Out of all respondents, depressive sensations were found with 11.2% of people, border depression status was found with 8,4%. Anxiety was found with 19,6% and border anxiety – 13.1% of people. Out of all respondents eight felt both – anxiety and depressive sensations.

Discussion

In the study we can see that there are emotional wellbeing disturbances among health care specialists. Most commonly it manifests as anxiety. In the future it would be interesting to investigate emotional wellbeing changes in a longer time period. It is the authors opinion it would be important to organize psycho-emotional rehabilitation for health care specialists.

Conclusions

1. Anxiety is more prevalent than depression among health care specialists. One-third of respondents have border anxiety or anxiety, and one-fifth have border depression or sensation of depression.
2. Around two-fifths of the respondents are worried about the current situation. In most cases people worry about the ambiguity of their future, the health of their relatives or selves and their financial situation.

Acknowledgement

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KNOWLEDGE OF LATVIAN DERMATOLOGISTS IN OCCUPATIONAL SAFETY USING LIQUID NITROGEN AND CRYOSURGERY SPRAY GUN

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Abstract

Knowledge of Latvian dermatologists in occupational safety using liquid nitrogen and cryosurgery spray gun

Key Words: cryosurgery, dermatology, occupational safety, liquid nitrogen

Background. Cryosurgery using liquid nitrogen and cryosurgery spray gun is often used among dermatologists all over the world, but information on occupational safety in this area is not easy to obtain.

Objectives. The aim of the study is to evaluate the knowledge of Latvian dermatologists in occupational safety using liquid nitrogen and cryosurgery spray gun.

Materials and methods. The methods used in the study include literature review and survey. The literature on safety aspects to be considered when working with liquid nitrogen and cryosurgery spray gun was reviewed. A web survey was used to evaluate the knowledge of dermatologists. IBM SPSS Statistics was used to analyze the results, descriptive statistical analysis and Independent Samples T Test was applied ($p < 0.05$ was considered as statistically significant).

Results. 28 respondents took part in the survey. Latvian dermatologists' knowledge of occupational safety using liquid nitrogen and cryosurgery spray gun reaches 63%. Individual results of the surveyed specialists varies from 30% to 90%. Most of the respondents (54%, $n=15$) admitted that they had not read the instructions for use of the cryosurgery spray gun, however, their knowledge of occupational safety was not statistically significantly worse than those who had read the instructions.

Conclusion. The knowledge of dermatologists can be assessed as mediocre. There is insufficient knowledge about the properties of nitrogen as a chemical element, as well as its storage conditions, various pressure regulation systems and the principles of operation of cryosurgery spray gun. In order to improve the knowledge, it is recommended to promote the availability of the instructions for use of the spray gun, to upgrade their content, to incorporate the issue in conferences related to dermatology, as well as to perform training in the workplaces of specialists.

Kopsavilkums

Latvijas dermatologu izpratne darba drošībā, izmantojot šķidro slāpekli un krioterapijas iekārtu

Atslēgvārdi: krioterapija, dermatoloģija, darba drošība, šķidrslāpekļis

Ievads. Dermatologi visā pasaulē savā darbā plaši pielieto krioterapiju, izmantojot šķidro slāpekli un krioterapijas iekārtu, tomēr informācija par darba drošību šajā sfērā ir grūti pieejama.

Mērķis. Pētījuma mērķis ir novērtēt Latvijas dermatologu izpratni darba drošībā, izmantojot šķidro slāpekli un krioterapijas iekārtu.

Metodes. Pētījumā izmantotās metodes ietver literatūras analīzi un aptauju. Literatūrā apskatīti jautājumi par drošības aspektiem, kas jāievēro, strādājot ar šķidro slāpekli un krioterapijas iekārtu. Dermatologu izpratnes izvērtēšanai izmantota tīmekļa aptauja. Rezultātu analīzei izmantota programma IBM SPSS Statistics, pielietota aprakstošā statistika un *Independent Samples T Test* (vērtība $p < 0.05$ tika uzskatīta par statistiski nozīmīgu).

Rezultāti. Aptaujā piedalījušies 28 respondenti. Latvijas dermatologu izpratne darba drošībā, izmantojot šķidro slāpekli un krioterapijas iekārtu, sasniedz 63% zināšanu līmeni. Aptaujāto speciālistu individuālie rezultāti svārstās no 30% līdz 90%. Lielākā daļa no aptaujātajiem (54%, $n=15$) atzinuši, ka nav izlasījuši krioterapijas iekārtas lietošanas instrukciju, tomēr viņu zināšanas darba drošībā, salīdzinot ar tiem, kas instrukciju ir lasījuši, nav statistiski nozīmīgi sliktākas.

Secinājumi. Dermatologu izpratne vērtējama kā viduvēja. Nepietiekamas ir zināšanas par slāpekļa kā ķīmiskā elementa īpašībām, kā arī tā uzglabāšanas noteikumiem, dažādām spiediena regulācijas sistēmām un krioterapijas iekārtas funkcionēšanas principiem. Zināšanu pilnveidei ieteicams uzlabot iekārtu lietošanas instrukciju pieejamību, papildināt to saturu, aktualizēt jautājumu ar dermatoloģiju saistītās konferencēs, kā arī veikt apmācību speciālistu darba vietās.

Introduction

Cryosurgery is a minimally invasive surgical technique that utilizes subzero temperatures to destroy benign, premalignant, and malignant lesions. (Bologna et al. 2018) In 1990, just 23 years after the creation of the first hand-held cryosurgery device, 87% of dermatologists already used cryosurgery in their practice, and today it has become even more common. (Freiman 2005) Usually

dermatologists use cryosurgery spray guns which is refilled every day from a liquid nitrogen storage tank. (Abramovits et al. 2016)

Over time, liquid air, nitrous oxide, dry ice and others have been used as a cold source or cryogen, but currently the most commonly used is liquid nitrogen. (James et al. 2020) Its advantages include low boiling point, low production costs, non-flammability, no need to keep under pressure during storage and transportation, and non-toxic vapors. (Abramovits et al. 2016)

The scientific literature available in the field of dermatology does not include information on occupational safety using liquid nitrogen and cryotherapy equipment. The user manual of the cryotherapy device is available only upon purchase, as well as on some websites of the manufacturers. According to Blackler et al., only 25% of people read the instructions that came with various devices.

The above raises doubts as to whether every medical specialist engaged in cryosurgery is sufficiently knowledgeable in matters of occupational safety. The aim of the study is to evaluate the knowledge of Latvian dermatologists in occupational safety using liquid nitrogen and cryosurgery spray gun.

Material and Methods

The literature on safety aspects to be considered when working with liquid nitrogen and cryosurgery spray gun was reviewed. A web survey was used to evaluate the knowledge of dermatologists. IBM SPSS Statistics was used to analyze the results, descriptive statistical analysis and Independent Samples T Test was applied ($p < 0.05$ was considered as statistically significant).

Results

28 Latvian dermatologists participated in the survey. Over 90% of respondents use cryosurgery in their work. 100% of them use liquid nitrogen and cryosurgery spray gun. (Table 1)

Most of the respondents have not read instructions for use of cryosurgery spray gun. (Figure 1)

Table 1. Use of cryosurgery, liquid nitrogen and cryosurgery spray gun among dermatologists

	Yes	No
Do you use cryosurgery in your work?	93% (n=26)	7% (n=2)
Do you use liquid nitrogen in your work?	93% (n=26)	7% (n=2)
Do you use cryosurgery spray gun in your work?	93% (n=26)	7% (n=2)

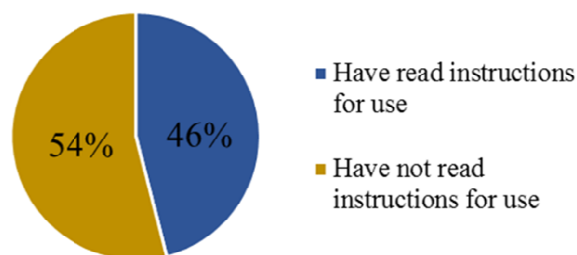


Figure 1. Proportion of those who read and did not read the cryosurgery spray gun instructions for use

Of the 28 respondents, 13 have read the instructions and 15 have not.

Respondents were asked to rate the truth of 10 statements as “True” or “False”. The statements as well as their truthfulness can be seen in Table 2.

Table 2. Statements included in survey used to evaluate dermatologists knowledge

Statement	Correct answer and its explanation
1. Gloves, goggles and closed shoes should be used when pouring nitrogen from its storage tank into the spray gun.	TRUE The use of personal protective equipment is mandatory. Spillage of liquid nitrogen on the skin, mucous membranes and eyes can result in serious damage. (Brand 2017)
2. In case of nitrogen spillage, room ventilation is required.	TRUE As nitrogen spills and evaporates, its volume increases 694 times. Although the ambient air contains 78% nitrogen, rapid expansion in poorly ventilated areas can quickly replace oxygen, leading to hypoxaemia. (Morales et al. 2017) According to the US Chemical Safety and Hazard Investigation Board, between 1992 and 2002, 80 people died of nitrogen-induced asphyxia in the United States.
3. To avoid nitrogen leakage, it is advisable to store it in an airtight container.	FALSE When nitrogen is stored, it gradually evaporates and the pressure in the tank increases. Excessive pressure would blow up the tank, so neither the storage tank nor the spray gun can be hermetically sealed.
4. Spray gun must be cooled before pouring nitrogen in it.	FALSE There is no need to cool it down.
5. When using a spray gun, it must be kept upright.	TRUE In order for nitrogen to be removed from the spray gun, its liquid part must be located at the bottom, from where it is discharged through an outlet pipe.
6. Tilting a filled spray gun by > 45° carries a high risk of a pressure explosion.	FALSE To prevent excessive pressure, each cryotherapy device has a safety valve. It releases excess pressure from time to time or when operating the machine. When the filled cryotherapy device is tilted, the pressure initially increases, however, the safety valve removes excess nitrogen.
7. Hissing sound from the spray gun is normal and does not indicate a malfunction of the device.	TRUE The operation of the safety valve produces a hissing sound.
8. Due to the flammability of nitrogen, cryotherapy should not be performed near an open flame.	FALSE Nitrogen is an inert gas, it is not flammable. In the event of a fire, it can even be used to extinguish the fire.
9. Excessive exposure to nitrogen vapor is associated with the development of chronic lung diseases.	FALSE There is no such data.
10. Exposure of liquid nitrogen to the skin is considered teratogenic due to its effects on tumor suppressor genes.	FALSE There is no such data.

When evaluating only one statement, absolutely all respondents evaluated it correctly. The range of correct answers for the other nine statements ranges from 21% to 89%. (Figure 2)

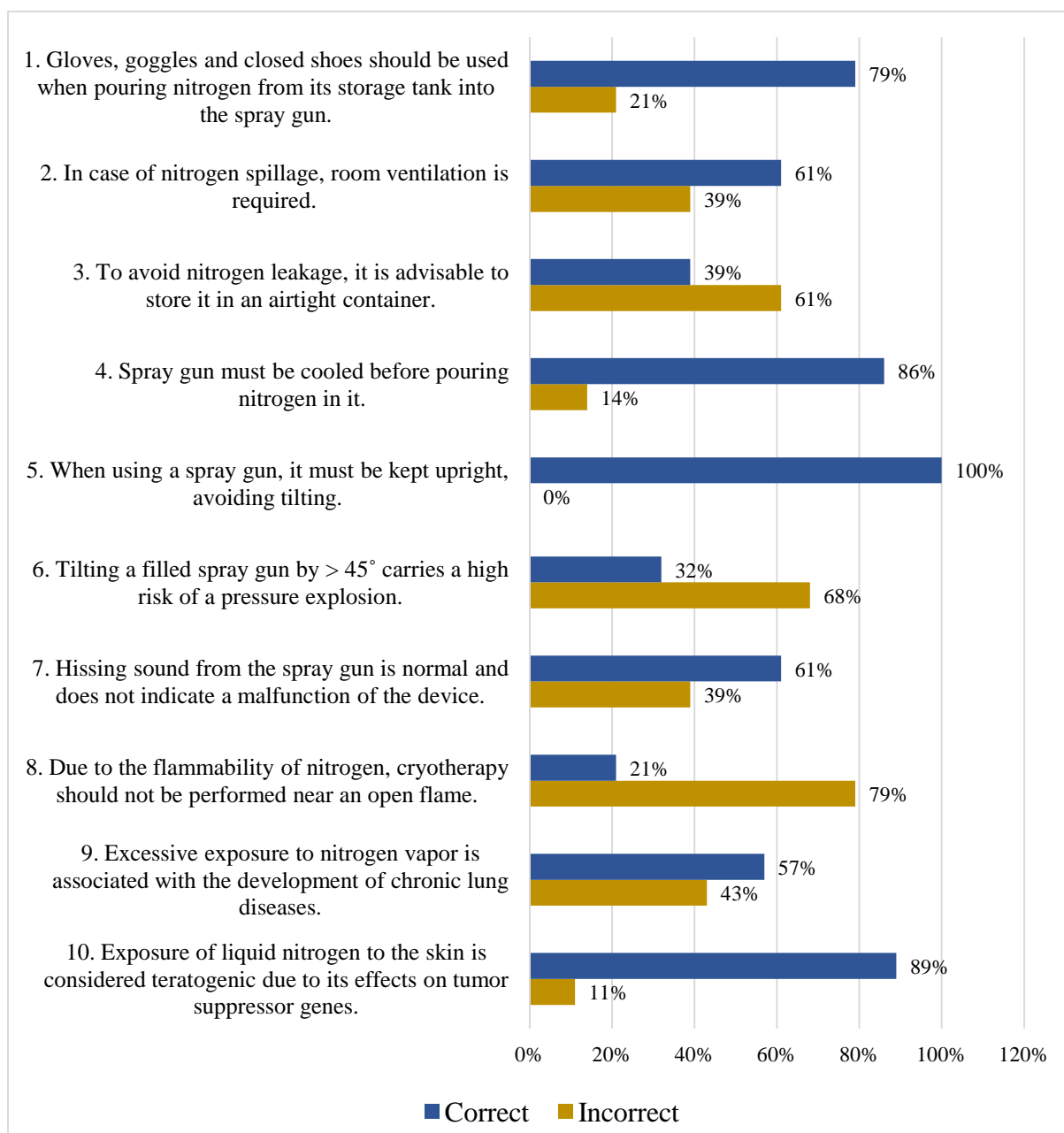


Figure 2. Percentage of correct and incorrect assessments of statements

Individual respondents' results vary from three correct answers (30%) to nine answers (90%). The median of the results is six correct answers. The mode of the results, or the most common number of correct answers, was six and seven.

The mean of the results is 6.3 (63%) correct answers. In the group that has read the instructions for use – 6.4 (64%), in the group that has not read the instructions for use – 6.1 (61%). Result difference between both groups are not statistically significant. (p=0,66) There is also no statistically significant difference in evaluation of individual statements.

Discussion

The lowest results are observed for nitrogen flammability and explosion hazards. Given this, it can be assumed that in some aspects dermatologists are even too cautious in their work.

Dermatologists' knowledge of occupational safety using liquid nitrogen and spray gun reaches 63% and can be assessed as mediocre. There is a need to improve their knowledge of nitrogen as a chemical element, as well as of the technical aspects of liquid nitrogen storage, various pressure control systems and the principles of operation of cryosurgery spray gun.

Realizing that cryotherapy equipment is not always used only by its owner, its manufacturers may attach to the device sold several instructions for use, which may be passed on to each of its users. Currently, they can only be downloaded from few of the manufacturers' websites on the Internet, but it is recommended that each manufacturer make them freely available. Instructions content must be upgraded, it must better explain the principles of operation and the consequences of possible actions.

Discussion of occupational safety in dermatology-related conferences should be considered. These include issues related not only to cryotherapy but also to other manipulations such as lasers and electrocautery. It is recommended to provide more extensive training during the residency, as well as in specialist workplaces.

Given the number of respondents included in this study, further research is needed to refine the data by expanding the amount of data processed.

Conclusions

The knowledge of dermatologists can be assessed as mediocre. There is insufficient knowledge about the properties of nitrogen as a chemical element, as well as its storage conditions, various pressure regulation systems and the principles of operation of cryosurgery spray gun. In order to improve the knowledge, it is recommended to promote the availability of the instructions for use of the spray gun, to upgrade their content, to incorporate the issue in conferences related to dermatology, as well as to perform training in the workplaces of specialists.

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DIABETIC KETOACIDOSIS AND ACUTE PANCREATITIS IN CHILDREN'S CLINICAL UNIVERSITY HOSPITAL FROM 2015 TILL 2017

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Abstract

Diabetic ketoacidosis and acute pancreatitis in Children's Clinical University Hospital from 2015 till 2017

Key Words: type 1 diabetes, diabetic ketoacidosis, acute pancreatitis, pediatrics

Introduction. Type 1 diabetes and pancreatitis both are common endocrine and exocrine pathologies of the pancreas in a pediatric population, while their acute presentations – diabetic ketoacidosis (DKA) and acute pancreatitis (AP) – require a prompt diagnosis and intensive treatment. Furthermore, as discussed in literature and research studies, there's still space for more research on the interchanging relationships between DKA and AP.

Aim. The aim of the study was to evaluate and analyze the characteristics and possible relations between DKA and AP in a pediatric population.

Research tasks and methods. A retrospective evaluation of 207 pediatric cases, corresponding International Classification of Diseases (ICD-10) codes E10.1 and K85, for the time period of 2015–2017 was carried out. Statistical analysis was done using *Microsoft Excel* and *IBM SPSS Statistics*.

Results. Most admission rates in the study group were due to type 1 diabetes with DKA (79,2%). DKA was a complication both in newly diagnosed (64%) and established type 1 diabetes patients (36%), and there was a significant correlation between the duration of illness and previous DKA episodes ($p < 0.01$). The analysis of AP diagnostic criteria showed the presentation of abdominal pain in 97,7% AP patients and a correlation between lipase and abdominal imaging results (95,3% versus 75,6%; $p < 0,01$). There was a nonspecific as well as marked increase, reaching diagnostic criteria, in pancreatic enzyme levels in type 1 diabetes patients with DKA and these findings were consistent with correlation between pH and lipase ($p < 0.01$).

Conclusions. DKA is an important complication both in newly diagnosed and established type 1 diabetes patients, presenting at different times in the course of the disease, and in a number of patients a rise in pancreatic enzyme levels can occur that can be associated with metabolic acidosis. AP has established diagnostic standards, including physical, biochemical and visual diagnostical criteria, that were reaffirmed in this pediatric study group.

Kopsavilkums

Diabētiskā ketoacidoze un akūts pankreatīts Bērnu klīniskā universitātes slimnīcā no 2015. līdz 2017. gadam

Atslēgvārdi: 1. tipa cukura diabēts, diabētiska ketoacidoze, akūts pankreatīts, pediatrija

Aktualitāte. 1. tipa cukura diabēts un pankreatīts aprakstītas kā biežākās aizkuņģa dziedzera endokrīno un eksokrīno daļu patoloģijas bērna vecumā. Šo slimību akūtie stāvokļi – diabētiskā ketoacidoze (DKA) un akūts pankreatīts (AP) – pediatriiskajā praksē pieprasa steidzamu diagnostiku, diferenciāldiagnostiku un intensīvu ārstēšanu, turklāt attiecības starp abiem stāvokļiem tiek raksturotas kā savstarpēji mainīgi lielumi, raisot diskusijas par savstarpējo mijiedarbību.

Pētījuma mērķis. Novērtēt un salīdzināt abu akūto stāvokļu – DKA un AP – raksturlielumus un to iespējamo saistību pediatriiskā populācijā.

Pētījuma uzdevumi un metodes. Retrospektīva medicīniskās dokumentācijas izpēte – 207 pacientu vēstures, atbilstoši Starptautiskā slimību klasifikatora (SSK-10) kodiem E10.1 un K85, par laika periodu 2015.–2017.gads; iegūto datu analīze, izmantojot *Microsoft Excel* un *IBM SPSS Statistics* – aprakstošās statistikas un korelāciju metodes.

Rezultāti. 79,2% stacionēto gadījumu bija 1.tipa CD pacienti ar DKA, turklāt DKA bija gan slimības pirmreizēja manifestācija, gan komplikācija jau iepriekš diagnosticētiem pacientiem, kā arī tika apstiprināta statistiski ticama saistība starp slimības ilgumu un DKA epizodēm anamnēzē ($p < 0.01$). Savukārt AP pacientu vidū vēdersāpes bija slimības klīniskā izpausme 97,7% gadījumu, kā arī apstiprinājās korelācija starp lipāzes līmeni un attēldiagnostikas atradni (95,3% versus 75,6%; $p < 0,01$). 1.tipa CD pacientiem ar DKA tika novērota aizkuņģa dziedzera enzīmu elevācija gan nespecifiskā līmenī, gan sasniedzot AP bioķīmiskos kritērijus, kā arī apstiprinājās saistība starp abu slimību diagnostiskajiem kritērijiem – pH un lipāzi ($p < 0.01$).

Secinājumi. DKA ir nozīmīga komplikācija 1.tipa CD pacientiem dažādos slimības periodos, savukārt nelielam skaitam pacientu var novērot arī aizkuņģa dziedzera enzīmu elevāciju asociācijā ar pH, liekot domāt par slimību savstarpējām attiecībām, ietekmi un diferenciāldiagnostiku. AP diagnostiskie standarti, kas iever gan klīnisko ainu, gan bioķīmiskos un attēldiagnostikas kritērijus, un to nozīme apstiprinājās mazāk pētītajā bērnu populācijā.

Introduction

Type 1 diabetes and pancreatitis both are common endocrine and exocrine pathologies of the pancreas in a pediatric population, while their acute presentations-diabetic ketoacidosis (DKA) and acute pancreatitis (AP) – require a prompt diagnosis, differential diagnosis and intensive treatment. (Wolfsdorf et al., 2014) (Párniczky et al., 2018)

Type 1 diabetes is a heterogenous, complex and chronic pathology with well documented acute and long-term complications, marking the disease as an important public health problem as described in such terms as a decreased quality of life, economic burden, morbidity, mortality and potentially years of life lost. Taking in account the typical age of presentation, meaning childhood and adolescence, as well as the presence of the acute complication – diabetic ketoacidosis – at presentation of type 1 diabetes and the chronic course of the disease, type 1 diabetes is an important health care problem with ever-changing goals and challenges. (Copenhaver et al, 2017) (Monaghan et al, 2015)

Acute pancreatitis is an acute inflammation of the pancreas with a varied etiology and usually with a good prognosis in children, but a rise in the incidence and associated morbidity has been noted within last decades in the pediatric population. It also should be noted that AP recommendations in pediatrics are based on consensus conferences and derived from adult guidelines, presenting the need for more research based on pediatric population. (Párniczky et al., 2018) (Abu-El-Haija et al, 2018)

Furthermore, as discussed in literature and research studies, there's still space for more data on the interchanging relationships between diabetic ketoacidosis and acute pancreatitis. (Aboulhosn et al., 2013) (Crain et al, 2010) (Nair et al, 2010)

Materials and methods

A retrospective evaluation of 207 pediatric cases, corresponding International Classification of Diseases (ICD-10) codes E10.1 and K85, for the time period of 2015–2017 was carried out. Statistical analysis was done using *Microsoft Excel* and *IBM SPSS Statistics*.

Research was performed taking in account the laws of the Republic of Latvia and Helsinki Declaration. The data collection was anonymous, confidential and collected data was used only for the purposes of this study.

Results

A retrospective evaluation showed that most admission rates in the study group were due to type 1 diabetes with DKA (79,2%). When looking in detail at type 1 diabetes patients with DKA, the average duration of the disease upon admission was 2,2 years (min. 0; max. 14). DKA was a complication both in newly diagnosed (64%) and already established type 1 diabetes patients (36%), and, furthermore, there was a significant correlation between the duration of illness and

previous DKA episodes in patient's history ($p < 0.01$). When it comes to biochemical results, the average pH was 7.2 ± 0.1 with glycemia that of 21.7 ± 7.9 mmol/L. All patients were positive for ketones and met the biochemical criteria for bicarbonate levels ($\text{HCO}_3\text{-std } 11.2 \pm 3.5$ mmol/L, $\text{HCO}_3\text{-act } 7.7 \pm 3.9$ mmol/L). When looking at the severity of DKA episodes, you can see that 33,5% of the patients had mild DKA episode, while 25% – a severe episode with pH below 7,1 (Figure 1).

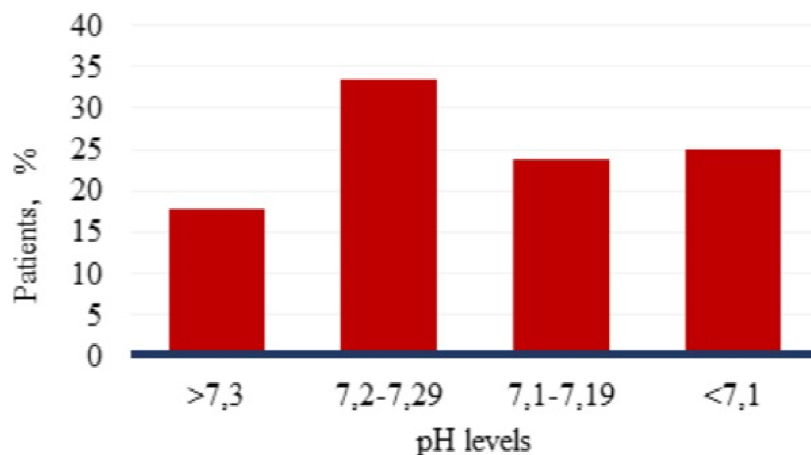


Figure 1. **The severity of diabetic ketoacidosis episode in type 1 diabetes patients**

The analysis of AP diagnostic criteria showed presentation of abdominal pain in 97,7% of admitted AP patients and reaffirmed that lipase is indeed a more specific biochemical marker for acute pancreatitis (amylase 806,8 U/L (min. 32,6, max. 3321,0), elevated ≥ 3 times in 59,5% of AP patients; lipase $2,3256e+98$ U/L (min. 10,9, max. $1,00e+100$), elevated ≥ 3 times – 95,3%). Data analysis also showed a definite correlation between lipase and abdominal imaging results (95,3% *versus* 75,6%; $p < 0,01$), as well as lipase and cholesterol levels ($p < 0,05$) in AP group.

When comparing both medical emergencies, there was a statistically significant difference between the two regarding admissions to Intensive Care Unit (49,4% DKA patients *versus* 2,3% AP patients, $p < 0,001$). There were also statistically significant differences between the two groups regarding such typical signs and symptoms upon presentation as polyuria, polydipsia, weight loss, wasting and abdominal pain ($p < 0,001$, Pearson Chi-Square test) (Figure 2).

One of the more interesting findings showed that there was a nonspecific as well as marked increase, reaching the diagnostic criteria, in pancreatic enzyme levels in type 1 diabetes patients with DKA – amylase and lipase was ≥ 3 times higher than normal in 3,3% DKA patients and these findings were consistent with a correlation between pH and lipase levels ($p = 0,005$, $p < 0,01$) (Figure 3).

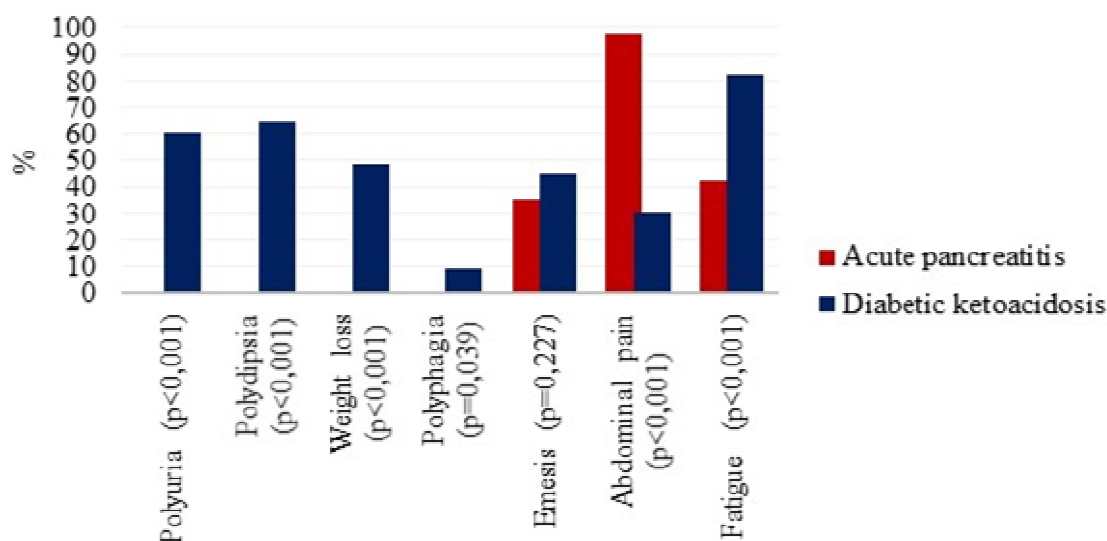


Figure 2. The clinical manifestations – signs and symptoms – in patient groups with acute pancreatitis and diabetic ketoacidosis

Pancreatic enzyme	Reference range	%
Amylase	<100 U/L	88,5
	100-300 U/L	8,2
	>300 U/L	3,3
Lipase	<60 U/L	91,1
	60-180 U/L	5,6
	>180 U/L	3,3

Figure 3. Pancreatic enzyme levels in type 1 diabetes patients with DKA

Discussion

As shown in this study, DKA is still a dangerous medical emergency in newly diagnosed and already established type 1 diabetes patients, with almost half of the patients (49,4%) requiring treatment in Intensive Care Unit and 25% presenting with a severe DKA episode. Thus, the importance of awareness and timely diagnosis as well as regular and adequate patient care both in health-care and familial settings should be emphasized, e.g., the education in recognising the typical signs and symptoms of type 1 diabetes and DKA.

Meanwhile, this study shows that the suggested recommendations for diagnosing pediatric pancreatitis, that are based on consensus conferences and have been derived from adult guidelines, work well also in the less researched pediatric population. Furthermore, based on the found correlation, this study also suggests that total cholesterol level testing should be considered in children with AP.

Exploring the relationships between the two medical emergencies, it should be noted that the severity of one acute state can cause complications regarding the other. As shown in this study, the pathology of endocrine pancreas – DKA – can also impair the exocrine part of the pancreas, causing a rise in pancreatic enzymes and exacerbating metabolic disorder.

Conclusions

This study shows that DKA is an important complication both in newly diagnosed and already established type 1 diabetes patients, presenting with typical symptoms and signs at different times in the course of the disease.

Meanwhile, AP has well-established diagnostic standards, including physical, biochemical and visual diagnostical criteria, that were reaffirmed in this study group, showing that these criteria work well also in the less researched pediatric population.

When researching the interchanging relationships between the two pathologies, the statistical analysis showed a rise in pancreatic enzyme levels in diabetic patients, and, furthermore, these changes correlated with metabolic acidosis, thus emphasizing the urgency of timely diagnosis and treatment.

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CORRELATION BETWEEN TUMOR MARKER LEVELS AND PET/CT FINDINGS IN PATIENTS WITH BREAST CANCER

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Abstract

Correlation between tumor marker levels and PET/CT findings in patients with breast cancer

Key Words: PET/CT, breast cancer, tumor marker, CEA, CA15-3

Objectives: In breast cancer patients tumor markers *Carcinoembryonic Antigen* (CEA) and Cancer Antigen (CA) 15-3 can help monitor the disease, however, these markers lack sensitivity and specificity. It is known that continuous analysis and other examinations may lead to unwanted anxiety and therefore decrease quality of life for the patient. Thus, the aim of this study was to clarify what correlation do tumor markers CEA and CA 15-3 have with Fluorine-18 fluorodeoxyglucose (¹⁸F-FDG) Positron Emission Tomography/Computed Tomography (PET/CT) findings in patients with breast cancer.

Materials and Methods: This retrospective study took place in Rīga Stradins University Nuclear Medicine Clinic from March of 2016 until June of 2019. Adult patients with histologically proven breast cancer who had tested their tumor marker levels and later underwent a PET/CT examination were included in this study. The patient histories, laboratory results and PET/CT reports were analysed.

Results: Out of 67 women with the median age of 53 years in PET/CT positive patients CEA median was 1.99 ng/mL and CA 15-3 median was 23.40 U/mL, but in PET/CT negative patients – 0.70 ng/mL and 15.00 U/mL, respectively (CEA p=0.011, CA 15-3 p=0.005). Both CEA and CA 15-3 were higher in patients with PET/CT positive bone metastases (CEA 5.35 ng/mL, CA 15-3 58.00 U/mL) than in patients without bone metastases (CEA 1.07 ng/mL, CA 15-3 16.15 U/mL) (CEA p=0.005, CA 15-3 p=0.001). Both markers were also higher in patients with other extra nodular metastases (CEA 2.48 ng/mL, CA 15-3 49.30 U/mL) when compared to patients without other extra nodular metastases (CEA 1.06 ng/mL, CA 15-3 17.29 U/mL) (CEA p=0.017, CA 15-3 p=0.013). Only CA 15-3 was higher in patients with lymph node involvement (26.10 U/mL) compared to patients with PET/CT negative lymph nodes (15.60 U/mL) (p=0.025). Furthermore, median CA 15-3 levels kept increasing with a higher number of metastases.

Conclusions: Higher CEA and CA 15-3 levels correlate with a positive PET/CT result, PET/CT positive bone and other extra nodular metastases, but only CA 15-3 level is higher in patients with lymph node metastases and an increasing number of metastases. Tumor marker levels within reference range do not exclude a positive PET/CT.

Kopsavilkums

Korelācija starp audzēju marķieru līmeni un PET/DT atradni pacientiem ar krūts vēzi

Atslēgvārdi: PET/CT, krūts vēzis, audzēju marķieri, CEA, CA15-3

Ievads: Krūts vēža pacientiem audzēju marķieri *Carcinoembryonic Antigen* (CEA) and Cancer Antigen (CA) 15-3 var palīdzēt monitorēt slimību, bet šiem marķieriem trūkst jutības un specifitātes. Ir zināms, ka analīžu atkārtošana un dažādi izmeklējumi var pacientiem radīt trauksmi un samazināt dzīves kvalitāti, līdz ar to šī pētījuma mērķis bija noskaidrot, kāda sakarība ir audzēju marķieru līmenim un Pozitronu Emisijas Tomogrāfijas/Datortomogrāfijas (PET/DT) atradnei pacientiem ar krūts vēzi.

Materiāli un metodes: Šis bija retrospektīvs pētījums, kas notika Rīgas Stradiņa Universitātes Nukleārās Medicīnas Klīnikā par laika posmu no 2016. gada marta līdz 2019. gada jūnijam. Pētījumā tika iekļauti pilngadīgi pacienti ar histoloģiski pierādītu krūts vēzi, kam bija noteikti audzēju marķieri un kuri vēlāk veica PET/DT izmeklējumu. Tika analizētas šo pacientu vēstures, analīžu rezultāti un PET/DT apraksti.

Rezultāti: No 67 sievietēm ar vecuma mediānu 53 gadi PET/DT pozitīviem pacientiem CEA mediāna bija 1.99 ng/mL un CA 15-3 mediāna bija 23.40 U/mL, bet PET/DT negatīviem pacientiem – 0.70 ng/mL un 15.00 U/mL respektīvi (CEA p=0.011, CA 15-3 p=0.005). Gan CEA, gan CA 15-3 līmenis bija augstāks pacientiem ar PET/DT pozitīvām kaulu metastāzēm (CEA 5.35 ng/mL, CA 15-3 58.00 U/mL) nekā pacientiem, kuriem šādu metastāžu nebija (CEA 1.07 ng/mL, CA 15-3 16.15 U/mL) (CEA p=0.005, CA 15-3 p=0.001). Tāpat abu marķieru līmenis bija augstāks pacientiem ar citām ārpus-limfmezglu metastāzēm (CEA 2.48 ng/mL, CA 15-3 49.30 U/mL) nekā pacientiem bez ārpus-limfmezglu metastāzēm (CEA 1.06 ng/mL, CA 15-3 17.29 U/mL) (CEA p=0.017, CA 15-3 p=0.013). Tikai CA 15-3 līmenis bija augstāks pacientiem ar limfmezglu metastāzēm nekā pacientiem ar PET/DT negatīviem limfmezgļiem (26.10 U/mL un 15.60 U/mL) (p=0.025), kā arī tā līmenis pieauga, palielinoties metastāžu skaitam.

Secinājumi: Augstāks audzēju marķieru CEA un CA 15-3 līmenis korelē ar pozitīvu PET/DT atradni, PET/DT pozitīvām kaulu un citām ārpus-limfmezglu metastāzēm, bet tikai CA 15-3 līmenis ir augstāks pacientiem ar limfmezglu metastāzēm un lielāku metastāžu skaitu. Normāls audzēju marķieru līmenis neizslēdz pozitīvu PET/DT iespēju.

Introduction

Breast cancer now is the most common female malignancy in the world and is the primary cause of death among women globally (Benson 2012). In Latvia approximately 1,000 women get diagnosed with breast cancer annually, and around 14 000 women live with the diagnosis (SPKC 2010–2017). This is a great burden for women themselves, as well as the national health system, which demands optimal disease management (Benson, 2012). At the moment the main methods for first diagnosis and follow up are imaging examinations and pathology. Additionally, tumor markers can play an important role in the diagnosis, monitoring, and prognosis of the disease (Wang, 2017). The most useful serum tumor markers in patients with breast cancer have been proved to be Carcinoembryonic Antigen (CEA) and Cancer Antigen 15-3 (CA 15-3). Although steadily rising CEA may be the first sign of cancer recurrence after treatment, the average time from CEA elevation to clinical recurrence is about 5 months. Serial determination of CEA and CA 15-3 may be beneficial in monitoring the response to therapy and for early detection of recurrence or metastasis, but the main disadvantages of these markers are lack of sensitivity for low-volume disease and lack of specificity. So, they are of no value in either screening or diagnosing early disease (Kabel 2017). In the last decades, in addition to conventional imaging techniques, Fluorine-18 fluorodeoxyglucose (18F-FDG) Positron Emission Tomography/Computed Tomography (PET/CT) has shown a relevant impact in the detection and management of breast cancer recurrence in doubtful cases when tumor markers are increasing and traditional imaging methods are conflicting (Piva 2017).

Thus, the aim of this study was to clarify what correlation do tumor markers CEA and CA 15-3 have with 18F-FDG PET/CT findings in patients with breast cancer.

Materials and Methods

This was a retrospective study that was conducted in Riga Stradins University Nuclear Medicine Clinic. Adult patients with histologically proven breast cancer who had had their tumor marker levels tested and later underwent a PET/CT examination from March of 2016 until June of 2019 were included in the study. A patient was included if she was tested for at least one of the following tumor markers – CEA, CA 15-3; other tumor markers were not investigated in this study. The patient histories, laboratory results and PET/CT reports were analysed. Patients with inconclusive PET/CT findings and patients who had their tumor markers tested more than two months before the PET/CT examination were excluded from this study. Positive PET/CT findings were not proven as metastases with biopsy. Increased levels of tumor markers were considered if CEA was greater than 5 ng/mL and/or CA 15-3 was greater than 25 U/mL (Shao, 2015). For the purpose of managing the statistical analysis, if by the laboratory the level of CEA was given as <0.5 ng/mL, it was considered as 0.5 ng/mL.

Statistical analysis was performed with SPSS Statistics analysing software. Chi – square tests were used for categorical variables. Statistical significance was considered with probability value $p < 0.05$.

Results

Together 67 patients were included, all of them women with the median age of 53 years (IQR 45–63). 10% (7) women had stage 1, 13% (9) women – stage 2, 34% (23) women – stage 3, 4% (3) women – stage 4 cancer, and 37% (25) patients did not have the cancer stage mentioned in the history records. 59 women had both tumor markers tested, 7 had only CA15-3, 1 had only CEA tested. PET/CT was positive in 64% (43), negative in 36% (24) of cases. Only 25 women had increased tumor markers – for 3 only CEA, for 14 only CA 15-3 and for 8 both markers were increased. Association between the marker levels and the PET/CT result is shown in Table 1.

Table 1. Distribution of increased tumor markers and PET/CT results

	Increased CEA	Increased CA 15-3	Increased both
PET/CT Positive	3 (100%)	14 (100%)	6 (75%)
PET/CT Negative	0 (0%)	0 (0%)	2 (25%)

As shown in Figures 1 and 2, in PET/CT positive patients CEA median was 1.99 ng/mL and CA 15-3 median was 23.40 U/mL, but in PET/CT negative patients – 0.70 ng/mL and 15.00 U/mL, respectively (CEA $p = 0.011$, CA 15-3 $p = 0.005$) Here and further in this paper if a result is considered as statistically significant, it is marked by a yellow star.

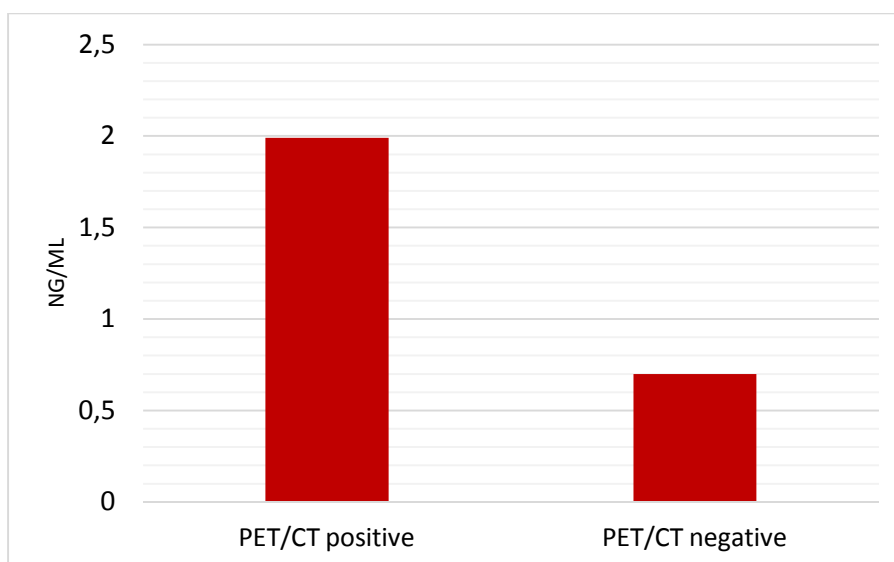


Figure 1. CEA levels according to PET/CT outcome

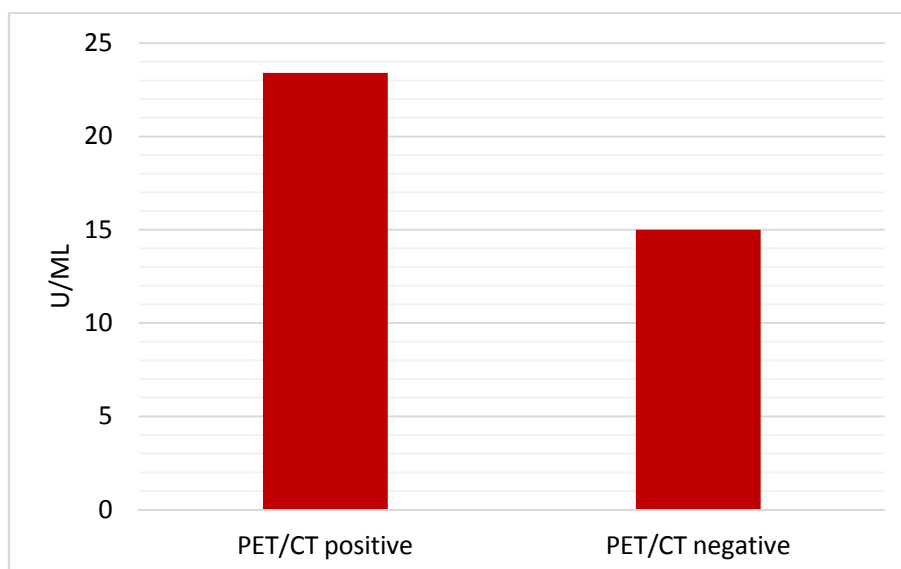


Figure 2. **Ca 15-3 levels according to PET/CT outcome**

Both CEA and CA 15-3 were higher in patients with PET/CT positive bone metastases (CEA 5.35 ng/mL, CA 15-3 58.00 U/mL) than in patients without bone metastases (CEA 1.07 ng/mL, CA 15-3 16.15 U/mL) (CEA $p=0.005$, CA 15-3 $p=0.001$). Both markers were also higher in patients with other PET/CT positive extra nodular metastases (CEA 2.48 ng/mL, CA 15-3 49.30 U/mL) when compared to patients without other extra nodular metastases (CEA 1.06 ng/mL, CA 15-3 17.29 U/mL) (CEA $p=0.017$, CA 15-3 $p=0.013$). Only CA 15-3 was higher in patients with lymph node involvement (26.10 U/mL) compared to patients with PET/CT negative lymph nodes (15.60 U/mL) ($p=0.025$) (Figures 3 and 4).

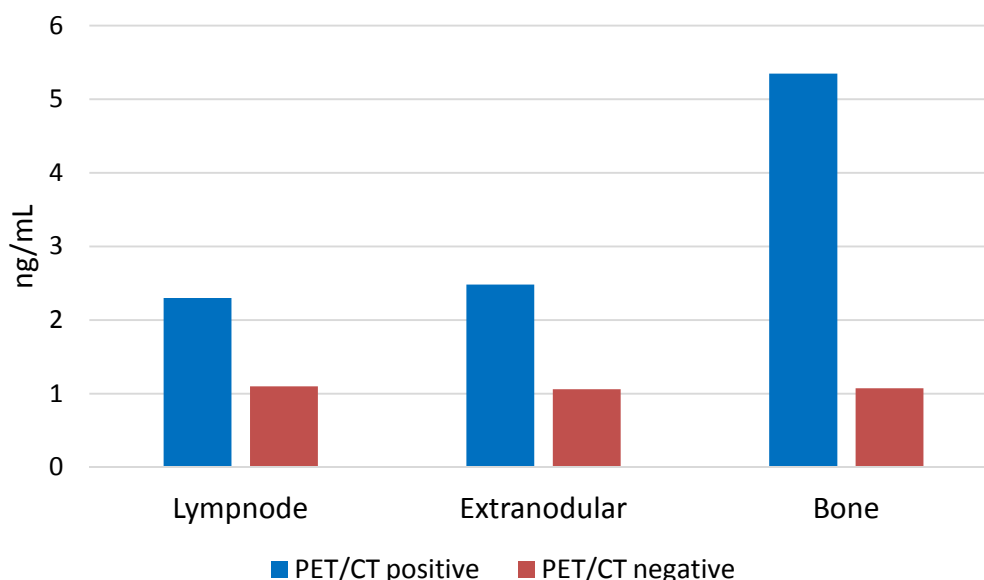


Figure 3. **CEA level correlation with the location of PET/CT positive metastases**

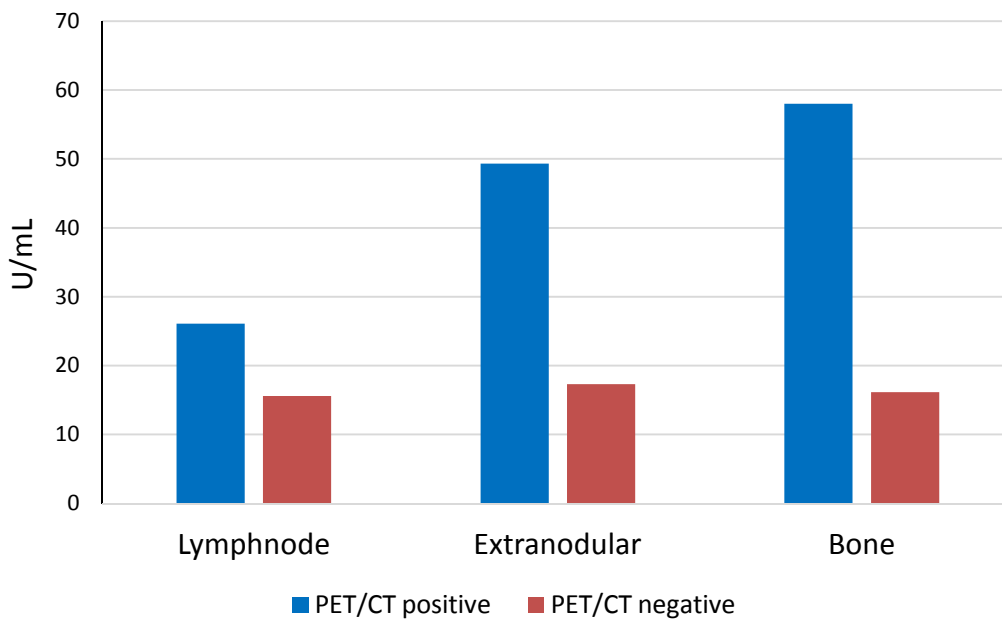


Figure 4. **Ca 15-3 level correlation with the location of PET/CT positive metastases**

Furthermore, median CA 15-3 levels increased in patients with a higher number of metastases: 12.40 U/mL in monometastatic, 21.10 U/mL in oligometastatic, 55.40 U/mL in polymetastatic disease ($p=0.001$) (Figure 5). In Table 2 it is visible that also CEA level increased with the number of metastases, but the result was statistically insignificant with the $p=0.09$.

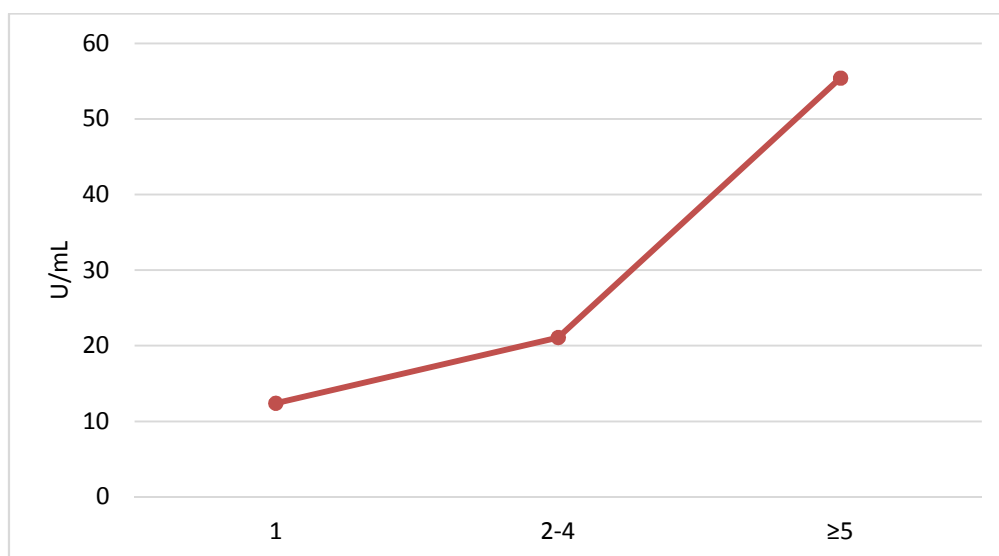


Figure 5. **CA 15-3 level correlation with the number of metastases**

Table 2. **CEA and CA 15-3 level according to the number of metastases**

	1	2-4	5≤
CEA ($p=0.09$)	1.50	1.70	2.34
CA15-3 ($p=0.001$)	12.4	21.1	55.4

Discussion

Our study found several correlations between tumor marker CEA and CA 15-3 levels and the findings of PET/CT in patients with breast cancer. First of all, the higher the markers, the higher the probability of a PET/CT being positive. It has been reported that CA15-3 blood levels >60 U/mL were always associated with positive a PET/CT, while CA15-3 blood levels <50 U/mL were always associated with a negative one (Evangelista, 2012), and CEA concentrations greater than 7.5 μ g/L are associated with high probability of subclinical metastases (Hirata, 2014). Our results differed – patients with much lower marker levels had positive PET/CTs, and some patients with very high levels had a negative result. The abnormally high markers could be explained by, for example, vast micrometastases that are not yet detectable on PET/CT, PET/CT negative macrometastases, or immune system dysregulation, due to cancer therapy or other factors. Relatively low marker levels with a positive PET/CT result, however, could be simply explained by the fact that the metastases found by PET/CT were not proved as such by biopsy, and could in fact be false positive. Another explanation could be that the particular type of cancer did not produce these tumor markers. We can expect that taking into account the molecular and histological breast cancer types in future studies could at least partly explain these incompatibilities.

To continue, both CEA and CA 15-3 were higher in patients with bone or other extra nodular metastases than in patients with no such metastases. Only CA 15-3 showed the same pattern for lymph node metastases. The highest levels of both markers were in patients with bone metastases. Furthermore, CA 15-3 also showed a correlation between increasing marker levels and the number of metastases. Research has shown conflicting results about whether CEA or CA 15-3 have better sensitivity and specificity for detecting breast cancer metastases, but it is clear, that the best results are when testing and analysing both of them (Banin, 2014). Our results support this statement, and moreover we can add, that when only CA 15-3 is increased, we might initially think about lymph node metastases, rather than other organ involvement.

What is interesting about the results we gathered, is that “higher levels” of tumor markers do not necessarily mean “increased” tumor marker levels. For example, the median CEA level for positive extra nodal metastases was 2.48 ng/mL, which is considered in the reference range, and the median CA 15-3 level for positive lymph node metastases was 26.10 U/mL, which is only slightly above the norm. To continue, we must look at the fact that research suggests different cut-off values for different purposes (Li, 2018). Therefore, tumor marker levels inside the reference range do not exclude the possibility of a positive PET/CT.

Conclusions

Higher CEA and CA 15-3 levels correlate with a positive PET/CT result, PET/CT positive bone and other extra nodular metastases, but only CA 15-3 is higher in patients with lymph node

metastases and an increasing number of metastases. Tumor marker levels within reference range do not exclude a positive PET/CT.

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PATIENT ASSESSMENT WITH COPD EXACERBATION IN RAKUS HOSPITAL “GAIĻEZERS”

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Abstract

Patient Assessment with COPD Exacerbation in RAKUS Hospital “Gaiļezers”

Key Words: COPD, exacerbation, treatment

Introduction: COPD exacerbation accelerate the loss of lung function, COPD progression, which in turn causes the decline of physical activities, reduces the quality of life, and increases the risk of death, exacerbations also increase the proportion of health care costs attributable to COPD.

Aim: To assess the patient treatment with COPD exacerbation and compare the findings with world-wide excepted guidelines and practices.

Methods: The study included 120 patients who had been treated at Riga East Clinical University Hospital “Gaiļezers” who were diagnosed with an exacerbation of and who have been hospitalized for at least 1 day.

Results: A total of 120 patients were analysed, of which 70.8% (n = 85) were hospitalized in the pulmonary ward, 16.7% (n = 20) were placed in the internal medicine ward and 12.5% (n = 15) in another profile ward. The average time spent by patients in the hospital regardless of which ward the patient was hospitalized to was 7.5 days (± 3.56).

Conclusions: Applied treatment and its duration was in line with the guidelines and foreign research data. The average time spent by patients in the hospital regardless of which ward the patient was hospitalized to was 7.5 days. In many cases, medical documentation had incomplete recommendations.

Kopsavilkums

Pacientu novērtējums ar HOPS paasinājumu RAKUS slimnīcā “Gaiļezers”

Atslēgvārdi: HOPS, uzliesmojums, ārstēšana

Ievads: HOPS uzliesmojums paātrina plaušu funkciju samazināšanos, HOPS progresēšanu kas savukārt izraisa fizisku aktivitāšu samazināšanos, samazina dzīves kvalitāti un palielina nāves risku, uzliesmojumi palielina arī veselības aprūpes izmaksu proporciju kas ir attiecināma uz HOPS.

Mērķis: Novērtēt pacientu ārstēšanu ar HOPS uzliesmojumu un salīdzināt iegūtus datus ar pasaulē pieņemtajām vadlīnijām un praksi.

Metodes: Pētījumā iekļauti 120 pacienti, kas ārstējās RAKUS “Gaiļezers” stacionārā un kuriem izrakstā no slimnīcas fiksēta HOPS uzliesmojuma diagnoze un kuri ārstējušies slimnīcā vismaz 1 gultas dienu.

Rezultāti: Kopumā pētījumā tika analizēti 120 pacienti no tiem 70,8% (n=85) tika stacionēti pulmonoloģijas nodaļā, 16,7% (n=20) tika stacionēti iekšējgo slimību nodaļā un 12,5% (n=15) cita profila nodaļā. Vidējais pacientu uzturēšanas laiks nodaļās neatkarīgi no tā kurā nodaļā pacients tika stacionēts bija 7,5 dienas ($\pm 3,56$).

Secinājumi: Pielietota ārstēšana un tas ilgums bija atbilstošs vadlīnijām un ārzemju pētnieciskajiem datiem. Vidējais uzturēšanās ilgums nodaļā bija 7,5 dienas. Daudzos gadījumos izrakstos bija nepilnīgas rekomendācijas.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is due to airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases and influenced by host factors including abnormal lung development (GOLD 2017).

Chronic obstructive pulmonary disease (COPD) is a major public health problem. COPD is one of the main causes of mortality and morbidity in the world. It has been projected that the global COPD burden will increase in the coming decades, due to the continued exposure of COPD risk factors and the aging of the overall population (GOLD 2017).

The relentless decline in lung function that characterizes COPD is associated with progressive symptoms and functional impairment, with susceptibility to respiratory infections called

'exacerbations'. Exacerbations are responsible for much of the morbidity and mortality. COPD has a significant impact on quality of life for those living with the condition, and on local economies for those affected, those caring for the affected and health services (S.A. Quaderi 2018).

Acute exacerbations of COPD are characterised clinically by symptoms of worsening dyspnoea, cough, sputum production and sputum purulence, as well as by worsening of airflow obstruction.

Exacerbations may be associated with acute viral or bacterial airway infections, or may occur independently of infection (A.S. Oliveiraa 2017).

COPD exacerbation accelerate the loss of lung function, COPD progression, which in turn causes the decline of physical activities, reduces the quality of life, and increases the risk of death, exacerbations also increase the proportion of health care costs attributable to COPD (GOLD 2017).

Exacerbations of chronic obstructive pulmonary disease are now recognized to be an important cause of the considerable morbidity and mortality associated with COPD (Alberto Papi 2006)

Aim

To assess the quality and safety of the treatment for chronic obstructive pulmonary exacerbations, to analyze the treatment and recommendations given to patients with worldwide excepted guidelines and practices, and to identify systemic mistakes in the care of these patients in an interdisciplinary in-patient care unit.

Study design: The study is retrospective, quantitative, descriptive case series analysis.

Objectives

1. Find and collect literature data on COPD exacerbations.
2. To conduct medical research and analysis of patients.
3. Compare the findings with world-wide excepted guidelines and practices.
4. To make conclusions and to propose possible solutions for improving the quality of treatment for COPD exacerbation.

Materials and methods

The study included 120 patients who had been treated at Riga East Clinical University Hospital "Gaiļezers" who were diagnosed with an exacerbation of chronic obstructive pulmonary disease diagnosed in a hospital (diagnostic code of ICD 10 classification list J44.0-J44.9) and who have been hospitalized for at least 1 day. The study analysed patient's history forms, carried out examinations, and extracts from the hospital discharge papers, the data were collected in the registration form (see 1. appendix), this form was intended for registration, processing and for further analysis of clinical data, further processing of data was carried out with Microsoft Excel and IBM SPSS Statistics 23.0 software.

Results

A total of 120 patients were analysed, of which 70.8% (n = 85) were hospitalized in the pulmonary ward, 16.7% (n = 20) were placed in the internal medicine ward and 12.5% (n = 15) in another profile ward. The average time spent by patients in the hospital regardless of which ward the patient was hospitalized to was 7.5 days (± 3.56) (minimum number of days was 1, maximum number of days 19).

Out of 120 cases, 13.3% (n = 16) had B group according to the GOLD guidelines, 12.5% (n = 15) had Group C, 29.2% (n = 35) Group D, in 36, 7% (n = 44) of cases there were no information regarding the COPD group, one (0.8%) patient was assigned mixed COPD-asthma phenotype (FEV₁ before bronchodilatation was 72% after bronchodilatation 82.5) and 9 (7.5%) patients were diagnosed with COPD for the first time.

Out of all patients, 42 (35%) received oral antibacterial therapy, with a median duration of antibacterial therapy of 5.88 days (± 2.1), with a minimum of two days of antibiotic use and a maximum of 11 days. Of the 42 patients who received antibiotics, 18 (42.9%) patients received penicillin group antibiotics, 13 (31%) patients received cephalosporin group antibiotics, and 11 (26.2%) received tetracycline group antibiotics (doxycycline).

Of the 120 analyzed patients, 9 (7.5%) of them had never smoked, 26 (21.7%) had previously smoked, 31 (25.8%) were active smokers, and in 54 (45%) cases there was no information regarding their smoking status. And so, of the 85 cases (patients who were active smokers and the patients whose smoking status was unknown), only 19 patients were recommended to stop smoking. Analysis of the data showed that there was no correlation between the length of smoking and the length of stay in the hospital.

When analyzing the discharge recommendations, 19 (15.7%) patients were advised to stop smoking. In only 17 (14%) cases, the discharge papers contained a recommendation for influenza and pneumococcal vaccination, in one case only pneumococcal vaccine was mentioned, and in the 102 (84.3) cases no recommendations for vaccination were mentioned. Long-term oxygen therapy was recommended in 24 (19.8%) patients. However, long-acting bronchodilators were recommended in 90.1% (n = 109) of cases.

Discussion

One of the main risk factors for the development of COPD is smoking (C. Terzanova 2017), therefore it is important to find out the patients smoking history, unfortunately out of 120 analyzed patients 54 (45%) patients had no information regarding their history of smoking, there may be several explanations, such as this information was obtained but was not reflected in the medical history or patients were reluctant to share this information and thus this information could not be reflected in their medical histories.

Smoking cessation has the greatest capacity to influence the natural history of COPD. If effective resources and time are dedicated to smoking cessation, long-term quit success rates of up to 25% can be achieved. Besides individual approaches to smoking cessation, legislative smoking bans are effective in increasing quit rates and reducing harm from second-hand smoke exposure. (D E O'Donnell 2005)

Assessing the correlation between smoking duration and length of stay, no correlation was found in the analysis of our data, though in similar foreign studies on the effects of smoking, results show that positive smoking status was associated with shorter hospital stays, one of the reasons is that such patients have greater symptom tolerance (Jadwiga A. 2017). In addition, the desire to be discharged from hospital may be exacerbated by additional motivating factors, such as the desire to smoke and thus such patients are being more active and are mobilizing earlier than non-smokers, subsequently shortening their length of stay in the hospital (Jadwiga A. 2017).

Awareness campaigns and health programs have the potential to revolutionize the diagnosis and management of COPD and COPD exacerbations, improving quality of life and health service cost and burden (S.A. Quaderi 2018).

Conclusions

Applied treatment and its duration was in line with the guidelines and foreign research data. The average time spent by patients in the hospital regardless of which ward the patient was hospitalized to was 7.5 days, the average duration of stay in the pulmonology ward was the shortest (7 days). In comparison to other EU countries the average time spent by patients in the hospital with the COPD exacerbation is 8.7 days (J. Vestbo 2008). In many cases, the medical documentation did not mention patient's smoking status, and when initiating oxygen therapy, either the type or the speed wasn't mentioned.

Of the 120 analyzed patients, 9 (7.5%) of them had never smoked, 26 (21.7%) had previously smoked, 31 (25.8%) were active smokers, and in 54 (45%) cases there were no information regarding their smoking status. And so, of the 85 cases (patients who were active smokers + patients whose smoking status was unknown), only 19 patients were recommended to stop smoking.

Regarding the recommendations for vaccination, in only 17 (14%) cases, the discharge papers contained information regarding recommendation for influenza and pneumococcal vaccination, in one case only pneumococcal vaccine was mentioned, and in the 102 (84.3%) cases no recommendations for vaccination were mentioned. Most patients with COPD exacerbation, the diagnosis and the COPD group was identified in accordance with the GOLD guidelines, which is considered to be the gold standard, as it allows to assess the patient's symptoms and the risk of future exacerbations.

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ADENOID VOLUME, ALLERGY AND GASTROESOPHAGEAL REFLUX DISEASE – POTENTIALLY INFLUENCING FACTORS OF THE OUTCOME OF ADENOTOMY

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Abstract

Adenoid volume, allergy and gastroesophageal reflux disease – potentially influencing factors of the outcome of adenotomy

Key Words: adenoids, adenotomy, allergy, gastroesophageal reflux disease

Introduction. The purpose of the study was to assess the outcomes of adenotomy by preoperative and postoperative questionnaire and to investigate the impact of allergy and gastroesophageal reflux disease (GERD) on the efficiency of the operation.

Material and Methods. The study was carried out in the preoperative, intraoperative and postoperative stages. During preoperative and postoperative stages parents filled in the questionnaires. Intraoperatively adenoid tissue volume were evaluated. Associations between adenoid volume, allergies and signs of GERD were assessed.

Results. Mean adenoid tissue volume was 2.31 ± 1.41 ml, with volume variety from 0.50 to 8.00 ml. Between mean adenoid volume (ml) and allergies or signs of GERD no statistically significant difference or statistically high correlation was found. Statistically significant difference ($P_{\chi} = 0.0132$) and moderate association ($Eta = 0.65$) was found between mean adenoid volume in combination with allergy and signs of GERD.

Discussion. The volume of adenoid tissue has no statistically significant correlation with clinical improvement after the surgery, but it is associated with combinations of symptoms of GERD and allergy. We suggest an evaluation of GERD in children younger than three years. Children with adenoids should be tested for allergy. If those diseases are suspected, we should examine the patient and treat them before an operation.

Kopsavilkums

Adenoīdu lielums, alerģijas un gastroezofageālā atvīļņa slimība – adenotomijas rezultātus potenciāli ietekmējoši faktori

Atslēgvārdi: adenoīdi, adenotomija, alerģijas, gastroezofageālā refluksa slimība

Ievads. Pētījums izstrādāts ar mērķi, lai, pirmkārt, novērtētu adenotomijas rezultātus, izmantojot pirmsoperācijas un pēcoperācijas anketas, un, otrkārt, izpētītu alerģiju un gastroezofageālā refluksa slimības (GERS) ietekmi uz pēcoperācijas rezultātiem.

Materiāli un metodes. Pētījums tika veikts pirmsoperācijas, intraoperatīvās un pēcoperācijas etapos. Pirmsoperācijas un pēcoperācijas etapā pacientu vecāki aizpildīja aptaujas anketas. Intraoperatīvā etapā tika novērtēts adenoīda lielums (ml). Tika analizētas asociācijas starp adenoīdu lielumu, alerģiju un GERS pazīmēm.

Rezultāti. Vidējais adenoīdu lielums bija $2,31 \pm 1,41$ ml, diapazonā no 0,50 līdz 8,00 ml. Starp vidējo adenoīdu lielumu (ml) un alerģiju vai GERS pazīmēm statistiski nozīmīgas atšķirības vai statistiski augstas korelācijas netika atrastas. Statistiski nozīmīga atšķirība ($P_{\chi} = 0,0132$) un mērena saistība ($Eta = 0,65$) tika konstatēta starp vidējo adenoīda lielumu un alerģiju, GERS pazīmju kombinācijām.

Secinājumi. Adenoīdu lielumam nav statistiski nozīmīgas korelācijas ar klīnisko uzlabošanos pēc operācijas. Adenoīdu lielumam ir saistība ar GERS un alerģiju simptomu kombinācijām. Ieteicams izvērtēt GERS bērniem, kas jaunāki par trim gadiem. Bērniem ar diagnosticētiem adenoīdiem jāveic alerģiju diferenciāldiagnostika. Ja ir aizdomas par GERS un / vai alerģiju, pacients ir jāizmeklē un, ja nepieciešams, jāusāk ārstēšana pirms adenotomijas veikšanas.

Introduction

The lymphoid tissue that circles the pharynx is collectively defined as the Waldeyer's ring. It serves as a defence against such antigens as microbes and allergens (Ameli et al., 2013). The pharyngeal tonsil is situated in the roof of the rhinopharynx. Enlarged pharyngeal tonsil is called adenoid (Tank & Grant, 2012, Applegate, 2011).

Adenoid is a common cause of upper airway obstruction in children (Aydin et al., 2014). As a part of the nasopharyngeal lymphoid tissue, mainly constituted by B-cell (50–65%) and T-cell (40%) lymphocytes, pharyngeal tonsil normally provides resistance against upper respiratory tract infections (Ameli et al., 2013, Evcimik et al., 2015). The precise mechanism of how lymphocyte stimulation and proliferation occurs has yet to be identified (Stapleton & Brodsky, 2008). Chronic stimulation with a pathogenic bacteria, chronic bacterial infection, allergic episodes and smoke exposure can enlarge pharyngeal tonsil (Keles et al., 2005). As a consequence of chronic stimulation, the adenoids may enlarge so that they may fill the space of rhinopharynx, interfering with the passage of the nasal airflow, obstructing the Eustachian tube, and blocking the clearance of the nasal mucus (Ameli et al., 2013). Adenoids can cause symptoms like nose congestion, sleep disturbed breathing, snoring, obstructive sleep apnea (OSA), recurrent or persistent otitis media, nasal speech (Ameli et al., 2013, Aydin et al., 2014). Such symptoms can also be present among children with allergic diseases and gastroesophageal reflux disease (GERD) (Aydin et al., 2014, Evcimik et al., 2015, Modrzyński & Zawisza, 2007). The primary or absolute indication for adenotomy (surgical removal of enlarged pharyngeal tonsil) is adenoid, with resultant upper airway obstruction or OSA (Gigante, 2005). Otitis media and recurrent or chronic rhinosinusitis or adenoiditis are relative indications for adenotomy (Darrow & Siemens, 2002).

Allergic rhinitis (AR) is frequently associated with relevant comorbidities, including other allergies, rhinosinusitis, recurrent respiratory infections, otitis media, and adenoids (Ameli et al., 2014). In some studies, the possible correlation between allergic rhinitis and adenoid size has been investigated and reported a positive association between the two disorders (Modrzyński & Zawisza, 2007, Huang & Giannoni, 2001, Said et al., 2012, Sih & Mion, 2010). On the contrast, another study reported that adenoids, visualized and measured during endoscopy, is not associated with AR, whereas large turbinates may be associated with small adenoids (Ameli et al., 2013).

Recent studies have shown the association between adenoids and GERD (Aydin et al., 2014). Chronic sinusitis, chronic rhinitis, otitis media with effusion, and laryngeal disorders have all been studied with possible etiologic links to GERD (Stapleton & Brodsky, 2008). Carr et al. (2001) studied the incidence of reflux in children undergoing adenotomy and found that 88% of the children aged one year or less and 32% older than one year had GERD. Medical treatment of GERD might obviate the need for adenoid surgery (Carr et al., 2001, Iqbal et al., 2012).

Adenotomy is the most frequently performed operation in Otolaryngologic Department of Children Clinical University Hospital (CCUH) in Riga, Latvia. Since the results of the operation are not studied yet, this research work is devoted to the exploration of the efficiency of adenotomy and its influencing comorbidities – allergy and GERD.

The aim of the study was to assess the outcomes of adenotomy by preoperative and postoperative questionnaire and to investigate the impact of allergy and GERD on the efficiency of the operation.

Research objectives:

- 1) To assess the volume of the adenoid during adenotomy.
- 2) To compare the volume of the adenoid with the severity of clinical symptoms caused by adenoid, allergy and/or GERD.
- 3) To evaluate the efficiency of adenotomy using a questionnaire before and after the operation.
- 4) To analyse and compare the preoperative factors that potentially influence the outcome of adenotomy.

Materials and Methods

Cross-sectional study was performed analyzing patients in Riga's CCUH who underwent adenotomy by conventional curettage technique from November 2015 till January 2017. The research protocol was previously approved by the Ethical Committee of the Riga Stradins University (#50/2015). The study was carried out in the preoperative, intraoperative and postoperative stages. During preoperative and postoperative stages parents filled in the questionnaires. The preoperative questionnaire contained questions about symptoms caused by the adenoid enlargement (especially breathing disturbances), signs of GERD and allergies, used medications. The postoperative questionnaire contained questions about the postoperative period, breathing disturbances and, if present, the degree of trouble breathing. In preoperative and intraoperative stages 196 children took part during the day of operation at CCUH. In postoperative stage 79 children took part by visiting CCUH ENT out-patient clinic 1–3 months after adenotomy. Exclusion criteria were impaired palatal functions, neurological or neuro-muscular abnormalities, syndromic abnormalities. Intraoperatively adenoid tissue volume, adenoid relations to other structures, and inferior nasal concha was evaluated. Adenoid tissue volume was measured after the surgery by placing adenoid tissue in the cylinder with the water. Adenoid tissue volume was equivalent to the amount of water that was pushed out.

Statistical analysis of data was performed using IBM SPSS v. 23.0. Mean values and standard deviation in this study had a confidence interval of 95%. Difference between two nominal groups was established using χ^2 criteria or Fishers's exact test. Statistically significant difference between groups was proven if $P_{\chi} < 0.05$. Difference between groups comparing their mean values was performed by one-way ANOVA. The result was statistically significant if $P_F < 0.05$. Eta (η) value was used to analyse the correlation between nominal and numeric data. It represents level of association: 0–0.2 – very weak; 0.2–0.4 – weak; 0.4–0.7 – moderate; 0.7–0.9 – strong; >0.9 – extremely strong; 1 – perfect.

Results

1. Results of preoperative, intraoperative stages of the research

The age of the patients varied from 24 to 204 months. The average age was 62.78 ± 29.83 months. Before surgery 26.02% (n=51) of patients were using medications, of whom 10.71% (n=21) used more than one medication. Most frequently used medication was intranasal corticosteroids (Figure 1). A nasal spray of mometasoni furoas (50 mcg/dose) was the most frequently used.

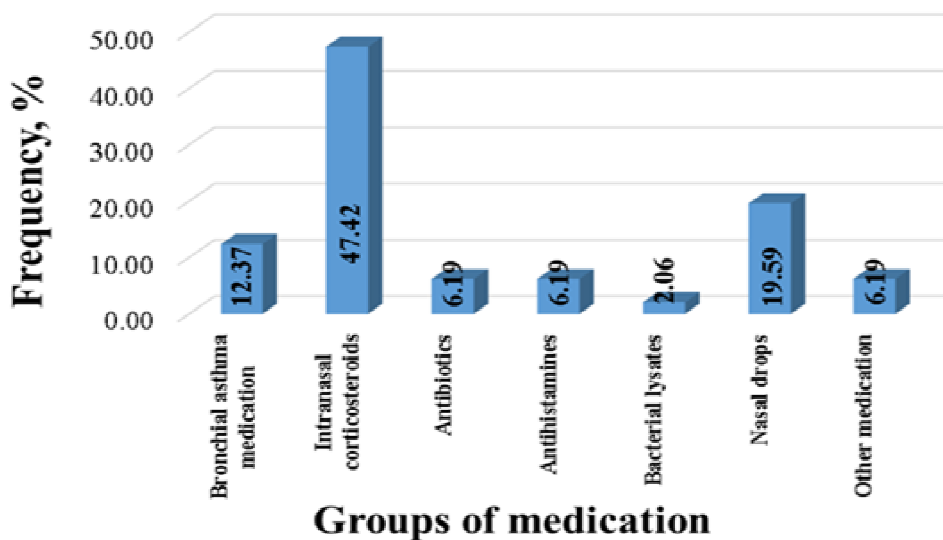


Figure 1. Distribution of medication used before adenotomy

Before surgery nose breathing problems were present in 89.23% (n=174) of the patients (Figure 2).

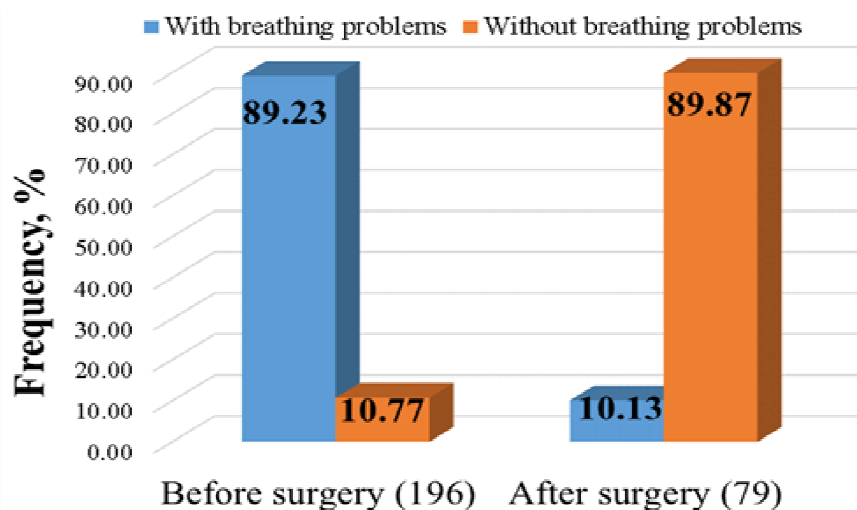


Figure 2. Breathing problems before and after surgery

Breathing disturbance during sleep (apnea, wheezing or hissing) was present in 97.37% (n=183) of patients. More than one disturbance was present in 30.01% (n=55) of patients.

Daytime breathing problem (breathing through the mouth, loud breathing, nasal voice) was present also in 97.37% (n=183) of patients (Figure 3). More than one daytime breathing problems were present in 25.68% (n=47) of patients. Mean adenoid tissue volume was 2.31 ± 1.41 ml, with volume variety from 0.50 to 8.00 ml with normal distribution (Kolmogorov-Smirnov test).

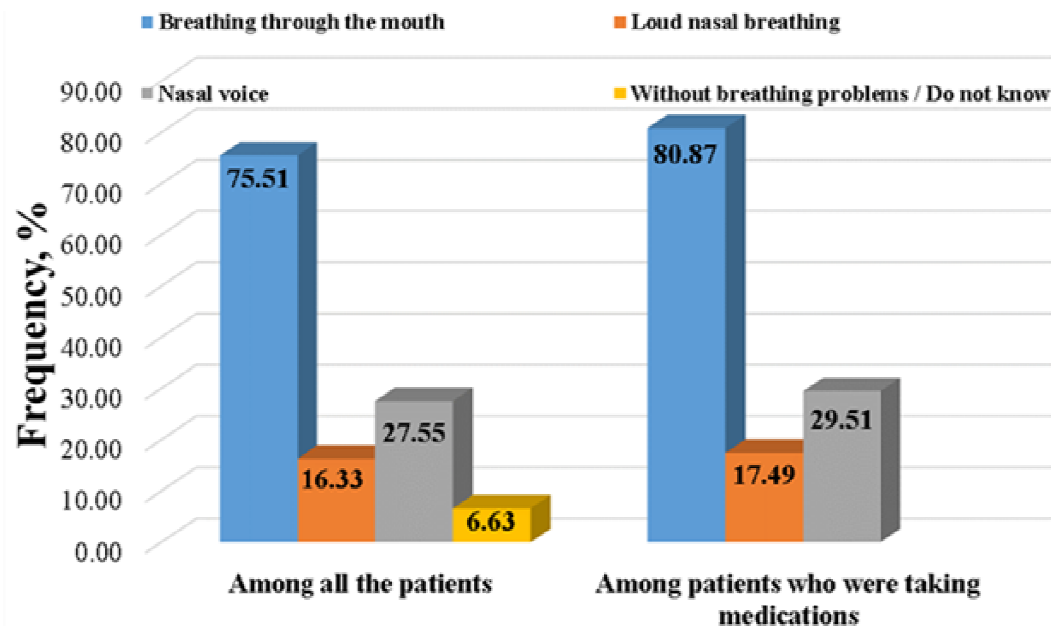


Figure 3. Breathing disturbances during daytime

Between the adenoid volume (ml) and breathing disturbances during sleep or daytime, no statistically significant difference or statistically high correlation was found.

The study contained 163 (83.16%) children with at least one GERD sign (Figure 4) and 59 (30.10%) children with at least one type of allergy (Figure 5). Most common GERD sign was halitosis, and most common type of allergy was a food allergy.

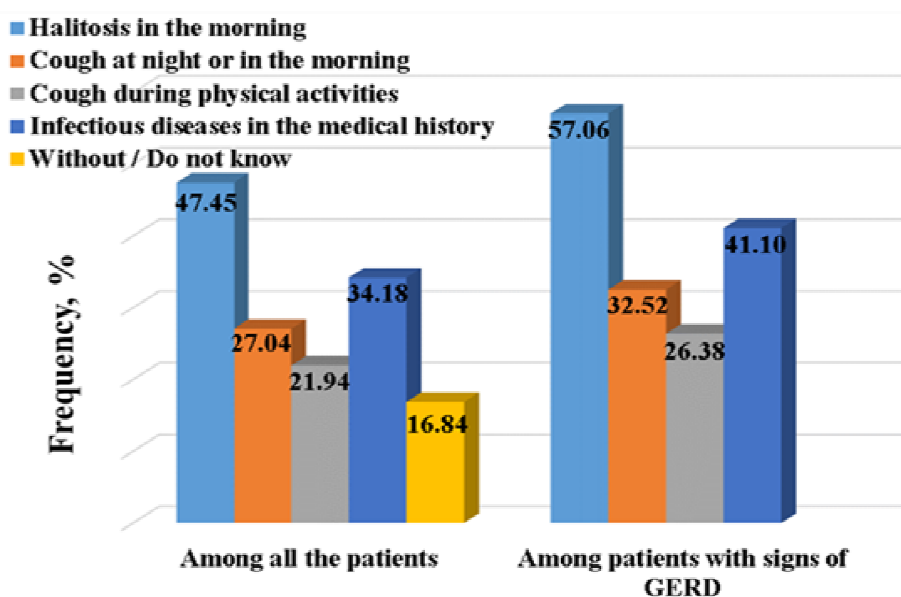


Figure 4. GERD signs distribution

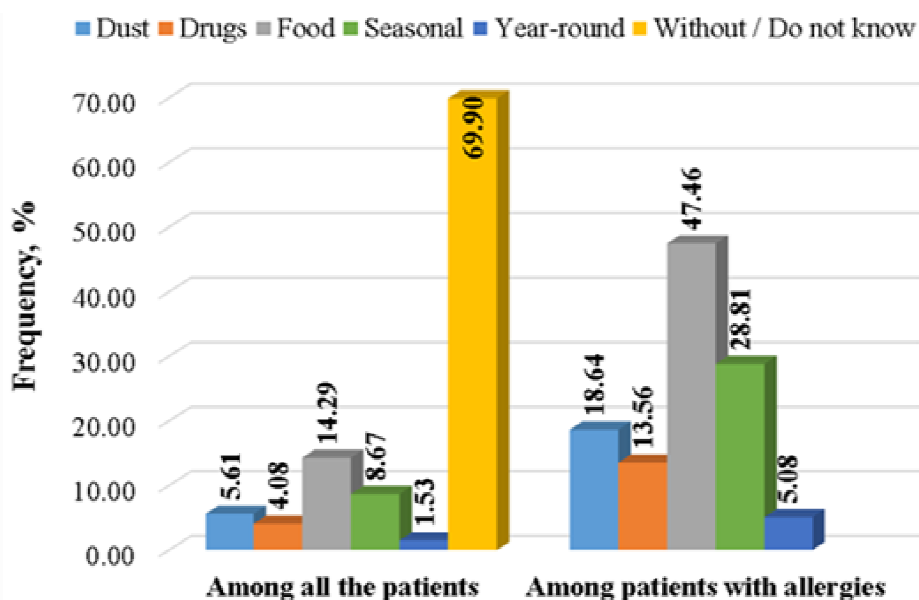


Figure 5. Allergy type distribution

Between signs of GERD and adenoid volume (ml), types of allergies and adenoid volume (ml), the size of inferior nasal concha and allergies, tobacco exposure and type of allergy no statistically significant difference or statistically high correlation was found.

Group of 50 patients had allergy and signs of GERD. Statistical analysis revealed no significant correlation between 33 different combinations of allergy type, signs of GERD and mean adenoid volume (ml) ($P_F = 0.67$). However, Eta value in statistical tests implies a strong correlation ($\eta = 0.77$) between combinations of allergy types, signs of GERD and mean adenoid volume (ml).

2. Results of postoperative stage of the research

The study contained data about 79 patients in the postoperative period. 98.73% ($n=78$) of patients had improvement after surgery. Breathing disturbance disappeared in 71 patients. No breathing improvement was found in 8 patients.

Postoperative period was complication – free. 15 patients had increased body temperature

In patients with postoperative data available mean adenoid volume was 2.52 ± 1.43 ml with values from 0.50 to 8.00 ml. Statistical analysis demonstrated no statistically significant difference between preoperative adenoid volume (ml) and postoperative breathing improvement. Breathing disturbance in postoperative period did not show statistically significant difference between allergies or GERD. Cramer’s V value demonstrated medium correlation.

In patients, all GERD signs and allergy types formed 55 combinations, including cases when the patient had GERD without allergy and vice versa. Statistically significant difference ($P_\chi = 0.0132$) and moderate association ($\eta = 0.65$) was between mean adenoid volume with allergies and GERD signs. The largest mean adenoid volume (6.50 ± 1.73 ml) was in patients with no allergies and combination of two GERD signs – halitosis and cough during physical activities.

The smallest mean adenoid volume (0.60 ± 0.57 ml) was in patients with food allergy and the combination of two GERD signs – cough at night and history of viral gastroenteritis.

Discussion

The median age of patients who underwent adenotomy in the research of Katra et al. (2014) was 61.4 months, which is similar to our result – 62.78 months.

Our results show that there is no correlation between the volume of adenoid and clinical signs of trouble breathing in daytime or during the sleep. These results emphasized the importance of adenoid relationship to other anatomical structure, not adenoid absolute size.

According to the research of Ameli et al. (2013) subjective perception of nasal obstruction is more reliable than the perception of posterior obstruction. They suggest a hypothesis for allergy: children with adenoids of grade 4 (completely blocked up nose) rarely are allergic. In fact, they underline that severe anterior obstruction and allergy may “protect” (OR=0.08 and 0.31) from severe hypertrophy of pharyngeal tonsil (Ameli et al., 2013). On the other hand, airborne allergens may overstimulate the immune system at the adenoid level. It is shown that adenoids are involved in IgE-mediated sensitization with a local differentiation of IgE-producing plasma cells (Papatziamos et al., 2006). Children with adenoids are characterized by impaired immunologic parameters, also persisting after adenotomy for a long time (Zielnik-Jurkiewicz & Jurkiewicz, 2002). Pharyngeal tonsil represents a fundamental site for the adaptive immune response by secretory immunity and regulating the production of the antibodies. The correlations among allergy, infections, and adenoids remain obscure.

We should take into account a certain amount of GER is considered normal in an infant until the age of 12 months (Carr et al., 2001, Halstead, 1999). The nasopharyngeal area may be directly exposed to the action of *Helicobacter pylori* in patients with GER (Aydin et al., 2014, Katra et al., 2014). Results of Katra et al. (2014) support the hypothesis that reflux episodes in childhood reaching upper oesophageal sphincter may play an important role in the transmission of *Helicobacter pylori* into the lymphoid tissue of the nasopharynx. There are studies which demonstrate *Haemophilus influenzae* and other β -lactamase producing bacteria as a predominant bacterium identified in core cultures of hyperplastic tonsils and adenoids (Stapleton & Brodsky, 2008, Brodsky et al., 1988). There are no doubts that pepsin is a possible etiological factor for the development or laryngopharyngeal symptoms, and there is currently no evidence to suggest that it originates anywhere else but gastric sources. However, Harris et al. (2009) did not find pepsin in any adenoids, leading that reflux cannot be a major cause of adenoids. Contrary to those arguments, Stapleton and Brodsky (2008) suggest to evaluate and treat every child younger than three years for reflux before undertaking tonsillectomy and adenotomy. In children with adenoids, allergy is found only slightly more often than in children without adenoids. On the other hand, the fact that the

clinical symptoms of allergic rhinitis and adenoids are similar is an additional complicating factor of the diagnosis. Adenoid tissues are located on the roof of the nasopharyngeal cavity, and it is constantly exposed to allergens entering with the air (Modrzynski & Zawisza, 2007, Winther & Innes, 1994). The frequency of infection in children with adenoids and allergic rhinitis was slightly higher than in children with adenoids but without allergy (Modrzynski & Zawisza, 2007).

Our results showed that 30.10% of patients have a history of allergic reactions to at least one allergen and 29.08% of patients had oedema in the posterior area of inferior turbinates. According to Ameli et al. (2013) specialist should not be surprised to find a discrepancy between large adenoids and small turbinates or vice versa.

Group of 50 people had different combinations of allergy types and signs of GERD. Statistical analysis revealed no statistically significant difference between these combinations and volume of the adenoid tissue. It can be explained by the fact, that some combinations had a count of cases lower than 5, which had an impact on statistical tests. Breathing disturbance in postoperative period did not show statistically significant difference with allergies or GERD. Cramer's V value demonstrated medium correlation because in patients with dust and seasonal allergies breathing problems were still present after surgery.

Weaknesses of the survey were multiple. Firstly, the conventional curettage adenotomy as an adenoid removal is a relatively 'blind' technique which risks nasopharyngeal injury and incomplete adenoid removal (Regmi et al., 2011). Secondly, adenoid tissue volume was measured after the surgery by placing adenoid tissue in the cylinder with water. One cylinder was used for all examples, and we assume that the data obtained are comparable to each other. Thirdly, endoscopic examination for evaluating adenoid size preoperatively was not used due to the patient's age. We strongly agree that the direct visualization of the rhinopharynx can improve treatment outcomes and that it should be considered as a routine examination (Ameli et al., 2013).

Conclusions

Mean adenoid tissue volume was 2.31 ± 1.41 ml. The volume of adenoid tissue has no statistically significant correlation with respiratory depression and clinical improvement after the surgery, but it is associated with combinations of symptoms of GERD and allergy. We suggest an evaluation of GERD in children younger than three years, especially, if the clinical signs are mild or moderate. Children with adenoids should be tested for allergy. If those diseases are suspected, we should examine the patient and treat them to avoid an operation. Allergy, GERD, and adenoids may present with similar symptoms leading to incomplete diagnosis and treatment.

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ROLE OF STABILOMETRY IN THE REHABILITATION ALGORITHM OF A PATIENT WITH VERTEBROBASILAR INSUFFICIENCY

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Abstract

Role of stabilometry in the rehabilitation algorithm of a patient with vertebrobasilar insufficiency

Key Words: *physical and rehabilitation medicine (PRM), physiotherapy, stabilometry, vertebro-basilar insufficiency (VBI)*

By definition, vertebro-basilar insufficiency (VBI) is a clinical pattern, resulting from decreased blood-flow in the posterior cerebral circulation. The incidence of VBI increase during last years.

We present a male patient of 65 years, transferred to our PRM Department for excessive pain and stiffness in the neck region and muscles around it; balance and gait instability. During clinical exam (at the admission) we diagnosed: vertebral syndrome, balance and gait instability, positive Romberg. X-Ray and Magnetic Resonance Imagery (MRI) of the cervical spine demonstrated osteochondrosis, spondylosis and spondylarthrosis. During Computerized Stabilometry, we observed altered center-of-Pressure (COP) trajectories and COP-oscillations with open and closed eyes.

We applied a complex rehabilitation, including preformed physical modalities (LASER and Magnetic field), individualized physiotherapeutic and occupational therapeutic programme, accentuating on balance and gait training, patient education.

We noticed significant efficacy of the rehabilitation: improvement of the range of motion of the cervical spine, pain relief, balance and gait stabilization, amelioration of autonomy in activities of daily life.

Our opinion is, that every patient with posture instability needs consultation with a medical doctor – specialist in Neurology and in Physical and rehabilitation medicine. We consider that early rehabilitation must be considered in cases with vertebra-basilar insufficiency. We emphasize on the impact of stabilometry for objective evaluation of the equilibrium disturbances and for individualization of PT-complex to the correspondent patient in the respective stage of his condition.

Some recommendations for the rehabilitation complex are formulated.

Introduction

By definition, vertebro-basilar insufficiency (VBI) is a clinical pattern, resulting from decreased blood-flow in the posterior cerebral circulation (Caplan, 2009; Simon, Aminoff, Greenberg, 2018). Typical signs and symptoms are: postural instability, vertigo, dizziness; in some patients – double vision, nausea, sleepiness (Caplan, 2009). The term 'vertebrobasilar insufficiency' is applied to describe disease in the vertebral and basilar arteries which predisposes to acute embolic events such as transient ischemic attacks (TIAs) and stroke.

VBI is considered as a predictor of stroke in the vertebrobasilar region of circulation.

Some authors consider VBI as a set of recurrent symptoms, resulting from atherosclerosis or stenosis of these arteries in combination with changes of blood pressure or head position (Caplan, 2009; Simon, Aminoff, Greenberg, 2018). Risk factors are: hypertension, dyslipidemia, diabetes, obesity, smoking, age over 50 years.

The incidence of VBI increase during last years.

The principal objective of the current article is to remind the role of stabilometry in the qualitative assessment of postural instability and balance disturbances, in a patient with vertebrobasilar insufficiency.

Case Presentation

Patient's Presentation

We present a male patient of 65 years, transferred to our PRM Department for excessive pain and stiffness in the neck region and muscles around it; balance and gait instability.

During clinical exam (at the admission), we diagnosed: vertebral syndrome, balance and gait instability, positive Romberg.

Risk factors: Diabetes, Arterial hypertension, Obesity, Sedentary lifestyle.

No data for vasculitis; no data for diseases of the connective tissue as sclerodermia or lupus.

X-Ray and Magnetic Resonance Imagery (MRI) of the cervical spine demonstrated osteochondrosis, spondylosis and spondylarthrosis (Fig. 1, Fig. 2, Fig. 3.).



Figure 1. X-ray of the cervical spine – face and profile

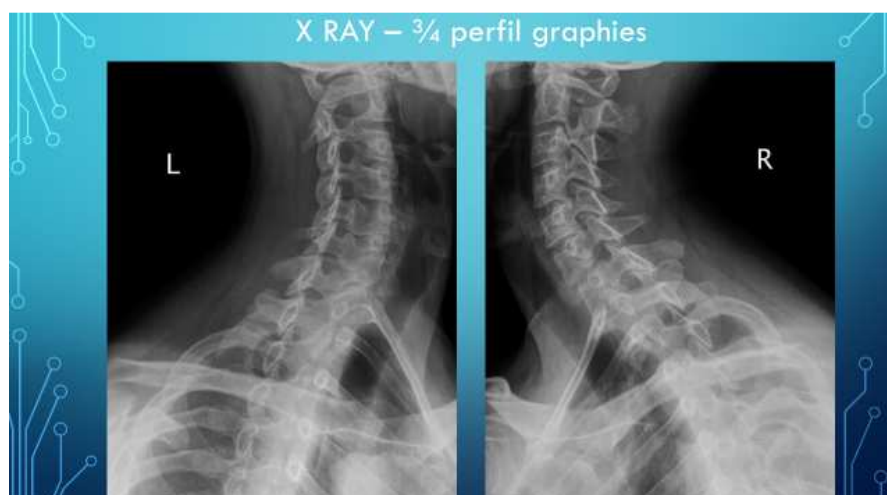


Figure 2. X-ray of the cervical spine – Collier profiles



Figure 3. MRI of the cervical spine

For objectification of balance instability we realized *Clinical stabilometry analysis* (Figures 4, 5, 6 and 7), executed according standard protocols (Kapteyn et al, 1983; Collins, 1993; Scoppa, 2013). We observed altered Center-of-Pressure (COP) trajectories and COP-oscillations with open and closed eyes.

Figure 4 presents the footprints with open eyes and closed eyes, with the Bipodal Load asymmetry and the oscillations of the CoP.

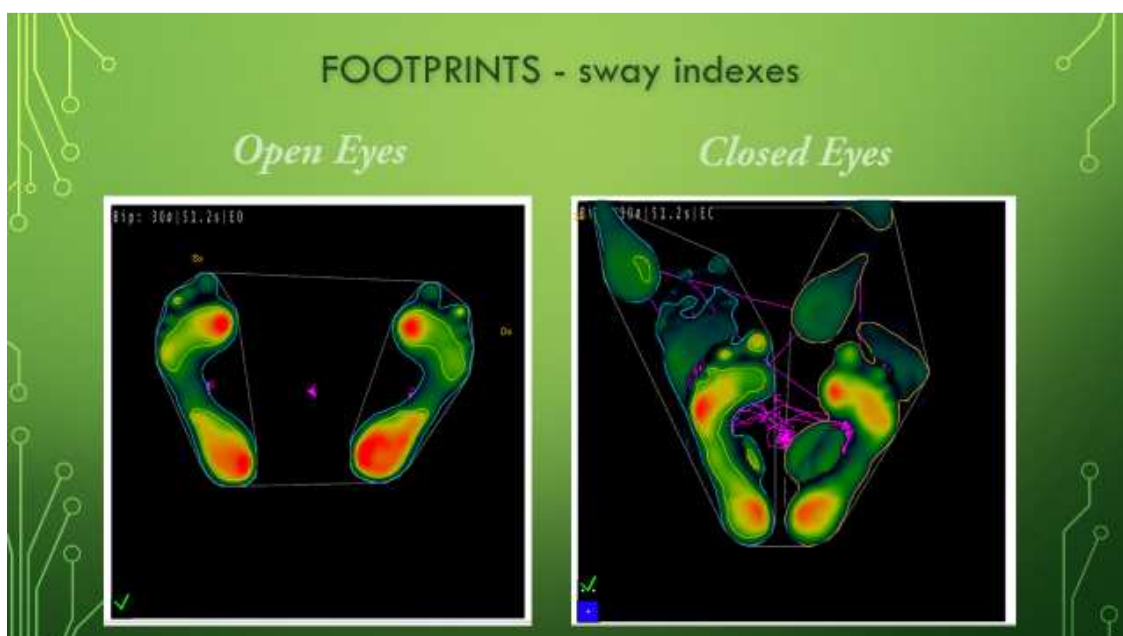


Figure 4. Stabilometry – footprints

Figure 5 presents statokinesiograms – with the graphic of CoP oscillations, respective sway and indexes

We can observe and analyze the difference in the oscillations of the center of pressure with closed and open eyes: confidence Ellipse-CoP and Sway rectangle.

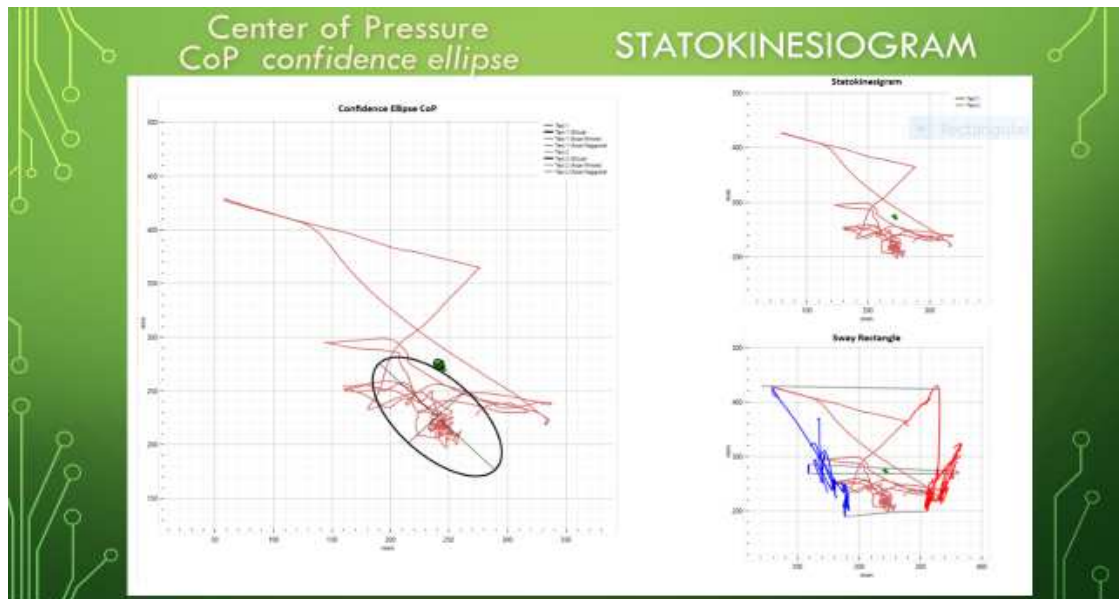


Figure 5. **Stabilometry – statokinesiogram**

Figure 6 presents radar balance – with open eyes (green) and closed eyes (red figure).

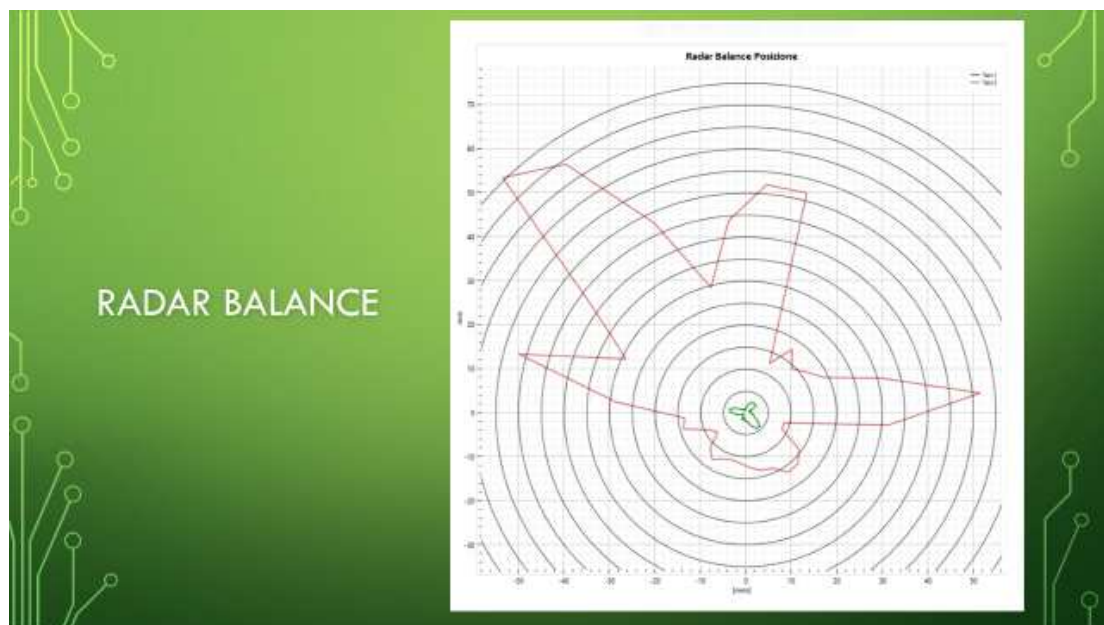


Figure 6. **Stabilometry – Radar balance**

Figure 7 contents the Spectral analysis of the sway; Velocity Diagram and Stabilogram.

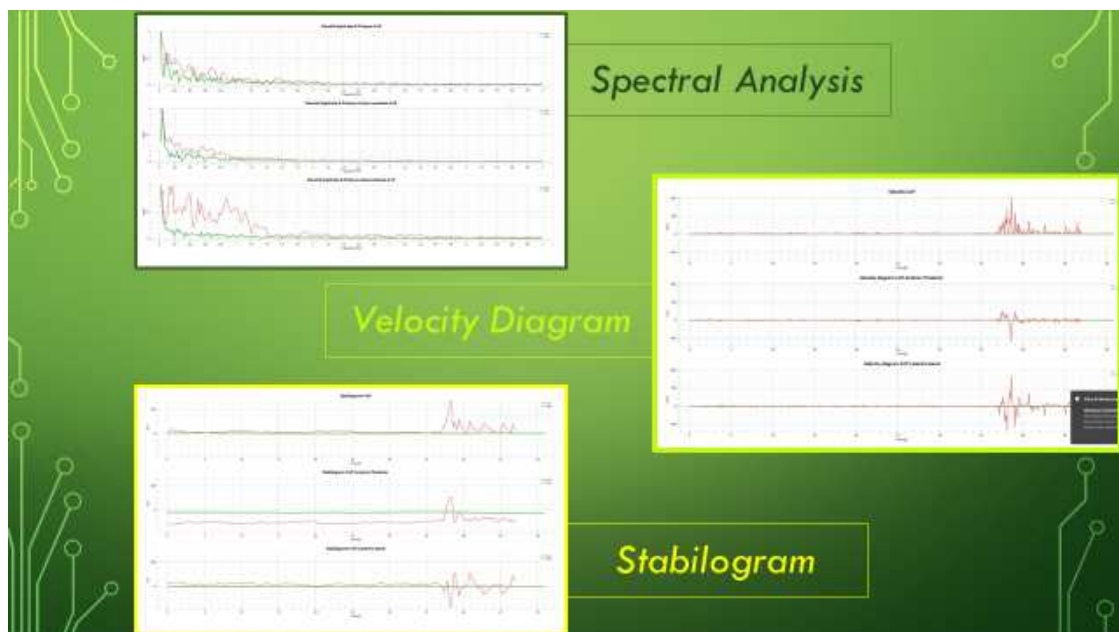


Figure 7. Stabilometry – spectral analysis, velocity diagram and stabilogram

PRM Program of Care

Goal and tasks: The **complex NR program** accentuates on *posture, balance and gait training*.

Our tasks were oriented to the *recovery of the stability / equilibrium stabilization; retrieval of spine flexibility and mobility; autonomic gait recovery with amelioration of autonomy in everyday life; enhancement of the health-related quality of life*.

We applied a complex rehabilitation, including: preformed physical modalities (LASER and Magnetic field), individualized physiotherapeutic and occupational therapeutic programme, accentuating on balance and gait training, patient education.

Applied methods:

- **Per oral drugs** – *antalgics (Paracetamol) and B vitamins B1, B6, B12;*
- **Posture (activity modification),**
- **Preformed physical modalities:** LASER and low intensity low frequency Magnetic field (MF) for pain relief;
- **Massage** – classic relaxing paravertebral massage for the cervical region;
- **Individualized physio-therapeutic (PT) program:** *correct spine position, analytic exercises for muscles flexors and rotators of the cervical spine (accentuating on sterno-cleido-mastoideus muscles); post-isometric relaxation /PIR/ for upper trapezius muscle;*
- **Balance and gait training** without technical aids; education in mobility with obstacles, up and down the stairs.
- **Occupational therapy (OT) & ADL training.**

Results of the Applied PRM Programme

We noticed significant efficacy of the rehabilitation: improvement of the range of motion of the cervical spine (Flexion 35 -> 75 degrees; Rotation from 10 to 45 degrees; Lateroflexions from 5 to 45 degrees), pain relief (VAS 9 to VAS 3), balance and gait stabilization, amelioration of autonomy in activities of daily life.

Recommendations after the Rehabilitation course

The treatment plan after the departure from the hospital includes:

- **Auto-PT at home:** physiotherapy every day at the 3th month after the injury; Analytic exercises for the paravertebral muscles (muscle belt) and for muscles of upper extremities; Balance training;
- Next rehabilitation course – 3 months later.

Discussion

Posture, Equilibrium and Stabilometry

The posture is the position of a person's body or body parts. The term derives from the classical Latin noun "positura", meaning pose or position (The American Heritage, 2016).

The term Equilibrium contains a root from the Latin Libra, meaning "weight" or "balance", and in all sciences, the special meaning refers to the balance of competing influences or forces (Chiari, 2009).

The ability of the human body to retain the stable position or Balance is clinically assessed by the test of Romberg (swaying of the body when the feet are placed close together and the eyes are closed).

Routinely, qualitative assessment is sufficient for the clinical practice. However, in case of mild disorders or latent alterations a quantitative evaluation is preferred.

The study of the postural equilibrium is called Static posturography; Stabilography or Computerized stabilometry. According definitions, stabilometry represents the objective assessment of body sway during quiet standing – stance in the absence of any voluntary movements or external perturbations [Chiari, 2009]. Practically, this is the objective analysis of the functioning of the postural control system (Collins, 1993; Winter, 1995). The method is very easy to perform and its efficacy is significant.

Neurorehabilitation

The detailed functional assessment is obligatory element of the complex rehabilitation algorithm, adapted to the individual patient in the concrete phase of his disease.

The complexity of neurorehabilitation imposes the necessity of a holistic approach to the patient – detailed functional analysis before and after the rehabilitation courses; application of therapeutic methods of different medical specialties (principally neurology and neurosurgery;

orthopedics and traumatology; rheumatology; PRM) and from non-medical fields (physiotherapy, occupational therapy, sociology, psychology). We apply basic principles of the specialty Physical and Rehabilitation medicine (White Book, 2007, 2018; Koleva, 2006).

In every phase of the recovery process, we must define precisely the goal, tasks and algorithms of rehabilitation. In every case, our goal is to assure a high quality of the rehabilitation, optimal for the clinical form of the principal disease or condition, adapted to the age, comorbidities, capacity and preferences of the concrete patient; with the strategic objective to receive the best result for his quality of life. We must put emphasis on balance and gait training, autonomy in everyday activities, pain control (Grasp and Gait rehabilitation, 2017; Llamas-Ramos, 2020).

Conclusion

Our opinion is, that every patient with posture instability needs consultation with a medical doctor – specialist in Neurology and in Physical and rehabilitation medicine.

We consider that early rehabilitation must be considered in cases with vertebrobasilar insufficiency.

We emphasize on the impact of stabilometry for objective evaluation of the equilibrium disturbances and for individualization of PT-complex to the correspondent patient in the respective stage of his condition.

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PHYSICAL MODALITIES AND CONTEMPORARY REHABILITATION METHODS FOR WELLNESS, SPA AND MEDICAL TOURISM IN BULGARIA

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Abstract

Physical modalities and contemporary rehabilitation methods for wellness, spa and medical tourism in Bulgaria

Key Words: *balneology, balneotherapy, health tourism, medical tourism, SPA, wellness*

Medical tourism refers to people traveling to a country other than their own to obtain medical treatment. In the past this usually referred to those who traveled from less-developed countries to major medical centers in highly developed countries for treatment unavailable at home.

Health tourism is a wider term for travel that focus on medical treatments and the use of healthcare services. It covers a wide field of health-oriented, tourism ranging from preventive and health-conductive treatment to rehabilitational and curative forms of travel. Wellness tourism and Medical tourism are related sub-fields; Wellness tourism is oriented to prevention. Medical tourism is oriented to treatment and rehabilitation.

Modern Balneology encloses a continuum of sciences, including investigation of mineral waters, hydro-geological knowledge, balneo-chemical and micro-biological analysis, balneo-engineering, methods of application of the water on the human organism (hydrotherapy, balneotherapy & thalassotherapy), combined methods (hydrokinesitherapy and balneokinesitherapy); procedures with therapeutic muds (peloidotherapy).

Ultimately, the modern notion of SPA (considered by some authors as acronym of "Salus per aquam" or "Sanitas per aquam" / "Health through water") was introduced in common life.

Bulgaria has a lot of mineral waters and therapeutic muds.

There is a tradition in the field of rheumatology, neurology & neurosurgery, orthopedics and traumatology.

Kopsavilkums

Fiziskās modalitātes un mūsdienu rehabilitācijas metodes labsajūtai, soa un medicīnas tūrismam Bulgārijā

Atslēgvārdi: *balneoloģija, balneoterapija, veselības tūrisms, medicīnas tūrisms, SPA, labsajūta*

Medicīniskais tūrisms attiecas uz cilvēkiem, kas ceļo uz ārvalstīm, lai ārstētos. Pagātnē, tas parasti attiecās uz tiem cilvēkiem, kas no mazāk attīstītām valstīm devās uz lielākiem medicīnas centriem augsti attīstītajās valstīs, kuri nav pieejami savā valstī.

Veselības tūrisms ir plašāks jēdziens terminam ceļot, kas koncentrējas uz ārstēšanu un veselības aprūpes pakalpojumu izmantošanu. Tas aptver plašu uz veselību vērstu tūrisma jomu, sākot no profilaktiskas un veselību vadošas ārstēšanas līdz rehabilitācijas un ārstnieciskām ceļošanas formām. Veselības tūrisms un medicīnas tūrisms ir saistītas apakšnozares. Labsajūtas tūrisms ir orientēts uz profilaksi. Medicīniskais tūrisms ir orientēts uz ārstēšanu un rehabilitāciju.

Mūsdienu balneoloģija ietver nepārtrauktas zinātnes, tostarp minerālūdeņu izpēti, hidroģeoloģiskās zināšanas balneoloģisko un mikrobioloģisko analīzi, balneo inženieriju, ūdens pielietošanas metodes cilvēka organismam (hidroterapija, balneoterapija un talasoterapija), kombinētās metodes (hidrokinezoterapija un balneokineziterapija); procedūras ar terapeitiskām dūņām (peloidoterapija).

Galū galā mūsdienu jēdziens SPA (ko daži autori uzskata par saīsinājumu "Salus per aquam" vai "Sanitas per aquam" / "Veselība caur ūdeni") tika ieviests kopsajūvē.

Bulgārijā ir daudz minerālūdeņu un ārstniecisko dūņu.

Reimatoloģijas, neiroloģijas un neiroķirurģijas, ortopēdijas un traumatoloģijas jomā ir tradīcijas.

Introduction

Medical tourism, wellness and health tourism

Medical tourism refers to people traveling to a country other than their own to obtain medical treatment. In the past this usually referred to those who traveled from less-developed countries to major medical centers in highly developed countries for treatment unavailable at home.

Health tourism is a wider term for travel that focus on medical treatments and the use of healthcare services. It covers a wide field of *health-oriented tourism*, ranging from preventive and health-conductive treatment to rehabilitational and curative forms of travel.

Wellness tourism and Medical tourism are related sub-fields; *Wellness tourism* is oriented to prevention. *Medical tourism* is oriented to treatment and rehabilitation.

Balneology, climatology and SPA

The application of water (including mineral water) for prevention and therapy is called *Hydrotherapy / Balneotherapy*.

Modern *Balneology* encloses a continuum of sciences, including investigation of mineral waters, hydro-geological knowledge, balneo-chemical and micro-biological analysis, balneo-engineering, methods of application of the water on the human organism (hydrotherapy, balneotherapy & thalassotherapy), combined methods (hydrokinesitherapy and balneokinesitherapy); climatic procedures and procedures with therapeutic muds (peloidotherapy). Ultimately, the modern notion of SPA (considered by some authors as acronym of “Salus per aquam” or “Sanitas per aquam” / “Health through water”/) was introduced in common life (Koleva, 2006).

In many European countries (including Bulgaria), balneotherapy and peloidotherapy are important chapters of the Specialty Physical and Rehabilitation Medicine (PRM) (White Book on PRM, 2006, 2018). In some countries, there is an independent medical specialty Medical Hydrology and Climatology, in others – Thermal Medicine or Health Resort medicine (Gutenbrunner et al, 2010; Cantista, 2012; Carpentier, 2012).

Bulgarian resources and traditions

Hydro-mineral resources in Bulgaria

Bulgaria has many mineral waters (Koleva, 2006). On the territory of 11 thousands square kilometers, Bulgaria has more than 800 sources of mineral waters, assembled in groups of 240 springs. The total debit is about 270 million liters for 24 hours. More than 75% of the waters are *hot – thermal and hyper-thermal* (with temperature from 35 to 101°C). In our country, we have almost *all principal types of mineral waters*, with different chemical ingredients: gases, organic substances, etc.(Koleva, Yoshinov, Marinov, Hadjijanev, 2015)

Bio-climatic resources in Bulgarian balneo-climatic centers

In our country, we have five physiological climatic zones (depending of the altitude): High mountain (altitude over 2000 m); Medium mountain (1200–2000 m); Transition zone (800–1200 m); Plains zone (under 800 m); Seaside zone (Black sea) – distance of 500 m next to the sea. For treatment, we principally use the seaside zone and the mountain zone (Koleva, 2006).

The first registered case of health tourism in Bulgarian antiquity – Sofia

According to the legend and the historical documents, the daughter of the Roman emperor Constantine the Great suffered from a severe disease. The medical council recommended the transfer of the young girl, named Sophia, to the small city of Serdika (a place of the Roman Empire, where the sky is always blue, the sun is shining all over the year; and with abundance of mineral waters). Some months after her arrival in Serdika, the daughter of the Emperor was healthy. His father (the Roman emperor) built a big church, designated to Sainte Sophia (the goddess of the intelligence – *Sophia means wisdom in Greek language*). Some centuries later, the name of the city of Serdika was changed to Sofia – the actual capital of Bulgaria (Koleva, 2006).

Scientific bases

Physical modalities

The group of physical modalities, applied in rehabilitation clinical practice, is divided in two sub-groups: natural and preformed (Koleva, 2006).

From the sub-group of **natural physical modalities**: water (incl. mineral waters), air (incl. ions & aerosols), temperature (heat or cold); movement (active & passive); with the respective parts of PRM: *hydro / balneo / therapy, aero / iono / therapy, thermo / cryo / therapy, kinesi (physio) therapy, ergo (occupational) therapy*.

From the sub-group of **preformed physical modalities**: electric currents, magnetic field, light (including laser), ultrasound; with the respective parts of PRM: *electro- & magneto-therapy, light-therapy, LASER-therapy, ultrasound-therapy*.

Reflex connections

In clinical practice, PRM uses many physical factors or physical modalities. We use some reflexory connections (Figure 1), existing between the surface of the human body and the internal organs, as follows: *cutaneous-visceral (zones of Head), subcutaneous-connective tissue-visceral (zones of Leube – Dicke), proprio-visceral (zones of Mackenzie), periostal-visceral (zones of Vogler-Krauss), and motor-visceral (zones of Mackenzie)* (Koleva, 2006).

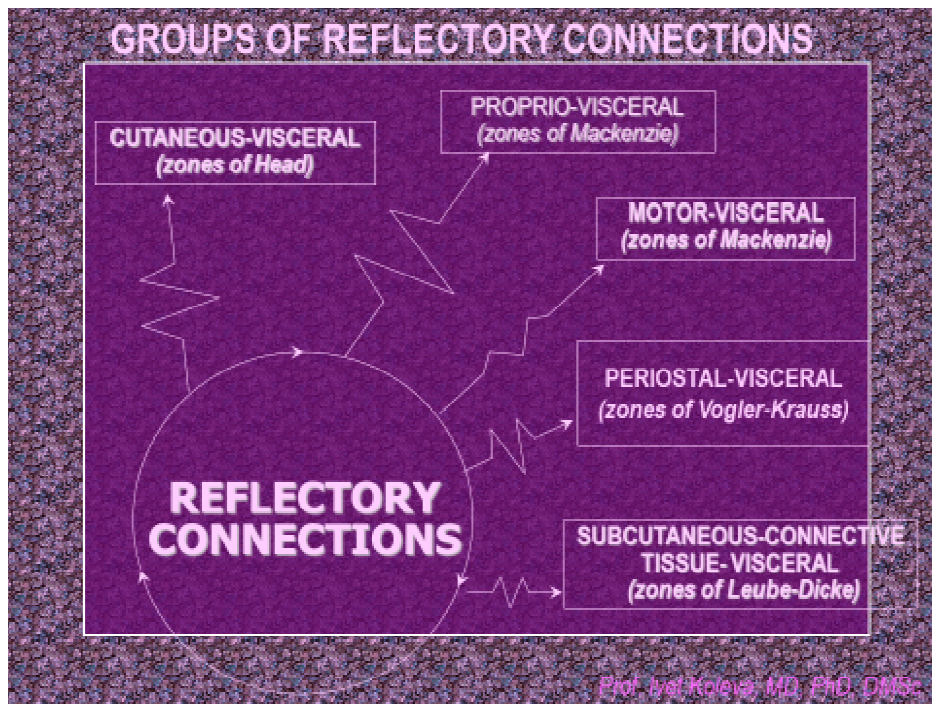


Figure 1. **Reflectory connections, used in rehabilitation practice**

Rehabilitation complex

The **rehabilitation complex** is a synergic combination of different preformed and natural physical modalities – a rehabilitation puzzle (Figure 2).

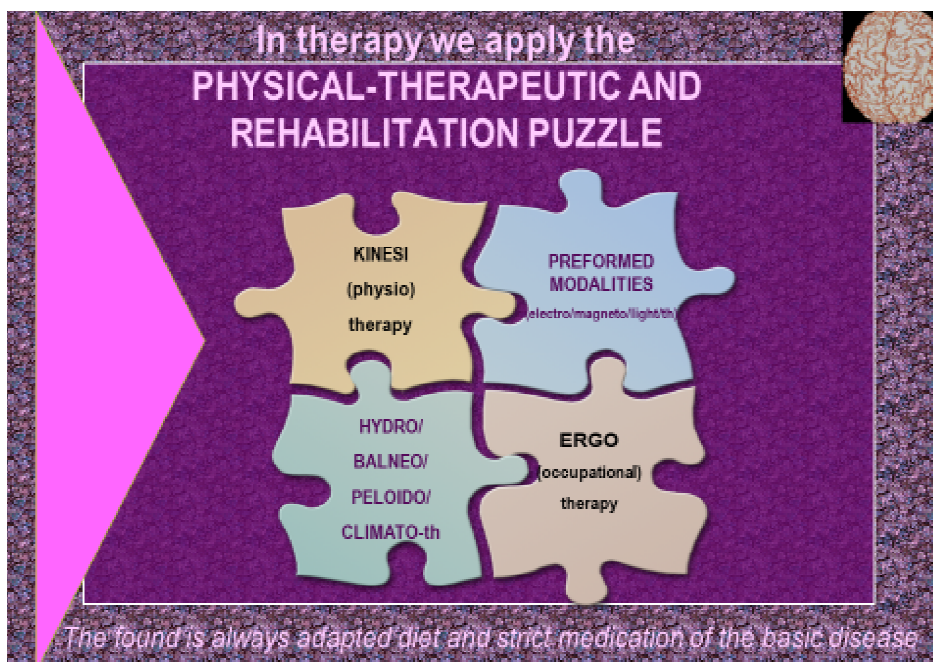


Figure 2. **Rehabilitation puzzle**

Balneoclimatology

Basic rehabilitation methods, applied in balneoclimatic centers, are: *Aero-therapy* (including aero-baths, respiratory exercises; wind – *Eol-therapy*); *Helio-therapy* (sun baths); *Thalasso-therapy* (swimming in the sea); *Hydro-therapy* (procedures with standard water); *Balneo-therapy* (mineral water procedures); *Peloido-therapy* (therapeutic mud, sea lye compresses).

Natural physical modalities, especially hydro- and balneotherapy, have many indications, few contra-indications, no side effects; applied techniques are very attractive and pleasant for patients (Koleva, 2006).

Different hydro- and balneo-therapeutic *techniques* are used (Koleva, 2006).

- *compresses*;
- *jets* – total or partial; with constant or variable temperature; with low or high pressure; Charcot jet; *underwater jet massage*;
- *baths* (Fig. 3, Fig. 4) – *standard or combined; hot, indifferent, cold baths*; drug baths, aromatic herbal baths (rosemary, lavender, valleriana, etc.), oils (eucalypt, menthol oil); with chemical ingredients – ions (sodium, potassium, Iod, Brom); *artificial gas baths* (Nitrogen, oxygen, H₂S – air bubbles); *Contrast baths; total baths, 3/4, 1/2 baths, partial baths*;
- *combined techniques (hydro or balneo-therapy and massage)* – manual massage under jets, jet massage in baths (Fig. 4), air jet in baths, vibration in baths;
- *hydro or balneotherapy in pool* (Fig. 4) – standard pool; pool with mechanical irritations (pool and physiotherapy / underwater exercises, artificial waves, pool with underwater jets, pool with underwater extension, training of locomotion / underwater walking); sport pools;
- *irrigations* – of nasopharynx, cavum oris; intestinal or rectal lavage.

Principal acting *factors* in hydrotherapy and balneotherapy include the temperature of the water, some mechanical and chemical factors. Depending of the *water temperature*, the water techniques can be: cold (temperature under 20 degrees), moderate (temperature between 21 and 33 degrees), indifferent (34°C < t < 36°C), hot (37°C < t < 39°C), hyper-thermal baths (over 40°C). The group of *mechanical factors* includes: the *hydrostatic pressure*, the *elevating force of the water* (according to the Law of Archimedes), and the *pressure of the jet* (water jets). Many investigations proved the impact of the chemical factors and the percutaneous penetration of some chemical elements: iodine, bromine, sulfur, calcium, sodium, potassium (Williams, 2008; Morer et al, 2017).



Figure 3. The SPA Tradition – Bankya, near to Sofia



Figure 4. SPA procedures

Peloidotherapy

Peloidotherapy is the treatment by peloids (Gomes, 2012). Different types of muds and mud-like substances (thermal mud, fango, clay, kaolin, etc.) are called peloids (from Greek: pelos = mud, slime). Peloidotherapy uses mechanical, thermal, chemic and biological factors of peloids (in Bulgaria: leman mud, source mud, volcanic mud; peat, mildews; maritime lye). Principal methods,

applied in Bulgaria, are: mud applications, mud baths, Egyptian method, combined methods (Fig. 5).

In clinical practice, we use some specific properties of peloids: Capacity for retention of humidity; Elevated relative mass; high heat capacity and poor heat conductivity; poor convection; elevated viscosity; high plasticity; high adhesive power; pH – peat has a low pH reaction, leman mud is alkaline (at 10); capacity for absorption; electro-dynamic forces; radio-activity (Koleva, 2006).

Therapeutic effects of peloids are: vasodilatation, sympaticolysis, trophic effect, stimulation of tissue regeneration, anti-oxidative effect. Principal indications for peloidotherapy include peripheral neurological disorders (radiculopathy, neuropathy, diabetic neuropathy; traumatic lesions of peripheral nerves, vibration disease), post-traumatic conditions (fractures, myofascial and ligamentar pain), rheumatologic maladies in chronic phase (arthrosis), dermatological diseases (Koleva, 2006).



Figure 5. Peloido-procedures

Efficacy of balneotherapy

Many authors (Lange 2006; Becker 2012; Corvillo et al, 2012; Roques 2012; Cozzi et al., 2018) consider that the inclusion of balneotherapy in the systematic rehabilitation, can make positive impact on health status and that balneotherapy has an important potential in cardio-respiratory and metabolic diseases (post-myocardial infarction; asthma and chronic obstructive pulmonary disease; metabolic syndrome, obesity and diabetes), in neurological and rheumatological conditions and diseases (spinal cord injury; osteoarthritis, rheumatoid arthritis, fibromyalgia)

The Bulgarian balneological school has a serious impact in the development of health, wellness and medical tourism in Bulgaria. There is a tradition in the field of rheumatology, neurology & neurosurgery, orthopedics and traumatology.

In our own clinical rehabilitation practice, we have obtained positive results in neurological patients; orthopedic and rheumatologic conditions. We paid special attention to the role of balneology (including balneotherapy and peloidotherapy) for prevention and rehabilitation of some socially important diseases in our country. We can present results of **our own modest clinical experience of 30 years** in the field of **rehabilitation – in neurological, rheumatological, orthopedical and traumatological conditions** (Koleva et al, 2008; 2015; 2017; 2018). Our goal was to prove and evaluate the efficacy of application of balneotherapy and peloidotherapy as an important element of the complex pain management and of the systematic rehabilitation algorithms for functional recovery and amelioration of the quality of life of patients with socially important diseases of the nervous and locomotory systems. We made a composition, clinical application and approbation series of many rehabilitation algorithms of many patients with neurological diseases, with rheumatologic maladies, with orthopedic and traumatic (OT) conditions, and after OT or neurosurgical intervention. The total of patients was divided into a lot of groups and subgroups, in each one we applied a different physical therapeutic and rehabilitation complex, composed by a synergic combination of natural and pre-formed physical modalities (of domains of electrotherapy, laser; cryo / thermo-therapy, hydro-/ balneo-/ peloido-therapy; physiotherapy and occupational therapy / ergotherapy). In most of groups, some balneo or peloido-therapeutic techniques were applied. Patients were controlled before, during and at the end of the rehabilitation course and one month after its end. The used battery of traditional and contemporaneous objective methods includes: tests and scales for motor deficiency, balance and coordination; pain scores; tests of functional grip of the upper limb; tests of gait and independent motion; complex functional scales for autonomy in everyday life and capacity for realization of different activities (self-service, family life, professional, social); scales for depression and anxiety; vibroesthesiometry; thermosensibility; laser Doppler flowmetry. Based on detailed qualitative and quantitative evaluation we proved the efficacy of application of different rehabilitation complexes and programs – on different types and levels of sensory, motor and functional deficiency in patients with diseases and conditions of the nervous and locomotory systems.

The impact of balneotherapy and peloidotherapy in rehabilitation is significant in patients with *diseases and conditions of the central and peripheral nervous system* (post stroke hemiparesis, multiple sclerosis, Parkinsonism, traumatic brain and spinal cord injuries; discogenic radiculopathy L5 with peroneal paresis, diabetic polyneuropathy with peroneal paresis), *rheumatological diseases* (rheumatoid arthritis, psoriatic arthritis, Bechterew' disease; coxarthrosis, gonarthrosis,

spondyloarthrosis, back pain, scoliosis; vibratory disease of upper extremities, carpal tunnel syndrome, morbus de De Quervain; diabetic podopathy, including cases with foot ulcers), *orthopedic and traumatologic conditions* (after joint distortions and contusions of lower limbs; after alloplasty of anterior cruciate ligament, after partial meniscectomy of the knee joint; after shoulder, hip and knee arthroplasty; phantom pain of the lower limb – after trans-femoral and trans-tibial amputation).

In the field of prophylaxis, in our country we have SPA programs for prevention of back pain; obesity; diabetes mellitus; osteoporosis; cerebro-vascular, cardiovascular and peripheral vascular diseases (transitory ischemic attacks and stroke, myocardial infarction, thrombophlebitis).

The management requires goal-oriented approaches. In physical medicine and rehabilitation clinical practice, we apply the SMART approach (acronym of Specific, Measurable, Attainable, Realistic and Timely approach). In preventive care, we use the 5 A approach (Ask, Advise, Assess, Assist, Arrange).

Conclusion

In conclusion, we can say that systematic prevention and rehabilitation (including balneo- and peloidotherapy) improve significantly the quality of life of patients with diseases and conditions of the nervous and locomotory systems. In clinical practice, we must emphasize on the great potential of mineral waters and peloids for prevention and treatment, for acceleration of functional recovery and stimulation of autonomy.

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IMPACT OF INFORMATION TECHNOLOGIES IN THE EDUCATION IN PHYSICAL THERAPY AND IN THE CLINICAL NEUROREHABILITATION

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Abstract

Impact of information technologies in the education in physical therapy and in the clinical neurorehabilitation

Key Words: *exoskeleton, hybrid assistive limb (HAL), gait, neurorehabilitation, autonomy, activities of daily living (ADL)*

During last years, we observe an introduction of information and communication technologies (ICT) in every field, including in education, diagnostics and therapy.

The goal of current work is to emphasize the potential of modern computer-based technologies in the process of rehabilitation – in clinical practice and in education.

Neurorehabilitation (NR) is an interdisciplinary thematic field between Neurology, Neurosurgery, Physical and Rehabilitation Medicine (PRM). Rehabilitation is a functional therapy, based on a detailed functional evaluation. Grasp, balance and gait are important elements of the everyday life functionality of patients in NR-clinical practice and is crucial for their independence in activities of daily living (ADL), respectively for their autonomy and quality of life.

Contemporaneous technologies are very useful during the assessment of balance – stabilometry or baropodometry. Robotic NR with exoskeleton is used for gait training. Virtual reality devices are applied for grasp and grip training.

We present some typical cases of diagnostics and NR with application of modern technologies from our own modest clinical practice. For illustration of clinical utility of stabilometry we present a case of vertebrobasilar insufficiency. Exoskeleton NR using Hybrid Assistive Limb (HAL) is explained by presentation of clinical case of post-stroke hemiparesis. Impact of Virtual reality devices in grasp and grip recovery is described by a case with hemiparetic hand (after stroke).

Importance of ICT in the learning process is demonstrated by the results in our students using electronic books with video-films on the educational disciplines: kinesiology, manual therapy, neurorehabilitation, balneology, ergotherapy. E-books ameliorate significantly the level of professional competences of students in physiotherapy, medical doctors-trainees in PRM and medical doctors and health professionals – participants in long-life learning courses.

Kopsavilkums

Informācijas tehnoloģiju ietekme fiziskās terapijas izglītībā un klīniskajā neirorehabilitācijā

Atslēgvārdi: *eksoskelets, hibrīda palīgdaļa (HAL), gaita, neirorehabilitācija, autonomija, ikdienas dzīves aktivitātes (ADL)*

Pēdējo gadu laikā mēs novērojam informācijas un komunikācijas tehnoloģiju (IKT) ieviešanu visās jomās, tostarp izglītībā, diagnostikā un terapijā.

Pašreizējā darba mērķis ir uzsvērt mūsdienu datorizēto tehnoloģiju potenciālu rehabilitācijas procesā – klīniskajā praksē un izglītībā.

Neirorehabilitācija (NR) ir starpdisciplināra tematiskā joma starp neiroloģiju, neiroķirurģiju, fizisko un rehabilitācijas medicīnu (FRM). Rehabilitācija ir funkcionāla terapija, kuras pamatā ir detalizēts funkcionālais novērtējums. Uztvere, līdzsvars un gaita ir nozīmīgi pacientu ikdienas dzīves funkcionalitātes elementi NR klīniskajā praksē, un tiem ir izšķiroša nozīme viņu neatkarībā ikdienas dzīves aktivitātēs (ADL), attiecīgi viņu autonomijai un dzīves kvalitātei.

Novērtējot līdzsvaru, ļoti noderīgas ir laikmetīgās tehnoloģijas – stabilometrija vai baropodometrija. Robota NR ar eksoskeletu izmanto gājiena apmācībai. Virtuālās realitātes ierīces tiek izmantotas satveršanas un saķeres apmācībai.

Mēs iepazīstinām ar dažiem tipiskiem diagnostikas un NR gadījumiem, izmantojot mūsu pašu pieticīgās klīniskās prakses modernās tehnoloģijas. Stabilitātes klīniskās lietderības ilustrēšanai mēs piedāvājam vertebrobasilāras nepietiekamības gadījumu. Eksoskelets NR, izmantojot hidrīdās palīgierīces (HAL), izskaidro ar pēc insulta hemiparēzes klīniskā gadījuma izsklāstu. Virtuālās realitātes ierīču ietekmi satveršanas un saķeres atjaunošanā raksturo gadījums ar hemiparētisku roku (pēc insulta).

IKT nozīmi mācību procesā parāda rezultāti, kad mūsu studenti izmanto elektroniskās grāmatas ar video filmām par izglītības disciplīnām: kinezioloģiju, manuālo terapiju, neirorehabilitāciju, balneoloģiju, ergoterapiju. E-grāmatas ievērojami uzlabo fizioterapijas studentu, personu ar ierobežotām pārvietošanās spējām ārstu-praktikantu, kā arī ārstus un veselības aprūpes speciālistus – mūžizglītības kursu dalībniekus profesionālās kompetences līmenī.

Neurorehabilitation & physical medicine

Neurorehabilitation

Neurorehabilitation (NR) is an interdisciplinary thematic field between Neurology, Neurosurgery, Physical and Rehabilitation Medicine (PRM) (Koleva, 2011).

Rehabilitation

Rehabilitation is a functional therapy, based on a detailed functional evaluation.

The World Health Organization's (WHO) definition of *rehabilitation* is: "The use of all means aimed to *reduce the impact of disabling and handicapping conditions*, and at enabling people with disabilities to achieve optimal social integration".

The *World Report on Disability* of the World Health Organization and World Bank (2011) defines the *goals of rehabilitation*: prevention and slowing the rate of loss of function; improvement, restoration or compensation of lost function; maintenance of current function. Modern rehabilitation has an *integrative and holistic approach to the patient*, based on the *International Classification, disability and Health (ICF, 2001)* and on clinical principles (Figure 1).

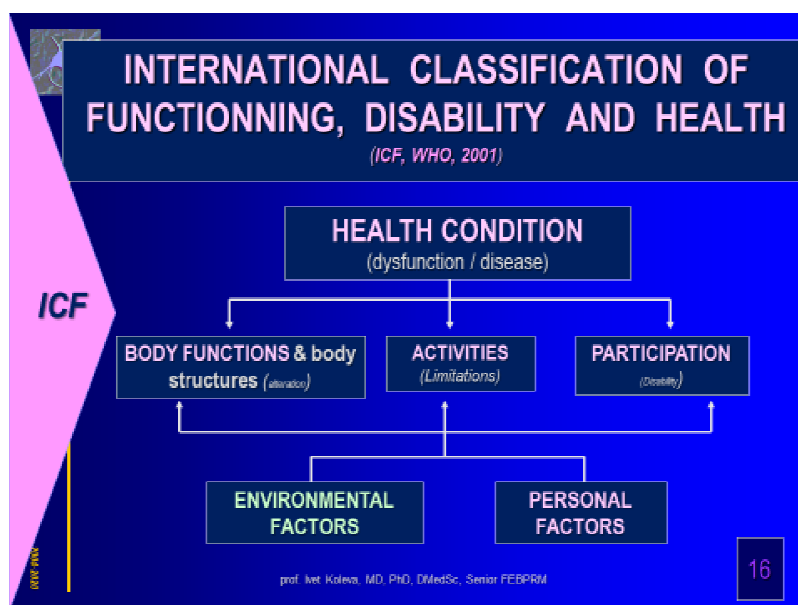


Figure 1. ICF

The rehabilitation process, according to the so-called rehabilitation cycle, includes an assessment and definition of the (individual) rehabilitation goals, assignment to the rehabilitation program, and evaluation of individual outcomes.

Rehabilitation is a functional therapy, realized in acute and chronic stage departments of hospitals for active or for long-term care; by a multi-disciplinary multi-professional team (medical doctors, nurses, physiotherapists, occupational therapists) – the "Rehabilitation Team" (Figure 2).

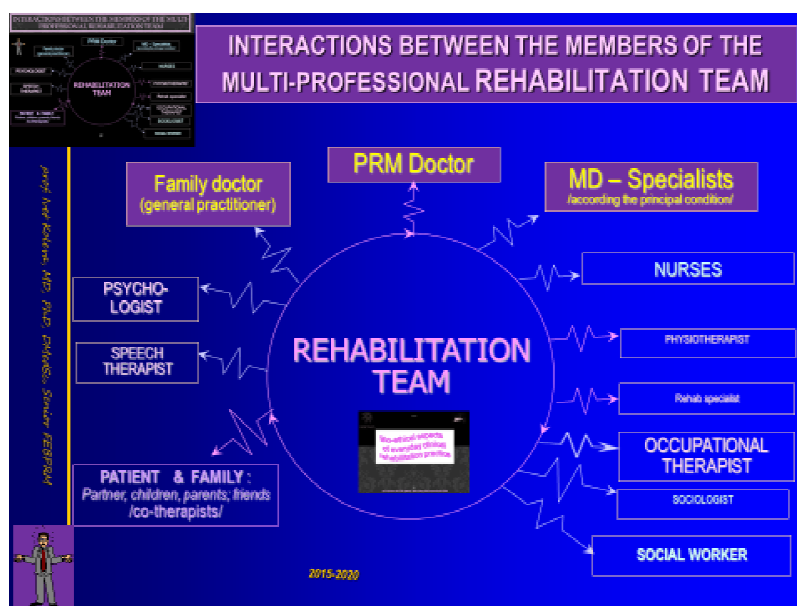


Figure 2. Members of the Rehabilitation Team

Physical Medicine

The Definition, amended by the Council of the European Union of Medical Specialists (UEMS, 2005), formulates that: “The medical act encompasses all the professional action, e.g. scientific, teaching, training and educational, clinical and medico-technical steps, performed to promote health and functioning, prevent diseases, provide diagnostic or therapeutic and rehabilitative care to patients, individuals, groups or communities in the framework of the respect of ethical and deontological value. It is the responsibility of, and must always be performed by a registered medical doctor / physician or under his or her direct supervision and/or prescription.”

According to the White Book of the specialty Physical and Rehabilitation Medicine (PRM) and the corresponding definition of the UEMS – PRM Section and Board (White Book, 2006, 2018): PRM is an „independent medical specialty, oriented to the promotion of physical and cognitive functioning, activities (including environment), participation (including quality of life) and changes in personal factors and environment. It is thus responsible for the prevention, diagnosis, treatments and rehabilitation management of people with disabling medical conditions and co-morbidity across all ages.”

PRM is a “Medicine of Functioning”, focusing on the improvement of functioning (Koleva, 2009).

The goal of PRM is prevention, treatment and rehabilitation.

In the clinical management of neurological and neurosurgical patients, the role of medical doctors – PRM specialists is central.

The number of chronic patients with invalidating diseases and conditions (predominantly of the nervous, motor and cardio-vascular systems) increases during last years. All these persons have

somato-sensory, motor and/or cognitive dysfunctions and deficits (Figure 3). Therefore, they need a complex rehabilitation programs, oriented to functional recovery and amelioration of their quality of life. In this process, the impact of PRM and rehabilitation is central.

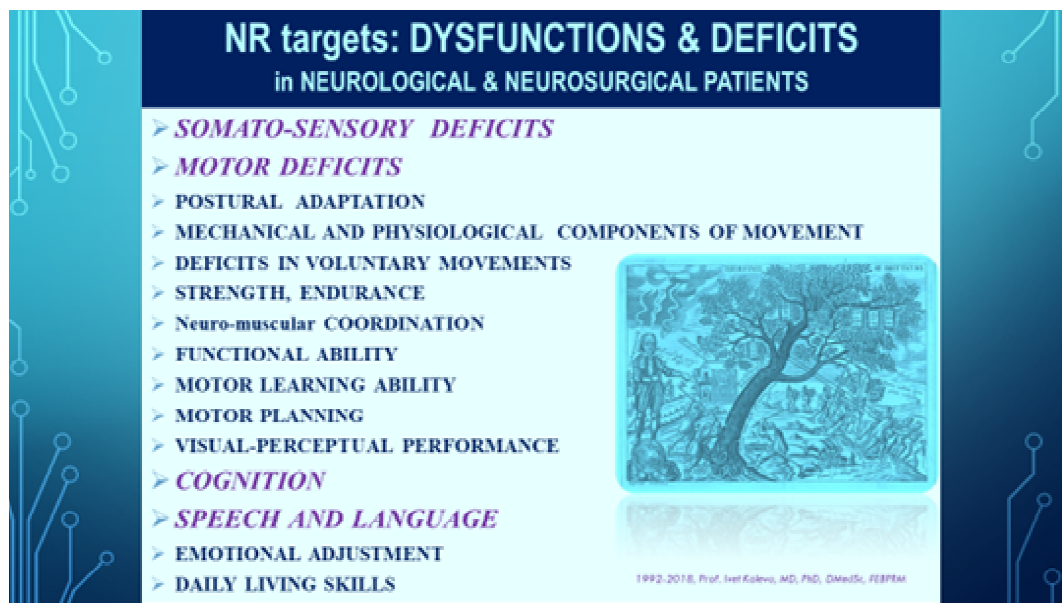


Figure 3. **Frequent dysfunctions and deficits in rehabilitation clinical practice**

The diagnosis in PRM is the interaction between the medical diagnosis and a PRM-specific functional assessment. Interventions in PRM are provided either directly by PRM physicians or within the rehabilitation team. They include a wide range of treatments, including medicines, physical therapies, exercises, education and many others.

Outcomes of PRM interventions and programs, showed reduction of impairments in body functions, activity limitations, and impacting on participation restrictions, and also reduction in costs as well as decrease in mortality for certain groups of patients (Koleva, 2017).

Rehabilitation algorithm includes detailed functional evaluation (based on ICF) and synergic combination of physical modalities (movement, activities, mineral waters, electric currents, etc.). The “rehabilitation puzzle” includes many natural physical modalities [water (mineral baths), air, sun, exercises, massage, manual therapy techniques (traction, mobilization, and manipulation); ergotherapy (work and activities)] and pre-formed physical modalities [electric currents, light, magnetic field, ultra-sound, etc.]. The principal physical modalities, applied in Neurorehabilitation clinical practice, are presented in Figure 4.

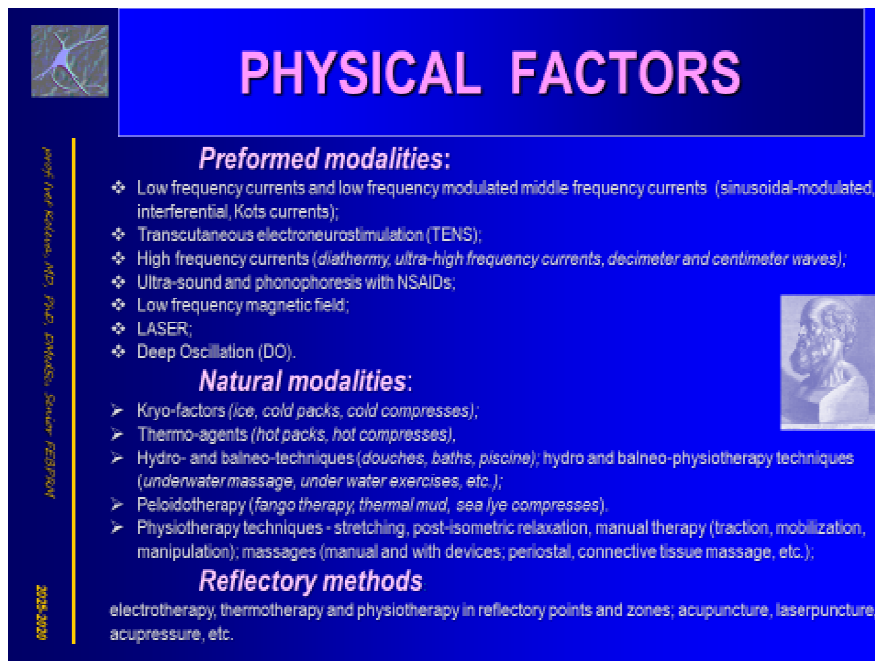


Figure 4. **Physical modalities (physical factors)**

The general rehabilitation algorithm includes one or two pre-formed modalities, one thermo- or cryo-agent, two or three physiotherapeutic procedures (including analytic exercises, post-isometric relaxation, stretching techniques, massage, etc.).

ICT in medicine and rehabilitation

During last years, we observe an introduction of information and communication technologies (ICT) in every field, including in education, diagnostics and therapy.

According to the World Disability Report (2011), ICTs are applied in different fields of medicine and rehabilitation:

- *Video and tele-conferences technologies;*
- *Mobile phones and mobile Internet;*
- *Tele-monitoring – e.g. Holter electro-cardiography.*

Potential users of ICT are patients, members of the family, members of the rehabilitation team, etc.

The goal of current work is to emphasize the potential of modern computer-based technologies in the processes of rehabilitation – in clinical practice and in education.

ICT for functional recovery of grasp and gait

Grasp, balance and gait are important elements of the everyday life functionality of patients in NR-clinical practice and is crucial for their independence in activities of daily living (ADL), respectively for their autonomy and quality of life.

- Contemporaneous technologies are very useful during the assessment of equilibrium – stabilometry or baropodometry – especially in cases with balance instability.
- Robotic NR with exoskeleton is used for gait training.
- Virtual reality devices are applied for grasp and grip training.

We present some typical cases of diagnostics and NR with application of modern technologies from our own modest clinical practice.

Robotic neurorehabilitation with exoskeleton

We present a typical case of a female patient of 50 years, with a post-stroke hemiparesis, treated with Hybrid Assistive Limb (HAL).



Figure 5. The hemiparetic patient, treated by HAL

Clinical data before the NR: left spastic hemiparesis, motor functions – of levels III–IV according S. Brunnstrom, left superficial hemihypoesthesia; with contractures of the left wrist and fingers, left ankle and toes.

For treatment, we created a complex NR-programme (of 20 procedures) with synergic combination of different physical factors: physiotherapy, ergotherapy, functional electrical stimulations (FES) and Exoskeleton-NR using Hybrid Assistive Limb (HAL) (Lamprecht, 2018).

We adapted the NR-complex to the concrete patient in the correspondent phase of the disease and disability: a stable method of FES with tetanic pulses – for the muscles extensors (dorsal flexors) of the ankle and toes.

We observed significant functional recovery: *reduction of the muscle weakness and contractures; balance stabilization; gait recovery – with walker and after – with crutches; amelioration of autonomy in activities of daily living.*

The robotic NR promotes neuroplasticity (activity-induced plasticity), encourages functional recovery of balance and gait stability. The gait training through Exoskeleton improves the bipedal synchronization, the combination of open- and closed-kinetic chains movements and the coordination of stance and swing phases of the gait cycle.

Virtual reality for grasp recovery

Impact of Virtual reality devices in grasp and grip recovery will be described by another clinical case with hemiparetic hand (after stroke).

We present a typical clinical case – a female patient of 73 years, with right central (spastic) hemiparesis, 6 month after the acute event (ischemic stroke).

The PRM-programme included: Electrical Stimulations (ES); Neuro-Physiotherapy & Neuro-Ergotherapy [I. Koleva, 2008], Virtual NR with Thyro-Motion system (Stein et al, 2011; Aprile et al, 2020).

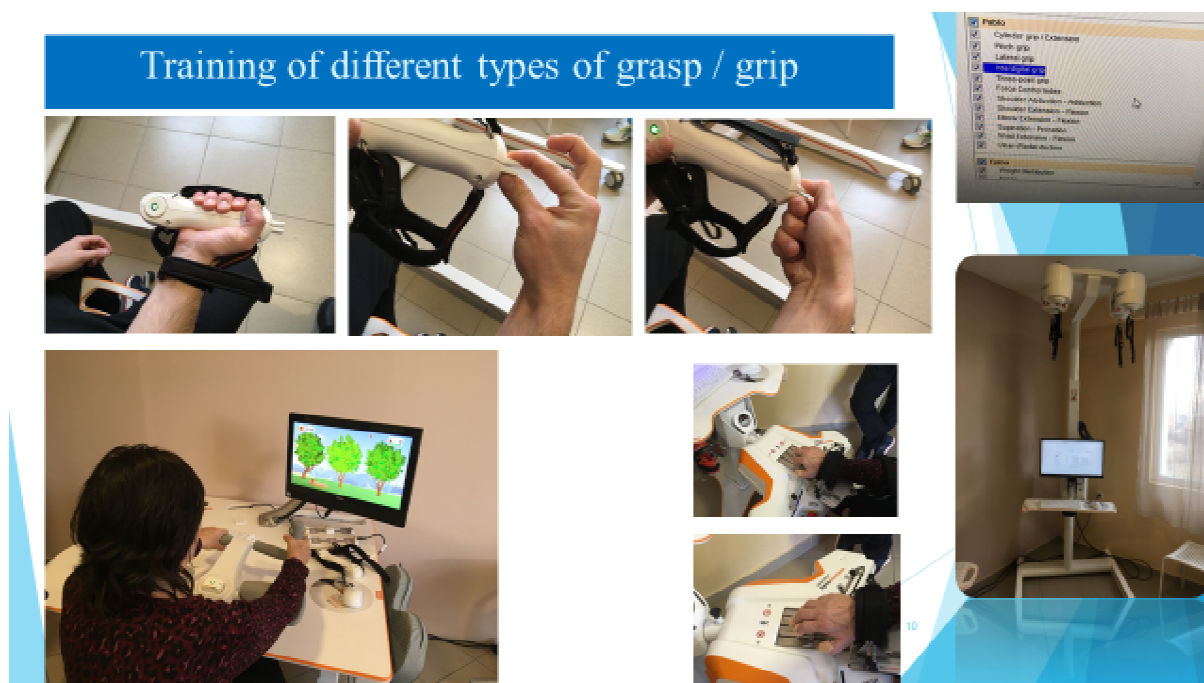


Figure 6. Training of different types of grasp / grip with Tyro Station

Results of the applied NR were positive: significant functional recovery: reduction of the muscle weakness and contractures; grasp recovery and amelioration of autonomy in activities of daily living.

The *virtual NR* promotes neuroplasticity (activity-induced plasticity), encourages functional recovery of grasp and autonomy in everyday activities. The grasp training through virtual reality improves the bimanual synchronization, the combination of open- and closed-kinetic chains movements and the coordination of different phases of the grasp cycle.

ICT & education

Importance of ICT in the learning process can be demonstrated by the results in our students and trainees, using electronic books with video-films. During last years, we prepared a series of e-book in Bulgarian and/or in English language, and we distributed these books to all our students and participants in long-life learning (LLL) educational courses, organized by the Medical University of Sofia in the field of Rehabilitation. Manuals in English were used too in Daugavplis University (DU) – for students in Physiotherapy (Koleva, 2019–2020).

In Bulgarian language, we prepared e-books with video-films on some educational disciplines and long-life learning courses: Kinesiology, Manual therapy, Balneology, Ergotherapy; Neurorehabilitation, Cardiorehabilitation. In English language, we prepared e-books in Manual therapy, Neurorehabilitation and Orthopedic Rehabilitation; designated to English speaking students (including from DU).

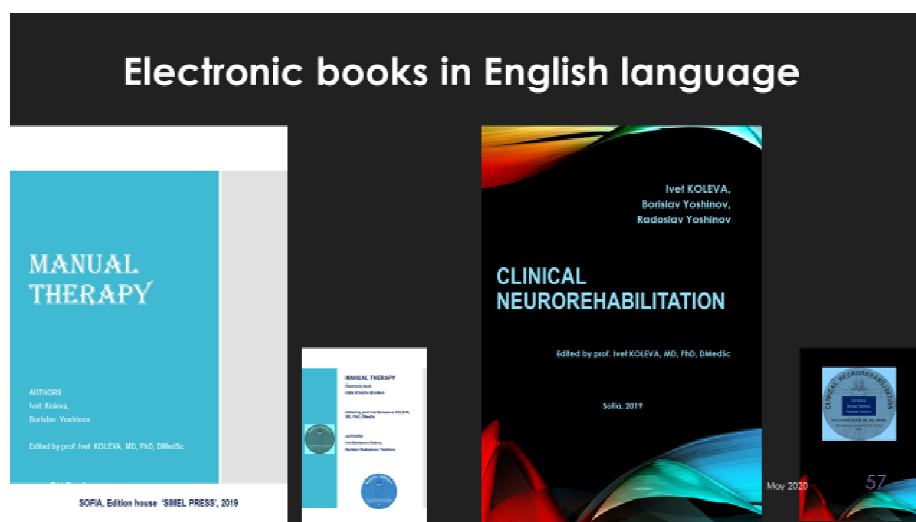


Figure 7. Some electronic books in English language

We realized a comparison of the level of theoretical knowledge and practical skills of these different types of practitioners – before and after the edition of the correspondent e-book, and we evaluated the results of the application of electronic learning on the professional competences in this field (Yoshinov et al, 2011; Koleva et al, 2016).

We created a set of tests and practical exams (including analysis of clinical cases) in the field of the respective e-book, adapted to the level of education of different types of practitioners (for students, for physiotherapists – bachelors and masters; for medical doctors – PRM specialists and PRM-trainees).

We applied these different levels of the exam set in: medical doctors (PRM-specialists and PRM-trainees) during the process of training and during LLL courses; in students in Kinesitherapy – bachelor’s degree and students in “Medical Rehabilitation and Balneology” –

master's degree)]; and in medical doctors (specialists and trainees in PRM) and in working physiotherapists during LLL courses, organized by the Medical Universities of Sofia and Pleven (2009–2020). We compared the level of theoretical knowledge and practical skills in groups of practitioners before and after the edition and application of the e-book and the video-films in the clinical practice (Koleva et al, 2019-a, 2019-b).

The results of the qualitative and quantitative evaluation of the introduction of e-learning demonstrates a statistically significant improvement in the level of theoretical knowledge and practical skills in all students and working members of the multi-disciplinary multi-professional rehabilitation team. Results were significantly better in experimental sub-groups (with e-book & presentations).

We consider very effective the application of our e-books on the level of theoretical knowledge and practical skills of the medical specialists and health professionals in clinical rehabilitation practice. We must highlight the significance of the electronic education in the field of rehabilitation (including PT) for the level of competences of all members of the multi-disciplinary and multi-professional rehabilitation team: medical doctors (specialists and trainees in Physical and Rehabilitation Medicine) and health professionals (actual and future bachelors and masters in Physiotherapy, Medical Rehabilitation and Balneology, Medical Rehabilitation and Ergotherapy).

Conclusion

In conclusion we must say that the systematic rehabilitation significantly improves the quality of life of patients with diseases and conditions of the nervous systems and the information technologies can be very useful in this process. E-books ameliorate significantly the level of professional competences of students in physiotherapy, medical doctors-trainees in PRM and medical doctors and health professionals – participants in long-life learning courses.

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DERMOSCOPIC MONITORING OF SHINY WHITE STREAKS DURING TOPICAL TREATMENT OF ACTINIC KERATOSIS

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Abstract

Dermoscopic monitoring of shiny white streaks during topical treatment of actinic keratosis

Key Words: shiny white streaks, chrysalis structures, actinic keratosis, dermoscopy

Background and Objectives. It has been shown that dermoscopy improves diagnostic accuracy of a clinician. Nevertheless, data on dynamics of dermoscopically seen structures and treatment impact on them is scarce; therefore, we chose to monitor shiny white streaks (SWS), during topical treatment of actinic keratoses (AK).

Materials and Methods. AK lesions located on face or scalp were treated with either topical 5% 5-fluorouracil cream (5FU) or daylight photodynamic therapy with methyl aminolevulinic acid (DL-PDT). Dermoscopic assessments were performed before start of therapy, at peak inflammatory phase and one-month post-treatment (Follow-up visit).

Results. Of 38 lesions followed, before start of therapy SWS were present in 18 (47%) lesions. In five cases (13%) SWS remained present through all visits. In three cases (8%) SWS were present until the Follow-up visit. In ten (26%) AKs SWS disappeared at the peak inflammatory phase, but in four (11%) of those SWS later reappeared. Of 20 (53%) lesions without SWS at the first visit, only one (3%) developed SWS at a Follow-up visit.

Conclusions. SWS seem to be variable structures that can be unseen in lesions with therapy induced inflammation, disappear following topical treatment of AK and sometimes appear for the first time post-treatment. It could be important to take into consideration the dynamics of SWS when assessing their presence.

Kopsavilkums

Balto spīdīgo strēļu dermatoskopiskā monitorēšana aktīnisko keratožu lokālās terapijas laikā

Atslēgvārdi: Baltās spīdīgās strēles, Krizāla struktūras, aktīniskās keratozes, dermatoskopija

Ievads un mērķis. Pētījumi liecina, ka klīniskajā praksē dermatoskopija uzlabo ārsta spēju precīzi diagnosticēt ādas veidojumus. Dermatoskopiskās diagnozes pamatā ir specifisku struktūru atpazīšana, tomēr atsevišķas dermatoskopiskās struktūras laika gaitā mainās un trūkst datu par to dinamiku, tai skaitā, lokālās terapijas ietekmi uz dermatoskopiskajām struktūrām. Šī pētījuma mērķis bija dinamiskā novērtēt baltās spīdīgās strēles (BSS) lokālās aktīnisko keratožu terapijas laikā.

Materiāli un metodes. Aktīniskās keratozes sejas un skalpa ādā tika ārstētas vai nu ar 5% 5-fluoruracila krēmu, vai ar dienas gaismas fotodinamisko terapiju izmantojot metilaminolevulināta krēmu. Veidojumi tika dermatoskopiski novērtēti pirms terapijas (1. vizīte), izteikta terapijas radīta ādas iekaisuma laikā (2. vizīte) un vienu mēnesi pēc terapijas (pēcterapijas vizīte).

Rezultāti. No 38 aktīniskajām keratozēm, kas atbilda iekļaušanas kritērijiem un tika novērtētas dinamikā, BSS tika konstatētas 18 (47%) veidojumiem. No tiem piecos gadījumos (13%) BSS saglabājās visās vizītēs. Trijos gadījumos (8%) BSS saglabājās līdz pēcterapijas vizītei, kad tās vairs nebija saskatāmas. Desmit (26%) gadījumos BSS izzuda 2. vizītē, kas atbilda visizteiktākajam terapijas radītajam ādas iekaisumam, bet četros gadījumos (11%) BSS vēlāk atjaunojās pēcterapijas vizītē. No 20 (53%) veidojumiem bez BSS 1. vizītē tikai vienam veidojumam (3%) attīstījās BSS, kas tika konstatēts pēcterapijas vizītē.

Secinājumi. BSS ir šķietami variablas struktūras, kas lokālās aktīnisko keratožu terapijas laikā var izzust terapijas radītā iekaisuma fāzē un pēc terapijas, kā arī dažkārt parādīties pēc terapijas. BSS dinamika būtu jāņem vērā analizējot to sastopamību.

Introduction

Shiny white streaks (SWS) also known as chrysalis or crystalline structures are white, perpendicular, few millimeters long lines that are only visible in a polarized light dermoscopy (Kittler et al. 2016). These structures, considered as a dermoscopic sign of dermal fibrosis, are caused by polarization of thickened hyaline fibrous bundles (Pizzichetta et al. 2014; Haspeslagh et al. 2016), and have been reported in a variety of skin lesions, including actinic keratosis (AK) (Balagula et al. 2012; Liebman et al. 2012). At present, the clinical significance of SWS has been associated with melanocytic skin lesions, namely a sign of 10-fold increased risk of malignancy (Shitara et al. 2014). The clinical significance of SWS in non-pigmented lesions is yet to be defined. Additionally, data on permanence of SWS and treatment impact on SWS is lacking. Therefore, we used topical treatment of AK as model to dermoscopically monitor dynamics of SWS.

Materials and methods

Presence of SWS was continuously assessed in eight patients with AK lesions located on face or scalp and treated with either topical 5% 5-fluorouracil cream (5FU) or daylight photodynamic therapy with methyl aminolevulinate (DL-PDT). Diagnosis of AK was made according to clinical and dermoscopic signs and confirmed histologically in each patient in a single 4mm punch biopsy specimen. Biopsied lesions were not included into assessment to exclude possible change in SWS due to scar formation. In addition, only lesions that lacked superficial scale and did not develop scales or erosions during therapy were included for continuous assessment of SWS. Dermatoscopic assessments of lesions treated with 5FU were performed before start of therapy (Visit 1), at peak inflammatory phase corresponding to three or four weeks of 5FU usage (Visit 2) and one-month post-treatment (Follow-up visit). Dermatoscopic assessments of lesions treated with DL-PDT were performed before start of therapy (Visit 1), at peak inflammatory phase corresponding to one-day post-treatment (Visit 2) and one-month post-treatment (Follow-up visit). All dermatoscopic pictures were taken in a polarized light mode with FotoFinder Systems GmbH medicam 1000 device. All dermatoscopic evaluations were performed simultaneously by two physicians specializing in dermoscopy (A.B. and E.O.).

Results

Eight patients had a total number of 90 AKs that were dermoscopically monitored. For continuous assessment of SWS only 38 lesions were suitable; the rest were excluded due to reasons stated above, mainly presence of superficial scale or development of erosions during therapy. Presence of SWS by visit number is depicted in Fig. 1. Before start of therapy SWS were present in 18 (47%) of AKs. Of those, in 5 cases (13%) SWS remained present in all visits; in 3 cases (8%) SWS were present until Follow-up visit, when SWS were no more visualized. In 10 (26%) AKs SWS disappeared at the Visit 2, corresponding to treatment induced inflammation, but in 4 (11%) of

those, SWS reappeared at a Follow-up visit (Fig.2). Of 20 (53%) lesions without SWS at the first visit, only 1 (3%) developed SWS at a Follow-up visit.

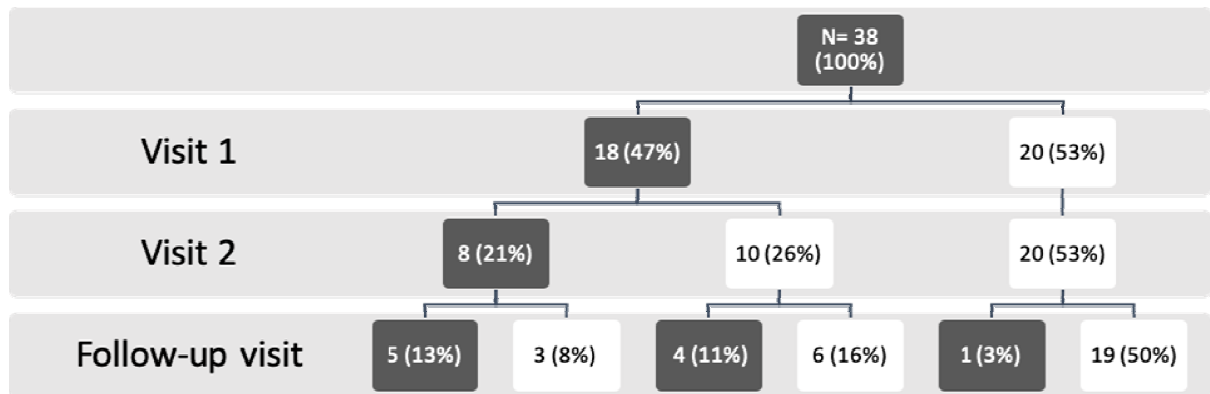


Figure 1. Presence of SWS by visit number. Dark grey cells indicate presence of SWS, white cells – absence of SWS. Visit 1 – before start of therapy; Visit 2 – at treatment induced inflammatory phase; Follow-up visit – one-month post-treatment

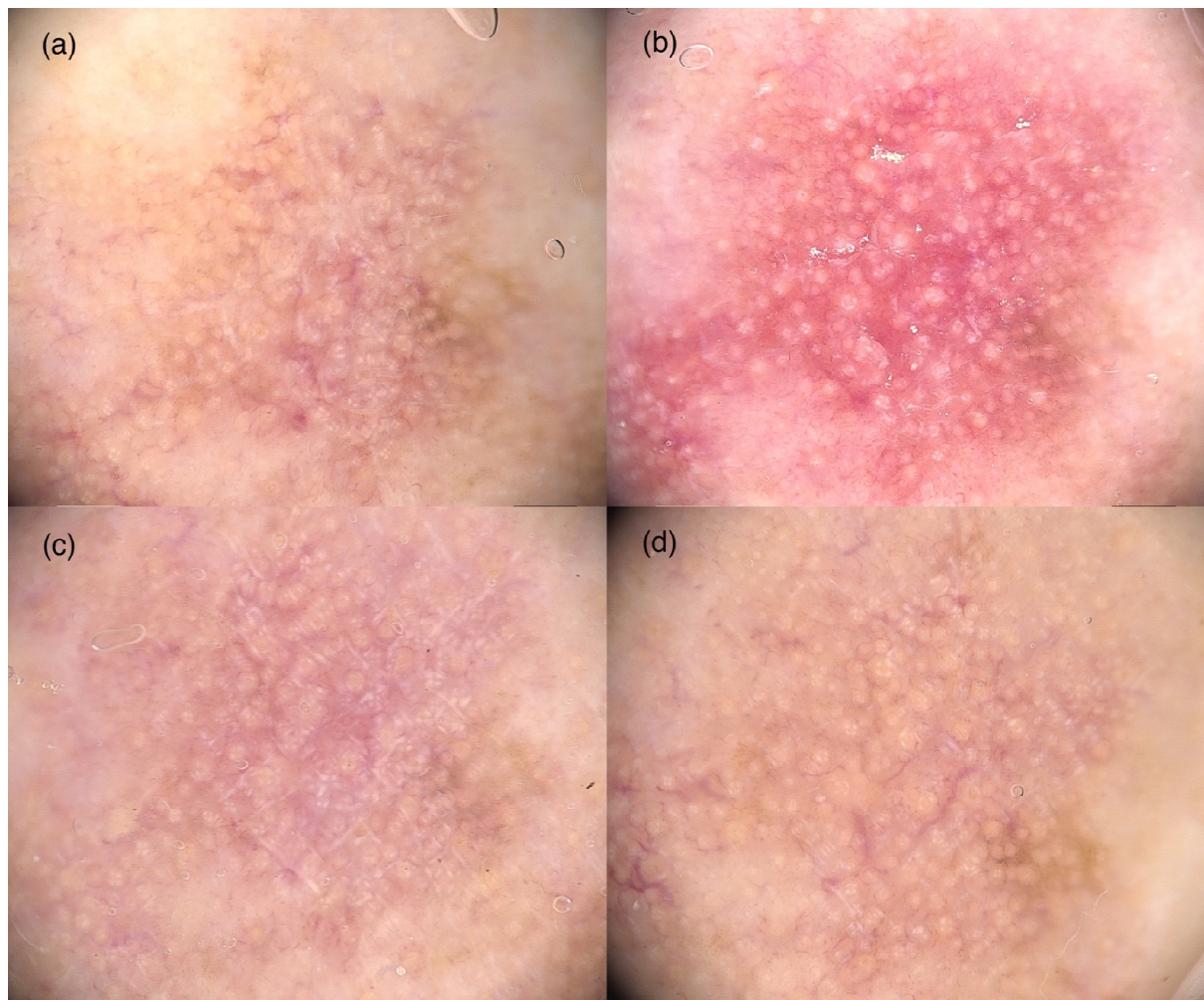


Figure 2. Dermoscopic monitoring of SWS in AK treated with DL-PDT. SWS are visualized at Visit 1 (a), 1 week after therapy (c) and to a smaller extent at Follow-up visit (d); SWS are lacking at Visit 2 (b), when therapy induced inflammation is observed

Discussion

Dermatoscope is an easy to use handheld device, that renders magnification and removes skin surface reflection, thus visualizing morphologic structures unseen with a naked eye (Pan et al. 2008). It has been shown to improve diagnostic accuracy of both pigmented and non-pigmented skin lesions and at times to provide relevant prognostic information through known dermoscopic-histopathologic correlations (Sinz et al. 2017). Common dermoscopic signs of AK are white-to-yellow surface scale, red pseudonetwork, which is formed by perifollicular erythema often combined with linear-wavy telangiectasia, targetoid-like hair follicles which are formed by yellowish keratotic plugs that fill and white halo that surrounds hair follicles, and rosette sign (Lee et al. 2014; Zalaudek et al. 2006). Although the clinical significance of SWS in AK is not yet fully established, SWS, as seen in our case series, is a common dermoscopic feature of AK with a higher prevalence than previously reported by *Balagula et al.* and *Liebman et al.* (Balagula et al. 2012; Liebman et al. 2012). This observation could be explained by selection of AK lesions, as lesions with scales that could possibly hide SWS were excluded from our study. Noteworthy, scale is a common feature of AK, with a prevalence of 79.4 – 85% (Lee et al. 2014; Zalaudek et al. 2006). In addition, scales, crusts and erosions commonly develop with topical treatment due to destruction of atypical keratinocytes and such lesions were also excluded. Another reason for high prevalence of SWS in our study was that even a small amount of SWS were counted as a positive feature and FotoFinder Systems medicam 1000 device offers higher magnification and resolution in comparison with handheld devices. In our study, despite the small sample size, it was possible to determine several possible scenarios of treatment impact on SWS. First, although successful therapy is usually associated with disappearance of dermoscopic signs, SWS can remain present through all treatment stages or even appear at a 1-month post-treatment visit without other dermoscopic signs of AK. As SWS is not a required feature for AK, permanence of SWS is not a counter-condition to treatment success. Second, as other dermoscopic structures, SWS can disappear during or after therapy and finally, SWS can temporarily disappear during treatment induced inflammation and reappear thereafter. This last observation was present in 13% of lesions analyzed, and although the exact reason for such phenomenon is not clear yet, it leads us to speculate that SWS might also be hidden in other clinically clearly erythematous lesions, not limited to AK.

To the best of our knowledge, this is the first study in which SWS are continuously monitored. In conclusion, we would like to emphasize that SWS seem to be variable structures that can be unseen in lesions with therapy induced inflammation, disappear following topical treatment of AK and sometimes appear for the first time after treatment. It could be important to take into consideration the dynamics of SWS when assessing their presence.

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AGE AS A RISK FACTOR FOR PHYSICAL ACTIVITY RECOMMENDATION WITHHOLDING

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Abstract

Age as a risk factor for physical activity recommendation withholding

Key Words: *physical activity, recommendations, age as a risk factor, sedentary, lifestyle*

Regular physical activity is significant for physical and mental health. All health professionals should counsel their patients to engage in physical activity independently on patient's age, physical state or disability.

The aim of this study was to determine whether age is a factor that impacts how often does a patient receive recommendations about physical activity.

Patients were interviewed with a questionnaire, it was developed based on guidance of World Health Organization guidelines "Global recommendations on physical activity for health" (2010). Statistical analysis was performed with SPSS.

This study included 101 hospitalized patients from National Rehabilitation Centre "Vaivari". 60.4% were women and 39.6% were men.

Patients were divided in to 3 age groups: under 30 years old, from 31 to 50 years old and older than 50.

From age group under 30 years old, 42.8% received recommendations about physical activity on every personnel visit, but 57.2% received them only once or not at all.

From age group 31 to 50 years old, 80% received recommendations about physical activity on every personnel visit and 20% received them only once or not at all.

From age group above 50 years old, 81.5% received recommendations about physical activity on every personnel visit and 18.5% received them only once or not at all.

Younger patients tended to receive recommendations less than older ones ($p=0.02$). This might be due to the fact that in the age group under 30 years 24% stated that they have had episodes when they did not wish to communicate with medical personnel and did not wish to receive recommendations. In the two remaining age groups 12% stated the same.

Age was a statistically significant factor. Younger patients received recommendations less. One could argue that it was because younger people have had more episodes when they did not wish to communicate and receive recommendations from the medical personnel.

Kopsavilkums

Vecums kā riska faktors rekomendāciju nesniegšanai par fiziskajām aktivitātēm

Atslēgas vārdi: *fiziskā aktivitāte, rekomendācijas, vecums kā riska faktors, mazkustīgums, dzīvesveids*

Regulāra fiziskā aktivitāte ir nozīmīga cilvēka fiziskajai un mentālajai veselībai. Medicīnas profesiju pārstāvjiem būtu jāsniedz rekomendācijas par fiziskajām aktivitātēm katram savam pacientam, neatkarīgi no pacienta vecuma, disfunkciju pakāpes vai mentālā stāvokļa.

Darba mērķis ir noteikt vai pacienta vecums ir riska faktors, kas ietekmē rekomendāciju sniegšanas biežumu.

Pacienti tika intervēti ar anketu, kas tika izstrādāta balstoties uz Pasaules Veselības organizācijas vadlīnijām "Global recommendations on physical activity for health" (2010). Statistiskā analīze tika veikta SPSS lietotnē.

Šis pētījums iekļāva 101 pacientu, kas uz intervēšanas brīdi atradās Nacionālajā Rehabilitācijas centrā "Vaivari". 60.4% no respondentiem bija sievietes un 39.6% bija vīrieši.

Pacienti tika iedalīti 3 vecuma grupās: jaunāki par 30 gadiem, no 31 līdz 50 gadiem un vecāki par 50 gadiem.

Vecuma grupā zem 30 gadiem, 42.8% saņēma rekomendācijas par fiziskajām aktivitātēm katrā personāla apmeklējuma vizītē, savukārt 57.2% tās tika sniegtas vienu reizi vai nemaz.

Vecuma grupā no 31 līdz 50 gadiem, 80% saņēma rekomendācijas par fiziskajām aktivitātēm katrā personāla apmeklējuma vizītē, savukārt 20% tās tika sniegtas vienu reizi vai nemaz.

Vecuma grupā virs 50 gadiem, 81.5% saņēma rekomendācijas par fiziskajām aktivitātēm katrā personāla apmeklējuma vizītē un 18.5% tās saņēma tikai vienu reizi vai nemaz.

Jaunāki pacienti retāk saņēma rekomendācijas ($p=0.02$). Šo varētu skaidrot ar to, ka 24%, vecuma grupā zem 30 gadiem, atzina, ka bija piedzīvojuši tādas situācijas, kurās nevēlējās, lai personāls sniedz tiem rekomendācijas par fiziskajām aktivitātēm. Pārējās grupās šis indivīdu īpatsvars bija 12% kopā uz abām grupām.

Vecums bija nozīmīgs riska faktors. Biežāk rekomendācijas netika sniegtas tieši jaunākiem cilvēkiem, ko varētu pamatot ar faktu, ka tie biežāk nonāca situācijās, kurās nevēlējās, lai personāls sniedz rekomendācijas par fiziskajām aktivitātēm.

Introduction

Regular physical activity is significant for physical and mental health. After World Health Organization data, physical activity must be provided for all at least for 150 minutes per week with individually adjusted intensity. According to the data from United States of America only 56% patients are asked about their physical activity habits and whether they engage in active lifestyle or not. About 34% receive recommendations after they have asked on their own and 22–45% patients after the age of 65 receive recommendations about physical activity from their general practitioners (Ribeiro 2007).

General practitioners admit that they do not provide recommendations about physical activity for all their patients because of various reasons. For example, most common reasons are: incompetency in specific area, patient age, lack of time or lack of patient involvement and motivation. Medical professionals also state that they fear that inadequate physical activity will worsen their patient conditions.

In general patients who have health issues and disabilities tend to receive recommendations less than healthy part of the population.

All health professionals should counsel their patients to engage in physical activity independently on patient's age, physical state or disability.

Our aim was to determine whether age is a factor that impacts how often does a patient receive recommendations about physical activity.

Our objectives were:

- to collect data on how age affects medical care for patients;
- to determine how often patients, receive recommendations about physical activity from medical personnel;
- to determine medical personnel reasons for withholding recommendations.

Material and Methods

This cross-sectional study included 101 patients from National Rehabilitation Centre "Vaivari". Data was collected from August 2019 to November 2019. Patients were interviewed with a questionnaire. The questionnaire was developed based on guidance of World Health Organization guidelines "Global recommendations on physical activity for health" (2010).

Patients were asked various questions about their age, gender, hospitalization department and length and how many times they have been hospitalized before. We also were interested in how often they received recommendations about physical activities from medical personnel, how often they have had situations that they did not wish to communicate with medical personnel and did not wish to receive recommendations about physical activity. Patients were also asked to express their

opinion about who should provide recommendations about physical activities from medical personnel. In the end we asked whether patients follow these provided recommendations.

Inclusion criteria:

- Hospitalized in National Rehabilitation Centre “Vaivari” during the period from August to November in 2019;
- Older than 18 years;
- Agrees to take part in the research.

Exclusion criteria:

- Disagrees to take part in the research;
- Does not fully fulfil the questionnaire.

Patients were compared between 3 age groups: under 30 years, 31 to 50 years and above 50 years.

Statistical analysis was performed with IBM SPSS software 23.0 (SPSS Inc, Chicago, Illinois, USA). Statistical significance and correlation were tested with *Pearson Chi-square* and *Mann-Whitney U* tests. Data were defined significant if $p < 0.05$.

Results

In this cross-sectional study we approached 120 patients from National Rehabilitation Centre “Vaivari”, but 19 of them met the exclusion criteria. Study analysed 101 hospitalized patients. 60.4% were women and 39.6% were men.

Patients were divided in to three age groups: 20.7% were under 30 years old, 14.8% were from 31 to 50 years old and 64.3% were older than 50 (Figure 1).

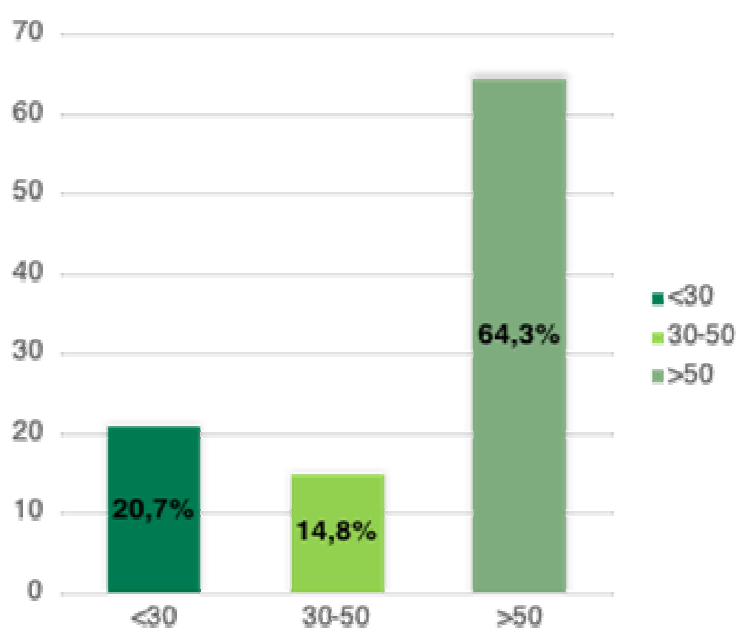


Figure 1. Patient age

In total patients were from 3 different departments. 32.7% were from general musculoskeletal rehabilitation department, 24.8% were from spinal patient rehabilitation department and 42.6% were from neurorehabilitation department.

From all patients 35.6% spent less than 7 days in the rehabilitation centre, 44.6% spent 8 to 14 days, 14.9% spent 15 days to 1 month and remaining 4.9% spent more than one month in the rehabilitation centre. Hospitalization length was not a significant factor.

For 41.6% this was their first hospitalization time, but 58.4% were hospitalized at least one time before. Hospitalization times were not a significant factor.

From the age group of under 30 years old, 42.8% received recommendations about physical activity on every personnel visit, but 57.2% received them only once or not at all. From the age group of 31 to 50 years old, 80% received recommendations about physical activity on every personnel visit and 20% received them only once or not at all. From the age group of above 50 years old, 81.5% received recommendations about physical activity on every personnel visit and 18.5% received them only once or not at all. (Figure 2)

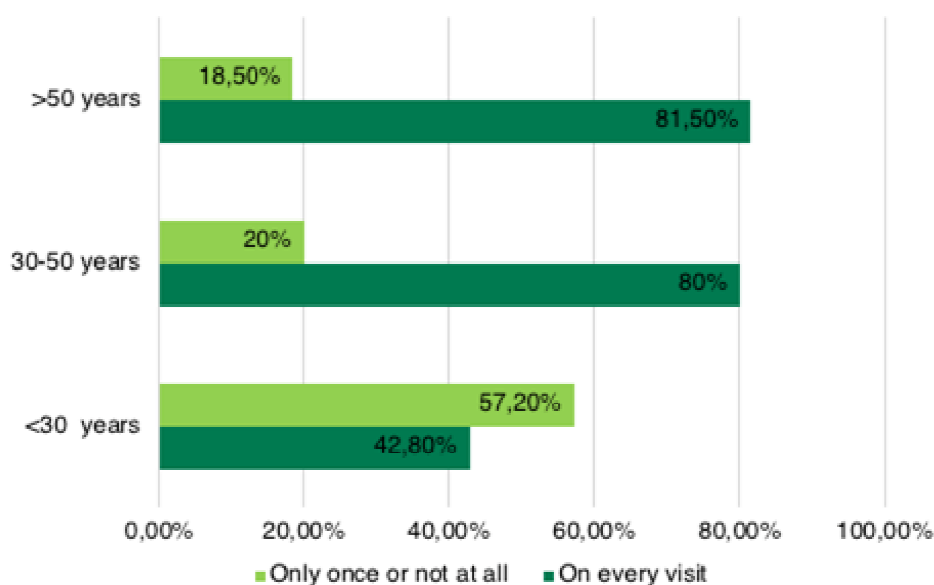


Figure 2. Recommendations received depending on age group

In the age group under 30 years patients tended to receive recommendations less than in other age groups ($p=0.02$). This might be due to the fact that in the age group under 30 years 24% stated that they have had episodes when they did not wish to communicate with medical personnel and did not wish to receive recommendations. In the two remaining age groups 12% in total stated the same.

Therefore, older patients received recommendations more often than younger ones.

When asked about respondent opinion on who should provide recommendations about physical activity, 28% stated that all medical personnel should engage in patient counselling, 13%

believed that it was medical doctor's responsibility, 41% stated that all counselling should be done by a physiotherapist. Remaining 18% believed that recommendations should be provided by a combination of nurses, medical doctors and physiotherapists.

Discussion

Age has been a factor for discrimination for many centuries. Age discrimination or ageism can lower health care quality, cause additional stress and be the reason for withholding needed medical care. One experimental study showed that ageism against age group above 65 years caused increased cardiovascular events compared to other age groups (Levy 2000). On the other hand, in our study, we proved that ageism was tended towards people younger than 30 years.

According to study carried out in The United States of America (Jensen 1994) little is known about the factors that influence patient adherence with exercise programs or medical professional knowledge and its use in clinical practice. A survey was carried out and therapeutic guidelines were developed on how to enhance a patient's cooperation with exercise regimen and how to provide adequate recommendations for different patient groups. Not only should we focus on recommendation receiving, which was the main goal of our study, but also on recommendation compliance. This study proves that to achieve best medical care we need to work from both patient and medical professional sides.

One of our goals in this research was to show that medical professionals withhold recommendations about physical activity depending on different factors with special focus on patient age. However, we did not include aspects of patient motivation and participation in their training programs as they did in a study which was carried out in Australia (Ehrlich-Jones 2011). The study stated that stronger beliefs that physical activity can be helpful for managing disease from both patient and physician can increase motivation to engage in physical activity and are related to higher levels of participation.

Physical activity and exercise are among the accepted clinical rehabilitation guidelines and are recommended for management of different diseases according to one research (Lonsdale 2012). It is important for health care workers to provide needed guidance to patients about physical activity and to provide adequate recommendations as it was emphasised in our study.

To sum up physical activity is important for everyone despite one's disability, mental state or age. Health care workers should enhance their patients to be active and to adjust their lifestyle. Friends and family are also an important facilitator for one's motivation to be physically active (Veldhuijzen zen Zanten, 2015).

Nevertheless, there are many other factors and reasons that should be researched on why medical personnel withhold information and recommendations on physical exercise. One of the aspects that should be researched is about provided resources for medical personnel. One study

showed that one of the main factors why physicians withhold recommendations was lack of time and resources. (Johnson 2015)

Furthermore support programs for medical personnel and patients about physical activity should be provided. Medical personnel knowledge should be tested and improved not only about the regimen of exercise, but also on how to counsel their patients and motivate them to engage in physical activities despite their disabilities, age and other factors. Ageism and other factors for discrimination should be excluded from clinical practice.

Conclusion

- Age was a statistically significant factor when it came to giving recommendations about physical activity.
- Older patients received recommendations more often than younger ones.
- One could argue that it was as a result from the fact that younger people tended to have more episodes when they did not wish to communicate and receive recommendations from the medical personnel.

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BIOLOĢIJA / BIOLOGY

EFFECTS OF SPERM DNA FRAGMENTATION ON THE QUALITY OF EMBRYOS OBTAINED BY THE ICSI PROCEDURE IN MALE INFERTILITY CASE

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Abstract

**Effects of sperm DNA fragmentation on the quality of embryos obtained by the ICSI procedure
in male infertility case**

Key Words: *spermatozoa, sperm DNA, embryo, pregnancy, in vitro fertilization*

Sperm DNA damage is common among infertile men and may adversely impact natural reproduction, assisted reproduction and to a lesser degree In vitro fertilization (IVF) pregnancy. Sperm DNA integrity is vital for successful fertilization, embryo development, pregnancy, and transmission of genetic material to the offspring. DNA fragmentation is the most frequent DNA anomaly present in the male gamete that has been associated to poor semen quality, low fertilization rates, impaired embryo quality, and preimplantation development and reduced clinical outcomes in assisted reproduction procedures. High DNA fragmentation index (DFI) may be associated with a poor outcome after Intracytoplasmic Sperm Injection (ICSI). Our aim was to determine whether DFI impacts embryo quality.

The study began in 2015. The study provides data about 123 pairs, for which subjected sperm DNA fragmentation assays. These patients have been treated for infertility with the ICSI method embryos were obtained and the morphological development of the embryos was assessed. At the moment we compiled the obtained results of first research year.

The research is performed in SIA AVA CLINIC accredited Medical Laboratory.

Kopsavilkums

**Spermatozoīdu DNS fragmentācijas ietekme uz ICSI procedūras rezultātā iegūto embriju kvalitāti
vīriešu neauglības gadījumā**

Atslēgvārdi: *spermatozoīdi, spermas DNS, embrijs, grūtniecība, apaugļošana in vitro*

Spermas DNS bojājumi ir bieži sastopami neauglīgiem vīriešiem un tie var negatīvi ietekmēt dabīgo auglību, medicīnisko apaugļošanu un tās rezultātā iestājušos grūtniecību. Spermas DNS integritātei ir būtiska nozīme veiksmīgai apaugļošanai, embriju attīstībai, grūtniecībai un ģenētiskā materiāla pāršanai pēcnācējiem. DNS fragmentācija ir visbiežāk sastopamā DNS anomālija vīriešu gamētās, kas saistīta ar sliktu spermas kvalitāti, zemiem apaugļošanas rādītājiem, sliktu embriju kvalitāti un pirmsimplantācijas attīstību, samazinātu grūtniecības iestāšanās biežumu medicīniskās apaugļošanas ārstēšanas ciklos. Augstu DNS fragmentācijas indeksu (DFI) var saistīt ar sliktu rezultātu pēc intracitoplazmatiskās spermatozoīda injekcijas olšūnas citoplazmā (ICSI). Mūsu mērķis bija noteikt, vai DFI ietekmē embriju kvalitāti.

Pētījums tik uzsākts 2015 gadā. Pētījumā iegūti dati par 123 pāriem kuriem noteikts spermatozoīdu DNS fragmentācijas tests. Šiem pacientiem ir veikta neauglības ārstēšana ar ICSI metodi, iegūti embriji un novērtēta embriju morfoloģiskā attīstība. Patreiz ir sākti iegūto rezultātu apkopošana un ir apkopot pirmajā pētījuma gadā iegūtie rezultāti.

Pētījums tiek veikts SIA AVA CLINIC akreditētā Medicīnas laboratorijā.

Introduction

Infertility is a current problem affecting about 15% of couples, and about half of these cases are directly related to male infertility. The causes of the problem of male infertility can be found in the processes of spermatogenesis. Male infertility is a common and serious health problem that can affect not only a man's ability to become the child's biological father, but also its emotional, social and psychological character. Despite the prevalence of infertility in Europe and the world, it has not received enough attention.

Over the last 25 years, significant advances have been made in the treatment of male infertility. One of the first in this area is the development of the intracytoplasmic sperm injection (ICSI) in the cytoplasm of the oocyte method and the introduction of associated medical insemination in clinical practice. With the technologies, thousands of infertile men have become the biological fathers of their children. Consequently, the positive aspect of medical insemination is accompanied by the issue of inheritance of genetic defects in the offspring, which has so far been limited from a biological point of view, preventing the natural transmission of these defects. To ensure a healthy generation of children born through medical methods of fertilization, it is necessary to test sperm function, including normal sperm DNA. And find out if sperm DNA fragmentation is linked to embryo quality. The integrity of sperm DNA is essential for successful fertilization and embryonic development. DNA fragmentation is the most common DNA abnormality in male gametes, associated with poor sperm quality, low fertilization rates, poor embryo quality and pre-implantation development, reducing the incidence of pregnancy in medical fertilization treatment cycles. (Avendano C, Franchi A, Duran H, Oehninger S. 2009).

In addition, these tools are important in a wider social context. Infertility is no longer just a personal problem, it has become a public health problem.

Depending on the country, up to 3.9% of births in the EU are currently due to medical fertilization (Nyboe Andersen 2009). Therefore, the use of medical methods of fertilization can have significant demographic and economic effects. The only factors leading to early diagnosis of the effects of the male genome are poor zygotes, embryonic morphology and slow embryonic division. The effects of sperm factors on the development of embryos during the pre-implantation period are called 'paternal effects or effects on the male genome', and the effects of the male genome have been shown to be responsible for repeated unsuccessful attempts at medical insemination (Nyboe Andersen et al., 2009).

The study of sperm DNA damage is very important in the field of medical fertilization, especially in the age of ICSI, because these technologies bypass the barriers of natural selection and infertile men have much more sperm DNA damage than fertile men. Sperm DNA damage has been shown experimentally to adversely affect embryonic development, pregnancy, and offspring health (Zini A, Meriano J, Kader K, Jarvi K, Laskin CA, Cadesky K. 2005).

Sperm DNA integrity has been used as a new marker of sperm quality in the prediction of pregnancy. No association with sperm DNA damage has been found for the early paternal effect. The diagnosis of the late paternal effect is thus based on the examination of sperm DNA integrity, which should be performed in cases of repeated assisted reproduction failure even if morphologically normal embryos result from fertilization with the patients spermatozoa. The only element leading to the diagnosis of the early paternal effect is poor zygote and embryo morphology

and low cleavage speed. The absence of increased sperm DNA damage does not exclude the presence of this pathology. ICSI with testicular spermatozoa has recently been shown to be an efficient treatment for the late paternal effect. The use of oral antioxidant treatment in this indication has also given promising results (Nyboe Andersen et al., 2009).

The method is based on the Sperm Chromatin Dispersion (SCD) test. In the absence of major sperm DNA damage, after denaturation in acid and separation of nuclear proteins, the DNA loops produce their characteristic halogen. Sperm with damaged DNA does not produce such a halo, or it is small. Halosperm validated ready-made kit is used in the study.

If a major anomaly is detected in a blastomere at a cell cycle checkpoint, the cell in question does not divide, which leads to the observation of a lower number of cells in the embryo than expected for a given time point. If the existing problem cannot be resolved, the cell in question is ultimately removed by fragmentation, resulting in an impairment of embryo morphology grade according to current cleaving embryo scoring systems. In view of the recent hypothesis suggesting that trophoctoderm arises from a single founder blastomere of the 4-cell embryo such partial blastomere losses may be compatible with embryo implantation in some cases and incompatible in others, depending on whether the trophoctoderm founder cell is or is not concerned. Limited production of fragments detaching from blastomeres may also occur as part of the remodelling mechanisms involved in cellular reparatory processes, which means that fragments may appear in human preimplantation embryos even if none of its blastomeres is ultimately lost. Both the slow cleavage and the poor morphology grade of cleaving embryos are thus likely to be consequences of active autodefence mechanisms employed by the embryo in its fight against aneuploidy and DNA damage in general (Hansis 2004).

Other studies have suggested the activity of the classical PCD pathway in the human seminiferous tubules (Francavilla 2002). However, these activities appear to prevent abnormal germ cells from reaching the ejaculate rather than promote DNA damage in ejaculated spermatozoa, and most of the germ cells concerned are dismantled by Sertoli cells. Thus, ejaculated sperm DNA damage has been suggested to be a sequela of oxidative damage occurring to spermatozoa after their release from Sertoli cell support (Nyboe Andersen et al., 2009).

Experimental studies have shown that mammalian embryo development and implantation depend in part on the integrity of the sperm DNA, with a threshold of sperm DNA damage beyond which these events are impaired (Ahmadi 1999).

In contrast, human studies indicate that DNA-damaged spermatozoa can fertilize successfully at IVF and ICSI and allow for normal embryo development and subsequent pregnancy (Collins 2008, Gandini 2004, Zini 2009, Hammadeh ME, Al-Hasani S, Stieber M, Rosenbaum P, Kupker D, Diedrich K, et al. 1996).

These observations have raised questions regarding the risks of using DNA-damaged sperm for IVF and ICSI (Barratt 2003, Perreault 2003, Henkel R, Kierspel E, Hajimohammad M, Stalf T, Hoogendijk C, Mehnert C, et al. 2003, Host E, Lindenberg S, Smidt-Jensen S. 2000).

Elevated levels of sperm DNA fragmentation are known to adversely affect early embryonic development, pregnancy and reproductive outcome, but there is no clear-cut view on this issue. Such a study has not yet been conducted in Latvia.

Aim

To Evaluate the quality of the obtained embryos in correlation with the level of sperm DNA fragmentation. Data on the quality of embryos obtained in medical infertility treatment cycles are collected and evaluated together with the result of a sperm DNA fragmentation test.

Work tasks

1. To determine the level of sperm DNA fragmentation using the chromatin dispersion method and to prepare the sperm for medical insemination by the swim-up (RI) method.
2. To evaluate the quality of embryos obtained as a result of ICSI procedure in correlation with the level of sperm DNA fragmentation.
3. To perform statistical analysis of data using MS Excel and SPSS Statistics applications.

Patients are provided with instructions for the transfer of semen, consent to the transfer of semen outside the clinic premises, if this is not possible on the clinic's premises, instructions for the transfer of semen sample, as well as recommendations on what to do and what not to do before handing over the sample. All documents are prepared in three languages LV, RUS and ENG. As well as a sperm transfer protocol to be completed and signed by the patient.

Material and methods

The study was started in 2015. In 2015 – 21 samples, 2016 – 29 samples, 2017 – 29 samples, 2018 – 24 samples, 2019 – 20 samples.

The study obtained data on 123 pairs for which a sperm DNA fragmentation test was performed. These patients have been treated for infertility with the ICSI method, embryos have been obtained and the morphological development of the embryos has been assessed. The research is performed in SIA AVA CLINIC accredited Medical Laboratory. At present, the compilation of the obtained results has been started and the results obtained in the first year of the research have been compiled.

The sperm transfer protocol

- 1 The process begins with the patient's ovaries being stimulated and supervised by the treating reproductive gynecologist.
- 2 This is followed by an ovarian puncture, which is performed under complete anesthesia. The doctor punctures the grown follicles very carefully, extracting follicular fluid from them.

- 3 Embryologist – A laboratory specialist looks for eggs in a follicular solution.
- 4 The eggs are then washed with an enzyme to free them from cumulus cells.
- 5 Semen is prepared by the swim-up method in an RI tube.
- 6 Once the semen is prepared and the eggs have been washed, ICSI can be performed.

ICSI is a fertilization procedure in which a single sperm is mechanically injected into an egg. ICSI fertilization is performed with a special micromanipulator mounted on an inverted microscope.

- 7 After ICSI the embryos are then placed in a time-lapse incubator and cultured for 3 or 5 days.

We used two time-lapse incubators in which we cultivate embryos in the laboratory. Gery incubator and the new Embrioscoop, which is much larger and the analysis of embryos in a time-lapse incubator, provides immeasurably more information about the development of each embryo. Allowing to evaluate and select the best embryos. These incubators use 1 step media, which allows to provide embryos with everything they need from zero to 5–6 days of development. The incubators have a constant temperature of 37 degrees with a reduced oxygen concentration of 5.0 and a nitrogen concentration of 6.0. To make the embryo development environment as close as possible to the woman's body.

Some researchers have looked for tests other than those recommended in WHO manuals to better assess male fertility. These include sperm function tests, oxidative stress tests as well as DNA fragmentation tests. DNA integrity is crucial to ensure that the sperm used for fertilization can maintain normal embryonic development and correlate with a reproductive outcome (Lin MH, Kuo-Kuang Lee R, Li SH, Lu CH, Sun FJ, Hwu YM. 2008, Micinski P, Pawlicki K, Wielgus E, Bochenek M, Tworkowska I. 2009, Muriel L, Meseguer M, Fernandez JL, Alvarez J, Remohi J, Pellicer A, et al. 2006).

The assessment of sperm DNA fragmentation

To assess sperm DNA fragmentation (SDF) in the study, I use the sperm chromatin dispersion (SCD) test.

The semen sample is first immersed in an agarose microgel, then applied to a prepared slide, then denatured in acid and then the nuclear proteins removed, then dried, stained and visualized under a microscope.

This kit is a verified and ready-to-use *in vitro* diagnostic kit. The procedure protocol is used as follows:

1. The kit is intended for the diagnosis of 10 samples. A fresh, ejaculated sperm sample is used to detect DNA fragmentation.
2. If necessary, dilute the semen sample with PBS phosphate buffer to a maximum concentration of 20 million per milliliter. PBS pH 6.88 (CaCl₂ / MgCl₂)

3. Immediately afterwards, add 50 μ l of the semen sample to an agarose gel tube and mix gently with a micropipette. To prevent the formation of air bubbles.
4. Then take 8 μ l of the prepared agarose / sample suspension and place on a beaker and cover with a coverslip. Press lightly to avoid air bubbles. The slides must be kept horizontal throughout the process.
5. Place the slide on a cold surface (eg a metal or glass plate pre-cooled to 4 ° C) and refrigerate at 4° C for 5 minutes to allow the agarose to solidify.
6. Prepare the denaturant solution (AD). Add 80 μ l of acid denaturation solution to 10 ml of distilled water, mix and pour into an incubation vessel.
7. Remove the slide from the refrigerator and carefully remove the coverslip by sliding it slightly. Treatment should be performed at room temperature (22 ° C).
8. Immediately immerse the slide in the acid denaturing solution in a horizontal position, incubate for 7 minutes. Do not exceed the prescribed time!
9. Then transfer the slide to the next incubation tray with 10 ml of Lysis solution. Incubate for 25 minutes in a horizontal position. Then, by moving the beaker only horizontally, transfer the sample to a container with a large quantity of distilled water to wash the Lysis solution. Leave to incubate for 5 minutes.
10. After washing, place the slide in an incubation vessel with 70% ethanol and incubate for 2 minutes and then in a vessel with 100% ethanol and incubate for 2 minutes. Leave to dry at room temperature. The glass is then stained with the Diff Quick kit.
11. After staining and re-drying, the sample is visualized under a bright light microscope at 40x magnification.
12. Calculate sperm DNA fragmentation. Sperm DNA fragmentation (SDF) frequency thresholds are recommended by Dr. Evenson et al. (Evenson 2006).
13. Count 400 sperm at the same time as identifying sperm with and without DNA fragmentation.

I chose to set a DNA fragmentation threshold of 18% to divide patients into two groups: a group with a high fragmentation threshold (DFI > 18%) and a group with a low fragmentation threshold (DFI \leq 18%). This cut-off value was also used by other authors (Nyboe Andersen et al., 2009, Henkel R, Kierspel E, Hajimohammad M, Stalf T, Hoogendijk C, Mehnert C, et al. 2003, Host E, Lindenberg S, Smidt-Jensen S. 2000) who have indicated that sperm fragmentation above 18%, as measured by the sperm chromatin dispersion test, is incompatible with the term pregnancy and successful continuation.

Results and discussion

Results obtained in 2015.

In 2015, results were obtained for 21 ICSI treatment procedures. Women aged 28–43 years, average age 34 years. Men aged 28–58 years, average age 37 years. 38 years is the mean age in a group with elevated DNA. The mean age of 34 years in the normal DNA group.

Sperm DNA fragmentation rates ranged from 8 to 69, with an average of 30. Of which 71% had increased DNA fragmentation above 18%, and 29% had normal DNA fragmentation levels less than or equal to 18%.

The total number of eggs obtained by puncture is 251, for each patient individually from 1 to 24 eggs. The number of mature eggs is 218 (from 1 to 23 eggs), which is 87% of all eggs obtained. Properly fertilized eggs 149 (1–17 zygotes), which is 68% of all mature eggs tested by ICSI. The number of splitting embryos is 147 (from 1–16 embryos), which is 99% of all eggs that were properly fertilized. TOP quality embryos for 3 days 124 (from 1–16 embryos), which is 84% of all embryos that divide.

Unfortunately, in 2015, BC (5 days embryo is blastocyst – BC) was cultured for only one pair of patients, which in my opinion is one of the most important indicators, because only after 3 days in the development of embryos is the male genome activated. 16 top quality embryos were left in BC. Up to the blastocyst stage, 8 embryos grew, which is only 50%. Patients received one 5-day embryo transfer. Which is highly recommended and therefore patients are advised to cultivate BC to perform the best embryo selection and transfer one embryo into the uterine cavity. Because multiple pregnancies often take place with complications and complications for expectant babies.

A total of 79% of embryos were vitrified in patients on days 3 and 5, which is 64% of all top quality embryos, but if you look at only 5 days, when the male genome with a high level of DNA fragmentation of 31% is connected to embryo development, then all top quality embryos that were 3 on day were vitrified only 5 embryos, which is 31%.

This fact is very frightening for patients, they think that few embryos survive to the BC stage and are therefore afraid to cultivate BC. But with the very explanatory work of a reproductive doctor over the years, tremendous progress has been made and BC cultivates almost all patients. Because they understand that BC cultivation helps to select the best embryos for ET (embryo transfer) and if there are more embryos for vitrification. Which, in my view, is very good because it does not allow patients to cherish false hopes that all embryos that have been vitrified will grow to the BC stage and give the desired pregnancy. Which helps to avoid unwanted activities such as unnecessary stimulation of patients to prepare their ET because ET is not always in the natural cycle. There are hopes, etc.

Positive pregnancy test as in 12 pairs, representing 57% of all who underwent ET. Clinical pregnancy occurred in only 33% of all patients undergoing ET. A total of 35 embryos were transferred to 21 patient pairs. Of which 9 embryos were implanted, representing 25% of all transferred embryos. A total of 7 babies were born from 9 embryos that were implanted. Which is 20% of all transferred embryos.

Comparing the quality of embryos with the level of DNA fragmentation. Sperm DNA fragmentation rates ranged from 8–69, with an average of 30. Of these, 71% had increased DNA fragmentation above 18% and 29% had normal DNA fragmentation levels less than or equal to 18%. A total of 218 mature eggs were obtained and 149 eggs were properly fertilized. 147 with increased DNA, which is 67%. 71 with normal DNA which is 33%. Properly fertilized eggs 149 (1–17 zygotes), which is 68% of all mature eggs that have undergone ISCI. 93 eggs in a group with elevated DNA, which is 64% of all eggs in this group. 56 eggs in a group with normal DNA, which is 79% of all eggs in this group. From the very beginning, fertilization can be seen to have a higher fertilization rate in the group with normal DNA fragmentation. In both groups, almost all embryos that fertilized correctly also continued to divide, 99 and 98% in each group, respectively. But the proportion of top quality embryos varies from group to group. 76 groups with increased DNA fragmentation, which is 82%. 48 groups with normal DNA fragmentation of 87%. It can be seen that embryos also share better in a group with normal DNA fragmentation.

Patients were vitrified 79% of the embryos on days 3 and 5, representing 64% of all top quality embryos. 43 groups with increased DNA fragmentation, which is 56%. 36 groups with normal DNA fragmentation of 75%. HCG was positive 9 in the elevated group, which is 60%. 3 in the normal group, which is 50%. Clinical pregnancy occurred in 4 patients in the elevated group, which is 44%, 3 patients in the normal group who are 100%.

Babies were born to 3 patients out of all who became pregnant, in the elevated DNA group which is 33%. And 3 babies in a group of patients with normal DNA, which is 100% of all, in this group who became pregnant.

Conclusions

From this it can be concluded that in the group of patients with increased sperm DNA fragmentation there is poorer fertilization, poorer embryo division, poorer quality embryos and although the incidence of pregnancy is higher in this group, in the clinical pregnancy group with increased DNA fragmentation only 44% in the group with normal sperm DNA fragmentation, they account for 100% of all positive pregnancies. And also the proportion of children born in the group with normal DNA is 100% of all pregnancies that occurred, in contrast to the group with increased sperm DNA fragmentation they are only 33%. It can also be observed that the age of men is higher

in the group with increased DNA fragmentation compared to the group in which the level of DNA fragmentation is normal, which indicates that the level of DNA fragmentation increases with age.

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FIZIKA / PHYSICS

THERMAL EFFECT OF PULSE LASER IMPACT ON MULTI-LAYERED STRUCTURES

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Abstract

Thermal effect of pulse laser impact on multi-layered structures

Key words: pulsed laser heating, Laplace transform method, heating and cooling kinetics of multi-layered structures, nonhomogeneous light absorption, thermal model of photo-structural transitions

An analytical solution to the problem of pulsed laser heating (by a rectangular laser pulse with a duration τ) of a three-layer system “coating – thin photosensitive film – substrate” [1] was considered. In the framework of the proposed thermal model of structural transformations during laser irradiation in thin films, expressions are obtained for the kinetics of heating and cooling of films both during the action of a pulse and after it is turned off. We studied cases of weak and strong absorption of radiation by a film (with thickness d) [1, 3], which can be assumed to correspond to a uniform ($q(x) = I/d = \text{const.}$) and inhomogeneous ($q(x) = Iae^{-ax}$) distribution of heat sources along the depth of the film.

It was shown [1, 5] that for small times ($0 < t \leq t_1$, where $t_1 \ll d^2/a_1$) the temperature on the film surface increases linearly: $\Delta T = It / c_1 \rho_1 d$. With an increase in the fraction of heat transferred from the film to the substrate and the coating (for times $t \gg d^2/a_1$), we obtain a temperature dependence of time of the form $\Delta T \sim I\sqrt{t}$. The effect of inhomogeneity of light absorption was also studied [3]. For nonhomogeneous absorption, the temperature dependence $\Delta T \sim \sqrt{t}$ becomes faster the smaller the absorption in the upper layer of the film and the greater the coefficient $v_{12} = K_1\sqrt{a_2}/K_2\sqrt{a_1}$.

The results obtained subsequently helped experimentally show the thermal character of the “amorphous – crystalline” ($a \rightleftharpoons c$) photo-structural transitions as applied to *Sb-Se-(In)* chalcogenide films [7]. Photo-thermal crystallization of the film is carried out in the range of radiation intensities determined by two threshold values: $I_1 \leq I \leq I_2$. The dependence $I_1\sqrt{\tau} \approx \text{const.}$ established during the experiment, as well as the kinetics of the amorphization process, is in satisfactory agreement with model below.

Kopsavilkums

Impulsa lāzera iedarbības uz daudzslāņu struktūrām termiskais efekts

Atslēgvārdi: impulsu lāzera iedarbība, Laplasa transformāciju metode, daudzslāņu struktūras sasilšanas un atdzišanas kinētika, nevienmērīga gaismas absorbcija, fotostrukturālo pāreju termiskais modelis

Tika apskatīts trīs slāņu sistēmas “pārklājums – plāna gaismas jutīga kārtiņa – pamatne” sasilšanas impulsa lāzera ietekmē (iedarbojoties ar taisnstūrveida lāzera impulsu ar ilgumu τ) gadījuma analītisks risinājums [1]. Piedāvātā strukturālo izmaiņu termiskā modeļa ietvaros plānas kārtiņas apstarošanas gaitā ar impulsu lāzeru tika iegūtas sakarības, kuras apraksta kārtiņas sasilšanas un atdzišanas kinētiku impulsa darbības laikā un pēc tā izslēgšanas. Mēs apskatījām gadījumus, kad kārtiņā (ar biezumu d) pastāv vai nu vāja, vai spēcīga starojuma absorbcija [1, 3], pieņemot, ka tās attiecīgi apraksta vienmērīgs ($q(x) = I/d = \text{const.}$) un nehomogēns ($q(x) = Iae^{-ax}$) siltuma avotu sadalījums visā filmas dziļumā.

Tika parādīts [1, 5], ka maziem laika periodiem ($0 < t \leq t_1$, kur $t_1 \ll d^2/a_1$) temperatūra uz kārtiņas virsmas pieaug lineāri: $\Delta T = It / c_1 \rho_1 d$. Palielinoties tai siltuma daļai, kas tiek nodota no kārtiņas uz pamatni un pārklājumu (kad $t \gg d^2/a_1$), iegūstam šādas formas temperatūras atkarību no laika: $\Delta T \sim I\sqrt{t}$. Tika pētīta arī gaismas absorbcijas nevienmērīguma ietekme [3]. Nehomogēnas absorbcijas gadījumā temperatūras atkarība $\Delta T \sim \sqrt{t}$ iestājas jo ātrāk, jo mazāka ir absorbcija kārtiņas augšējā slānī un jo lielāks ir koeficients $v_{12} = K_1\sqrt{a_2}/K_2\sqrt{a_1}$.

Iegūtie rezultāti palīdzēja eksperimentālā ceļā konstatēt “amorfo - kristālisko” ($a \rightleftharpoons c$) foto-struktūras pāreju termisko raksturu, kas tika novērots *Sb-Se-(In)* halkogenīdu filmu gadījumā [7]. Kārtiņas fototermiskā kristalizācija notiek starojuma intensitātes diapazonā, kuru nosaka divas robežvērtības: $I_1 \leq I \leq I_2$. Atkarība $I_1\sqrt{\tau} \approx \text{const.}$, kā arī amorfizācijas procesa kinētika, kas tika novērotas eksperimenta gaitā, parādīja apmierinošu sakritību ar zemāk aprakstīto modeli.

Introduction

The classical problem of heat flux in multilayer film structures has long been of great interest in connection with various practical applications – for example, in such fields like design of optical information storage devices, laser annealing of semi-conductor materials, electron beam

lithography, and ion implantation. What is essential for all these processes, is the determination of a thermal effect upon heating of multilayer systems and its role in the structural and other changes have been observed when samples are irradiated with external energy sources. In this paper, we consider the heating of a three-layer system consisting of a light-absorbing film, substrate and coating, based on the approach of [2] to a two-layer system.

Material and methods

We can assume that the film and coating thicknesses deposited on a substrate (which we consider semi-infinite) are equal to d and b , respectively. We also consider the light is absorbed exclusively in the film. The values of the coefficients of thermal conductivity K_i , specific heat c_i and densities ρ_i ($i = 1, 2, 3$ for the film, substrate and coating, respectively), as well as the optical parameters are taken independent of temperature. The film is excited by a single rectilinear laser pulse with an intensity $I < 10^8$ W/cm² [4, 9, 10] and a duration τ with a leading edge at $t = 0$. Let τ satisfy condition $\tau_1 \ll \tau \ll \tau_2$, where τ_1 is the characteristic time of energy transfer from the electronic to the vibrational subsystem for the photosensitive film (for a number of amorphous semiconductor films $\tau_1 \leq 10^{-9}$ s [11], $\tau_2 \sim r^2/a_i$ [12]; where r – the radius of the light spot, $a_i = K_i/c_i \rho_i$ – the corresponding thermal diffusivity coefficients.) Then the photo-induced heating process can be described by introducing a stationary volumetric heat source $q = I/d$ (I – the intensity of the radiation absorbed by the film); also, we can neglect the radial component of heat flow in the film, the substrate and the coating. This allows us to consider the problem in the one-dimensional approximation. Simultaneously, τ_2 is the upper limit of times, for which this problem statement is valid (Fig. 1).

Pulsed laser heating of a three-layer “coating-film-substrate” system

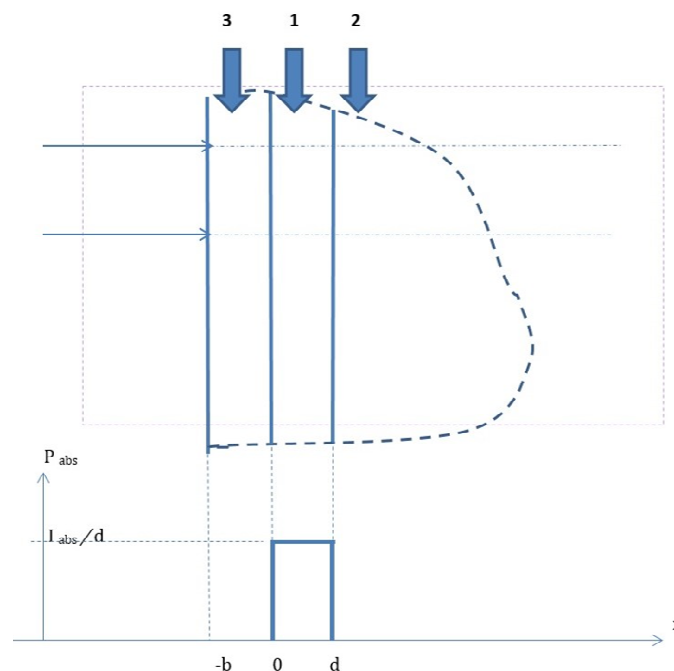


Figure 1. Pulsed laser heating of a “coating-film-substrate” (“3-1-2”) system (the rays on the left indicate the diameter of the light spot, $D = 2r$)

In the case of neglecting heat transfer with the environment and ideal thermal contacts between the layers, the kinetics of changes in the temperature of the layers is described by the following system of equations with a boundary and initial conditions:

$$\begin{aligned} \partial T_i(x, t) / \partial t - a_i \partial^2 T_i(x, t) / \partial x^2 &= q_i(x, t) / c_i \rho_i \quad (i=1, 2, 3); \\ T_i(x, 0) &= T_0 \quad (i=1, 2, 3); \\ T_1(0, t) &= T_3(0, t); \quad K_1 \partial T_1(0, t) / \partial x = K_3 \partial T_3(0, t) / \partial x; \\ T_1(d, t) &= T_2(d, t); \quad K_1 \partial T_1(d, t) / \partial x = K_2 \partial T_2(d, t) / \partial x; \\ K_3 \partial T_3(-b, t) / \partial x &= 0; \quad T_2(\infty, t) = T_0. \end{aligned} \quad (1)$$

From the assumptions made above it follows that $q_2(x, t) = q_3(x, t) = 0$ and $q_1(x, t) = \text{const.} = q$. Using the method of Laplace transforms in time (see, for example, [8]), when solving the boundary-value heat conduction problem (1) for the Laplace's transform image of the film temperature, $T_{1L}(x, s)$, we obtain:

$$\begin{aligned} T_{1L}(x, s) &= T_0/s + q/(c_1 \rho_1 s^2) \{ 1 + [(\exp(2\sqrt{\frac{s}{a_3}} b) - 1)(v_{12} - 1) \exp(-\sqrt{\frac{s}{a_1}} d) + (1 + v_{13}) \cdot \\ &\cdot \exp(2\sqrt{\frac{s}{a_3}} b) - (1 - v_{13})] \cdot \exp(\sqrt{\frac{s}{a_1}} x) + [(\exp(2\sqrt{\frac{s}{a_3}} b) - 1)(v_{12} + 1) \cdot \exp(\sqrt{\frac{s}{a_1}} d) + (1 + v_{13}) - \\ &- (1 - v_{13}) \exp(2\sqrt{\frac{s}{a_3}} b)] \cdot \exp(-\sqrt{\frac{s}{a_1}} x) \} / \{ (1 + v_{12}) \cdot \exp(\sqrt{\frac{s}{a_1}} d) [(1 - v_{13}) - (1 + v_{13}) \cdot \\ &\cdot \exp(2\sqrt{\frac{s}{a_3}} b)] + (1 - v_{12}) \exp(-\sqrt{\frac{s}{a_1}} d) [(1 - v_{13})(\exp(2\sqrt{\frac{s}{a_3}} b) - (1 + v_{13}))] \}, \end{aligned} \quad (2)$$

Where $v_{12} = K_1 \sqrt{a_2} / K_2 \sqrt{a_1}$, $v_{13} = K_1 \sqrt{a_3} / K_3 \sqrt{a_1}$.

Results

We consider two special cases below:

1. $b \gg \sqrt{a_3 t}$ – the depth of propagation of the temperature front in the coating is much less than b ; this corresponds to cases of either semi-infinite coverage or small times,
2. $b \ll \sqrt{a_3 t}$ – the speed of propagation of the temperature front in the coating is very high and the latter heats up almost instantly.

The first case corresponds to the following condition for the Laplace image: $b \sqrt{sa_3^{-1}} \gg 1$, which gives the following dependence for the Laplace image of the film temperature $T_{1L}(x, s)$:

$$\begin{aligned} T_{1L}(x, s) &= T_0/s + q/c_1 \rho_1 s^2 \{ 1 - [(v_{12} - 1) \exp(-\sqrt{\frac{s}{a_1}} d) + (1 + v_{13})] \cdot \exp(\sqrt{\frac{s}{a_1}} x) + [(v_{12} + 1) \cdot \\ &\cdot \exp(\sqrt{\frac{s}{a_1}} d) + (v_{13} - 1)] \exp(-\sqrt{\frac{s}{a_1}} x) \} / \{ (1 + v_{12})(1 + v_{13}) \exp(\sqrt{\frac{s}{a_1}} d) - (1 - v_{12})(1 - v_{13}) \cdot \\ &\cdot \exp(-\sqrt{\frac{s}{a_1}} d) \}. \end{aligned} \quad (3)$$

The inverse Laplace transform of (3) gives

$$\begin{aligned}
 T_1(x, t) = & T_0 + q/c_1\rho_1 [t - 1/((1 + v_{12})(1 + v_{13})) \sum_{n=0}^{\infty} [(v_{12}-1)(v_{13}-1)/ \\
 & /((v_{12}+1)(v_{13}+1))]^n \{ (v_{12}-1)[(t + ((2n+2)d-x)^2/2a_1) \cdot \operatorname{erfc}([(2n+2)d-x]/2\sqrt{a_1 t}) - \\
 & - ((2n+2)d-x)\sqrt{t}/\sqrt{\pi a_1} \exp(-((2n+2)d-x)^2/4a_1 t)] + (v_{13}+1)[(t + ((2n+1)d-x)^2/2a_1) \cdot \\
 & \cdot \operatorname{erfc}(((2n+1)d-x)/2\sqrt{a_1 t}) - ((2n+1)d-x)\sqrt{t}/\sqrt{\pi a_1} \cdot \exp(-((2n+1)d-x)^2/4a_1 t)] + \\
 & + (v_{12}+1)[(t + (2nd+x)^2/2a_1) \cdot \operatorname{erfc}((2nd+x)/2\sqrt{a_1 t}) - (2nd+x)\sqrt{t}/\sqrt{\pi a_1} \cdot \exp(-((2nd+ \\
 & +x)^2/4a_1 t)] + (v_{13}-1)[(t + ((2n+1)d+x)^2/2a_1) \cdot \operatorname{erfc}(((2n+1)d+x)/2\sqrt{a_1 t}) - \\
 & - [((2n+1)d+x)\sqrt{t}/\sqrt{\pi a_1}] \cdot \exp(-((2n+1)d+x)^2/4a_1 t)] \}]. \quad (4)
 \end{aligned}$$

An analysis of (4) shows that for times $0 < t \leq t_1$ (when $t_1 \ll d^2/a_1$) the temperature on the film surface $T_1(0, t)$ grows linearly with time:

$$\Delta T_1(0, t) = T_1(0, t) - T_0 \approx It/c_1\rho_1 d. \quad (5)$$

For times $t \gg d^2/a_1$ we get the temperature increase in form:

$$\Delta T_1(0, t) = B(t) (2/\sqrt{\pi} + \beta [\exp 1/\beta^2 \cdot \operatorname{erfc} 1/\beta - 1]); \quad (6)$$

Where $B(t) = It/(c_2\rho_2\sqrt{a_2 t} + c_3\rho_3\sqrt{a_3 t})$,

$$\beta = \beta(t) = c_1\rho_1 d(1 + 1/v_{12}v_{13}) / (c_2\rho_2\sqrt{a_2 t} + c_3\rho_3\sqrt{a_3 t}).$$

In (6), $B(t)$ is proportional to the heating of the substrate and coating layers with thicknesses $\sqrt{a_2 t}$ and $\sqrt{a_3 t}$, respectively. $\beta(t)$ determines the ratio of the bulk heat capacity of the film to the total heat capacity of the heated coating and substrate layers.

For the second case (when $b \ll \sqrt{a_3 t}$) we have the dependence of the same form as (6), however now

$$B(t) = It/c_2\rho_2\sqrt{a_2 t}, \beta = \beta(t) = (c_1\rho_1 d + c_3\rho_3 b) / (c_2\rho_2\sqrt{a_2 t}) + b/\sqrt{a_3 t}. \quad (7)$$

Here $B(t)$ describes the heating of a substrate layer with a thickness which is equal to $\sqrt{a_2 t}$. The first term in $\beta(t)$ characterizes the ratio of the thermal energy accumulated in the film and coating to the thermal energy transferred to the substrate, and the second term characterizes the degree of heating of the coating. It is important to notice that $\Delta T_1(0, t) \rightarrow \rightarrow B(t) \cdot 2/\sqrt{\pi}$, when $\beta(t) \rightarrow 0$.

Thus, a thin coating ($b \ll \sqrt{a_3 t}$) plays a role only at the intermediate stage of heating. In the case of a thick coating ($b \gg \sqrt{a_3 t}$), the heat sink from the film is distributed between the substrate and the coating. In the general case of arbitrary values of $b/\sqrt{a_3 t}$, the general solution $T_1(x, t)$ can be found by numerically inverting formula (2) for the Laplace temperature image. However, using simple physical considerations, it is possible to obtain an approximate formula for $T_1(x, t)$, for assessment of the heating effect for any $b/\sqrt{a_3 t}$ ratios. We consider the change in the

temperature of the film, substrate, and coating under simple assumptions that the film and the heated layers of the substrate and coating with a thickness of $\sqrt{a_2 t}$ and $\sqrt{a_3 t}$, respectively, have the same temperature $T_0 + \Delta T$; the rest of the system has a temperature T_0 . Then from the heat balance equation of the system we have

$$\Delta T(t) = It / (c_1 \rho_1 d + c_2 \rho_2 \sqrt{a_2 t} + c_3 \rho_3 \sqrt{a_3 t}) \quad (8)$$

Where the term $\sqrt{a_3 t}$ for $t \geq b^2/a_3$ becomes equal to b .

It is easy to see that as $t \rightarrow 0$, when the fraction of thermal energy transferred from the film to the substrate and coating is small, formula (8) goes over into (5), and as $t \rightarrow \infty$:

$$\begin{aligned} \Delta T(t) &= It / (c_2 \rho_2 \sqrt{a_2 t} + c_3 \rho_3 \sqrt{a_3 t}) \quad (b \gg \sqrt{a_3 t}) \quad \text{and} \\ \Delta T(t) &= It / c_2 \rho_2 \sqrt{a_2 t} \quad (b \ll \sqrt{a_3 t}), \quad \text{which correlates with (6).} \end{aligned}$$

Let us describe approximately the kinetics of the cooling process after the end of the pulse. The continuation of the dependence $\Delta T_1(0, t)$ for $t > \tau$ (film cooling stage) for the exact solution of (1) can be obtained in general form using the drain method [1, 6]. The general solution has the form (for $t > \tau$):

$$\Delta T_1^*(0, t) = \Delta T_1(0, t) - \Delta T_1(0, t - \tau); \quad (9)$$

Where $\Delta T_1(0, t)$ has the form of a solution to the heating problem (6). Expression (9) is valid only with linearity (1) and stationarity of the heating sources.

If the final stage of film heating is described by dependence (6), then for times $t \gg \tau + d^2/a_1$ the cooling of the film is determined by the following expression:

$$\begin{aligned} \Delta T_1^*(0, t) &= B(t) (2/\sqrt{\pi} + \beta(t) [\exp 1/\beta^2(t) \cdot \operatorname{erfc} 1/\beta(t) - 1]) - \\ &- B(t - \tau) (2/\sqrt{\pi} + \beta(t - \tau) \cdot [\exp 1/\beta^2(t - \tau) \cdot \operatorname{erfc} 1/\beta(t - \tau) - 1]). \end{aligned} \quad (10)$$

This expression is valid for both $b \ll \sqrt{a_3 t}$ and $b \gg \sqrt{a_3 t}$.

The asymptotic behaviour of solutions of (10) for both cases as $t \rightarrow \infty$ has the form:

$$\Delta T_1^*(0, t) \approx I \tau / A \sqrt{\pi t}, \quad (11)$$

Where $A = c_2 \rho_2 \sqrt{a_2} + c_3 \rho_3 \sqrt{a_3}$ (for semi-infinite coverage),

$A = c_2 \rho_2 \sqrt{a_2}$ (for thin coating).

General view of kinetics $\Delta T_1(t)$

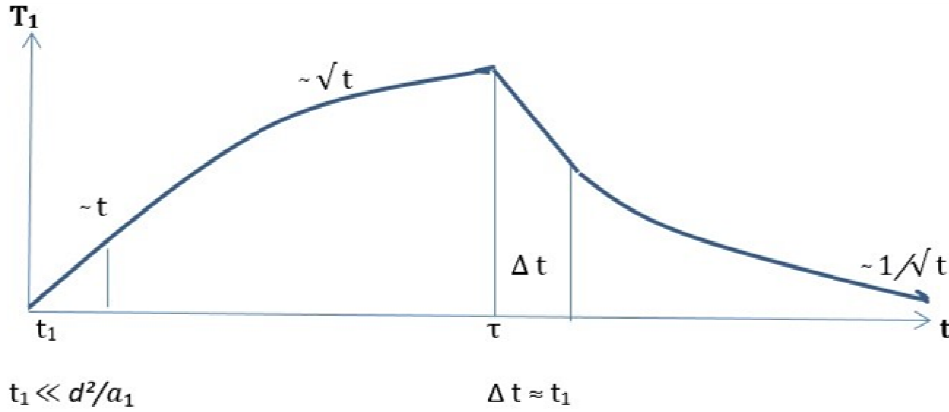


Figure 2. General view of kinetics $\Delta T_1(t)$

Using the drain method, we can estimate the cooling rate of the film surface after the end of the pulse:

$$V_{\text{cool}} = \partial T_1^*(0, t) / \partial t \approx \Delta T_1^*(0, t) / \Delta t. \quad (12)$$

For this, we consider a simple dependence (8). Then the cooling of the film surface in the case of a thick coating will have the form:

$$\Delta T_1^*(0, t > \tau) \approx It / (c_1 \rho_1 d + c_2 \rho_2 \sqrt{a_2 t} + c_3 \rho_3 \sqrt{a_3 t}) - I \cdot (t - \tau) / (c_1 \rho_1 d + c_2 \rho_2 \sqrt{a_2(t - \tau)} + c_3 \rho_3 \sqrt{a_3(t - \tau)}) \quad (13)$$

In the case when $c_1 \rho_1 d \ll c_2 \rho_2 \sqrt{a_2 t} + c_3 \rho_3 \sqrt{a_3 t}$, for the instantaneous cooling rate like $t \rightarrow \tau$ we get:

$$V_{\text{cool}}(t) = \partial T_1^*(0, t) / \partial t \approx -I / c_1 \rho_1 d. \quad (14)$$

When $t - \tau \gg d^2/a_1$, we get:

$$V_{\text{cool}}(t) \approx I(t^{-1/2} - (t - \tau)^{-1/2}) / 2 (c_2 \rho_2 \sqrt{a_2} + c_3 \rho_3 \sqrt{a_3}). \quad (15)$$

The obtained dependences of the film cooling rate on the intensity and duration of the light pulse are important for assessing the ranges of values of the parameters of light exposure at which the process of photo-thermal transformations in glasses is realized. For example, when realizing a photo-induced transformation of the “amorphous state \rightarrow crystalline state” type ($a \rightleftharpoons c$), it is necessary that the condition $V_{\text{cool}} \leq V_{\text{cr}}$ is satisfied, where V_{cr} is the maximum cooling rate of the film at which it still has time to crystallize. Using (14), we can approximately estimate the values of the parameters of the laser action for which this condition is realized. It is easy to see that the light intensity should not exceed a certain critical value $I_{\text{cr}2}$, defined by the expression:

$$I_{\text{cr}2} \approx 2 V_{\text{cr}} (c_2 \rho_2 \sqrt{a_2} + c_3 \rho_3 \sqrt{a_3}) / (t^{-1/2} - (t_1 - \tau)^{-1/2}), \quad (16)$$

Where t_1 is time corresponding to the cooling of the film to the crystallization temperature. On the other hand, the light intensity should be sufficient so that during the pulse the film temperature reaches the effective crystallization temperature T_{cr} . Then the smallest permissible value of I is determined by the condition following from (8): $I \geq I_{cr1}$,

Where
$$I_{cr1} \approx \Delta T_{cr} \cdot C' / \tau \sim \Delta T_{cr} / \sqrt{\tau}, \quad (17)$$

$$C' = c_1 \rho_1 d + c_2 \rho_2 \sqrt{a_2 \tau} + c_3 \rho_3 \sqrt{a_3 \tau} \approx (c_2 \rho_2 \sqrt{a_2} + c_3 \rho_3 \sqrt{a_3}) \sqrt{\tau}, \Delta T_{cr} = T_{cr} - T_0.$$

So far we have looked at the kinetics of heating induced by laser pulse under the assumption of homogeneous absorption of radiation. But besides this, we also solved the problem similar to that considered in (1), but with heat sources in the film, depending on the depth according to the law $q(x) = I\alpha e^{-\alpha x}$ (where $I = I_0 (1-R)$ is the absorbed light intensity on the film surface ($x=0$), α – the absorption coefficient).

As shown above, in the case of a thin coating and sufficiently large times (when $b \ll \sqrt{a_3 \tau}$), the heat transferred to the coating is much less heat transferred to the heated substrate layer, i.e., $c_3 \rho_3 b \ll c_2 \rho_2 \sqrt{a_2 \tau}$. Under these conditions, the influence of the coating can be neglected and considered instead of a three-layer to two-layer system. In this case, on $t \gg d^2/a_1$, the dependence of the film temperature on time for $q(x) = I\alpha e^{-\alpha x}$ has form:

$$\Delta T_1(x, \beta) = (Id/K_1) (1 - e^{-\alpha d}) \{v_{12}^2 [(2/\sqrt{\pi}) 1/\beta + \exp 1/\beta^2 \cdot \operatorname{erfc} 1/\beta - 1] + [(\exp 1/\beta^2 \cdot \operatorname{erfc} 1/\beta - 1) (1 - \alpha d - e^{-\alpha d}) + (1 - \alpha x - e^{-\alpha x})] / [\alpha d (1 - e^{-\alpha d})]\}, \quad (18)$$

Where $\beta = v_{12} d / \sqrt{a_1 t}$. We introduce the notation $\tilde{I} = I(1 - e^{-\alpha d})$ – the average absorbed intensity for nonhomogeneous light absorption by the film.

In the case of homogeneous absorption at $t \gg d^2/a_1$, as follows from the results of [1, 2]:

$$\Delta T'_1(\beta) = (\tilde{I}d/K_1) v_{12}^2 (2/\sqrt{\pi} \cdot 1/\beta + \exp 1/\beta^2 \cdot \operatorname{erfc} 1/\beta - 1), \quad (19)$$

Where $\tilde{I} = I\alpha d$ – the average absorbed intensity with homogeneous absorption.

Introducing the dimensionless variable $\theta = T/T_c$ (where $T_c = \tilde{I}d/K_1$), from formula (1) we obtain:

$$\Delta \theta_t = \Delta \theta'_t + \Delta \theta''_t, \quad (20)$$

Where $\Delta \theta'_t = \Delta T'_t/T_c$, $\Delta \theta''_t$ is the addition that takes into account the distribution of heat sources along the depth of the film.

We studied the asymptotic behaviour of $\Delta \theta''_t$ as $t \rightarrow \infty$. On the back side of the film ($x=d$), $\Delta \theta''_t/t \rightarrow \infty \rightarrow 0$ and on the front surface ($x=0$) $\Delta \theta''_t/t \rightarrow \infty \rightarrow (\alpha d + e^{-\alpha d}) / [\alpha d (1 - e^{-\alpha d})]$. Two limiting cases can also be distinguished here. With strong absorption ($\alpha d \gg 1$),

$\Delta\theta''_1 \rightarrow (\alpha d - 1)/\alpha d$; in the limit case when $\alpha d \rightarrow \infty$, $\Delta\theta''_1 \rightarrow 1$. In the case of weak absorption ($\alpha d \ll 1$) $\Delta\theta''_1 \rightarrow 1/(2 - \alpha d)$; as $\alpha d \rightarrow 0$, we obtain $\Delta\theta''_1 \rightarrow 1/2$.

It follows from the obtained dependences that for sufficiently large times ($t \gg d^2/a_1$), a quasi-stationary transverse temperature gradient (along the film depth) is established in the film, the value of which depends on the degree of absorption. In this case, the film can be approximately considered as a two-layer system, in the first layer of which light energy is effectively absorbed, and the second is a thermal buffer, the temperature of which increases due to heat transfer from the first layer. The higher the degree of absorption is, the smaller the thickness of the absorbing layer.

We analysed the effect of heterogeneity in the distribution of heat sources on the kinetics of film heating. Introducing new variables and looking at the $\log p_k^{-1} = f(\log \nu_{12})$ dependences (where $p_k = d/\sqrt{a_1 t_k}$ is the dimensionless variable and $t_k = d^2/a_1 p_k^2$ is the characteristic time for the film at which $\Delta\theta'_1 = \Delta\theta''_1$), it has been shown, that for times $t \gg t_k$ $\Delta\theta'_1$ becomes $\gg \Delta\theta''_1$ and the influence of the temperature gradient due to its smallness can be neglected. We also compared the heating kinetics for different degrees of absorption by analysing the dependences $\log \Delta\theta_1 = f(\log p^{-1})$ (for different values of αd). When $\nu_{12}=0.1$, the dependence $\Delta\theta_1 \sim \sqrt{t}$ is reached at $(p_{kl})^{-1} \gg 1$, and $(p_{kl})^{-1}$ the greater, the greater the inhomogeneity of absorption in the film ($(p_{kl})^{-1} \sim \alpha d$). Comparison of the dependencies $\log \Delta\theta_1 = f(\log p^{-1})$ for $\nu_{12}=0.1$ (i.e., with a significantly lower thermal conductivity of the film compared to the substrate) and $\nu_{12}=1.0$ (for which $(p_{kl})^{-1} \leq 1$) for different absorption degrees showed that time which passes from the beginning of the pulse to the reaching the dependence $\Delta T_1 \sim \sqrt{t}$ is much longer for the first value of ν_{12} .

Discussion

As follows from our research, the kinetics of the photo-induced processes is mainly determined by the integral absorption of the film and the thermo-physical parameters of the substrate (but not the corresponding parameters of the film or its thickness d). We assume that the proposed model might also be applied to the consideration of photo-induced processes in multilayer structures using other radiation sources, such as an electron beam. Various publications show us that in such experiments massive problem usually is to determine the achieved temperatures. This way, the use of our model to determine the purely thermal effect and eventual structural changes caused by it could be of great help in the further studies of complex layered compounds. Of course, the fundamental difference between the action of an electron beam and a laser pulse must always be taken into account. However, the total thermal energy transferred to the samples could well be estimated and compared in both cases. For example, in [13] an undesirable appearance of the crystallization process in a thin amorphous Sb_2Se_3 film during its irradiation with an electron beam

is indicated. Apparently, the application of model outlined above could help in choosing the optimal parameters for the beam power and the irradiation time to try to avoid unwanted effects.

Conclusions

1. It was shown [1, 5] that for small times ($0 < t \leq t_1$, where $t_1 \ll d^2/a_1$), when the fraction of heat transferred to the coating and substrate is significantly less than remaining in the film, the temperature on the film surface increases linearly: $\Delta T = I t / c_1 \rho_1 d$. With an increase in the fraction of heat transferred from the film to the substrate and the coating (for times $t \gg d^2/a_1$), we obtain a temperature dependence of time of the form $\Delta T \sim I \sqrt{t}$, where the coating plays a role similar to the substrate if $\sqrt{a_3 t} \leq b$, or is a certain heat reservoir of constant heat capacity if $\sqrt{a_3 t} \geq b$.
2. In the case of a thin coating and sufficiently large times (or long pulses), if $b \ll \sqrt{a_3 t}$, the fraction of heat transferred to the coating during heat transfer will be much less than the heat transferred from the film to the heated substrate layer during the same time, then the influence of the coating can be neglected and structure can be already considered two-layer instead of a three-layer system. Also, when exposed to long pulses ($\tau \gg d^2/a_1$ (see (6)), at the final stage of irradiation the total fraction of the energy remaining in the film becomes substantially small and the heating of the film ΔT is practically independent of its thermo-physical properties and is mainly determined by the substrate: $\Delta T^*_{1}(0, t) \approx I \tau / A \sqrt{\pi t}$; $A = c_2 \rho_2 \sqrt{a_2}$ (for a thin coating) [1, 5].
3. Using the drain method [1, 6], it was shown that immediately after the end of the pulse action ($t \rightarrow \tau$), a linear cooling of the film is observed: $\Delta T(t) = \Delta T(\tau) - I(t - \tau) / \rho_1 c_1 d \sim \sim I t$, and for times $t - \tau \gg d^2/a_1$ film cooling is characterized as $\Delta T(t) \sim I \sqrt{t}$. The duration of the transition from the type $\Delta T \sim I t$ to $\Delta T \sim I \sqrt{t}$ is the shorter, the less absorption and the greater the ratio ν_{12} (in the case of a thin coating) [3].
4. Photo-thermal crystallization of the film occurs in the range of light intensities determined by two threshold values $I_1 \leq I \leq I_2$. I_1 is the lowest light intensity at which the film heats up during the pulse to the effective crystallization temperature T_{cr} . I_2 corresponds to heating the film to the melting point T_m by the end of the pulse [1, 7].
5. For non-homogeneous absorption of light by a film, there is a characteristic time t_k such that on $t \gg t_k$ heating is determined by the dependence $\Delta T_1 = \Delta T'_1 + \Delta T''_1$, where the first term characterizes the temperature increase in a thin film with a homogeneous distribution of heat sources in it, and the second is determined exclusively by the non-homogeneity of absorption [3].

6. The experimentally proved relationship $I_1 \sqrt{\tau} = \text{const.}$ and studied amorphization kinetics after the termination of the excitation pulse in the case of Sb-S-(In) compounds [7] showed good agreement with the proposed model.

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DABAS AIZSARDZĪBA UN VIDES PĀRVALDĪBA / NATURE PROTECTION AND ENVIRONMENTAL MANAGEMENT

FOREST MANAGEMENT IMPACT ON BLACK STORK (*CICONIA NIGRA L.*) HABITAT LANDSCAPE CHANGES IN THE FUTURE SCENARIO

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Abstract

Forest management impact on black stork (*Ciconia nigra L.*) habitat landscape changes in the future scenario

Key Words: *habitat, suitable, forest stand, metapopulation, LANDIS*

In this study, potential landscape changes, and impacts on black stork habitats, considering the legislative framework and intensity of forestry activity, landscape scenarios for species habitats were modeled for the next 100 years. Using 32 micro-reserves and 40 randomly selected plots (6 x 6 km), LANDIS-II model identified a dynamic change in the forest landscape in time. Given the conditions applied to the metapopulation of the species, landscape characteristics were obtained using the Fragstats 4.2. model, thus describing the resulting changes in the forest landscape. The change in landscape metrics through statistical analyses was determined to reduce forest stands suitable for habitats over time and these stands will become more fragmented and isolated but over time significantly increases unsuitable stands. The scenario means that over time the availability of potential black stork sites is declining significantly and is becoming more isolated. In the current landscape inhabited by the black stork, there has been no statistically significant difference from the random landscape in Latvia, and over time, in the case of a future scenario, changes to the landscape of habitats do not differ from changes in the randomly chosen landscape. After 100 years, more suitable habitat sites are in randomly selected landscapes, linked to differences in the aging structure of forest stands between two samples and the planned management. Since trends in the results obtained and the current mechanism for protecting the micro-reserves of the black stork do not provide sustainable protection for the species, it is advisable to remove the status of micro-reserves. However, it would be possible to ensure the presence of the species preferred landscape sites by limiting the average amount to be felled in the forest landscape to less than the current average of 10%.

Kopsavilkums

**Mežsaimnieciskās darbības ietekme uz melnā stārķa (*Ciconia nigra L.*) dzīvotnes ainavas izmaiņām
nākotnes scenārijā**

Atslēgvārdi: *dzīvotne, piemērota, mežaudze, metapopulācija, LANDIS*

Šajā pētījumā melnā stārķa dzīvotņu potenciālās ainavas izmaiņas un ietekme uz dzīvotnei raksturojošiem rādītājiem, ņemot vērā mežsaimnieciskās darbības normatīvo regulējumu un intensitāti, sugas dzīvotņu ainavas scenāriji tika modelēti turpmākajiem 100 gadiem. Izmantojot 32 mikroliegumu un 40 nejauši izvēlētus parauglaukumus (6x6km) ar LANDIS-II modeļa palīdzību tika noteiktas meža ainavas dinamiskās izmaiņas laikā. Ņemot vērā sugas metapopulācijai piemērotos nosacījumus, izmantojot Fragstats 4.2. modeli, tika iegūti ainavu raksturlielumi, tādējādi raksturojot iegūtās meža ainavas izmaiņas. Nosakot ainavu metrikas izmaiņas ar statistisko analīžu palīdzību tika noteikts, ka laika gaitā samazinās dzīvotnei piemērotās mežaudzes un tās kļūs fragmentētākas un izolētākas, bet nepiemērotās audzes laikā būtiski palielinās. Scenārijs paredz, ka laika gaitā arī potenciālo melnā stārķa pārceļšanās vietu pieejamība būtiski samazinās un tās kļūst izolētākas. Pašreiz esošajās melnā stārķa apdzīvotās ainavās nav konstatēta statistiski būtiska atšķirība no nejaušām ainavām Latvijā, un laika gaitā nākotnes scenārija gadījumā izmaiņas dzīvotņu ainavā neatšķiras no izmaiņām nejauši izvēlēta ainavā. Pēc 100 gadiem vairāk piemērotu dzīvotņu vietu ir nejauši izvēlētas ainavās, kas saistāms ar mežaudžu vecumstruktūras atšķirībām starp abām paraugkopām un plānveida apsaimniekošanu. Tā kā iegūto rezultātu tendences un pašreizējais melnā stārķa mikroliegumu aizsardzības mehānisms nenodrošina sugas ilgtspējīgu aizsardzību mikroliegumu statusu būtu ieteicams atcelt. Savukārt, sugai vēlamo pārceļšanās vietu esamību ainavā būtu iespējams nodrošināt nosakot ierobežojumus ar vidējo nocērtamo apjomu meža ainavā mazāk par pašreiz vidēji cērtamajiem 10%.

Introduction

The Black Stork (*Ciconia nigra* L.) is a globally important bird species (European Parliament and Council 2009) with specific conservation status and in Latvia most often with a microreserve status (Cabinet of Ministers 2012a). There have been many studies about the black stork population decline reasons, and one of the reasons is intensified forestry management (Banaś et al. 2019). It comes with a decrease in suitable nesting habitats (Rosensvald, Lõhmus 2003) and breeding sites (Lõhmus et al. 2005; Strazds 2011). The black stork is relatively selective in the selection of the breeding site, as it requires forest areas that contain large and old trees with large and strong branches (Banaś et al. 2019; Treinys et al. 2009; Moreno-Opo et al. 2011). In Eastern Europe, the main reason for the decline in habitats suitable for nesting is to be considered the decline of forest lands: deforestation, increased disturbance by forest management which reduces the number of aged suitable trees for nesting (Lõhmus, Sellis 2003; Rosensvald, Lõhmus 2003; Banaś et al. 2019). The black stork species protection plan states that the protection status should only be ensured by creating micro-reserves for all the identified nest sites (Ķemeru National Park Administration 2005). Any forestry activity is prohibited in the area of the microreserve, while there are no cutting restrictions on surrounding forest stands, arises the question of how such a situation would have an impact on the typical habitat of the black stork from the ecological metapopulation theory point of view, where the success of the species breeding depends on the possibility of relocating suitable places in the landscape (Hanski 1998). It is possible to analyze this issue by looking at the dynamic development of the forest at a time which can be identified through forest successions and dynamic modeling at the landscape level (Gustafson et al. 2010). One of the models of forest landscape succession is the LANDIS-II model, in which it is possible to model forest landscape changes on a large scale of spatial time with a variety of ecological processes (Mladenoff 2004; Scheller et al. 2007). The characterization of landscape fragmentation is one of the main processes of landscape change analysis (Turner, Gardner 2015) and a wide range of landscape indicators (McGarigal, Mark 1995) are applied to identify and quantify landscape fragmentation and structure. Forecasts for the conservation of the characteristic habitat of the black stork and the vision for the future in the forest landscape in Latvia have not been analyzed so far. Forest landscape management should consider many interlinked ecological processes in a broad spatial and time scale (Lindermayer, Franklin 2002).

Material and methods

Study area and suitable habitats

The study identified scenarios for the development of a suitable habitat for the black stork metapopulation under the current legislative framework and intensity of forest management activity in the country and the constraints on the management of protected natural areas. The selected study

sites in Latvia are the micro-reserves of the black stork established in the last 5 years ($n = 32$) in forest lands outside nature reserves and national parks. Random plots were selected ($n = 40$) for the comparison of sample sets between populated and unpopulated forest lands of the black stork. Each landscape plot analyzed in the area of 6 x 6 km where the micro-reserve or randomly selected point is located at the center of each plot (Fig. 1).

The area of the selected landscape plot with a radius of 3 km on average corresponds to half the distance between the two actual nests of the black stork in the landscape. The requirements applied to the habitat of the black stork in the study were classified as suitable forest stands aged > 70 years and unsuitable forest stands ≤ 70 years (after Treinys et al. 2009; Löhmus, Sellis 2003; Strazds 2011). The average transfer distance, if the nest becomes invalid, is accepted at 250 m (Ķemeru National Park Administration 2005), so in the study, the model is looking for the forest stands suitable for metapopulation at such a distance. The area of the suitable stand for the black stork nesting is applied at ≥ 4 ha (after Banaś et al. 2019).

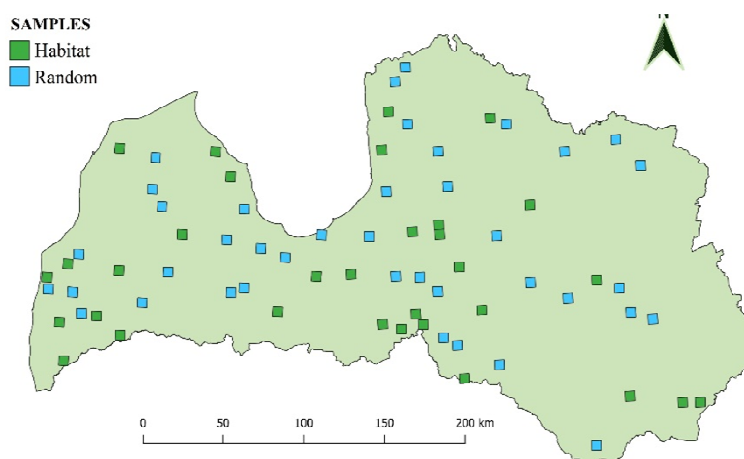


Figure 1. **Placement of samples ($n=72$) in the territory of Latvia (created by the author using the limited accessibility information of the formation of FST micro-reserves)**

Used data

Decisions for the establishment of micro-reserves of the black stork and the information of the forest inventory sections of the landscape to be analyzed were obtained from the State Forest Service and the Forest State Register provided by Service. The study includes the 10 most common tree species in Latvia (Forest State Service 2019a). In the simulation are used data from the fields of the Rural Support Service's open-access field register using the metadata available from WFS services. Free-access data on ditch systems, existing and planned forest roads, the construction of road structures of Latvia's State importance, and planned roads in the future are included. Data of roads and ditches are not included in the modeling of future scenarios due to the inaccuracy of these vector data at the scale of the landscape exposed to the simulation. The data decrypted in the raster

layer with the *Random Forest Algorithm*. *Sentinel-2* satellite images were used with 10 m accuracy during the active vegetation period.

Simulation of future forest landscape scenarios

The forest simulation model LANDIS-II with the Base Harvest scenario, which simulates the dynamic changes of the forest over decades, takes into account forest restrictions and conditions, was used to determine the changes in the habitat of the black stork over the next 100 years. Forest management activities restrictions include Natura 2000 management regulations and micro-reserve management requirements (Cabinet of Ministers 2010, 2012a). Forest sections in plots are subjected to cutting reaching the relevant age (Saeima 2012) within a specified decade. The scenario of the Base Harvest provides for the recovery of the forest stand with *Pinus sylvestris* in the associated forest types (Cabinet of Ministers 2012b). The model provides for the cutting of 10% of the area of the forest stand reached by the main cutting age, as such is the current average forestry activity intensity in Latvia (Forest State Service 2018, 2019b).

Identification of forest landscape changes

The Fragstat model 4.2. (McGarigal 2015) is used to describe changes to habitat landscapes. The landscape metrics produced by Fragstat 4.2. model describe the fragmentation of the landscape of habitats and random sampling plots and changes in structure over time. At the landscape level, diversity metrics are selected and mainly fragmentation metrics at class level, but at the metapopulation patch level shape, area and isolation metrics (after Wang et al. 2014; Lamine et al. 2018; McGarigal 2015). A total of 36 landscape metrics are used. The model includes the conditions for the appropriate stands of the black stork metapopulation, namely the search for habitat suitable stand age and area within a radius of 250 m.

To interpret data from a model, several data processing methods are used in the study. Descriptive statistics and DCA ordinations have been used to describe habitats and random sample plots at a given moment. The ranking-based non-parametric Kruskal-Wallis H test was used to identify statistically significant differences between the plots of the black stork habitat during the 100-year modeling period, but the simple t-test for comparing the habitat and random samples was applied to determine statistically significant differences between the two samples over each decade over the 100 years.

Results and discussion

Samples description

Following the distribution of the dominant species of trees in the DCA ordinations (Fig. 2), the comparison of average values and the ranking values of the Kruskal-Wallis H test shows that there are no significant differences in the composition of tree species between the habitat and the random samples. Significant differences have been identified in the prevalence of unsuitable (≤ 70

years) stands of birch and spruce, specifically that such unsuitable stands have been significantly more identified in the sample plots of black stork habitats. Significant differences between the two samples have also been identified in the network of ditches, forests and future roads, where the location of these sites is significantly higher in the landscape of the black stork. Often, the presence of forest roads can serve as a measure of the deviation of natural conditions, namely the denser road infrastructure can be found in the landscape, the more it has been modified (Lindermayer, Franklin 2002). Therefore, the landscape of the black stork habitat in the year of 2020 as a whole is characterized as more intensely managed areas compared to the random sample plots. It also derives from the fact that a younger forest stands within the presence of birch and spruce are significantly more present in the habitat sample. The diversity indexes of Shannon and Simpson, on the other hand, do not show any significant changes between two samples or between black stork habitat plots.

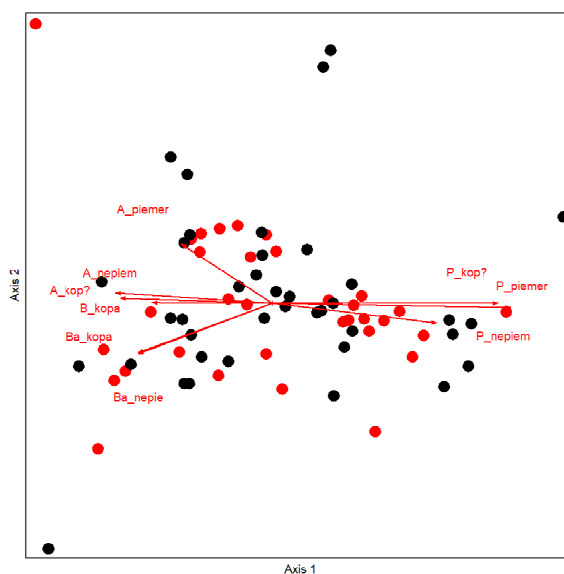


Figure 2. Similarities between the habitats of black stork and the plots of a random sample set (terms: red – habitat, black – random)

The habitat sample plots show a significantly lower edge effect for metapopulation patches, which is considered to be a positive indicator since the black stork is mostly nested in a known distance from the ecotone (Banaś et al. 2019; Lõhmus et al. 2005). For transfer suitable patches are present in the form of individual fragments in the landscapes corresponding to the metapopulation theory of the species' existence (Hanski 1998).

Description of habitat changes

The modeling results show that, despite the average cutting of only 10%, virtually all areas of forest compartments where forest management activity is not limited are cut during the modeling period of 100 years. As there are statistically significantly more unsuitable forest stands in the

habitat sample, it is these forest landscapes that are occupied by the black stork that is more endangered than any other place in Latvia. Clearcuttings formed as a basis for the entry of the pioneer species in these forest openings. One of the following tree species is the identified birch. In a mixed forest, birch and spruce stands are considered to be a typical phenomenon dominated by the dynamic development of unequal aged stands (Prévost et al. 2010). The structure of the forest landscape changes in fragmented mosaics (Fig. 3) over 100 years where the habitat plot in row 1 is located in the center and its stand age structure will increase over time because forest management activity in the micro-reserve is prohibited.

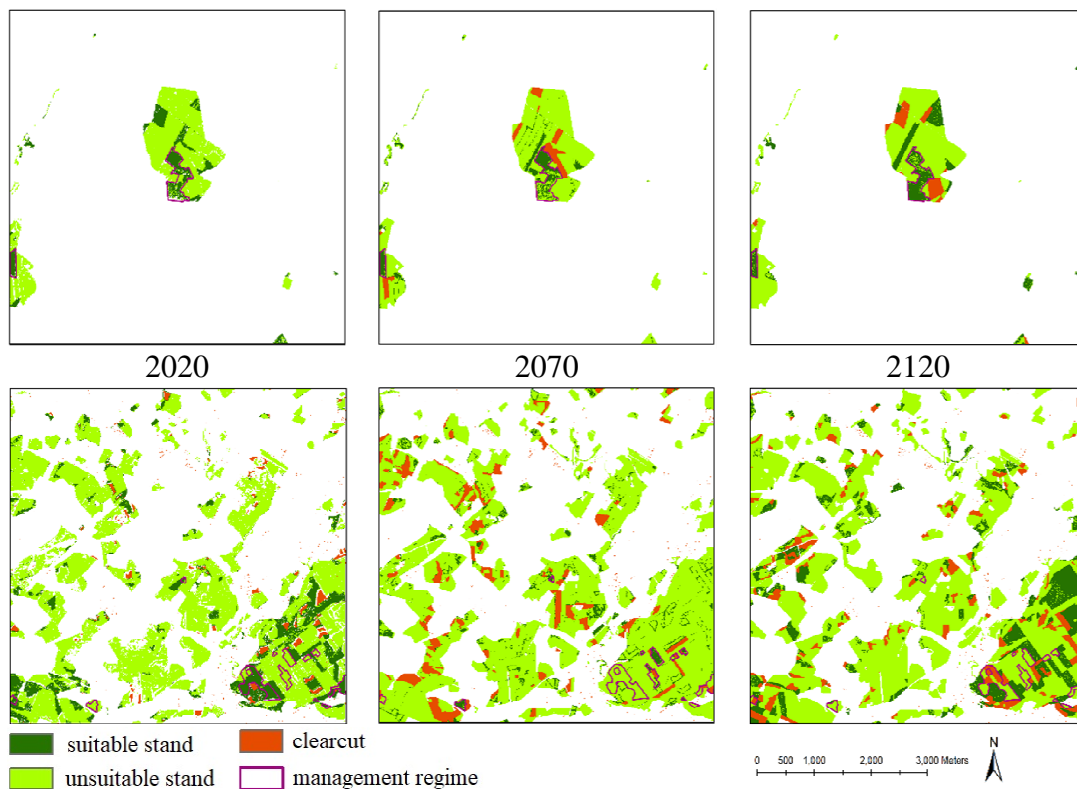


Figure 3. **LANDIS-II results: 1. row – habitat plots, 2. row – random plots with the spread of forest stand ages**

The landscape continuity for the survival of the black stork species is a vital component since the theory of the ecology of metapopulation requires the continuity of the patches suitable for the habitat or even physical continuity. Since the average transfer distance of the species has been observed at 250 m, the continuity of the suitable patches in the landscape must be practically physical connected to ensure the possibility of displacement, which should in practice be ensured by reducing the forestry intensity below the current cut 10%, thus maintaining and naturally developing older forest stands in the landscape. This study shows a decrease in the percentage (PLAND) of age-suited stands in both habitat and random sampling landscapes (Fig. 4) over time as well as increased isolation (ENN_MN) and fragmentation over time. However, unsuitable stands

are increasing over 100 years and are becoming more compact with a significantly higher proportion of such forest stands in the sample plots of black stork habitats. Thus, the continuity of the suitable patches is likely to decline.

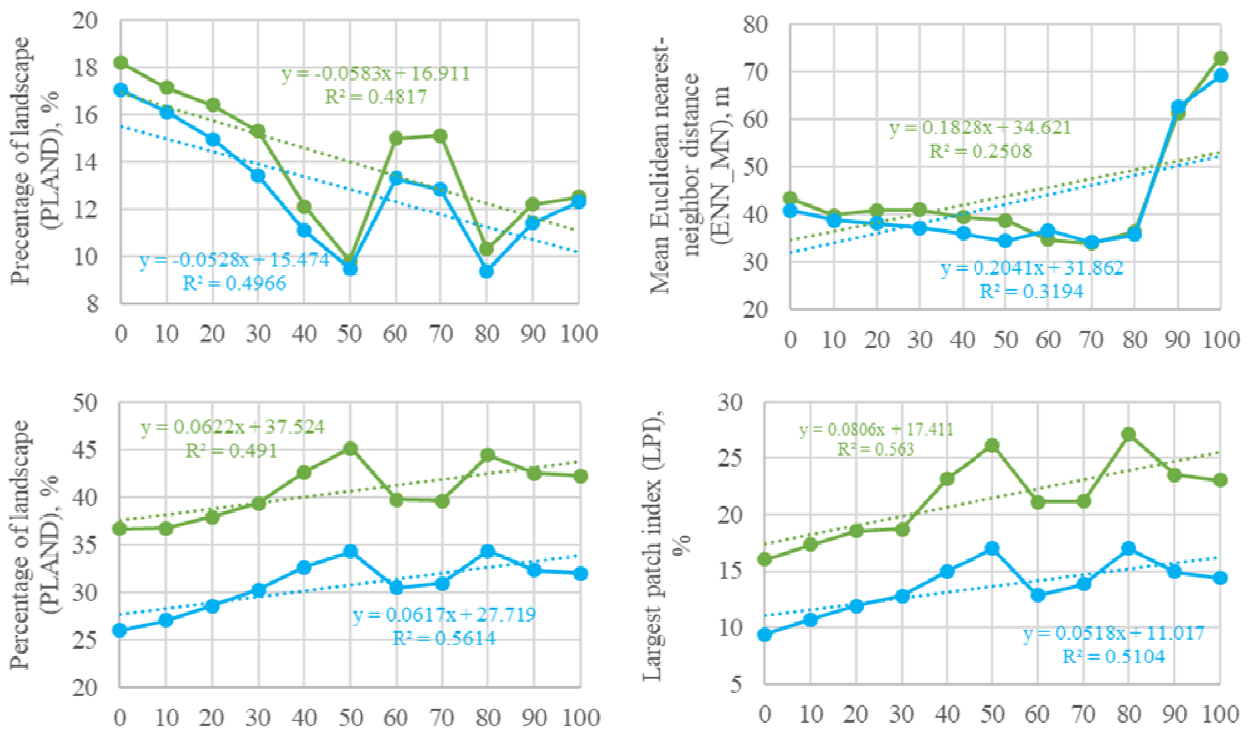


Figure 4. Class level fragmentation metrics differences in mean values for suitable stands (1. row) and unsuitable stands (2. row) between habitat (green) sample and random (blue) sample

Results of the study show that within 100 years a significant reduction in forest stands suitable for the metapopulation of the black stork. Since the sub-population of the black stork depends on the proximity of the suitable stands (Lõhmus, Sellis 2003), which is an average of 250 m, the results obtained show that the probability is significantly reduced (in Fig. 5 PROX index) for the black stork to find suitable stands for transferring in which it would potentially be possible to nest. Such stands are becoming more fragmented and isolated (Fig. 5), forest stands under the age of 70 are increasingly developed between them. Such newer stands will mostly consist of birch and spruce, potentially not the primary tree species selected by the black stork (Strazds 2011; Lõhmus, Sellis 2003). A significantly higher probability for a black stork to find a suitable location for himself exists in the random sample set.

The habitats required by the current forest management intensity and modeled scenario will be affected in the long term, and trends in the results of this study point to the potential for a significant decline in the success of black stork nesting in the future, as the bird will have to spend longer time searching suitable place for nesting. Planning forest management activities at landscape

ecological level in the long term will increase the possibility of targeting mono dominated age forest stands (Ziemelis 2020) by ensuring the connectivity of tree species and forest stands, reducing the isolation effect, since bird societies, in general, are directly affected by the appropriate habitat area and the abundance of species (Newton 1998). Planning of forest areas on a large spatial scale will increase the likelihood of providing many metapopulation needs in a single forest landscape area.

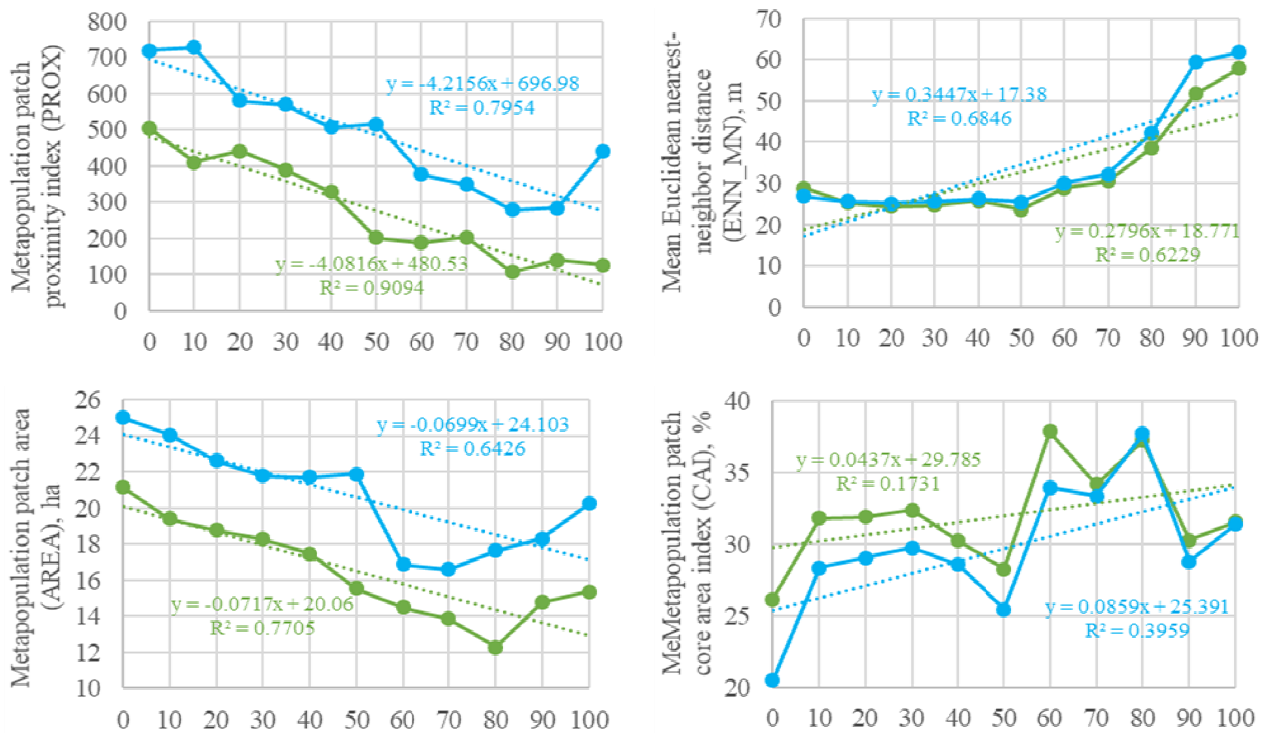


Figure 5. Metapopulation suitable patch level metrics differences in mean values between habitat (green) sample and random (blue) sample

Conclusions and recommendations

There are no statistically significant differences in landscapes occupied by the black stork from accidental landscapes in Latvia, except for the fact that there is a greater overall length of ditches and forest roads in the habitat landscapes. Concluded that changes in the habitat landscape do not differ from changes in the randomly selected landscape. After 100 years, the share of unsuitable habitats will increase significantly in the black stork habitats, but suitable stands get fragmented and isolated. Over time, the availability of potential black stork sites is also declining. After 100 years, more suitable habitat sites are in randomly selected landscapes. It is concluded that the current mechanism for protecting the black stork, namely the status of micro-reserve, does not provide sustainable protection of the species since after 100 years there will be a significant reduction in habitats due to the substantial reduction and insulation of older forest stands in the forest landscape. Thus, the protection status of the micro-reserve for the black stork should be

abolished, while maintaining the strict protection status of NATURA 2000 sites. It is necessary to carry out planned and science-based planning of the ecological level of landscape with regard to species protection and forest management. In order to provide future potential breeding sites for the black stork species, it would be necessary to set maximum cutting limits for forest sections at the average size to be cut in the landscape below the current average of 10%, thereby contributing to increasing the proportion of older stands in the forest landscape. It is also necessary to develop a new version of the black stork protection plan, which would include the requirements for the habitat of the species in conjunction with the dynamics of the forest landscape.

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FACTORS INFLUENCING ECO-FRIENDLY CHOICES AND ENVIRONMENTALLY SUSTAINABLE ACTION TAKING REGARDING CHEMICAL PRODUCT USAGE IN HOUSEHOLDS, LATVIA: A PILOT STUDY

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Abstract

Factors influencing eco-friendly choices and environmentally sustainable action taking regarding chemical product usage in households in Riga, Latvia: a pilot study

Key Words: chemical products; sustainable consumption; infrastructure accessibility; household chemical pollution; environmental behaviour

With growing concern towards environmental problems and chemical pollution, it is important that more environmentally sustainable choices are made. With the increasing consumption of goods and services, more strain is put on the ecological systems and earth's capability to restore its resources, therefore pollution, global warming, decline in flora and fauna, as well as other issues has become more important than ever. Consumers have the ability to improve or worsen the situation by purchasing or choosing eco-friendly products or services, however the decision making process is complex and can be influenced by different factors.

The aim of this study is to determine factors that influence the choices and actions of citizens of Riga, Latvia, regarding consumption of household chemicals and taking environmentally sustainable actions.

Data collection was made using focus group interviews. A total of 5 focus group interviews were made during October – November 2019 and February of 2020, gathering the opinions of 36 individuals living in Riga and its peri-urban area.

Efficiency, product cost, the accessibility of infrastructure and/or service, the simplicity of use and product's impact on the environment and health were the most often mentioned aspects while impact of marketing, peer/expert example or recommended action/choice and country of manufacture/origin of the product were less mentioned. The importance of the effectiveness and getting the expected result, as much as the accessibility of the infrastructure or service was admitted by the majority of respondents.

Kopsavilkums

Videi draudzīgu izvēļu un ilgtspējīgu rīcību ietekmējošie faktori saistībā ar ķīmisko produktu lietošanu mājāsaimniecībās Rīgā, Latvijā: pilotpētījums

Atslēgvārdi: ķīmiskie produkti; ilgtspējīgs patēriņš; infrastruktūras pieejamība; sadzīves ķīmiskais piesārņojums; vides uzvedība

Pieaugot rūpēm par vides problēmām un ķīmisko piesārņojumu, ir būtiski, lai cilvēki pieņemtu vairāk videi ilgtspējīgus lēmumus. Tā kā preču un pakalpojumu patēriņš tikai pieaug, ekoloģisko sistēmu un Zemes spēja atjaunot savus resursus tiek pārslogota, kā rezultātā kļūst aktuālas tādas problēmas kā piesārņojums, globālā sasilšana, floras un faunas daudzveidības samazināšanās un daudzas citas. Patērētājiem ir iespēja šo situāciju vai nu uzlabot, vai nu pasliktināt savā mājāsaimniecībā izvēloties un iegādājoties videi draudzīgus produktus vai servissus, tomēr lēmuma pieņemšanas process ir sarežģīts un to ietekmē dažādi faktori.

Šī pētījuma mērķis ir noskaidrot faktorus, kas ietekmē izvēles un darbības saistībā ar ķīmisko vielu lietošanu un ilgtspējīgu rīcību veikšanu Rīgā. Pētījuma ietvaros tika veiktas 5 fokusa grupu intervijas laika posmā no 2019. gada oktobra līdz 2019. gada novembrim un 2020. gada februārī. Kopumā fokusa grupu intervijās piedalījās 36 cilvēki, kas dzīvo Rīgā vai tās piepilsētas zonā – Pierīgā.

Efektivitāte, produkta cena, infrastruktūras vai pakalpojuma pieejamība, rīcības vai lietošanas vienkāršība un produkta ietekme uz vidi un veselību bija iemesli, ko dalībnieki minēja visbiežāk. Tāpat mārketinga, apkārtējo piemēru vai ieteiktā rīcība/izvēle un preces ražošanas/izcelsmes valsts tika pieminēti, tomēr retāk. Produkta efektivitāte un vēlamā rezultāta iegūšana, tāpat kā infrastruktūras pieejamība tika atzīti kā būtiskākie faktori, kas ietekmē videi draudzīgu izvēļu un ilgtspējīgu rīcību veikšanu.

Introduction

The environment is what humans depend on for their life – it is the air we breathe, water we drink, soil we use and so on, therefore it is essential to understand that society is “a part of, and not

apart from the rest of the nature”. Sustainability is described as the ability of all systems (earth`s natural systems, human cultural systems and economies) to survive and adapt to the always present changes of the environment (Tyler Miller 2009). Chemical pollution is one of the many ways causing harm to the environment, but in order to change the situation the first step is to acknowledge it. In the most recent Eurobarometer report on environmental issues (European Commission 2020) data shows that on average nine out of ten Europeans agree that they are worried about environmental impact of the chemicals found in the products used daily and 60% of respondents in Latvia responded that they “totally agree” that they are worried of everyday product chemicals impact on their health. Consumers have the ability to prevent or decrease the pace of pollution by choosing eco-friendly or “green” products and services (Joshi and Rahman 2015), which goes in line with what Europeans believe to be the way of tackling this problem – 33% of respondents in the Eurobarometer survey agree that changing the way they consume chemical products will lessen environmental problems (European Commission 2020). Some research has found that there is a gap between attitudes, opinions and actual purchases suggesting that positive attitudes towards green product or servicing purchasing does not always lead to an action (Joshi and Rahman 2015, Bamberg 2003, Tam and Chan 2017). The answers to the questions: “Why do people act environmentally and what are the barriers to pro-environmental behavior?” were extremely complex and no definite answers have been found (Kollmuss and Agyeman 2002). Studies show that many factors contribute to this gap including product price and availability (Eckhardt et al. 2010), as well as the other studies finding that social norms and influences affect the purchases of green products (Itani 2012)

This study aims to determine the factors influencing eco-friendly choices and taking environmentally sustainable actions.

Although data on European thoughts and opinions is gathered and available through Eurobarometer and other surveys, studies on this gap between the opinions and actual actions is limited. Therefore, it is essential to determine the factors that influence eco-friendly choices and taking environmentally sustainable actions.

Materials and methods

A qualitative research method of conducting focus groups were used for this study. A purposive sampling method was used for this study, meaning that the respondents were chosen to give an insight-of the opinions of the adult population of Riga. A total of 5 focus group interviews were held in the autumn of 2019 (October – November 2019) and early 2020 (February 2020), gathering the opinions of 36 individuals living in Riga, Latvia or its peri-urban area. The study group consisted of individuals aged between of 19 to 52; the total group consisted of 12 men and 24 women. All focus group interviews were done at the Riga Stradins University facilities, except one

case, which was done at the premises of enterprise because of convenience. Two of the focus groups consisted of adults living either in houses (N=5) or apartments (N=8), and the other 3 were student focus group interviews, consisting of 24 students mostly living in apartments (N=22). Each interview was approximately 90 minutes long and the interviewer used open-ended questions to gather respondents opinions on topics like chemical pollution, household caused pollution; waste management; environmental information availability and the health threats of environmental pollution.

This study was approved by the Ethics Committee of Riga Stradins University. Informed written consents were obtained from participants before data the interviews were tape-recorded, transcribed and analyzed using coding link to thematic analysis.

Results

Several factors that influence participants' choice or actions were mentioned: product efficiency, economic aspect, advertising or marketing, a positive example, provision of infrastructure and availability of services, simplicity of choice or action, environmental friendliness, health impact and country of manufacture/origin of the product.

Product efficiency is the ability of a product to achieve the desired effect. It was mentioned in all focus groups as a factor that is important in making environmental and chemical choices. Product efficiency was mentioned mainly in connection with cleaning products and personal hygiene products, as well as in terms of the use of fertilizers.

“Well, every product already has the functionality it needs to perform. If it doesn't, it doesn't matter how economic or ecological it is. In this situation, what you are trying to do is to wash the laundry or wash the floor. Your goal is not to be ecological; your goal is to achieve your aim using the tools that are available.”

In all focus groups, it was mentioned that efficiency was often difficult to achieve with ecological cleaning products, the desired effect was much easier to achieve with more chemical aggressive agents. Some respondents indicated that they prefer a product that delivers faster and easier result, however some respondents noted that in their case their priority was environmental friendliness of the chemical product.

“Perhaps there is lack of effectiveness? If it was close as possible to the result that can be achieved using chemical products that are possibly more harmful. Because the purchase is done consciously. Now we know that it (the chemical product) cleaned everything in 10 minutes without effort... and if I have to buy some eco-things, where you spend an hour really scrubbing – is it worth it? Maybe I just save my time.”

It is worth mentioning that the importance of efficiency was mostly discussed among adults who make decisions on groceries daily. Adults who were not responsible for economic matters in the family (students) mentioned this aspect less.

Economic aspect is the importance of price or cost while making choices regarding the environment and household chemical products. The economic aspect was widely discussed while speaking about the choice of cleaning and personal hygiene products, waste management and sorting, connection to centralized networks. The importance of price was noted in all focus groups, mentioning financial position as the determining factor in choosing a service or product. Respondents who disagreed still admitted that price is an important factor influencing their choice.

“When you can influence some decision, decisive factor will be how much you have to pay for it. If you as a consumer could choose, for example, a heating system, and that eco heating system with lower emissions would be more expensive, probably as a consumer you would choose what is cheaper for you. In the moment of choice you will always choose what is cheaper.”

But some respondents, whose financial situation allows them to choose, prefer slightly more expensive ecological products or products with better expected effect or less impact on health:

“In general, I buy more ecological products that are made more from natural products and plants. I do it more for myself, because I don't like to choose very chemical products, because it is very bad for the skin in general and worsens the structure of it. And I also prefer products for sensitive skin, especially in winter. I pay attention to all this. It requires quite a lot of money, but it's important.”

Advertising, marketing and the example of others. Choices are also influenced by the information respondents receive from others – this could be information contained in advertising or marketing campaigns, as well as recommendation from a friend or a public figure or opinion leader. Advertising and marketing influence the choice of electronics, detergents, cleaning products and personal care products. Specialist recommendations have influenced the choice of hair care products, but recommendations from friends and acquaintances were mentioned very often. For waste sorting respondents noted the examples shown by their parents, as well as the importance of the positive example in schools and workplaces.

“Often (I make choices) based on the advice of friends who were perhaps more interested in the environment. Then if they have tried it, I ask about their opinion on it.”

“Well, people tend to follow an example. Parental example and also what I have seen at my school, at my workplace or anywhere else. For example, if I see how waste sorting is done, then I think: “It looks OK, maybe I will try it”. Because firstly and most importantly – if see people not doing it, why should I bother?”

The promotion of environmentally friendly behavior was noted very positively. It was expressed that *influencers* have the ability to make them interested in changing their behavior or choices. This leads to a discussion that the example of famous people is interesting, but the effect of it is weak and does not change behavior. The importance of society's example was mentioned too: one respondent shared his experience of living abroad – when entering another society, his behavior changed and adapted to the norms and rules of that society.

Provision of infrastructure and availability of service. The importance of these factors was mentioned by respondents in terms of large waste and tyres, old clothing and electronics management, the connection to centralized networks, but especially of waste sorting issues. Infrastructure provision often was mentioned as a key factor for pro-environmental action.

In all focus groups the possibility to dispose used batteries in specialized boxes at supermarkets was mentioned as a good practise. However the situation regarding waste sorting infrastructure or the availability of this service was seen negatively in all focus groups. Respondents noted that inappropriate infrastructure and lack of it are the main reason for not sorting waste and most shared the opinion that waste sorting is for eco-conscious people.

“We had sorted waste like plastic bottles and went to throw it away in the specialized container, but it was full, overpacked and the waste was falling out. And I truly understand people who sort their waste, try to dispose it, but there's not even place where to put it. You can't place your garbage on the ground, because then there will be wind, and everything will get around. And then they throw it in the regular container, even if the waste is sorted.”

Environmental friendliness and health effects. Regarding environmental friendliness as a behaviour influencing factor, it was mentioned in various aspects. Some of the respondents identified environmental friendliness as a priority that affects not only their behaviour and choices but also their lifestyle. In these cases the simplicity of usage, cost, infrastructure and other important factors mentioned above were not decisive and hardly influenced the final choice:

“I'm one of those weird people who support the Zero waste initiative and minimalism, because I think it's really crazy that we go to the shop and just buy waste.”

In turn, some respondents, when choosing a household chemical product, tried to choose a product with lower impact on the environment, but did not studied the composition of the product (simplicity of operation is a priority), or do waste sorting as long as the sorting containers are located close to their house, but after the changes in infrastructure they stop sorting their waste (provision of infrastructure is a priority). Many respondents noted that they are trying to find a balance between environmental friendliness, efficiency, simplicity, infrastructure, cost and other factors when making environmental and chemical choices:

“(When buying) hygiene products, I pay attention at both the price and how eco-positive it is, at least I try to do that.”

“I think it is better to buy slightly more expensive, but recyclable things.”

The impact on health is another important factor influencing respondents' choices and behavior. Health and environmental impacts (environmental friendliness) are directly related and were often mentioned together. The importance of health effects was mentioned mostly in connection with the choice of cleaning and personal hygiene products:

“When I buy household chemicals, I think more about how healthy it is for us, our skin, our health. If it is better for us, it will be better for the environment too.”

Discussion

The findings in this study suggest that the price of the product is seen as the most important aspect when it comes to decision-making. Most of our study respondents agreed that the price of the product is a very important factor which most of the times makes it easier to choose the environmentally less friendly product since these products are often lower cost. This can be seen as “economical rationalization” which has been identified in a study of Eckhardt et al (Eckhardt et al. 2010). In this study with 20 in depth interviews with customers researchers concluded that respondents saw cost as more important than any other consideration and used this to justify their behaviour which was focused mainly on personal consumer benefit. Although most of our informants responded that price influence their purchases the most, there were respondents who saw themselves as those with higher income and increased environmental awareness that chose the eco-friendly products despite the higher cost. This suggests that a part of the society thinks more altruistically and it can be explained as the people who have satisfied their personal needs are more likely to act pro-environmentally because they have more resources to care about bigger and less personal problems (Kaufmann et al. 2012).

Most of our respondents agreed that the lack of infrastructure and its unaccessability are the main reasons for them not to recycle, expressing the belief that only the very eco-conscious people recycle and that recycling is not seen as an individual responsibility. This is similar in other economies where social democracy is in place, as in Sweden or Germany. In the previously mentioned study by Eckharadt et al. (Eckhardt et al. 2010) the interviewed Swedes believed that if the government allows the product to hit the market then it is no longer consumers responsibility to evaluate it's harm or good for the environment. However, the interviewed Germans shared their opinion, that they as individuals don't feel the obligation on responsibility of thinking about environmental issues, that this should be the topic of the government.

Our results show that respondents doubt the effectiveness of eco-friendly products and have experienced their failures. As the effectiveness is a subjective matter and is very much impacted on

different factors such as water hardness, detergent dosage and types of stains in case of washing or cleaning products. In a large study including more than 4,000 respondents from different countries of Europe results showed that many people lack the knowledge of product dosage and water hardness, which both directly impact the efficiency of a laundry detergent (Ferri et al. 2016); therefore, it is suggested that education on these factors could increase the usage of eco-friendly detergents. In a study of comparing alternative washing agents with an eco-labeled compact detergent (Laitala 2012) results showed that alternative washing agents such as laundry balls, soap nuts, washing pellets and laundry magnets showed the washing effect similar to pure water. In our study it was not further investigated what kind of alternative or eco-friendly products were used and concluded to be ineffective.

Eco-friendly product purchase decision is also influenced by information available like reviews, recommendations and marketing campaigns. Product branding and companies positioning as environmentally friendly influences product purchase decision (Buhkari and Rana 2017) meaning that if a company positions itself as eco-friendly and sustainable, environmentally conscious people will buy their products. Personal factors like drive for environmental responsibility and supporting environmental protection positively affects eco-friendly product purchase since people who are pro-environmental and with higher environmental awareness understand the consequences of their consumer patterns and therefore choose environmentally responsible purchases (Kumar 2015).

Conclusions

Price is the most important factor when it comes to choosing environmentally friendly products however for those respondents who see themselves as in an economically better positioned product environmental friendliness becomes more important. Previous experience in using eco-friendly laundry detergents and cleaning products lead to conclude that environmentally friendly products are not efficient and acquire more time for their use than traditional, more “chemical” products. Further research should be done to evaluate efficiency of eco-friendly products or services, and education on this topic could help to increase the usage of environmentally friendly products and services.

The lack of infrastructure and its unaccessability is a factor influencing action – without proper and easily accessible waste sorting bins only those who see themselves as environmentally conscious and proactive will sort their household waste.

Product and brand marketing, reviews and recommendations as well as personal factors such as environmental friendliness and increased environmental awareness influence the choices and actions for environmentally friendly products.

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KVARTĀRVIDES PĒTĪJUMI / RESEARCHES OF THE QUATERNARY ENVIRONMENT

GEOMORPHOMETRY AND GEOLOGY OF NUMERNE LATERAL SHEAR MORAINÉ RIDGE

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Abstract

Geomorphometry and geology of Numerne lateral shear moraine ridge

Key Words: lateral shear moraine, geomorphometry, landform morphology, glacial sediments, Eastern Latvia lowland

The assemblages of glacial landforms that are preserved in Latvia at the beds of paleo-ice streams are the indicators providing important data on the paleogeography of the ice masses during the last deglaciation. One of such geomorphological indicators is lateral shear moraines (LSM). LSM are landforms of glaciotectonic origin and their geographic distribution is mainly controlled by the location of ice margins. Hence the geomorphological studies of these relief features can provide insight into the spatial distribution of paleo-ice streams and paleogeography of the area under study. Numerne ridge, located at the south-eastern edge of Eastern Latvia lowland, is also classified as LSM. However, its geomorphological characteristics remain insufficiently studied, because the previous analysis of this complex landform has been performed using topographic map-derived data. In order to provide much more detailed insight into the issues on the shape, dimensions and morphology of the ridge, the GIS-based geomorphometric analysis was applied. The obtained results indicate that the application of geomorphometry and use of high-resolution DEM in GIS environment provide more detailed data than those previously obtained from the analysis of topographic maps and manual digitizing of contour lines, particularly in terms of interpretation of surface morphology and geomorphometric characteristics of glaciotectonic landforms. However, further field work has to be carried out and shallow geophysical survey by GPR has to be performed in order to elucidate internal structure of this LSM. In addition, AMS ¹⁴C dating of peat samples deposited in the glaciokarst kettles on the surface of LSM has to be done allowing to get insight into the chronology of LSM development during transition from glacial to periglacial and later to post-glacial conditions in this region.

Kopsavilkums

Numernes laterālās bīdes morēnas vaļņa ģeomorfometrija un ģeoloģija

Atslēgvārdi: laterālās bīdes morēna, ģeomorfometrija, reljefa formu morfoloģija, glaciālie nogulumi, Austrumlatvijas zemiene

Glaciālo reljefa formu sakopojumi, kas ir saglabājušies Latvijā seno ledāja plūsmu un mēļu gultnēs, ir tie indikatori, kas sniedz nozīmīgus datus par ledāja masu paleoģeogrāfiju pēdējā apledojuma laikā. Viens no šādiem ģeomorfoloģiskiem indikatoriem ir laterālās bīdes morēnas (LBM). LBM ir glaciotektoniskas cilmes reljefa formas un to ģeogrāfisko izvietojumu galvenokārt noteica ledāja malas lokalizācija. Tādējādi šādu reljefa veidojumu ģeomorfoloģiskie pētījumi var nodrošināt ieskatu ledāja paleoplūsmu telpiskajā izvietojumā un paleoģeogrāfiskajā situācijā pētījumu teritorijā. Numernes valnis, kas atrodas Austrumlatvijas zemes dienvidaustrumu malā, arī tiek izdalīts kā LBM. Tomēr šī vaļņa ģeomorfoloģiskie raksturlielumi joprojām nav noskaidroti pietiekami detāli, jo agrāk veiktie šīs kompleksās reljefa formas pētījumi balstījās uz topogrāfisko karšu analīzi. Ar mērķi nodrošināt augstas detalizācijas pakāpes datu iegūvi par LBM vaļņa apveidu, dimensijām un tā morfoloģiju, ĢIS vidē tika veikta ģeomorfometriskā analīze. Iegūtie rezultāti parāda, ka ģeomorfometrijas metodes pielietojums un augstas izšķirtspējas DEM izmantošana nodrošina daudz detalizētākus datus salīdzinot ar tiem, kas iegūti, apstrādājot manuāli vektorizētus topogrāfisko karšu horizontālu tematiskos slāņus, it sevišķi attiecībā uz glaciotektoniskas reljefa formas virsmas morfoloģijas interpretāciju un ģeomorfometrisko raksturlielumu noteikšanu. Tomēr, turpmāk ir jāveic papildus lauka pētījumi un jārealizē ģeofizikālā zondēšana ar ģeoradaru, lai noskaidrotu LBM vaļņa iekšējās uzbūves iezīmes. Papildus tam, nepieciešams veikt uz vaļņa virsmas esošajās glaciokarsta iepakās uzkrājušās kūdras paraugu AMS ¹⁴C datējumus, kas ļaus gūt ieskatu vaļņa attīstības hronoloģijā laika periodā, kad notika pāreja no glaciāliem uz periglaciāliem, un vēlāk uz pēcapledojuma vides apstākļiem šajā reģionā.

Introduction

Data on the geographic distribution of glacial landforms and their patterns, as well as allocation of associated glacial sediments are crucial for the paleogeographic reconstruction of the Weichselian glaciation at its retreat phase in Latvia and the south-eastern part of the Baltic region (Zelčs et al. 2011). The assemblages of glacial landforms and deposits that are preserved in Latvia at the beds of former ice lobes and tongue-like local paleo-ice streams are geomorphological indicators providing important data on the regional paleogeography. These data can also provide useful information for understanding the dynamics of ice masses (Lamsters and Zelčs 2015; Batchelor and Dowdeswell 2016) and can be utilised for paleoclimate modelling at regional scale (Kalm 2012). Configuration of ice streams and their retreat towards the end of last glaciation had a substantial impact not only on changes of paleoenvironmental conditions but also on the local geomorphology, distribution of landforms and development of Quaternary sediments cover (Kleman et al. 2008). In such a context, during the last decades knowledge on the ice-flow patterns and the processes which create glacial landforms in Latvia has been developing tremendously (e.g. Zelčs and Markots 2004; Zelčs et al. 2011). Although the number of research programmes recently conducted in the field of Quaternary geology and geomorphology in Latvia increases, only a few of these researches are focused on the studies of landforms of specific morphology, i.e., linear ridges that are parallel to the local paleo-ice flow directions (Putniņš 2012). Such landforms in relation to ice streams have been relatively recently documented in the scientific literature by A. Dyke and T. Morris (1988), providing the first detailed description of an example from Prince of Wales Island, Canadian Arctic. Dyke and Morris (*ibid.*) assumed that such highly elongate landforms may have marked a shear zone at the lateral margin of paleo-ice stream. Since this publication (*ibid.*) in Quaternary geology and geomorphology the term 'lateral shear moraine' proposed by Dyke and Morris has been used to identify such ridge-like features. LSM are landforms of glaciotectionic processes dominated origin (Zelčs 2000) and the geographic distribution of them is mainly controlled by the locations of ice stream margins (Stokes and Clark 2002; Batchelor and Dowdeswell 2016; Stokes 2018). Typically, these relief features form linear ridges that are parallel to the local paleo-ice flow direction. Hence, the studies of topographic indicators of lateral shear-moraines can provide insight into the spatial distribution of paleo-ice streams as well as into reconstructing their dynamics.

Although the landforms morphologically similar to LSM and located in the eastern part of Latvia were described by J. Straume in 1979 as 'ice cleavage ridges', until now there is a lack of scientifically reliable data on the geological structure and topographic characteristics of these features. In addition, it is comparatively little known about the characteristics and formation of LSM in comparison to other landforms in Latvia that have been formed by glaciotectionic or

glaciofluvial processes as regards ice stream configuration and flow directions. Hence, the issues of formation and composition of these geomorphological features continue to remain among those issues of Quaternary geology of Latvia which are poorly documented. One of such geomorphological features is Numerne ridge located at the south-eastern edge of Eastern Latvia lowland; this ridge is also classified as LSM (Putniņš 2012). Its geomorphological characteristics remain insufficiently studied, because the previous analysis of this complex landform has been performed using topographic map-derived digital elevation models (DEM). Hence, the objective of this study was to carry out geomorphometric analysis and field survey in order to provide much more detailed insight into the issues regarding the shape, dimensions and morphology of the LSM ridge.

Material and methods

To achieve the objective of this study and to carry out geomorphometric analysis of Numerne LSM, at the first phase of research program an interdisciplinary approach was used, and different research methods based on modern technological solutions were applied. Geomorphometry, which in brief can be described as the science of digital terrain analysis (Pike et al. 2009; Evans 2012), is the scope of methods and techniques for quantitative land surface analysis that can be used to obtain data on morphological, morphographic and other aspects of landforms.

Thus, DEM with high horizontal resolution and high vertical accuracy was generated from the LiDAR cloud point data provided by the Latvian Geospatial Information Agency as *.LAS format. For optimization of DEM constructing process, at first, the *.LAS files were converted into *.LAS dataset covering entire LSM area, and then LiDAR point cloud was filtered with ArcGIS 10.7 software by classification code 'ground', thus, extracting from *.LAS dataset only the points representing the relief surface. After that from pre-processed data ESRI regular grid raster format DEM with spatial resolution 0.4 m was created by ArcGIS tool 'LAS Dataset to Raster'. In order to provide a visual identification of LSM ridge, hill-shaded relief model was derived from DEM. Considering that interpretation of landform features from single hill-shaded map is usually biased by the direction of illumination, four thematic raster layers were created with a constant sun altitude of 45° and variable sun azimuths of 45°, 135°, 225° and 315° following the procedure described by Smith and Clark (2005) and Evans (2012). Finally, in the process of visual interpretation, combining raster layers with variable azimuths, the identification and delineation of Numerne ridge crest line, foothills and other geomorphological elements were performed by ArcGIS 10.7 software package tools using DEM and following the standard procedure described in the scientific literature (Hardt et al. 2015; Putkinen et al. 2017). Hence the detailed geomorphological framework for further geomorphometric analysis was established. Bearing in mind that recent materials and data about LSM morphology are fragmented and require higher spatial resolution and summarizing, the

authors of the present research carried out a study based on analysis of airborne LiDAR elevation data and field geomorphological reconnaissance supported by GPS survey. After that, during the geomorphometric analysis a shape in planar view, orientation of the LSM ridge, its hypsographic curve, elements of topography and other parameters of the ridge were extracted by ArcGIS 10.7 tools.

As it was noted previously, beside geomorphometry, the spatial distribution of glacial sediments is also an important indicator providing data on the paleogeographic reconstruction of ice streams and development of LSM. Therefore, geological field survey was carried out and the geographic distribution of superficial Quaternary sediment cover was ascertained, performing large-scale geological mapping on the basis of survey data. As operating quarries or fresh outcrops with sediment sections are absent within LSM under study, mainly conventional geologic survey, i.e., near surface augering (<2 m depth) by AMS MudAuger system and georeferencing by GPS Trimble Juno SB, was employed to investigate both the lithofacies of glaciofluvial sediments and their geographic distribution.

Results and discussion

Numerne LSM is located in the eastern part of Latvia (Fig. 1 A). This area, according to physiographic subdivision of Latvia, belongs to Adzele elevation, which in turn is encompassed by Eastern Latvia lowland.

In terms of paleogeographic situation, the LSM under study marks the zone between the south-eastern edge of Eastern Latvia lowland and the north-western ice-contact slopes of Latgale upland (Fig. 1 A). In recent paleogeographic reconstructions of deglaciation history of Latvia (Zelčs and Markots 2004; Zelčs et al. 2011) this area is indicated as a zone between ice-stream flows of the Lubāns ice lobe (located in Eastern Latvia lowland) and stagnant or dead ice masses (located along the north-western slopes of Latgale upland). The highest point in the eastern part of Numerne ridge reaches altitude of 163.3 m a.s.l. (Fig. 1 B), but the maximal relative height of the ridge is 58 m.

The total length of the LSM along the ridge crestline is 9,152 m. It stretches from west-southwest to east-northeast. The LSM is slightly undulated (Fig. 1 B), its sinuosity index obtained by dividing the length of the LSM ridge by the length of a straight line between the start and endpoints is 1.05. The results of geomorphometric analysis indicate that in planar view Numerne LSM has triangle flag-shaped outlines, which widen in the eastern-north-eastern direction. The width of the LSM varies greatly from 85 m in its western part till 1,120 m in the central part and 975 m in the eastern part. As it is noted in the previous studies (Putniņš 2012), undulation of LSM is possibly caused by glaciotectonic deformations as a result of laterally orientated dynamic shear stress of the Lubāns ice lobe during the formation of LSM.

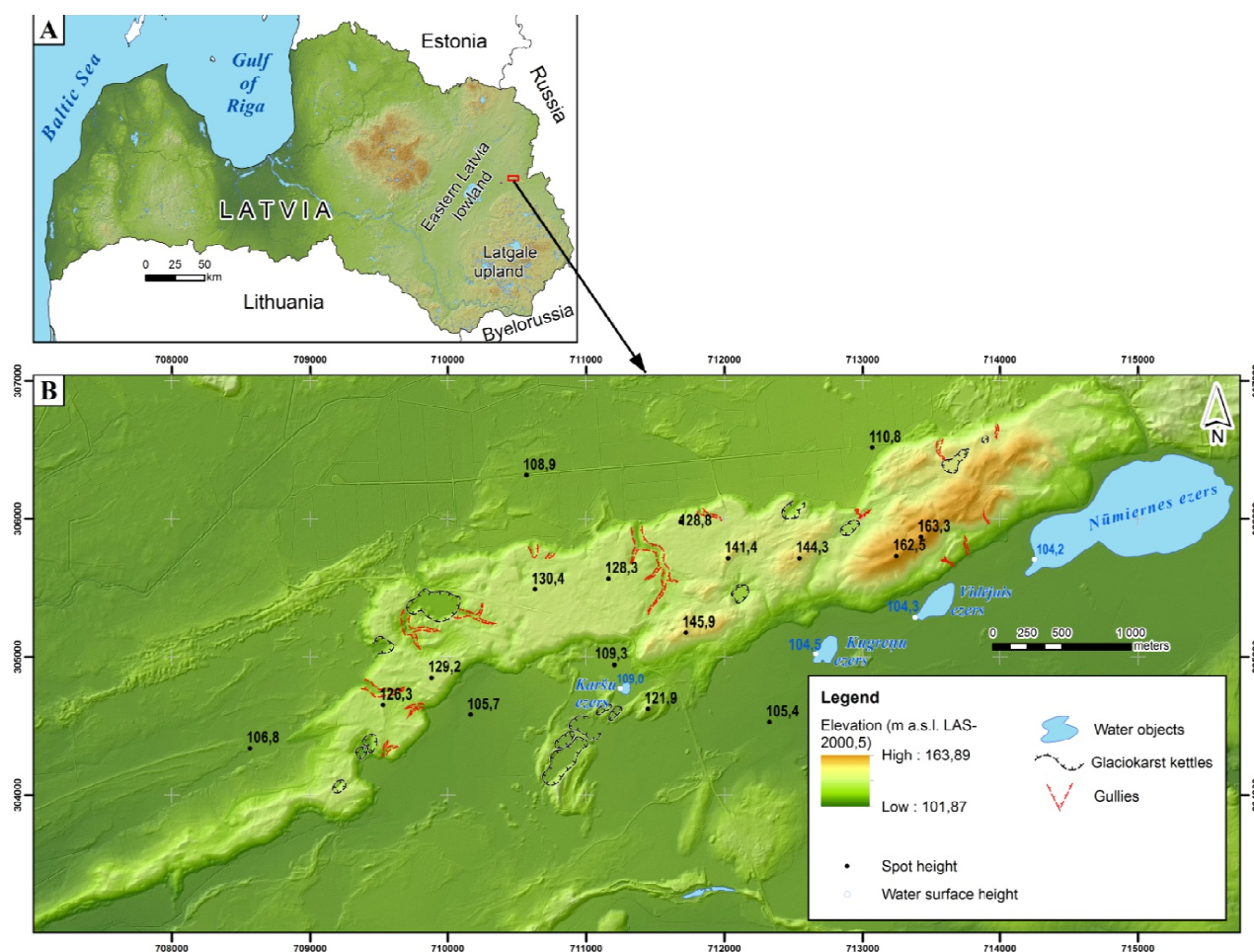


Figure 1. Location of study area in Latvia (A) as regards position of Eastern Latvia lowland and the Latgale upland; digital elevation model (DEM) of Numerne LSM

Source: *.LAS data for DEMs – Latvian Geospatial Information Agency, 2017

Along both edges of Numerne ridge wide depressions are located, which have been recently occupied by lakes and bogs. The surface of LSM has different topography. For example, the western part of LSM has a ridge-like shape similar to eskers with a narrow crest part and relatively steep slopes. The surface of LSM in its central part is wide and flattened, with elevations 126–130 m a.s.l. Eastwards from the local motorway P48 on this flattened surface there are several elongated hummocks and small eskers with relative height from 7 till 12 m. These surface relief features have a subparallel orientation. Further, towards the east the highest part of LSM is located, where altitudes exceed 160 m a.s.l. In this part the surface of LSM has a shape of a wide morainic ridge with steep slopes of a convex-concave cross-profile.

In many places the slopes of LSM are dissected by gullies (Fig. 1 B), the longest of which reaches the length of 670 m. The majority of these erosion landforms are inactive; U-shaped old gullies are partially filled with sediments. Only in some gullies, due to the inflow of groundwater, recent linear erosion incisions can be observed. In addition, many circular or irregular, closed or partially closed depressions, which are identified as glaciokarst kettles, can be observed on the

surface of the LSM (Fig. 1 B). These depressions mark the locations of dead ice blocks buried under sediments at the end of the last glaciation.

The results of geomorphometric analysis and subsequent construction of hypsometric curve and plotting of elevation frequencies reveal the dominance of heights 120–135 m a.s.l., demonstrating that 56.3% of the total surface of LSM is at an elevation range close to the average hypsometric level (Fig. 2). It corresponds to the flattened surface areas of the LSM in its western and central parts. As Fig. 2 shows, the hypsometry of the LSM extends to lower elevations. Moreover, the hypsometric curve exhibits relatively uneven distribution of heights. Despite the significant absolute relief of the eastern part of the LSM, its contribution to hypsometry of landform is less significant – only 9.8% of the total surface of the LSM, which is considerably lower proportion than the adjacent flattened surfaces and is a result of a smaller surface area at a higher elevation range between 140 and 165 m a.s.l.

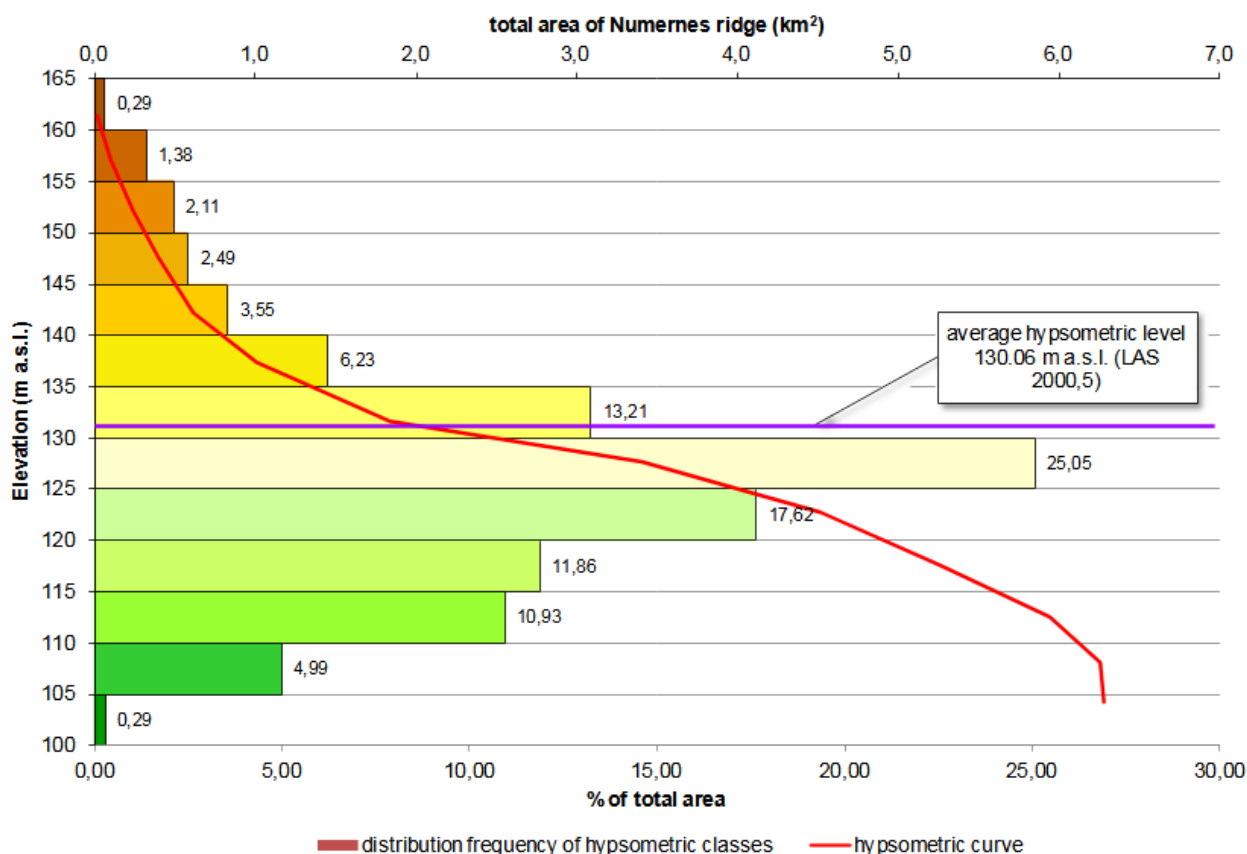


Figure 2. The elevation frequency histogram and hypsometric curve of Numerne lateral shear moraine ridge

The results of the geological survey indicate that geographically the most abundant and dominant type of sediments is glaciofluvial (fQ₃ltv) fine, medium and coarse sand with silt interlayers and gravel-pebble inclusions. These deposits form the Quaternary cover at lower elevated western and central parts of Numerne LSM (Fig. 3). The contribution of the Upper

Pleistocene glacialigenic (gQ_3ltv) deposits, i.e. glacial tills represented by stony, sandy loams and loams, is less significant. As Fig. 3 shows, the moraine material forms the highest eastern part of Numerne ridge, as well as ablation moraine covers south-eastern slopes of the ridge. Sporadically, younger bog sediments (bQ_4) – peat of the Holocene time – have been formed and continue to accumulate in small glaciokarst kettles on the surface of the LSM. Peat also fills wide depressions recently occupied by bogs and wetlands on both sides of Numerne ridge (Fig. 3).

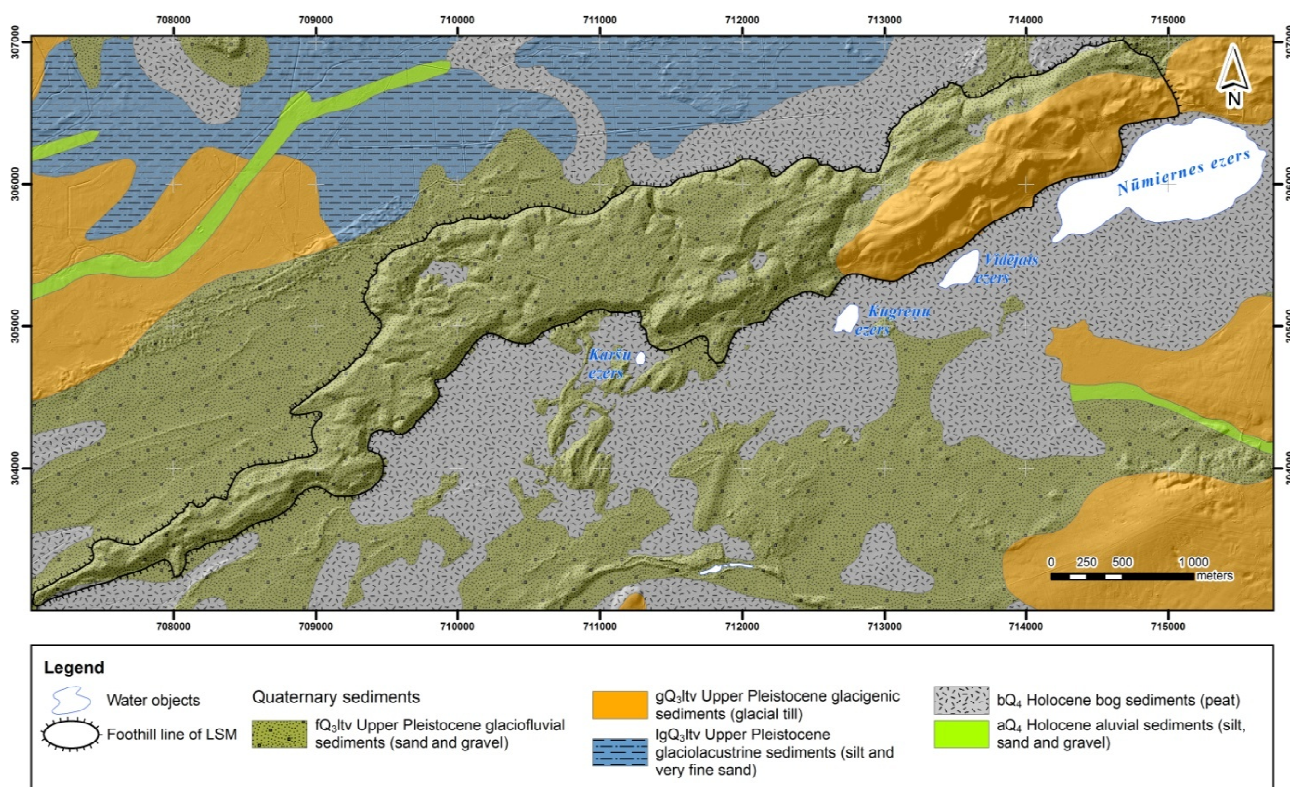


Figure 3. **Map of geographic distribution of Quaternary sediments in Numerne LSM and adjacent areas**

Despite the wide distribution of glaciofluvial sediments, the previous studies (Putniņš 2012) performed in the sand and gravel quarries located near the LSM have revealed the presence of compressional deformation structures in the subglacial and glacioaquatic sand and gravel material. These structures clearly indicate the impact of glaciotectonic processes during the formation of core part of the LSM.

Conclusions

The obtained results on morphology of Numerne LSM indicate that the application of geomorphometry and use of high-resolution DEM in GIS environment provide more detailed data than those previously obtained from the analysis of topographic maps and manual digitizing of contour lines, particularly in terms of interpretation of surface topography and geomorphometric characteristics of glaciotectonic landforms.

The results of the geological survey and mapping of Quaternary superficial deposits reveal patterned spatial distribution of glaciofluvial and glacial sediments, where glacioaquatic sand and gravel form lower parts of the LSM, while glacial till covers a higher eastern part of the landform. It indicates that the accumulation of material transported by glacial meltwater streams towards the end of the Weichselian glaciation and at the beginning of the Holocene has played the main role in the formation processes of Quaternary sediment cover in Numerne ridge.

Considering the location of Numerne ridge, its geomorphometry and orientation of longitudinal axis, in the first phase of the research we can assume that this landform presumably has been formed in the shear zone between fast-flowing ice stream of the Lubāns ice lobe, which was situated in Eastern Latvia lowland, and stagnant ice masses located along the north-western slopes of Latgale upland. At the same time, the morphology of the central part of the LSM with a flattened surface and relatively steep slopes, as well as minor esker-like subparallel landforms on the surface of the central part suggest that after the glaciotectonic formation of the ridge, glaciofluvial accumulation took place at the lower hypsometric levels of the LSM, presumably after stagnation of the Lubāns ice lobe. In this case kame terrace-like and esker-like features were formed along and on the top of the primary glaciotectonic structures, when melting of the ice and draining of extra-glacial waters from the already ice-free parts of adjoining Latgale upland provided a surplus of sediments. Hence Numerne ridge represents a polygenetic landform which consists of the older part of glacial morphogenesis in shear stress zone and younger part of glaciofluvial origin.

However, further field work has to be carried out and shallow geophysical survey by GPR has to be performed in order to elucidate glaciotectonic internal structure of this LSM. In addition, AMS ¹⁴C dating of peat samples deposited in the glaciokarst kettles on the surface of the LSM has to be performed allowing to get insight into the chronology of the LSM development during transition from glacial to periglacial and later to post-glacial conditions in this region.

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