ISSN 2544-1361

European Journal of Clinical and Experimental Medicine

Formerly: Medical Review

Quarterly

Vol. 15, No. 1

Publication date: June 2017

Rzeszów, Poland 2017

Technical development, layout and interior design: Wojciech Pączek
Cover design: Wiesław Grzegorczyk

ICV: 74,77
MNiSW: 7,0

Indexing:
Ministry of Science and Higher Education (Poland)
Index Copernicus
The Central EuropeanJournal of SocialSciences and Humanities (CEJSH)
POL-Index
Central Medical Library (Poland)
SPORT Computer Base
ARIANTA – Science and branch Polish electronic journals

ISSN 2544-1361

EDITORIAL CORRESPONDENCE
European Journal of Clinical and Experimental Medicine Editorial Office
35-959 Rzeszów, ul. Kopisto 2A,
tel. 17 872 11 53, fax 17 872 19 30
e-mail: ejcemur@gmail.com
https://mc04.manuscriptcentral.com/pmur

PUBLISHER: THE UNIVERSITY OF RZESZÓW
35-959 Rzeszów, ul. prof. S. Pigonia 6,
tel. 17 872 14 26, tel./fax 17 872 14 26
e-mail: wydaw@ur.edu.pl

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ISSN 2544-1361

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 4

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ISSN 2544-1361

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Editorial

Dear Sir or Madam

For the last ten years, the editorial office of the only medical journal published by the University of Rzeszow (Medical Review, and formerly Medical Review of Rzeszow University and National Institute of Drugs) was acted by Professor Andrzej Kwolek. At that time 40 issues of the journal, a total of 480 original, review, casuistic and historical papers were published, mostly in the field of physical medicine and rehabilitation.

Undoubtedly, the success of our quarterly is mainly due to the authors of their works, the Reviewers and members of the Editorial Board and, above all, Professor Andrzej Kwolek, who ran the quarterly. The formula revised in early 2017, which requires a different look at the journal by the new editor-in-chief, has resulted in changes of the editorial board. In addition, the University has set up a new publishing title: "European Journal of Clinical and Experimental Medicine" (Eur J Clin Exp Med), which will be the new publishing body from January 2017 only in English. I hope, European Journal of Clinical and Experimental Medicine will become an international magazine with the further cooperation of existing Authors, Reviewers and new people.

I thank all members of the Editorial Committee, especially Professor Andrzej Kwolek, for your past years of work and wish you continued success in your professional career.

Greeting you, I wish you fruitful cooperation and I strongly encourage you to publish the results of your research.

Rafał Filip
Editor-in-Chief of European Journal
of Clinical and Experimental Medicine

© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.1

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 6–11

ORIGINAL PAPER

Kateryna Goncharova [1(ABDE)], Rafał Filip [3(ABDFG)], Paulina Świeboda [1(BCDE)], Olena Prykhodko [1,2(BCD)], Olexandr Fedkiv [1(BCD)], Katarzyna Szwiec [1,4(BCD)], Jose Luis Valverde Piedra [4(BCD)], Blanka Majda [1(BCD)], Stefan Grzegorz Pierzynowski [1,2(ACDH)]

Model development of hydroxyproline induced hyperoxaluria in young growing pigs

[1] Department of Cell and Organism Biology, Lund University, Helgonavagen 3b, 223 62 Lund, Sweden;
[2] Department of Medical Biology, Institute of Rural Health, Jaczewskiego 2, 20-950 Lublin, Poland;
[3] Department of Gastroenterology of Clinical Hospital 2, University of Rzeszow, Lwowska 60, Rzeszow Poland
[4] Department of Toxicology and Environmental Protection, University of Life Sciences, 20-950 Lublin, Poland
[5] Department of Biochemistry and Animal Physiology, University of Life Sciences, 20-950 Lublin, Poland

ABSTRACT

Aim of the study. In this study, we sought to create a model of reversible hyperoxaluria in pigs by feeding with hydroxyproline (HP).

Materials and methods. The experiment included 12 pigs divided into 2 groups (n = 6). The pigs were fed twice a day. At the beginning of the experiment, in the adaptation period, all pigs were given standard feed. In the next 7 days, an increasing amount of hydroxyproline (1–3% HP), was added to the feed. In next 14 days, 4% HP was administered in each pig meal. After 14 days of 4% HP diet, the pigs were randomly divided into 2 groups. For 6 pigs, 4% HP treatment had been continued for the next 14 days while the second group of pigs for the next 14 days received a standard HP free diet. 24h urine samples, blood and fecal samples were collected on particular days.

Results. The addition of HP to the diet increased urinary oxalate excretion. A characteristic increase was noted after 12 days of treatment with 4% HP. During the removal period, oxalate excretion decreased in the group without HP in diet, while in the group which continued with a 4% HP diet, oxalate excretion significantly increased. Gross examination of kidneys showed that in the group which had 4% HP diet for 4 weeks, kidneys were fibrotic with enlarged cavities, and had small visible urinary stones. In second group, kidneys were relatively normal looking with no visible stones.

Conclusion. Hyperoxaluria is reversible, if HP is removed 14 days after the start of 4% HP diet. Prolonged exposure up to 4 weeks causes pathologic changes in kidneys including crystals, sand and small stone formation.

Keywords. pig model, hyperoxaluria, kidney stones, hydroxyproline

Corresponding author: Rafał Filip, Medical Faculty, University of Rzeszow, Poland, e-mail: r.s.filip@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 13.01.2017 | Accepted: 14.03.2017
Publication date: June 2017

Goncharova K, Filip R, Świeboda P et al. *Model development of hydroxyproline induced hyperoxaluria in young growing pigs*. Eur J Clin Exp Med. 2017;15(1):6–11. doi: 10.15584/ejcem.2017.1.1

Introduction

Kidney stones formation is a known problem worldwide affecting from 5 to 15% of the population. The development of stones has been shown to be a multifactorial process, caused by metabolic and environmental factors.[1] This disease mainly occurs in the 3rd to 5th decade of life. Men suffer three times more often than women. 15% of people who have experienced an episode of renal colic, will sustain another attack within 3 years, and 30–50% in the next 15 years.[2] Patients forming kidney stones are prone to recurrence even after surgical removal. Recurrence rates are close to 50%.[3] There are about 16 types of different minerals that form urinary tract stones. The most common form of stones that occurs in about 70% of cases consist of calcium oxalate.[4] Hyperoxaluria is a major risk factor in calcium oxalate stone disease. This disorder is characterized by an excessive production of oxalate. Oxalate is an end product of metabolism, which normally over 90% is excreted by healthy kidneys. Increased excretion of oxalate in urine may lead to oxalic acid combining with calcium and formation of small crystals and eventually kidney and bladder stones. The conditions of increased excretion of oxalate in urine are defined as a primary and secondary hyperoxaluria. Both are autosomal recessive diseases.

Primary hyperoxalurias (Type I and II) are genetic defects that cause faults in the metabolism of glyoxylate and oxalate. In Primary hyperoxaluria Type I (PHI) alike oxalate acid, glycolic acid is also excreted in excess amount. It's cause is reduced or completely inhibited activity of the liver specific, peroxisomal, pyridoxal phosphate – dependent enzyme alanine: glyoxylate amino transferase. The gene for this enzyme-AGXT is located on chromosome 2q37.3. The second type PH2 is caused by a deficiency of cytosolic enzyme, glyoxylate reductase. In this type oxalic acid and L-glyceric acid are excreted in excessive amounts. Location of the gene for this enzyme-GHPR is on chromosome 9p11. PH1 is the most common form of PH.[5,6]

The western type diet, which has an abundance of animal protein, has been implicated as an increased risk factor for the formation of kidney stones in humans.[7] In rats, oral intake of ethylene glycol or hydroxyproline (HP) increased urinary oxalate. Pigs fed with HP became hyperoxaluric, causing crystalluria, calcium oxalate plaques formation on renal papillae and stones.[7,8] It was also shown that in healthy humans, food enriched with gelatin, a food ingredient that contains HP, caused elevated excretion of urinary oxalate and glycolate.[9]

Objectives

The purpose of this study was to establish a reversible model of hyperoxaluria in young growing pigs as a result of a diet enriched in hydroxyproline. Trans-4-hydroxyproline (HP) used in this study is a physiological precursor of oxalate, proline derivative and a component of collagen. The intention was to develop a model for imitation of human primary hyperoxaluria disease.

Materials and methods

All experimental procedures were approved by the University of Lund Ethics Review Committee on Animal Experiments.

Animals and housing

The experiment was carried out at the research farm of the Department of Agricultural Biosystems and Technology, Swedish University of Agricultural Sciences. Batches of 12 pigs (Large White × Landrace, males) that were 6–12 weeks of age and weight 12.1 ± 1.2 kg at the beginning of experiment, were used in the experiment. The pigs were housed in identical, individual "home - design" metabolic cages. All cages were equipped with perforated flooring, heating lamps and a drinking nipple. For the first 5 days animals were trained and acclimated to metabolic cages.

Model design

All the pigs were fed twice daily (2% body mass per meal) in the morning and in the evening with standard cereal based pellet feed. The adaptation and experimental periods lasted for 40 days. After 5 days of adaptation period, pigs were challenged with hydroxyproline (HP). HP was administered twice a day to pigs as a mixture with feed. HP concentration in the diet was increased during the 7 days of the experiment from 1 to 3% HP. After adjustment, in the next 14 days, 4% of HP was administered in each pigs meal. After 14 days of the 4% HP diet, pigs were divided into 2 groups. For 6 pigs, 4% HP treatment was continued for the next 14 days. This means that this selected group of animals obtained, twice a day, 4% HP during 28 days. The second group of pigs for next 14 days got a standard HP free diet. This means that this group of pigs was kept on 4% HP diet only for 14 days. 24 h drinking water intake was measured during the study. At the end of the study pigs were scarified and internal organs including kidneys, liver and urine bladder were taken for further studies. A general study design and model of hydroxyproline induced hyperoxaluria development in pigs is shown on Figure 1.

Sample collection and analysis

Urine samples. To monitor hyperoxaluria development, 24 h urine samples were collected at the following time points: basal (at the end of adaptation time), the last days on 1% HP and 3% HP, every 2–3 days before randomization, and every 2–3 days during the removal period. 24 hour urine samples were gathered to a pot containing 5-15 mL of

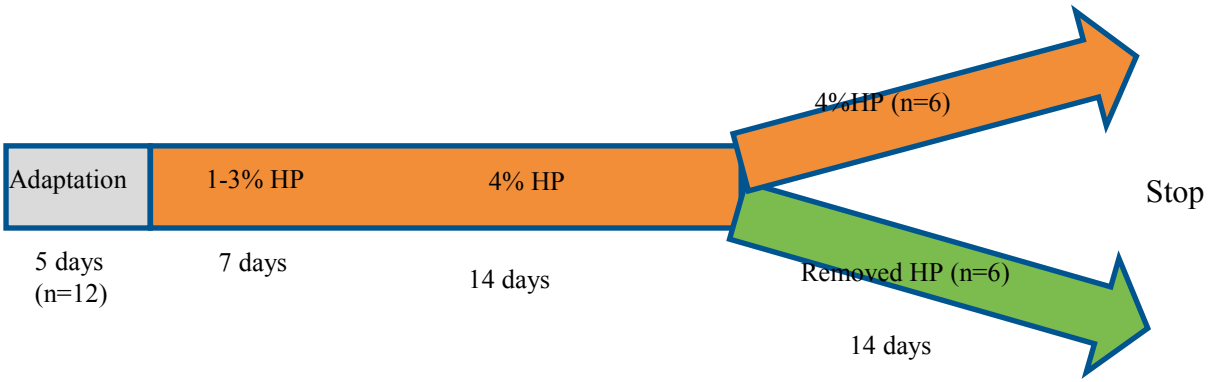

Figure 1. Model development of hydroxyproline induced hyperoxaluria in pigs

6 N HCl to acidify the samples and achieve pH~3 to preserve all oxalate soluble in the urine. Total volume of urine was measured and 3 ml samples were transferred to plastic tubes and stored for further analysis.

Blood samples. 5 ml blood samples were collected at the following time points: on the last day of adaptation to metabolic cages period, first day on 3% HP, every 3–5 days during treatment period. Samples were collected before feeding from the jugular vein. Collected blood samples were placed in vacutainer heparin tubes. After collection, tubes were centrifuged for 15 minutes at 3000 rpm and blood plasma was separated to new tubes. Two 0.5 mL samples were stored at –20°C for further analysis.

Fecal samples. A small fraction of fecal sample was occasionally collected from pigs in the morning for oxalate estimation. Each sample was weighed and stored at -20°C in plastic bags for further analysis.

Estimation of renal function by creatinine clearance measurement

Creatinine clearance is expressed as excretion rate (U_{cr} × V), where U_{cr} presents concentration of creatinine (mg/dL) in V (the 24h urine sample (mL/24h)), divided by plasma creatinine (P_{cr}) (mg/dL). This is represented mathematically as:

$$C_{cr} = \frac{(U_{cr} \times V)}{(P_{cr} \times 24)} = \frac{mL}{h}$$

Collection of organs for histo-pathological analysis and gross examination

Gross analysis. At the end of the experiment, pigs were euthanized with sodium pentobarbiturate (20 mg/kg) and submitted to gross postmortem examination. Kidneys, liver and small and large intestine were gross examined. Kidneys and liver weight was recorded. Both right and left kidney were divided transversely longitudinally, exposing the corticomedullary surface and papillary tips. Gross appearance of the kidneys was recorded and digital images were obtained. After the gross examination, specimens of the kidneys, fixed in 10% formalin, were taken for future histopathology analysis and Yasue specific staining.

Histopathology. Each kidney was cut in 12 serial sections at 4 μm per kidney and stained with hematoxylin and eosin for routine histological examination, or by specific Yasue metal substitution histochemical method to detect the presence of calcium oxalate crystals in the renal tissue.

Statistical Analysis

Statistical analysis was performed on the data generated from this study using the unpaired two-tailed Student's t-test. Differences were considered significant if $p \leq 0.05$, all data are expressed as a mean ± standard deviation (± SD).

Results

Determination of the oxalates concentrations in urine

Hyperoxaluria development was monitored by measurement of changes in urinary oxalate excretion. Presence of oxalates in acidulated urine were determined by the Jaffe method with the help of a commercial oxalate kit from Trinity Biotech. Amount of oxalates was expressed in mg per twenty four hours.

A slow increase of urinary oxalate from basal concentration 3.83 ± 3.0 mg/24h was demonstrated during the HP challenge period. A significant increase was noted after 12 days of treatment with 4% HP when urinary oxalate levels reached 78.15 ± 94.53 mg/24h in the HP(-) and 77.21 ± 78.69 mg/24h in the HP(+) group ($p > 0.05$). During the removal period, oxalate excretion decreased dramatically in the HP(-) group to 19.1 ± 10.48 mg/24h, while in group which continued to be fed with 4% HP (HP(+) group) oxalate excretion increased even more to 116.48 ± 55.34 mg/24h at the end of the experiment ($p > 0.05$). This was significantly higher ($p > 0.05$). The results for oxalate excretion with urine are shown in Figure 2.

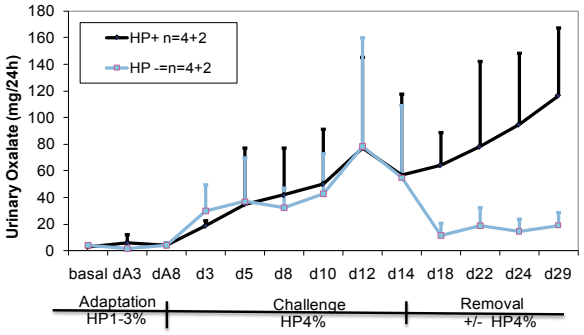

Figure 2. Effect of HP administration on oxalate excretion. In all statistical analysis, $p < 0.05$ was taken as the level of significance

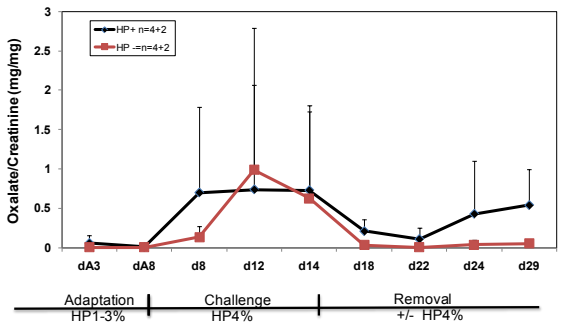

Figure 3. Oxalate /creatinine ratio in urine. In all statistical analysis, $p < 0.05$ was taken as the level of significance

Determination of blood oxalates levels

The presence of plasma oxalates in samples was measured using Trinity Biotech Oxalate reagents (Kit #.591 D Trinity Biotech, Ireland). The amount of oxalates were expressed in mmol /L. The level of plasma oxalates changed with HP challenge. In animals treated with HP for the whole study, the plasma oxalate level changed from 0.026 ± 0.016 mmol/L to 0.059 ± 0.038 mmol/L ($p < 0.05$). In the group without 4% HP in diet during last 2 weeks, the plasma oxalate level changed from 0.027 ± 0.018 mmol/L to 0.033 ± 0.015 mmol/L and was almost 50% lower than in the group treated with 4% HP for 2 weeks ($p < 0.05$).

Oxalate/creatinine ratio

There were differences in this ratio during the experiment between groups. The higher value for Ox/Cr ratio in group treated with 4% HP for 4 weeks is the result of higher oxalate level in urine in that group ($p < 0.05$). Urinary oxalate/creatinine ratio presented on Figure 3.

Creatinine clearance

There were no differences in creatinine clearance between groups during the course of experiment ($p < 0.05$). Creatinine clearance is presented in Figure 4.

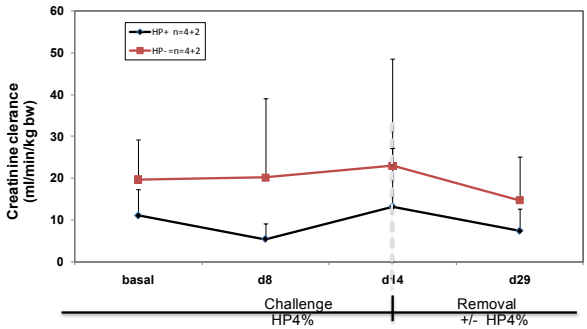

Figure 4. Creatinine clearance. In all statistical analysis, $p < 0.05$ was taken as the level of significance

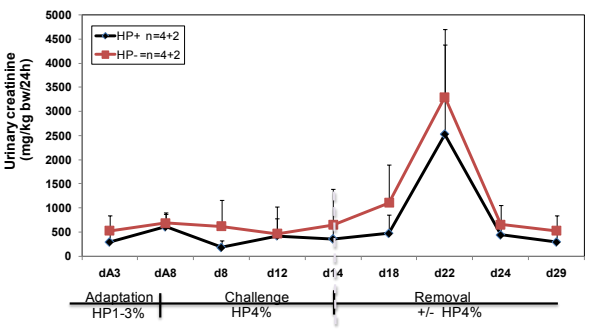

Figure 5. Urinary Creatinine. In all statistical analysis, $p < 0.05$ was taken as the level of significance

Urinary and plasma creatinine

Results for urinary and plasma creatinine is presented in Figure 5 and 6 respectively ($p < 0.05$).

Body weight

Pigs had normal growth and food intake suggesting that the given dose of 4% HP was well tolerated, but was high enough to induced significant and reversible hyperoxaluria without hyperoxalemia ($p < 0.05$). The body weight of pigs during the experiment are shown in Figure 7.

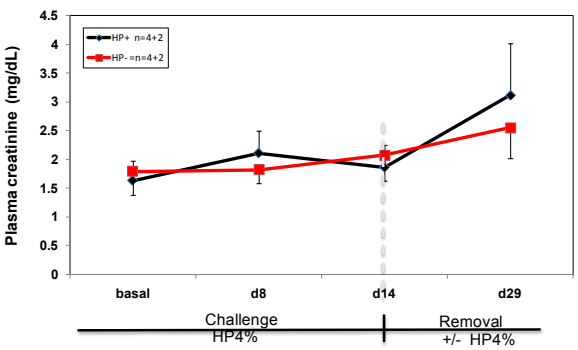

Figure 6. Plasma Creatinine. In all statistical analysis, $p < 0.05$ was taken as the level of significance

Macroscopic examination of the kidney

In pigs which obtained a diet containing 4% HP for 4 weeks, kidneys were found to be fibrotic with enlarged

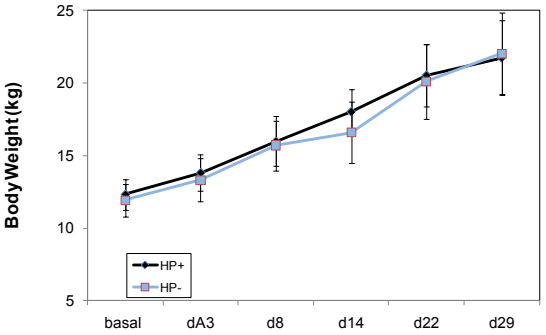

Figure 7. Body Weight changes. In all statistical analysis, $p < 0.05$ was taken as the level of significance

cavities and hemorrhages. Urinary stones were visible with the naked eye. Stone size was varied and ranged from 3 to 4 mm. In all these kidneys, crystalline forms were present. In stone-free kidneys, no crystalline forms were found. Kidneys kept their natural morphological features. Stone-free kidneys were isolated from animals which did not get HP in the last 2 weeks of the experiment.

Discussion

Swine models have proven useful in biomedical research because of the similarities in organ structure and function to humans. It is important to address that at a functional level, human and pigs share many similarities with regard to genitourinary structures. In addition to being multipyramidal structures, human and swine have comparable maximal urinary concentration, glomerular filtration rate and total renal blood flow characteristics. Pig models of hyperoxaluria and calcium oxalate stone disease after feeding with hydroxyproline was describe by others.[8-10] The purpose of this study was to develop a model of hyperoxaluria disease by feeding young growing pigs with 4% HP mixed with regular feed and to determine if hyperoxaluria is reversible if HP is removed from the diet 7–14 days after the start of the study. Dietary hydroxyproline is a precursor of oxalate in the pig model. An increase in urinary oxalate excretion can be achieved with adequate dose of HP in diet.

The data obtained points out that hyperoxaluria caused by uptake of dietary HP can be spontaneously ceased by as yet undescribed mechanisms. Elevated oxalate levels in urine or in blood or presence of HP in the gut switch on natural mechanisms of elimination of oxalate from the body. This probably explains the origin of individual variation of oxalate in urine. The mechanism can be related to specific gut bacteria overgrowth, which utilizes oxalate, or to a natural mechanism of mobilization of Ca from bones to produce salt in the gut. Participation of gut bacteria (e.g. *Oxalobacter*) in these mechanisms is not excluded. Low levels of oxalate (Ox) in the blood reflects low levels of Ox in the gut and consequently low numbers of bacteria utilizing oxalate as a substrate. Enhanced levels of oxalate in blood affect gut levels. Elevated levels of Ox in gut provokes the corresponding oxalate dependent bacteria to grow and utilize oxalate; this can eliminate Ox from blood and, in consequence, from urine.[11,12]

Enhanced absorption of oxalate can result in urolithiasis, nephrocalcinosis, metabolic acidosis, hematuria, pyelonephritis, hydronephrosis, and renal failure. In primary hyperoxaluria, there is a systemic deposition of calcium oxalate in almost all body tissues including kidneys, heart, bone, cartilage, teeth, vasculature, and brain.[8,7,13]

In the most popular model, ethylene glycol, a precursor of oxalate, is given to animals specially rodents in their drinking water. Ethylene glycol consumption causes development of hyperoxaluria, leads to crystalluria and CaOx crystal deposition in the kidneys. Mandel et al., observed that feeding pigs with 10% HP induced hyperoxaluria, which reached a maximum at day 6 and leveled off until the end of the study despite further increases in HP in the diet to 20%. Addition of such high HP doses results in hyperoxaluria, CaOx crystalluria, nephrolithiasis, metabolic acidosis, and may lead to multiorgan injuries. Additionally, crystalline calcium phosphate deposition in kidneys and ureters leads to hypercalciuria. Modification of the diet by high dosing of HP causes appetite loss resulting in lowering the weight gain, and may also interfere the water intake and urine excretion.[14,15] Such disorders may have an impact on the results of the studies. Mild reversible hyperoxaluria has important implications since it presents a model that can be used for testing future therapies. Also mild hyperoxaluria will not switch mechanisms of oxalate elimination. Taking into account potential complications of more toxic responses seen with agents such as ethylene glycol and high doses of HP, we induced mild hyperoxaluria by administrating a diet enriched with 4% HP. One group of 6 pigs administrated with a 4% HP diet for 2 weeks and the other cohort of 6 pigs continued on a diet supplemented with 4% HP for next 2 weeks. Our intention was to develop a model of hyperoxaluria disease by feeding young growing pigs with 4% HP mixed with regular feed and to determine if hyperoxaluria is reversible when HP is removed from the diet 14 days after treating with 4% HP.

We reported that administration of a diet enriched with 4% hydroxyproline to growing pigs induces reversible hyperoxaluria and promotes formation of CaOx crystal deposits and morphological changes in the pigs kidneys. Our study shows that supplementation with 4% HP did not affect the weight gain, water and feed intake, urine excretion or creatinine clearance. It has significant meaning, when taking under consideration overall condition of animals.

Conclusion

Proposed porcine models of reversible hyperoxaluria show that in animals after 2 weeks of HP administration, urine oxalate level return normal when pigs are not treated with HP for next 2 weeks. Longer exposure of animals on HP treatment lasting 4 weeks caused elevated hyperoxaluria and manifestation of morphological lesions on kidneys with crystals, sand and stone formation. Normal growth of pigs suggests that the given dose of 4% HP was well tolerated, but was high enough to induced significant and reversible hyperoxaluria. This presented model mimics oxalate urolitiasis in man and can be used for testing of different medical substances preventing stone formation in kidneys. This model is attractive because of its reversibility.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.2

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 12–17

ORIGINAL PAPER

Grzegorz Kucaba [(DEFG)], Katarzyna Bebło [(C)], Marek Wojtaszek [(ADG)], Dawid Filip [(BG)], Marek Muster [(BG)], Maciej Naróg [(BD)], Andrzej Włodyka [(C)]

Evaluation of farmers' first aid knowledge in most common injuries at work in agriculture – a pilot study

Chair of Medical Rescue, Medical Faculty, University of Rzeszów, Poland

ABSTRACT

Introduction. According to the International Labour Organisation (ILO), agriculture is one of the most dangerous industries. The rate of fatal accidents in agriculture is about twice the average for other sectors.

Aim. The aim of this study was to evaluate the level of knowledge of first aid concerning the most common injuries that occur in agricultural work. The analysis of the types of injuries during work in agriculture and their incidence among Polish farmers in the years 2013–2014 made it possible to define the most common types of injuries and their causes for the selected professional group and to draw up a survey for the farmers in order to achieve the main research goal.

Material and methods. The study was conducted in two stages. At first, data from KRUS – Kasa Rolniczego Ubezpieczenia Społecznego (the Polish Agricultural Social Insurance Fund) was analyzed with reference to the incidence and the type of injuries that occurred in agriculture in 2013 and 2014. Then research was carried out by means of a survey based on the data obtained in the first stage. The study was preliminary and it was carried out on a sample of 51 persons.

Results. The most common cause of the 41,702 incidents qualified by the Agricultural Social Insurance Fund as an accident in agriculture in Poland in the years 2013 and 2014 was a fall from heights. Every fourth respondent had witnessed or had been directly involved in an accident in agriculture. Despite the fact that everyone declared familiarity with the principles of first aid, over a half of the respondents had never given it.

Conclusion. All of the respondents declared having knowledge of the principles of first aid, however, research shows that their knowledge is incomplete and not consolidated. Due to the fact that there are few reports on the research topic, it seems advisable to continue it in a larger study group. With reference to pesticide use, despite having knowledge of the hazard of intoxication by organophosphate compounds, a majority of farmers included in the study did not use any personal protective equipment.

Keywords. injuries at work in agriculture, trauma, first aid

Corresponding author: Grzegorz Kucaba, ul. Pigonia 6, 35-310 Rzeszów, Tel. 017 872-11-95, e-mail: gkucaba@ur.edu.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 23.03.2016 | Accepted: 20.02.2017
Publication date: June 2017

Kucaba G, Bebło K, Wojtaszek M et al. *Evaluation of farmers' first aid knowledge in most common injuries at work in agriculture – a pilot study*. Eur J Clin Exp Med. 2017;15(1):12–17. doi: 10.15584/ejcem.2017.1.2

Introduction

Injuries are an integral part of human life at any age. They are distinguished primarily depending on their location and mechanism. Most often they cause wounds, amputations and frequently lead to death. It is for the treatment of the effects of injuries that substantial resources are allocated all around the world. In the United States, these injuries constitute the fourth leading cause of death among all age groups, and at the same time the most common cause of death among children and adults up to 44 years of age. About one third of injuries are incidents involving agricultural machinery. In the UK around 2,500 people die annually as a result of injuries. In Poland there are about 3.5 million injuries a year, and 300,000 victims require specialist treatment.[1]

According to the International Labour Organisation (ILO), agriculture is one of the most hazardous industries. Along with mining and construction, it is ranked as one of the three most dangerous sectors. In many countries including Poland, the rate of fatal accidents in agriculture is about twice the average for other sectors.[2] Pursuant to Article 11, section 1 of the Law on farmers' social insurance, an accident at work in agriculture is defined as a sudden event caused by external circumstances which occurs during the course of work related to conducting agricultural activities or in connection with performance of these activities. This incident must occur on the premises of the farm run by the insured or where they perform their duties on a permanent basis, or in the household directly connected with this farm. In addition, an accident at work in agriculture is defined as an event which takes place during the journey from the place of residence to the farm, or on the way back, as well as while performing routine jobs related to conducting agricultural activity outside its premises, or related to these activities.[3]

Aim of the study

The aim of this study was to evaluate the level of first aid knowledge among farmers from the county of Tarnobrzeg concerning the most frequent injuries at agricultural work based on the analysis of incidence and the types of injuries that occurred at agricultural work in the years 2013-2014 in Poland.

Material and methods

This pilot study and was carried out in two stages. In the first stage, data developed by Kasa Rolniczego Ubezpieczenia Społecznego (KRUS), the Polish Agricultural Social Insurance Fund was gathered and placed on the website: http://www.krus.gov.pl. For this purpose a scientific research protocol was drawn up to provide for standardized collection and analysis of retrospective data. At this stage, 45,313 incidents registered by the Agricultural Social Insurance Fund were analyzed as incidents at agricultural work in the years 2013 and 2014. The analysis was made in terms of the most common causes, the number of reported incidents, as well as the number of incidents, including fatalities, qualified by the Agricultural Social Insurance Fund as an accident at agricultural work within the guidelines of the Law on Farmers' Social Insurance. With relation to the main causes of accidents at work, the analysis was made based on the accepted criteria, including such incidents as 'being hit, crashed, bitten by animals', 'falling objects', 'being caught in or hit by moving parts of machines and devices', 'falling from heights', and 'other'. In the category referred to as 'other', no detailed descriptions of incidents falling into this category were found, thus it was omitted in the construction of the survey questions. It should be emphasized that the classification published by the Agricultural Social Insurance Fund refers only to incidents in which the victims were granted a one-off compensation. On the basis of this data, figures and percentages of the discussed problem were presented.

The study covered 35 women and 16 men; the youngest person was 18, the oldest 56. Most respondents (36 persons) lived in rural areas. The place of residence for a quarter of respondents (13 persons) was a city with up to 10 thousand residents, while for 2 persons it was a city with over 10 thousand residents. Participation in the study was anonymous and voluntary, and the respondents were informed that the results obtained would be used for research purposes only. Criteria for inclusion in the study were to work in agriculture and live in the area of the county of Tarnobrzeg. Studies of figures and graphs were performed using Excel Microsoft Office 2007®.

The study was conducted through a survey of own design, prepared on the basis of data collected from reports published by the Agricultural Social Insurance Fund. The survey comprised 15 questions, of which 6 were related to demographic and social data such as sex, age, education level, place of residence, occupation and number of years of work on the farm. The next 3 questions were formulated on the basis of information contained in the reports published by the Agricultural Social Insurance Fund. They concerned subjective assessment of the most common causes of accidents at agricultural work, whether the respondents had witnessed an accident at agricultural work and whether they knew the principles of giving first aid. Another set of questions made it possible to determine the level of respondents' knowledge on how to deal with victims of the most common injuries that occur as a result of accidents at agricultural work. These questions concerned knowledge of the steps to take in the case of cervical spine injuries, limb fractures, hemorrhages, traumatic amputation, foreign bodies in the wound, the use of plant protection products and the risk of poisoning. For each question, multiple choice answers were given, from which respondents could choose only one, according to their current knowledge.

Results

Based on the analysis of statistics published by the Agricultural Social Insurance Fund, it has been shown that in 2013 and 2014 a total of 45,313 incidents were reported as accidents at agricultural work. Out of these, 41,702 reported cases were qualified as accidents at agricultural work within the guidelines of the Law on Farmers' Social Insurance. In 2013, 21,093 out of 23,374 registered incidents were qualified as accidents at work in agriculture, of which 15,806 were granted compensation.[4] However, in 2014 out of 21,393 reported incidents, 20,609 cases were qualified as accidents at agricultural work, and compensation was given to 15,649 people.[5] Both in 2013 and in 2014, out of all reported accidents, 77 were fatal each year, accounting for 0.36% in 2013 and 0.37% in 2014 of all accidents. This data is presented in Table 1.

In the discussed period, the largest number of accidents occurred in the Lubelskie Voivodeship: 2,145 in 2013 and 2,251 in 2014. The fewest accidents were in the Opolskie Voivodeship: 189 events each year, both in 2013 and in 2014. Information on the number of accidents in agriculture in the years 2013–2014 from each voivodeship is given in Table 2.

Among the causes of accidents at agricultural work the following categories were distinguished: being hit, crashed, bitten by animals, falling objects, being caught in or hit by moving parts of machines and devices, as well as a fall from heights. The latter amounted to as many as 8,281 incidents in 2013 and 7,674 in 2014. Another most common cause of accidents in agriculture was being caught in or hit by moving parts of machines and equipment, which accounted for 1,863 of the total number of accidents in 2013 and 2,047 in 2014. Being hit, crashed, bitten by animals accounted for 1,807 accidents in 2013 and 1,876 accidents in 2014. Accidents caused by falling objects were the least common – and occurred 1,266 times in 2013 and 1,320 times in 2014. All of the above incidents were the cause of the total of 13,217 cases in 2013 and 13,917 cases in 2014. Causes referred to as 'other' accounted for 2,589 incidents in 2013 and 2,732 in 2014.[4, 5] This data is presented in Table 3.

Out of 51 people who took part in the survey 29 were aged 18–25 years, 9 were aged 26-35 years and 7 persons were 36–45 years old. The smallest group was made up of persons over 46 years of age – 6 people. In the studied group there were more people with secondary education

Table 1. Accidents at agricultural work in the years 2013 and 2014 in Poland [4,5]

Accidents at agricultural work	2013	2014
number of incidents reported in the reporting period as accidents at agricultural work	23,374	21,393
number of events qualified as accidents at agricultural work in the reporting period	21,093	20,609
number of decisions with granted compensation	15,806	15,649
Including		
fatal	77	77
number of denied decisions	7,825	7,352

Table 2. Number of accidents in particular voivodeships in 2013 and 2014 in Poland [4,5]

Voivodeship	Number of accidents			
	2013		2014	
	Total	Including Fatal	Total	Including Fatal
TOTAL	**15,806**	**77**	**15,649**	**77**
Dolnośląskie	561	1	504	0
Kujawsko-pomorskie	1,003	3	1,002	5
Lubelskie	2,145	9	2,251	15
Lubuskie	193	0	219	0
Łódzkie	1,459	8	1,357	6
Małopolskie	1,307	7	1,180	9
Mazowieckie	2,058	11	2,049	12
Opolskie	189	0	189	2
Podkarpackie	1,127	4	1,067	4
Podlaskie	1,308	5	1,230	2
Pomorskie	616	5	568	2
Śląskie	316	4	284	0
Świętokrzyskie	790	7	836	2
Warmińsko-mazurskie	774	5	775	2
Wielkopolskie	1,720	7	1,907	9
Zachodniopomorskie	240	1	231	1

Table 3. Number and type of accidents at agricultural work in 2013 and 2014 in Poland

Voivodeship	Fall from heights		Falling objects		Being caught in, hit by parts of machines and devices		Being hit, crashed, bitten by animals		Other	
	Year									
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
TOTAL	**8,281**	**7,674**	**1,266**	**1,320**	**1,863**	**2,047**	**1,807**	**1,876**	**2,589**	**273**
Dolnośląskie	305	256	68	51	71	57	32	33	86	107
Kujawsko-pomorskie	484	481	67	77	119	95	139	152	194	197
Lubelskie	1,203	1,142	171	202	228	294	162	176	381	437
Lubuskie	106	115	18	24	20	26	18	27	31	27
Łódzkie	767	696	135	115	190	192	164	163	203	191
Małopolskie	766	645	91	98	175	181	93	81	182	175
Mazowieckie	1,068	987	145	148	267	287	283	289	295	338
Opolskie	63	75	22	19	39	27	20	21	45	47
Podkarpackie	681	590	76	72	125	149	50	44	195	212
Podlaskie	578	500	101	77	140	151	235	265	254	237
Pomorskie	313	274	39	45	75	68	75	76	114	105
Śląskie	165	122	25	21	33	50	40	36	53	55
Świętokrzyskie	455	447	44	81	98	108	76	74	117	126
Warmińsko-mazurskie	355	344	72	59	70	69	129	146	148	157
Wielkopolskie	854	889	174	207	175	251	268	279	249	281
Zachodniopomorskie	118	111	18	24	38	42	23	14	43	40

(23 people), slightly fewer (18 people) with primary education, 8 people with higher education and 2 people who had basic vocational education. Most of the respondents (27 people), in addition to working in agriculture, continued their education and were enrolled as pupils or students. The rest were blue-collar workers – 15 respondents, or white-collar workers – 8 people, and 1 person was retired. Most respondents (27 people) had been working in agriculture for less than 5 years. The second group of 7 people were persons who had been working in agriculture for 5–10 years. The third group consisting of five people were persons who had been working in agriculture for more than 15 years. Only one person had been active in agricultural work for 10–15 years.

In order to compare the data published by the Agricultural Social Insurance Fund concerning the most common agricultural accidents with the opinions of respondents, the participants of the study were asked what type of incidents they believed occurred most frequently in their work environment. According to 21 people, the most common cause of accidents was 'being caught in and and hit by moving parts of machines.' At the same time, 36 out of 51 respondents had never witnessed any accident that would occur due to the operation of farm machinery, whereas 15 people were witnesses to such incidents. Another most common cause of accidents in agriculture mentioned by respondents was 'contact with sharp handheld tools and other sharp objects.' This answer was given by 17 people. The third reason, mentioned by 7 people, was 'being hit, crashed, bitten by animals', where a vast majority of study participants, i.e. 41 people, had livestock. A 'fall from heights' was the fourth leading cause of injury mentioned by 5 people, while 1 person considered 'falling objects' to be the most common cause of accidents in agriculture. All of the respondents gave a positive answer to the question concerning knowledge of first aid.

A further part of the survey referred to management of various types of injuries according to the principles of first aid. Respondents were asked about the easiest way to immobilize cervical spine, through a choice of five answers: with own hands or knees, using the Kendrick Extrication Device (K.E.D.), cervical collar, and spinal board. 28 out of 51 people, answered that they would use a cervical collar for immobilization in a suspected cervical spine injury. Only 17 respondents indicated a correct answer, i.e. immobilization of cervical spine with one's hands or knees. According to 4 people, most preferable would be the use of orthopedic boards, whereas two people chose K.E.D. In the opinion of 46 study participants, their knowledge concerning immobilization of a fractured lower or upper limb in the position in which they found the victim after an accident was good. Only 5 people did not know how to immobilize a fractured limb. As the easiest way to stop the bleeding 17 people chose direct pressure on the wound. Another 28 people said they would apply a pressure dressing. According to 4 persons, a tourniquet should be put, one person would apply pressure above the bleeding site and also one per-

son would apply pressure below the bleeding site. With reference to the use of a tourniquet – 26 of all respondents gave a correct answer, i.e. application on the shoulder for upper limb amputation, or on the thigh for lower limb amputation. Another 17 people said the tourniquet should be placed about 10 cm above the bleeding site, 5 persons would put it about 15 cm above the site of bleeding, and 3 people stated that the place of application did not matter. To the question about procedure in the case of an embedded foreign body in the wound (here a knife stabbed into lower leg), 32 people answered they would stabilize the stabbed object, 12 people would remove the knife and dress the wound, and 7 persons did not know what to do in such a situation. With reference to the question on traumatic amputation, 33 respondents answered that they knew what traumatic amputation was, out of whom 17 knew how to protect the amputated part and the stump (they would apply a tourniquet). There was no data in any of the analyzed Agricultural Farmers' Social Insurance reports concerning accidents related to the use of plant protection products, which are used at almost every farm in larger or smaller amounts. Thirty-one people confirmed this fact in the question concerning contact with plant protection products while working in the field. Out of these, 14 people did not use any personal protective equipment. In the studied group, 28 people enumerated excessive sweating, headache, salivation, and watery eyes as first symptoms of pesticide poisoning. According to 16 respondents, the main symptoms of poisoning with plant protection products are muscle tremors, numbness in the limbs, excessive sweating and dizziness. According to 5 people, the first signs are a mild headache connected with a sensation of tension, and visible widening of blood vessels, whereas according to 2 people, the signs of such poisoning are color vision disturbance with reduced sensitivity to red, and tooth loss.

Discussion

The aim of the survey was to present the extent and types of agricultural injuries and assess the level of farmers' knowledge concerning familiarity with and ability to give first aid to victims of the most common injuries that occur in their work environment. Some of the preliminary results of this research coincide with reports of other authors who obtained comparable results in similar studies carried out in developing countries.

It has been observed that compared to 2013, in 2014 there was a drop by 1,981 (6.1%) incidents reported as accidents at agricultural work. The number of incidents qualified by the Agricultural Farmers' Social Insurance as an accident at work in agriculture also went down in relation to 2013, but only by 484 incidents. In 2014 there was an observed decrease by 3.4% in the causes of accidents in agriculture, defined as a 'fall from heights', along with an increase in other causes, from 0.4% in the case of incidents defined as 'falling objects' to 1.3% in the case of 'being caught in or hit by moving parts of machines and devices.' Similar results were obtained in a study by Fleszar, Chojnacki and Sławinski, who compared accidents in agriculture in 2005 and in 2010-2013, and found that there was a significant improvement in safety in 2013 compared to 2005, observed in the reduction in the number of accidents by some 2.7% per year. This study also shows that in 2010-2013 there was a slowdown in the reduction in the number of accidents to 1.75% annually.[6]

The number of fatal accidents in 2013 and in 2014 was the same, i.e. 77 cases each year. Research conducted in 2012 by the Canadian Agricultural Injury Reporting (CAIR) shows that between 1990 and 2008 as many as 1,975 people were killed as a result of accidents at agricultural work in Canada, which averaged to 104 people per year.[7] Stawicki, Grieger and Sedlak in their work: 'Analysis of the risk of accidents arising from the operation and use of machinery and equipment' point out that despite the fact that agricultural machinery and equipment rank third among the main causes of accidents at agricultural work, for the victims they were the cause of 54% of all fatal accidents in 2012, whereas in 2014, agricultural machinery and equipment contributed to 27% of all fatal accidents.[8]

Our research shows that there is a large discrepancy between the data presented by the Agricultural Farmers' Social Insurance and the assessment of study participants concerning the most common causes of accidents. In the studied group, the most common cause of accidents in agriculture was 'contact with sharp hand-held tools and other sharp objects', however, according to information published by the Agricultural Farmers' Social Insurance, the most frequent cause of accidents in agriculture is a 'fall from heights'. In a similar study by Molineri, Signorini and Tarabla, carried out in 78 farmers in the province of Santa Fe in Argentina, the most common cause of accidents at agricultural work were wounds and bruises caused by objects (39.7%), the second a fall from heights (26.4%), while in the study conducted in Finland by Taattola, Rautiainen, Karttunen et al., and published in 2012, falling and slipping were the most common mechanisms leading to accidents at agricultural work.[9,10]

In the studied group, more than a half, i.e. 36 persons had never witnessed an accident at work in agriculture, which is consistent with the results of research by Dąbrowska, which showed that only one in four respondents (26%) witnessed or participated in a serious accident in agriculture.[11]

First aid, as defined in the Law on State Emergency Medical Services, is a set of actions that can be taken to rescue a person in an emergency. They should be taken by any person present at the scene, including the use of medical devices and medicinal products obtained without prescription, which was confirmed by all respondents.[12]

The outcome is satisfactory, compared with the results of research by Semwal, Juyal, Singh and Kandpal, which showed that knowledge of first aid was declared only by 25.6% of respondents.[13]

Further results of our study indicate that subjective assessment of knowledge on the principles of first aid is not fully consistent with respondents' actual knowledge. For example, in the case of suspected cervical spine injury more than half of the respondents would use a cervical collar to immobilize the victim, which can only be performed by qualified paramedics. Similarly in the case of bleeding, where 26 people would first apply a pressure dressing instead of direct wound compression, which would only be applied by one-third of the respondents. Also, concern remains for the fact that 14 out of 31 people using plant protection chemicals at agricultural work did not use any personal protective equipment. Similar results were obtained by Salemach, Baldi, Brochard, Abi Saleh, who proved that more than 50% of respondents did not apply, or applied inappropriate personal protective equipment while using plant protection products.[14] Remaining satisfactory is the fact that 42 persons out of all respondents could tell the main symptoms of poisoning by plant protection products. In her research based on data from the National Institute of Hygiene, Matyjaszczyk showed that since 2004 in Poland the number of cases of poisoning with plant protection products has been around 100 people per year, whereas fatalities amounted to 8. It is worth noting that the data may be incomplete. However, data from the Agricultural Farmers' Social Insurance reports concerning accidents involving plant protection products shows that they are not classified separately, as is the case with other causes of accidents, which makes it difficult to analyze this type of occurrences. They should be put together with other incidents involving chemical substances as 'accidents resulting from impact of harmful materials'.[15]

Results

1. There was no change in the number of fatal accidents at agricultural work in the years 2013-2014.
2. A large discrepancy has been shown to exist between what the study participants identified as the most common causes of accidents at agricultural work and the data presented by the Agricultural Farmers' Social Insurance.
3. All of the study subjects declared that they knew what first aid was and that they would be able to accurately present its scope.
4. Knowledge of first aid among farmers is incomplete and not consolidated.
5. Some respondents did not use personal protective equipment during the use of plant protection products, despite having knowledge on organophosphate compounds poisoning.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.3

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 18–23

ORIGINAL PAPER

Konrad Klekot [1(ABCDFG)], Barbara Zubelewicz-Szkodzińska [2(ADF)]

Bioactive food components in the diet of patients diagnosed with cancer

[1] Institute of Nursing and Health Sciences, Faculty of Medicine, University of Rzeszow
[2] Department of Nutrition-Related Disease Prevention, School of Public Health in Bytom, Medical University of Silesia in Katowice, Poland

ABSTRACT

Introduction. Cancer, after cardiovascular disease, is the second most common cause of death both in Poland and Europe, so it is important to investigate and search for dietary components with anti-cancer properties. Components which can modulate different stages of carcinogenesis through epigenetic process are called bioactive food components.

Aim. The aim of this study was to evaluate nutritional habits of patients diagnosed with cancer in terms of level of bioactive food components consumption.

Material and methods. A group of 123 patients diagnosed with cancer were enrolled the study. The study was conducted by means of an anonymous questionnaire on diet history prepared by the authors. Statistical analysis was performed using IBM SPSS software, statistical significance was adopted at the level of $p < 0.05$.

Results. Based on the results of the questionnaires, major risk factors that increase the prevalence of cancer disease were age (above 55 years) and increased BMI (the score indicated overweight or obesity). Additionally, it was observed that cancer diagnosis resulted in change of eating habits in approx. 61.8% of the participants. Enrolled patients mostly consumed inadequate amounts of green vegetables, legumes, green tea and whole grains before the diagnosis. Moreover, patients with breast and colorectal cancer were found to be more likely to consume more red meat in comparison to others.

– Both non-modifiable factors: age and modifiable ones: body weight and lifestyle influence morbidity.

– Most participants ate incorrectly before cancer diagnosis; diagnosis of the disease changed their eating habits.

Key words. cancer, bioactive food components, diet, nutrigenomics, epigenetics

Corresponding author: Konrad Klekot, Faculty of Medicine, University of Rzeszów, al. mjr. W. Kopisto 2 a, 35-310 Rzeszów, Polnad, tel. 601 884 116, e-mail: konrad.klekot@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 30.12.2016 | Accepted: 14.03.2017
Publication date: June 2017

Klekot K, Zubelewicz-Szkodzińska B. *Bioactive food components in the diet of patients diagnosed with cancer*. Eur J Clin Exp Med. 2017;15 (1):18–23. doi: 10.15584/ejcem.2017.1.3

Introduction

Cancer, after cardiovascular disease, is the second most common cause of death both in Poland and Europe. According to the estimates of the European database – Health for All, cancer morbidity and mortality amount to 379 cases and 168 deaths per 100,000 people respectively.[1] In the coming years they are predicted to become the leading cause of death before the age of 65 in women and men.[2]

Recent scientific findings suggest that improper diet and lack of regular physical activity may contribute to 30-40% of diagnoses, therefore, apart from promotion of an active way of spending free time, dietary components that have anti-cancer properties are searched.[3,4] Food components that can affect the individual stages of carcinogenesis are referred to as bioactive food components. The best-known bioactive food components with potential anti-cancer properties include: isothiocyanates contained in cruciferous vegetables, diallyl disulfide derived from allium vegetables, catechins found in green tea, soy isoflavones, and certain vitamins and minerals.[5,6] It is believed that bioactive food components can prevent the onset of cancer by overlapping mechanisms of action such as oxygen free radical scavenging, inhibition of cellular proliferation, expression of oncogens and induction of suppressor gene expression, regulation of gene expression, cell cycle and induction of apoptosis, modulation of detoxifying enzymes, stimulation of immune system, regulation of hormone metabolism, angiogenesis, and antiviral, and antimicrobial activity.[7] A recent review claims that their protective action may be related to epigenetic modifications, i.e. changes in the genes functioning that are not accompanied by changes in the DNA sequence itself. Major mammalian epigenetic control mechanisms include DNA methylation, histone protein modifications, and RNA interference (RNAi).[8]

DNA methylation involves the addition of methyl groups to the nitrogen-containing base of nucleotides most often in position 5 of cytosine, which is possible thanks to specialized enzymes – DNA methyltransferases (DNMT). This process plays an important role in regulation of gene expression, since methylation in the promoter area (mainly CpG dinucleotides) prevents the attachment of transcriptional proteins, but also other transcription machinery components.[9,10]

Another control mechanism is histone modification, connected with post-translational changes of amino acid residues of histones, which are the alkaline proteins belonging to the nucleoprotein complex called chromatin. In the construction of histones such features can be distinguished as: the globular domain, C-carboxylic and N-amino acids end groups, which may be subject to various post-translational modifications e.g. methylation, acetylation, and phosphorylation. Such changes contribute to the formation of transcriptionally inactive heterochromatin or active euchromatin. Thanks to precise regulation, it is possible to inhibit and activate certain fragments of DNA. The best known post-translational histone modifications include acetylation carried out by histone acetyltransferase (HAT) with acetyl-CoA. As a result, the interaction of histone proteins with DNA is impaired and DNA groove becomes uncovered. Proteins that enable access of the transcription device can attach to the groove. The reverse process - deacetylation of histones is caused by histone deacetylase (HDAC) and leads to chromatin condensation and prevents the transcription device from functioning.[11]

The last least understood process is RNA interference (RNAi) in which small double-stranded RNA molecules (dsRNA) can initiate post-transcriptional gene inactivation. One type of small RNA molecule is the microRNA (miRNA). Scientific studies have demonstrated that mutations and disorders of miRNA expression occur in some cancers in humans, therefore, more and more attention is paid to them in the pathogenesis of neoplasms.[12,13]

In 2004, the complete human genome sequence was published. This discovery contributed to the development of nutrigenomics – a field of science exploring the influence of individual food components on regulation of gene expression. This regulation takes place by means of the epigenetic modifications described above, in which bioactive food components are involved.[14] Currently, they are believed to play an important role in the prevention and treatment of cancer.

Aim of the study

The aim of this study was to evaluate nutritional habits of patients diagnosed with cancer in terms of bioactive food components consumption. In order to meet this goal, the relationship between the frequency of consumption of products rich in bioactive food components and the Body Mass Index (BMI) (according to WHO, World Health Organization), sex, age and diagnosed cancer were also assessed. The questionnaire on dietary history was designed to assess the nutritional habits of patients before cancer diagnosis. In addition, the study attempted to assess the impact of cancer diagnosis on the change in eating habits.

Material and methods

123 patients (98 women and 25 men) who were diagnosed with cancer in the last 12 months were enrolled in the study. Questionnaires were collected in the Silesian Province (University Center for Ophthalmology and Oncology in Katowice, Starkiewicz Specialist Hospital in Dąbrowa Górnicza - Zagłębie Center of Oncology) and Podkarpackie Province (Markiewicz Podkarpackie Oncology Center in Brzozów). The inclusion criteria were as follows: cancer diagnosed in the last 12 months, clinical status allowing to complete the questionnaire, sufficient patient memory in terms of eating habits before cancer

diagnosis, and patient's informed consent to participate in the study.

The study was conducted using the anonymous dietary history questionnaire prepared by the authors, which contained 26 closed questions about the frequency and amount of bioactive food components consumed prior to cancer diagnosis. The questionnaire was validated prior to a proper survey.

For the purpose of this paper, the following tests: V Kramera (tables 2x3, 4x5, etc.), Phi (2x2 tables) were used for the questions on nominal scales to verify the hypotheses. In case of questions in measurement scales, Tb - Kendall or Tc - Kendall tests were used – the first one for tables 2x2, the second one 2x3, 4x5, etc. In case the crosstab consisted of the nominal and order scale, statistics were read at the lower level.[15] All measures of relationship strength were normalized in order to be represented by the values in the range of 0–1, therefore, 0–0.29 was a weak relationship, 0.30–0.49 – a moderate relationship, 0.5–1 – a strong relationship respectively.[16] Statistical analysis was performed using the SPSS software and relationships were assumed statistically significant when $p < 0.05$.

Results

The age structure of the examined patients indicated that 90% of them were above the age of 55, while the patients aged 55 to 64 accounted for 50% of all respondents.

Exceeded norm of BMI was found in 67.5% of the studied patients. BMI score in 41.5% of the subjects indicated overweight and in 26% obesity. Statistical analysis showed no statistically significant difference ($p = 0.09$) between sexes (male, female) and BMI (underweight, normal weight, overweight, obesity), and no statistically significant difference ($p = 0.37$) between the type of diagnosed cancer (breast cancer, colorectal cancer, other cancer) and BMI score (Table1).

More than a half of the respondents (51%) were diagnosed with breast cancer, while the second most commonly diagnosed cancer in the group of the respondents was colorectal cancer (24%). Lung cancer (6%), pancreatic cancer (5%) and cancer of other organs (14%) were much less frequent.

Diagnosis of cancer disease affected dietary habits in 61.8% of the patients, however, statistical analysis showed no statistically significant difference ($p = 0.24$) between sex and the influence of cancer diagnosis on changes in eating habits (Table 2).

At the next stage of the study, the frequency of consumption of individual products rich in bioactive food components was analyzed. There was a correlation between the consumption of cauliflower ($p = 0.007$), cabbage ($p = 0.03$), onion ($p = 0.01$) and BMI. The obese consumed these vegetables before diagnosing the cancer more often than the rest. There was no statistically significant relationship between the frequency

Table 1. BMI score in the group of men and women

			Sex		Total
			Female	Male	
BMI	Underweight	N	1	2	3
		%	1.0%	8.0%	2.4%
	Normal weight	N	27	10	37
		%	27.6%	40.0%	30.1%
	Overweight	N	42	9	51
		%	42.9%	36.0%	41.5%
	Obesity	N	28	4	32
		%	28.6%	16.0%	26.0%
Total		N	98	25	123
		%	100.0%	100.0%	100. 0%
		p = 0.09			

Table 2. The influence of cancer diagnosis on the change of eating habits with respect to the sex

			Sex		Total
			Female	Female	
Did the diagnosis of the disease affect the change in eating habits?	YES	N	58	18	76
		%	59.2%	72.0%	61.8%
	NO	N	40	7	47
		%	40.8%	28.0%	38.2%
Total		N	98	25	123
		%	100.0%	100.0%	100.0%
		p = 0.24			

of consumption of individual products and the diagnosis of cancer.

Statistical analysis showed that among the respondents, women were more likely to eat healthy products before diagnosis of the disease than men ($p = 0.009$). These products included brassica, alliaceous, legumes vegetables, green tea and whole meal products.

In addition, it was found that 46% of the respondents never or very seldom consumed green tea. Of all patients, only 15% declared drinking it at least once a day.

A half of the respondents (50%) declared red wine consumption several times a month, while 5% consumed it several times a week. Among the patients who consumed red wine, the majority (71%) consumed one glass (150 ml).

Products containing the bioactive components which were most commonly consumed by the patients before the diagnosis of the disease include cabbage, onion, garlic and leek. At least once a week the cabbage was eaten by 53%; onions 77%; garlic 56%; 49% and cauliflower 34%.

Vegetables such as spinach, broccoli and legumes were less popular: 14, 27 and 20% of the respondents respectively ate them at least once a week. Kale and asparagus were the least frequently consumed, as they were absent from the diet, of 88% and 72% of the patients respectively.

Discussion

It is believed that one of the non-modifiable factors increasing the risk of cancer is age. Data from Cancer Research UK - one of the world's largest organizations advocating cancer research and awareness suggests that in the United Kingdom between 2010 and 2012, an average of 80% of breast cancer cases were diagnosed in women over 50 years of age, with about one in four diagnosed in the UK after the age of 75. According to statistics on colorectal cancer of the same organization in 2010–2012, as many as 95% of diagnosed cases of this disease occurred in people over 50 years of age and 43% over 75 years of age.[17] Our results reflect the data presented, since the age structure of the respondents shows that as many as 90% of them are over 55, which confirms the fact that age is an important non-modifiable factor increasing the risk of cancer.

Another factor that positively correlates with the increase in incidence of certain types of cancer (e.g. breast, colon, ovarian, and pancreatic cancer) is BMI.[3] Some publications claim that the predicted increase in the risk of these types of cancers due to exceeded BMI ranges between 3% and 10% for the growth of this indicator.[18] In 2015, Lancet Oncology published a paper which estimated that in 2012 around 481,000 new cases of cancer in people over 30 in the world were caused by elevated BMI. In the group of the most vulnerable people are women and people living in developed and highly developed countries.[19] Our report indicated that BMI was above the norm in 67.5% of the respondents on the day of the survey, which may indicate BMI as a risk factor for the cancer.

One of the bioactive food ingredients that are responsible for modulating epigenetic processes at the level of DNA methylation and modification of histone protein are polyphenols. Gallus epigallocatechin (EGCG), found in green tea, belongs to polyphenols with well-known antioxidant and antitumor properties – especially in vitro and in animal models.[20] The conclusions of the review and meta-analysis are no longer so clear. In a Cochrane Library review published in 2009, which reviewed 23 cohort studies, 27 case studies and one randomized clinical trial, it was found that current scientific data are insufficient and contradictory to form binding recommendations for green tea consumption in the prevention of cancer. However, it has been further added that the indicated green tea intake is between 3 and 5 cups per day (up to 1200 ml), which provides 250 mg of catechins.[21] Although most current scientific research seem to support previous assumptions, it should be noted that ambiguous epidemiological results may be due to the fact that dietary polyphenols intake is relatively low compared to doses used in in vitro or in animal models. In addition, cancerogenous agents differ between populations, and green tea consumption may affect carcinogenesis only in specific cases.[22] Referring to the above-mentioned publications, it was observed that, despite ambiguous scientific evidence on the effect of green tea on the reduction of cancer risk, the group of the respondents was characterized by its very low consumption, only 15% of the patients consumed it once a day. In addition, the subjects who consumed green tea most often drank one cup a day.

One of the questions in our questionnaire focused on the consumption of red dry wine as a source of resveratrol in patients before the diagnosis of cancer. Only 5% of the patients consumed it several times a week, while half of the respondents declared red wine consumption several times a month. The patients identified the consumption of this alcoholic beverage with pro-health effects. Scientists believe that one of the most bioactive components found in red wine is a polyphenol-resveratrol compound. Although its role in the prevention of the cardiovascular diseases is well known, the impact on cancer prevention is no longer so clear. Current scientific evidence points to the chemopreventive effect of resveratrol in colorectal cancer which was evaluated in in vitro and in vivo studies. Animal models have also been shown to reduce the number of pre-cancerous lesions and some papers claim that preclinical studies also appear promising.[23] However, further research are required to increase the bioavailability and pharmacological properties of resveratrol, despite high absorption (75% of the administered dose), it is characterized by very low bioavailability (<1%) due to rapid metabolism in the intestines and the liver.[24] In addition, Advances in Nutrition published in 2016 a review which determined 1g as a therapeutic dose of resveratrol for a day. Such a dose can be found in about 505 liters of good

quality red wine, 2857 kg of dark chocolate, 2500 kg of apples or 795 kg of dark grapes. The quantities presented are impossible to be supplied with food.[25] Alcohol itself is considered to be a carcinogen. There is extensive scientific evidence that it increases the risk of oral, larynx, esophagus and liver cancers. However, red dry wine due to the increased content of bioactive food components is often treated as an alcoholic drink with health benefits. It should be remembered that patterns of consumption and changes in alcohol consumption are difficult to estimate. In addition, people who consume wine often lead a healthier lifestyle, and the effect of alcohol on health may in some studies be attributed to other interfering factors.[26] Based on the literature data, our data may suggest that low consumption of red wine among the respondents may be associated with worse eating habits in these people. On the other hand, bearing in mind that excessive alcohol consumption increases the risk of certain types of cancer, it may be concluded that the patient's eating habits were correct given only red wine consumption.

Definitely the most popular products containing bioactive food components among the patients were typical Polish dishes such as cabbage, onion, garlic or leeks. Brassicas besides vitamins (C, E, K, folate) and minerals contain substances called glucosinolates, which are sulfur-containing chemicals.[27] During the food processing, chewing and digestion, glucosinolates are decomposed to biologically active compounds, i.e. indoles, nitriles, thiocyanates and isothiocyanates. The most bioactive are indol-3-carbinol and sulforaphane. In animal models of breast, colon, lung, liver or stomach cancer, these two compounds protected cells from DNA damage, inactivated carcinogens, acted anti-inflammatory, antibacterial, antiviral, induced apoptosis, inhibited angiogenesis and metastasis.[28] As in above mentioned studies, the results of the study involving people are not unequivocal but promising. The meta-analysis and systematic review published in 2014 analyzing epidemiological studies describing the association between crucifers consumption and colon cancer development indicate that crucifers consumption is inversely correlated with the risk of colorectal cancer (OR = 0.84). The researchers have found that broccoli, which were less popular among the respondents, is particularly effective.[29] However, they underline that due to the low number of studies, strong conclusions cannot be formulated.[30] It is suspected that increased consumption of brassica vegetables may also reduce the risk of pancreatic, ovarian or prostate cancer.[31-33] Despite promising findings in literature, our study results showed that the consumption of cabbage ($p = 0.03$) and cauliflowers ($p = 0.007$) was significantly associated with obesity. This unexpected relationship may be, in our opinion caused by the traditions of Polish cuisine, where the vegetables are consumed with added fat or fatty foods. Such habits can contribute to overweight and obesity.

Allium family including onion, garlic, leek or chives are rich in bioactive components, among which scientists focus primarily on sulfur compounds. In recent years, some interesting papers have been published that assess the relationship between allium vegetables consumption and the risk of gastrointestinal cancer. Galeone et al. (2006) assessed the effect of Allium vegetables on the etiology of different types of cancer. Using data from Italian and Swiss clinical and control studies on onion and garlic consumption, the odds ratio was estimated using the multivariate regression model. The researchers found that the consumption of garlic and onions prevented colorectal cancer. The highest consumption of onions (≥7 servings a week) was associated with a reduction in the risk of colorectal cancer from OR 0.44. Moderate and high garlic consumption were also associated with a decrease in the risk of colorectal cancer, respectively from OR 0.88 and 0.74.[34] Despite unclear evidence, current literature reports indicate that intake of these vegetables may be particularly helpful in the prevention of gastrointestinal cancers. This information may be confirmed by randomized study.[35] As in the case of brassica family vegetables, our results showed that obese people more often than those with underweight, normal weight and overweight consumed onions before diagnosing cancer ($p = 0.01$). These results may suggest that apart from taking care of the proper content of bioactive food components in our diet, attention should be paid to its energy value.

Limitations

The authors are aware that the paper has some limitations. They include: a small and heterogeneous group of the respondents and lack of a control group, so it is advisable to continue research in this direction. The control group could be elderly people in the risk group but without cancer. The results of such studies would not only allow assessing the differences in the amount of bioactive food components between groups, but also help to determine the optimal dosage of compounds that affect epigenetic modifications.

Conclusion

— The incidence of cancer can depend on non-modifiable factors: age and modifiable: body weight, lifestyle.
— Most of the subjects before diagnosis of cancer had an improper diet; and diagnosis of the disease in most cases affected the change in eating habits.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.4

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 24–31

ORIGINAL PAPER

Joanna Majewska [1(ABCDEFG)], Magdalena Szczepanik [1(ABCDE)], Mariusz Drużbicki [1(ABCDE)], Sławomir Snela [1,2 (AD)], Wojciech Rusek [1 (ABC)], Grzegorz Sobota [3 (C)], Ewelina Nowak [4(C)], Jacek Durmała [5(AD)], Marcin Bonikowski [6(AD)]

Assessment of relation between gait and static balance in children with cerebral palsy

[1] Institute of Physiotherapy, University of Rzeszow, Poland
[2] Clinical Department of Orthopaedics and Traumatology, Regional Hospital No. 2 in Rzeszow, Rzeszow, Poland
[3] Department of Biomechanics, Academy of Physical Education in Katowice, Poland
[4] Outpatient Clinic of Physiotherapy ‚Neurorehabilitation of children and adults', Katowice
[5] Department of Rehabilitation, School of Health Sciences in Katowice,
Medical University of Silesia in Katowice, Poland
[6] Department of Pediatric Neurology and Rehabilitation, Psychiatry Center, Zagorze, Poland

ABSTRACT

Introduction. Cancer, after cardiovascular disease, is the second most common cause of death both in Poland anIntroduction. In children with cerebral palsy, gait and balance assessment allows for an objective gait pattern evaluation as well as for therapy planning and assessment. It was hypothesised that asymmetry of the lower limbs load in a standing position causes asymmetry of spatiotemporal gait parameters.

Material and methods. 19 children with spastic diplegia and 20 healthy children participated in this study. 3D gait analysis was performed using the BTS Smart optoelectronic system. Stabilometric evaluation was performed using the Zebris Force Plate. Additionally, the Symmetry Index for selected gait and balance parameters was calculated.

Results and conclusion. It was shown that symmetry of gait parameters and lower limb load in standing position differs significantly between the study and control groups. There was no correlation confirmed between lower limbs symmetry in standing position and symmetry of gait parameters. It was shown that 80% of children with cerebral palsy had asymmetrical gait patterns. It has also been shown that asymmetry of lower limbs load in a standing position correlates with an asymmetry of spatiotemporal gait parameters. The majority of children with spastic diplegia present asymmetrical gait patterns and asymmetrical balance parameters, but it has no influence on gait symmetry.

Keywords. spatiotemporal gait parameters, postural stability, asymmetry

Corresponding author: Joanna Majewska, Institute of Physiotherapy, University of Rzeszow, ul. Warszawska 26 A, 35-205 Rzeszów, Poland, phone: +48 178721920, fax: +48 178721930, mobile phone: +48 791849854 ,e-mail: joadud@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 6.01.2017 | Accepted: 20.02.2017
Publication date: June 2017

Majewska J, Szczepanik M, Drużbicki M et al. *Assessment of relation between gait and static balance in children with cerebral palsy*. Eur J Clin Exp Med. 2017;15(1):24–31. doi: 10.15584/ejcem.2017.1.4

Introduction

Human gait involves complex movement and requires coordination between successions of the swing phase and the stance phase that induce oscillations of the head and trunk observable in the sagittal and frontal planes.[1] The subject must constantly maintain postural balance while propelling himself forward to move in space.

An important gait feature that is recently often investigated and reported, particularly in hemiplegic patients and single leg amputees where one limb is predominantly affected, is symmetry. However, asymmetrical behavior of the lower limbs is not limited only to hemiplegic population and moreover is also present in healthy subjects.[2] Clinically, gait asymmetry is important since it may be associated with a number of negative consequences. These are challenges to control balance.[3]

It is well known that the children with cerebral palsy (CP) have varying levels of deficits in balance and postural control, which is a major component of the gait disorder.[4]

Postural control, specifically postural stability, is a fundamental prerequisite for motor development in children. It is the complex ability of an individual to maintain the center of the gravity of the body over the support base when we are standing still (static balance), in motion (dynamic, functional balance), preparing to perform a movement or preparing to end a movement.[5] Postural control depends on the delicate integration of vision, vestibular and proprioceptive sensations, commands from the central nervous system and neuromuscular responses. In patients with cerebral palsy, these interactions are known to be affected, which may be a reason why postural control is impaired and the maintenance of stability is critical.[6]

Postural control often plays a major role in contributing to motor disorders in children with CP. Postural stability is crucial for purposeful movement and functional activities. Poor postural control limits gross motor functions, ability to explore and interact with the environment, affecting the quality of life for children with CP. Among various measures used to assess stance stability, the motion of the center of pressure (COP) is one of the most common parameters.[7]

In children with cerebral palsy analysis of gait and postural stability parameters asymmetry can provide information on the control of walking and balance and may help clinicians in making treatment decisions. Human gait can be considered as a continual state of imbalance caused by the relationship between the center of mass (COM) and the COP. Every individual must constantly maintain postural balance while propelling himself forward to move in space.[8]

This led us to the hypothesis that presumed asymmetry of the lower limbs load in a standing position affects the spatiotemporal gait parameters symmetry and according to the clinical perspective balance training might increase gait symmetry in patients with CP.

Although the literature has widely investigated the degree of functional limitation of gait and posture in children with CP using 3D movement analysis there are not many studies analyzing the symmetry of gait and balance simultaneously with the use of the symmetry ratio.[7,9–16]

Aim of the study

Therefore the purpose of this study was to investigate the relation between gait parameters and static balance in CP children.

This study compares spatiotemporal gait parameters and postural stability parameters during quiet standing between non-disabled children and children with CP as well as the level of symmetry of these parameters and relation between the symmetry of static balance and gait characteristics.

Material and methods

The research was single, cross-section examination conducted on homogenous group of both healthy children and children diagnosed with CP. The purpose and process of the research was presented and explained to the parents of all participants. All parents gave their written consent to participation of their children in the examination. The project of the research was approved by Bioethics Board. The research was conducted among children consecutively admitted to rehabilitation or orthopedic clinics for CP children.

19 children with cerebral palsy and 20 age-matched healthy children were qualified and participated in this study (age 8–13 years). The qualifying criteria to the control group were as follows: children with spastic diplegia; the ability to stand independently without support for more than 30 seconds; the ability to walk independently; a classification to level II–III in the Gross Motor Function Classification System (GMFCS); and no disorders of higher mental functions. Disqualifying criteria included: children treated with botulinum toxin within the preceding 6 months; children treated surgically within a 1-year period prior to the examination; active drug-resistant epilepsy; baclofen therapy with the use of an implanted infusion pump; inhibiting casts worn during the preceding 6 months; significant amblyopia and hearing loss and lack of patient cooperation. Children being able to stand barefoot without support for more than 30 seconds and with no history of any orthopedic or neurological disorders were included in the control group. The demographic characteristics of the participants of both groups are presented in Table 1.

Ten children with cerebral palsy (52%) were classified as Gross Motor Function Classification System (GMFCS) level II, whereas nine (48%) were classified as GMFCS level III.

Gait analysis was performed by means of the BTS Smart motion analysis system (BTS Bioengineering, Italy).

Table 1. Participants' characteristics

	Study group (n = 19)	Control group (n = 20)
Age, years, mean, [median]	10.1 [10.5]	10.6 [11.1]
(sd)	(2.2)	(2.4)
Gender: males/females, n (%)	10/9 (52/48)	8/12 (40/60)

sd: standard deviation;

This system contains 6 digital infrared cameras with 120 Hz sampling frequency and two visible range Network-Cam AXIS 210A cameras with 20 Hz frequency. All those devices make the measurements simultaneously. Cameras were calibrated each day before the first gait assessment. The scheme of their location in the laboratory of movement analysis is presented in Figure 1. Motion analysis were used to capture 22 photo-reflective markers placed at the bony landmarks of the participant in accordance with the modified Davis model.[17] Each marker must be seen by at least two cameras. The participants walked barefoot at their preferred speed in a minimum of six trials on a 7 m x 0.90 m gait track. The data was collected by the USB/PC controller and analyzed by BTS Smart Analyzer. The research stages included: BTS Smart Capture – data collection, Smart Tracker – markers' tracking and Smart Analyzer – analysis and data processing. The following spatiotemporal gait parameters such as the percentage share of the stance-, swing- and double-stance phase, step length, mean gait velocity and step width were analyzed. Then, spatiotemporal parameters from the BTS Smart were averaged from the six gait cycles for each lower limb trial for each participant.

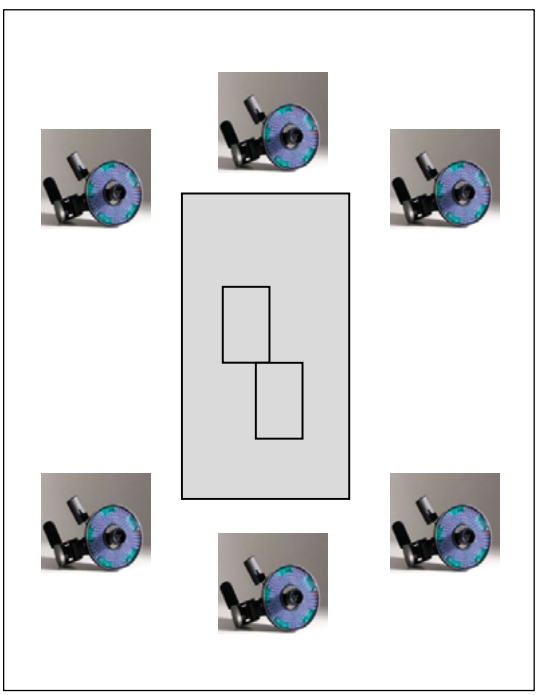

Figure 1. Scheme of cameras location

Stabilometric evaluation was performed with the use of the Zebris WinPDMS Force Plate (Zebris Medical GmbH, Germany), which measures the pressure distribution of static forces. The WinPDMS system analyzes the statical pressure distribution in real-time. The platform dimensions are: 600 mm x 380 mm x 20.1 mm (B x H x T) and it is equipped with 1536 pressure sensors with pressure measurement ranges of 1–120 N/cm^2 and a resolution of 1 sensor/cm^2 and sensor area 320 mm x 480 mm. The sensors respond to the lower limbs load changes. The testing was performed and data was recorded at the recommended sampling frequency of 20 Hz. Afterward the system automatically performed basic analysis of the captured signals for stabilometric assessment. Multiple COP deflection during the test were marked by lines creating the ellipse of different size. The ellipse includes 95% of the COP. Characteristics of the ellipse are presented in a chart.

Balance ability was evaluated during 2 quiet standing tasks: eyes open on a firm surface (EO) and eyes closed on a firm surface (EC). Each child was shown how to stand on the platform. The children were asked to stand barefoot on the platform, with their feet at pelvic width, parallel to the anterior-posterior axis of the platform and with arms at their sides. Children were allowed to stabilize their position for 30 seconds, and then the balance evaluation began with the participants trying to balance themselves while standing in the EO and EC test positions. Each balanced standing position had to be kept for 30 seconds. Subsequently, there was a 30 second long rest between each trial and the child was allowed to sit during that period. Before the EO test, barefoot children standing on the platform had been instructed to fix their eyes on a black point located 1.5 meters away. The position of the black point was adjusted according to the heights and eye level of the participant.

COP sway area, COP length, average value of COP anterior-posterior and medio-lateral sway, as well as the percentage share of right and left lower limb load, were analyzed.

All calculations and statistical analyses were performed with the use of STATISTICA ver. 10.0 (StatSoft, Poland).

Both the normalities of the gait and stabilometric parameters distributions were examined with the Shapiro-Wilk test while the homogeneity of variance was assessed with the use of Levene's test. The analysis revealed that some data were not normally distributed; therefore the authors decided to apply parametric and nonparametric tests. Comparisons between groups were performed with the use of the t-student test for independent variables and the U Mann–Whitney test. The results of parametric tests were marked in bold. Not only mean values but also

the standard deviations, medians and 95% confidence interval were used for a better statistical description. To identify and test the strength of a relation between two sets of data, Pearson correlation and Spearman's rank correlation tests were used. A value of $P < 0.05$ was considered to be statistically significant.

To determine the symmetry of selected balance and gait measures the symmetry ratio was applied and calculated according to the following formula: the value of the specified parameter for the one limb/ the value of the specified parameter for the opposite limb (the greater value was divided by the lower value). For calculation of the different parameters of gait and balance symmetry average data were used. A symmetry ratio of 1 indicates that the values for both limbs are equal (i.e. perfect symmetry).[3]

Results

Analysis of the spatiotemporal gait parameters demonstrated that all differences in the spatiotemporal gait parameters between the study- and the control group were statistically significant. The stance phase and double stance phase for the study group were longer. The step length was shorter in the study group than in the control group. Both the step width and the mean gait speed were lower for the study group than for the control group (Table 2).

The symmetry of gait parameters in the study and the control group also significantly differed statistically. Better results of symmetry were observed in the control group in which values of analyzed parameters were more similar to 1.0 (Table 3).

Table 2. Spatiotemporal gait parameters

	Study group n = 19		Control group n = 20		p
	x (s)	95% CI	x (s)	95% CI	
Stance phase r	65.9 (6.2)	62.9–68.9	59.4 (1.9)	58.6–60.3	0.0001
Stance phase L	66.0 (6.8)	62.8–69.3	58.9 (2.2)	57.9–59.9	0.0001
Swing phase r	34.1 (6.1)	31.1–37.0	40.6 (1.9)	39.7–41.4	0.0001
Swing phase L	33.8 (7.0)	30.4–37.1	41.1 (2.2)	40.1–42.1	0.0001
Double stance r	15.8 (7.3)	12.3–19.3	9.3 (2.0)	8.4–10.2	0.0005
Double stance L	16.8 (6.5)	13.7–19.9	9.3 (2.1)	8.3–10.3	0.0000
Step lenght r	0.3 (0.1)	0.2–0.3	0.5 (0.1)	0.5–0.5	0.0000
Step length L	0.3 (0.1)	0.2–0.3	0.5 (0.1)	0.5–0.5	0.0000
Step width	0.2 (0.0)	0.2–0.2	0.1 (0.0)	0.1–0.1	0.0000
V (m/s)	0.4 (0.1)	0.3–0.4	1.1 (0.2)	1.1–1.2	0.0000

x – average, s – standard deviation, 95% CI – 95% confidence interwal, p – p-value, V – gait velocity (m/s), r/l – right/left lower limb

Table 3. Symmetry ratio of gait parameters

	Study group n = 19		Control group n = 20		p
	x (s)	95% CI	x (s)	95% CI	
Stance phase ratio	1.06 (0.05)	1.04–1.08	1.01 (0.01)	1.01–1.02	0.0001
Swing phase ratio	1.13 (0.13)	1.06–1.19	1.02 (0.01)	1.01–1.03	0.0001
Double stance ratio	1.76 (1.55)	1.01–2.50	1.09 (0.09)	1.05–1.13	0.0036
Step lenght ratio	1.21 (0.19)	1.12–1.31	1.04 (0.03)	1.03–1.06	0.0003

x – average, s – standard deviation, 95% CI– 95% confidence interval, p – p-value;

Table 4. Stabilometric parameters (open eyes)

	Study group n = 19		Control group n = 20		p
	x (s)	95% CI	x (s)	95% CI	
Sway Area (mm2)	654.3 (616.5)	357.2–951.5	110.5 (136.0)	46.9–174.2	0.0000
COP Length (mm)	1450.9 (468.5)	1225.1–1676.8	1358.9 (263.3)	1235.7–1482.2	0.7045
Hd (mm)	12.3 (9.3)	7.8–16.8	3.5 (1.8)	2.6–4.4	0.0000
Vd (mm)	10.5 (4.8)	8.2–12.8	6.0 (2.8)	4.7–7.3	0.0003
F L (%)	51.0 (16.3)	43.2–58.8	50.3 (4.3)	48.3–52.3	0.8534
F R (%)	49.0 (16.3)	41.1–56.8	49.7 (4.3)	47.7–51.7	0.8513
F ratio	1.9 (0.8)	1.5–2.3	1.1 (0.1)	1.1–1.2	0.0018

COP – center of pressure, Hd (mm) – horizontal deviation (mm), Vd (mm) – Vertical deviation (mm), F L (%) – Left Average forces, total (%) F R (%) - Right Average forces, total (%), F ratio (F L/F R)

Table 5. Relationships between spatiotemporal gait parameters symmetry and symmetry of the lower limbs load

*R significant at p < 0.05	F ratio			
	Study group n=19		Control group n=20	
	EO	EC	EO	EC
Stance phase ratio	-0.05	-0.01	0.17	-0.12
Swing phase ratio	0.01	0.10	0.19	-0.12
Double stance ratio	0.26	-0.06	0.15	0.01
Step lenght ratio	-0.09	-0.21	-0.04	-0.05

EO – eyes open, EC – eyes closed, F ratio – (Left Average forces, total (%) / Right Average forces, total (%))

In terms of stabilometric parameters statistically significant differences between the study and the control group in both EO and EC trials were related to the confidence ellipse area, as well as to the horizontal and vertical COP deviation. The results of the CP children were higher, (i.e., worse) than children from the control group. When compared with the control group, the symmetry ratio of average forces during quiet standing was higher in the study group and was also statistically significantly different. Due to similar results in both trials in terms of statistically significant differences, Table 4 presents the results only of the EO test.

Although it was shown that gait parameters of symmetry and symmetry of lower limbs loading in standing position differs significantly between the study and the control group there were no statistically significant correlations between symmetry of the lower limbs loading during standing and symmetry of spatiotemporal gait parameters (Table 5).

Discussion

Spastic diplegia is the most prevalent type of CP. It is characterized by a wide range of ambulatory outcomes.[18] Children with diplegic-type CP have impaired motor control, which frequently leads to limitations in their mobility. As a result, the balance control and the corresponding walking functions are affected.[19]

The ability to control posture during standing is being developed early in life. At the same time the child's walking performance is also developing. With increasing age children tend to walk faster with smaller physiological cost and with a more mature gait. It seems that balance functions are tightly correlated with walking performance in non-disabled children. In children with spastic CP stepping reactions can only be observed in the case of independent walkers, not non-walkers. Therefore it can be assumed that in children with CP balance function is also correlated with independent walking performance. Balance and locomotor abilities are also positively correlated in children with spastic diplegia. The latter ones have a decreased rhythmic shifting ability when compared with children without CP, and this ability is correlated with walking function.[20]

Additionally, Katz-Leurer et al. found a significant linear inverse correlation between balance performance and step length variability among children with traumatic brain injury.[21] Ambulatory children after severe traumatic brain injury had decreased gait speed when compared with age – matched typically developed (TD) ones.

Our study researched differences in stabilometric parameters, as well as in spatiotemporal characteristics of gait in children with CP compared with TD children.

The aim of this study was to evaluate the relation between gait parameters and static balance in CP children. Some researchers believe that asymmetric alignment in posture is especially characteristic in children with unilateral neurological lesions such as unilateral CP (spastic hemiplegia).[22] However, as previously noted, asymmetrical behavior of the lower limbs is not characteristic only for hemiplegic population, so the authors hypothesized that children with CP present asymmetrical patterns of static balance and spatiotemporal gait characteristics and that asymmetry of the lower limbs load in a standing position may cause asymmetry of spatiotemporal gait parameters. To assess the level of symmetry the authors used the symmetry ratio proposed by Patterson et al.[3]

The literature indicates that CP children present a lower postural balance ability when compared with TD children.[23–25] Poor postural control can trigger the delays and deviations in motor skill acquisition and development in CP children. Postural control is often assessed by means of posturography, that is, the quantitative analysis of center-of-pressure (COP) trajectories measured with the use of a force platform.[26] COP data proved to be sensitive in discerning balance performance in healthy adults, patients with post-stroke hemiparesis, cerebellar deficits, Parkinson's disease, healthy adolescents and children with cerebral palsy.[27–34]

Velocity and center of pressure sway, mainly in the medial-lateral direction, exhibit the greatest increases in patients with cerebral palsy.[24,26] Donker at al. found that posturogram characteristics of CP children differed considerably from those of TD children.[26] An interesting and unexpected finding in their study was that the total COP deflation did not differ significantly between CP and TD children. Liao at all reported, that the standing stability of the children with CP was poorer than that of TD children with different sensory conditions.[20]

In this study patients with spastic diplegia presented a significant increase in their COP confidence ellipse area and in both horizontal and vertical COP sway with the EO and EC compared to TD children. Moreover, CP children present asymmetry of average forces during quiet standing.

Regarding spatiotemporal gait parameters Chang et al. proved that children with spastic diplegic CP walk with reduced walking speed and stride length, increased stride time and step width, which indicates reduced gait efficiency.[35]

Our findings showed significantly lower spatiotemporal gait parameters, including walking velocity and step length in children with spastic diplegic CP than in TD children. Step width was larger in children with CP. Moreover, significant differences in proportions of the stance phase (single- and double-limb stance) were observed in children with spastic diplegic CP while compared with TD children. The duration of single- and double--limb support in CP children was longer. Our findings are consistent with those of previous studies reporting deteriorated gait function and altered gait pattern in children with spastic diplegic CP.[36–38] Because of motor weakness and poor voluntary motor control, children with CP use a wider step width than TD children, what indicates that children with CP may choose a wider base of support in order to stabilize the COP.[39]

In addition, in our study the symmetry of gait parameters in the study- and the control group also statistically significantly differed. Better results symmetry were observed in the control group in which values of symmetry ratio were closer to 1.0. However, we didn't find statistically significant correlations between symmetry of the lower limbs_loading during standing and symmetry of spatiotemporal gait parameters.

Kurz et al showed no difference in the walking speeds of the children with CP (aged 7.8 ± 2.8 yrs) and the TD children (CP = 0.79 ± 0.05 m/s; TD = 0.81 ± 0.03 m/s; p = 0.28). During their examination children with CP used a significantly (p = 0.005) wider step width than the TD children (Fig. 3), but had a similar amount of step width variability (CP = 26.0 ± 4.2%; TD = 28.6 ± 4.3%; p = 0.70). Children with CP did not have a longer step length than the TD children (CP = 0.60 ± 0.03; TD = 0.60 ± 0.01; p = 0.78), but their step length was significantly (p = 0.01) more variable [38]. This demonstrates the large variability of gait in CP children. According to Diop et al. due to maturation of gait during growth, gait variability in children is age dependent, being higher in children under eight years old, and inter-stride variability decreases with age.[40] Hausdorff et al. described an inter-stride coefficient of variation as 8.4% at 4 years old, 4.3% at 7 and 1.9% at 11 years old.[41] Prosser et al. reported that children with CP demonstrate slower walking velocity, decreased cadence, shorter step length, and reduced single limb support compared with TD children, which is consistent with our findings.[42]

In our study children with CP spastic diplegia presented a lower standing balance and significant differences in spatiotemporal gait parameters compared with TD children. Although there were no correlations between symmetry of the lower limbs loading during standing and symmetry of spatiotemporal gait parameters measured with the use the symmetry ratio. Rehabilitation therapies for CP patients should focus on improving standing balance and postural stability because postural balance is integral for all motor abilities.

Limitations

The authors acknowledge some limitations of this study. One of the limitations was that the influence of treatments was not taken into account in this hereby analysis. This issue will become the subject of future research concerning further investigation of the influence of both balance treatments and gait profiles as well as observations of the longitudinal evolution of the patients. Another limitation was the lack of standardized, reliable, validated outcome measures of static balance assessment in children.

Additionally, future research should examine the variability and symmetry of other walking characteristics, such as kinematics, kinetics, and muscle activation patterns as well as symmetry of dynamic stability parameters.

Conclusion

There were significant differences in both walking performance and static balance characteristics in spastic diplegic CP children while compared with TD children.

The results of the hereby research revealed that the majority of CP children with spastic diplegia present asymmetrical gait patterns and asymmetrical balance parameters, but asymmetry of the lower limbs load in a standing position does not affect the spatiotemporal gait parameters symmetry. However, the further research of those aspects is needed not only to determine a link between asymmetric control of balance and gait but also to identify other factors that can help to explain gait asymmetry.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.5

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 32–38

ORIGINAL PAPER

Jan Gawełko [1(ABCDEF)], Marek Cierpiał-Wolan [3(BCDE)], Justyna Podgórska-Bednarz [2(DEFG)], Andrzej Kawecki [1(BCDE)]

Morbidity trend of lip cancer in Podkarpacie and in Poland in the years 1963–2013

[1] University of Rzeszow, Institute of Nursing and Health Sciences.
[2] University of Rzeszow, Institute of Physiotherapy
[3] Provincial Statistical Office in Rzeszów

ABSTRACT

Introduction. The dramatic decline in the incidence of lip cancer, which until the 80s of the twentieth century was the cause of significant morbidity, is an example of changes in the structure and trends of cancer incidence both in Poland and in the regions.
Aim. Therefore, the aim of this paper is to analyze the changes in the morbidity trend of the lip cancer during the last 50 years, both in Poland and in Podkarpacie.
Material and methods. A retrospective analysis of the lip cancer morbidity in the Podkarpackie region and in Poland in the years 1963–2013 was carried out based on data from the literature and our own research.
Results and conclusion. A steady decline in the incidence of lip cancer in Podkarpacie has been observed since 1982 for men and 1983 for women. In Poland these trends have been observed since 1972 for men and 1993 for women. In the analyzed period significant changes in the incidence structure in terms of sex are observed – from approximately 1:10 (women / men) in 1963 similarly in Podkarpackie and Poland – to 1:4.6 in Podkarpacie and 1: 2.6 in Poland in 2013.
Keywords. lip cancer, incidence, morbidity trend

Introduction

Lip cancer, which for almost three decades was the cause of significant morbidity especially among men, is an example of changes in the structure and trends of cancer morbidity in Poland and in other regions. In the first half of the 1950's, it was second only to gastric cancer in terms of cancer in men in Poland.[1] Between 1963 and 2013, the percentage of lip cancer decreased in men more than 13 times, both for Poland and Podkarpacie. A similar trend, although several times smaller in terms of both absolute count and percentage was observed in women.[2-8] The analysis of these phenomena using statistical methods showed significant differences in the dynamics of lip cancer morbidity trends between Podkarpacie, other regions, and Poland.

Corresponding author: Jan Gawełko, tel. +48 603 754 301, +48 872 11 09, email: jangawelko@o2.pl, Instytut Pielęgniarstwa i Nauk o Zdrowiu, Al. mjr. W. Kopisto 2a, 35-310 Rzeszów

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 3.10.2016 | Accepted: 20.02.2017
Publication date: June 2017

Gawełko J, Cierpiał-Wolan M, Podgórska-Bednarz J, Kawecki A. *Morbidity trend of lip cancer in Podkarpacie and in Poland in the years 1963–2013*. Eur J Clin Exp Med. 2017;15(1):32–38. doi: 10.15584/ejcem.2017.1.5

Aim of the study

The aim of this paper is to analyze the changes in the morbidity trend of the lip cancer during the last 50 years, both in Poland and in the Podkarpackie region.

Material and methods

A retrospective analysis of the lip cancer morbidity in the Podkarpacie region and in Poland in the years 1963–2013 was carried out based on available data.

In the analyzed period, Podkarpacie as a region included: the area of former Rzeszow province from 1963 to 1975, and in the period 1976–1998: the former Krosno, Przemysl, Rzeszow and Tarnobrzeg province. Also from 1999 to date – the area of the present Podkarpackie province.

Using conventional statistical methods, based on demographic data from Provincial Statistical Office in Rzeszow, our own publications and Podkarpackie Cancer Register – incidence rates and structure indicators (percentage) for the lip cancer (designation code C00 in ICD10) were calculated. Due to changes in the administrative division of the country, the calculation of standardized rates for Podkarpacie was possible since 1999. Based on the published data of the Department of Epidemiology, Oncology Centre in Warsaw, similar data for Poland were compiled.

In 1997–1998 due to strikes in Health Care, among other causes, cancer reports were not filled in, therefore, there is no data available for this period for both Poland and Podkarpacie – which was marked on the charts.

Results

In the years 1963–2013 in Podkarpacie 3,586 cases of the lip cancer were registered, including 2,990 in men and 596 in women. The absolute morbidity count increased from the 50's and in 1963 was 80 for men with an incidence rate of 10.0/100 thousand and a percentage of 8.1%. For women in the same year the number of cases was 7, with an incidence rate of 0.8/100 thousand, and a percentage of 0.7%. The highest number of cases in total (117) was recorded in 1982. In subsequent years, a decrease in the morbidity was observed in Podkarpacie. In 2013, the morbidity in men amounted to 28 cases with an incidence rate of 2.7/100 thousand, standardized ratio of 1.6/100 thousand, and a percentage of 0.6%. In women, the absolute morbidity amounted to 6, with an incidence rate of 0.6/100 thousand, standardized ratio of 0.3/100 thousand, and a percentage of 0.2%.[2-6]

The results in the years 1963–2013 for Podkarpackie are presented in Figures 1,2,3,4.

In this time window in Poland, 41,362 cancers were registered in this location – 35,610 in men and 5,752 in women. In 1963 the morbidity totaled 850 in men and 84 in women. This resulted in the incidence rate of 5.4/100 thousand, a standardized rate 6.5/100 thousand and a percentage of 5.4% in men and 0.5/100 thousand for incidence rate and standardized rate and a percentage of 0.4% in women, respectively.

In Poland, the largest morbidity was registered in 1972 – 1,240 cases, including 1,136 in men and 104 in women. In the subsequent years, a clear downward trend was observed.

In 2013, 372 cases were registered, including 270 in men and 102 in women. Incidence rate for men was 1.4/100 thousand, standardized rate - 0.8/100 thousand, percentage of 0.4% and in women, it was respectively 0.5/100 thousand and 0.2/100 thousand, and 0.1%.[1,7-9] The results in the years 1963-2013 for Poland are shown in Figures 5,6,7,8.

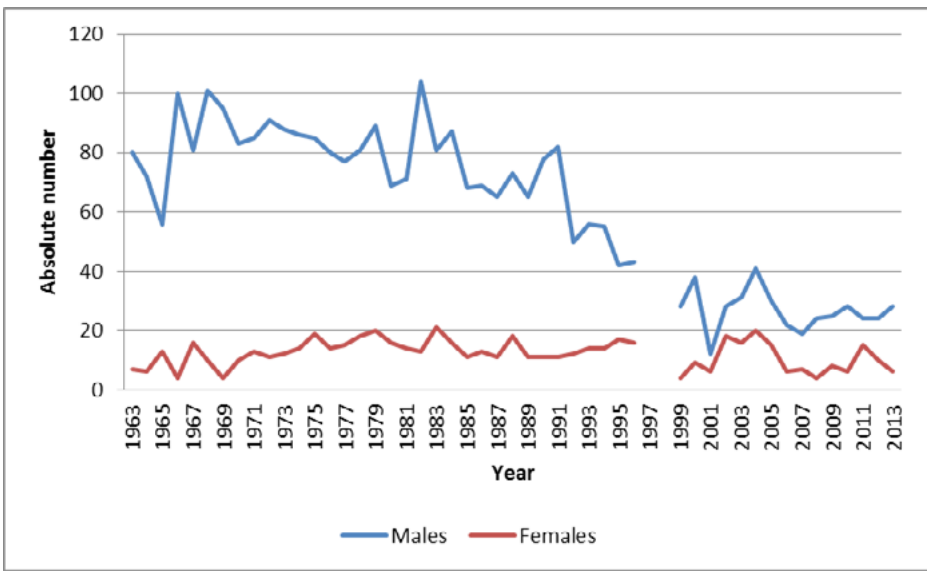

Figure 1. The absolute count of lip cancer morbidity in Podkarpacie between 1963 and 2013

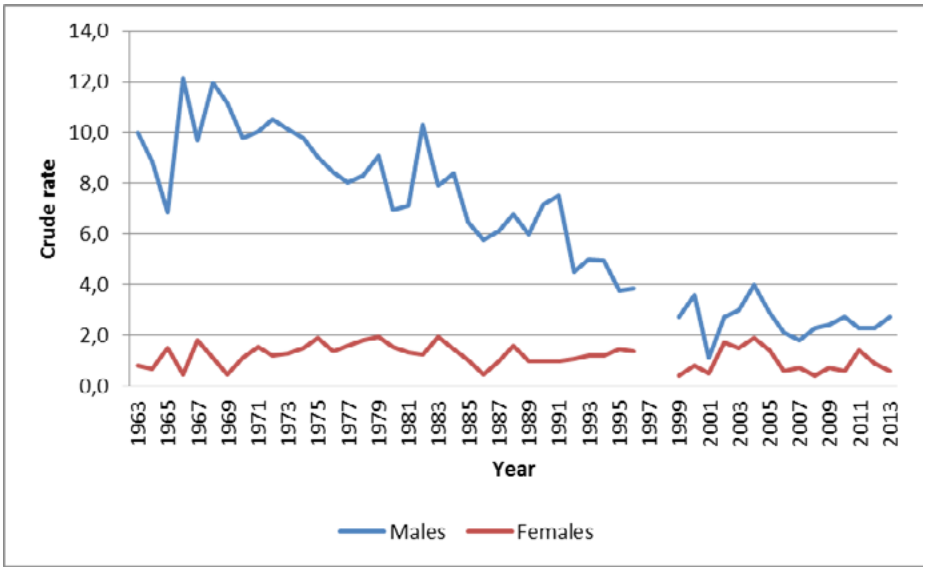

Figure 2. The incidence rate of lip cancer in Podkarpacie between 1963 and 2013

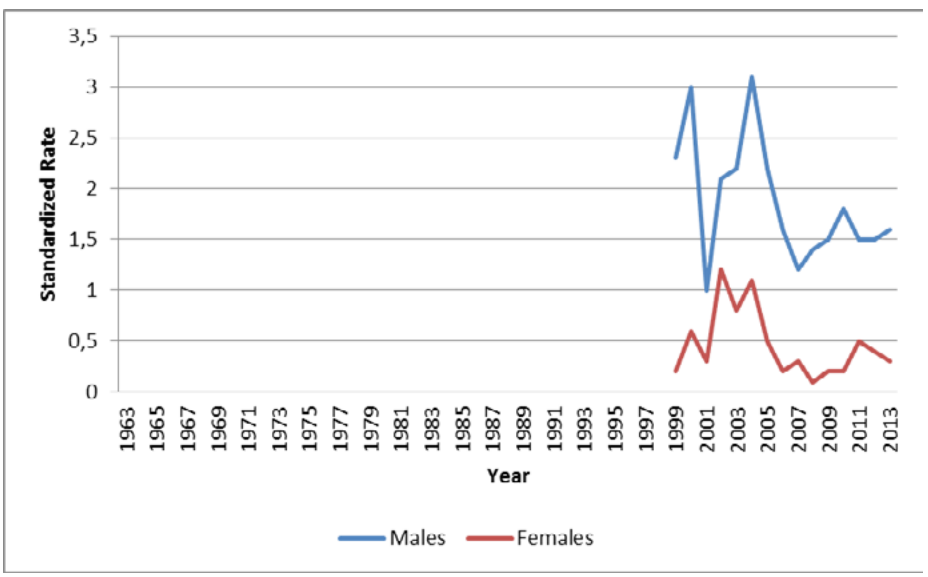

Figure 3. Standardized lip cancer morbidity rate in Podkarpacie in the years 1999-2013

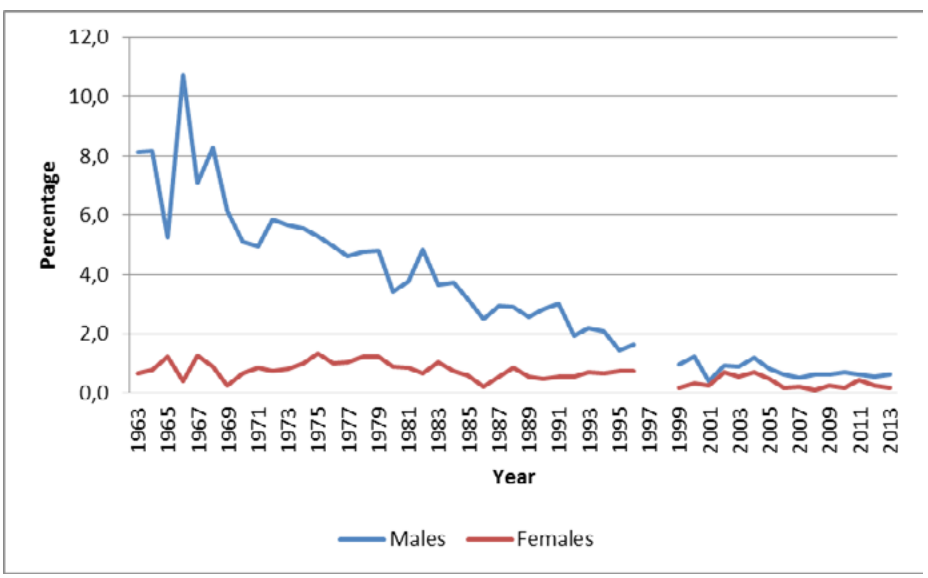

Figure 4. The percentage of lip cancer morbidity in Podkarpacie in the years 1963–2013

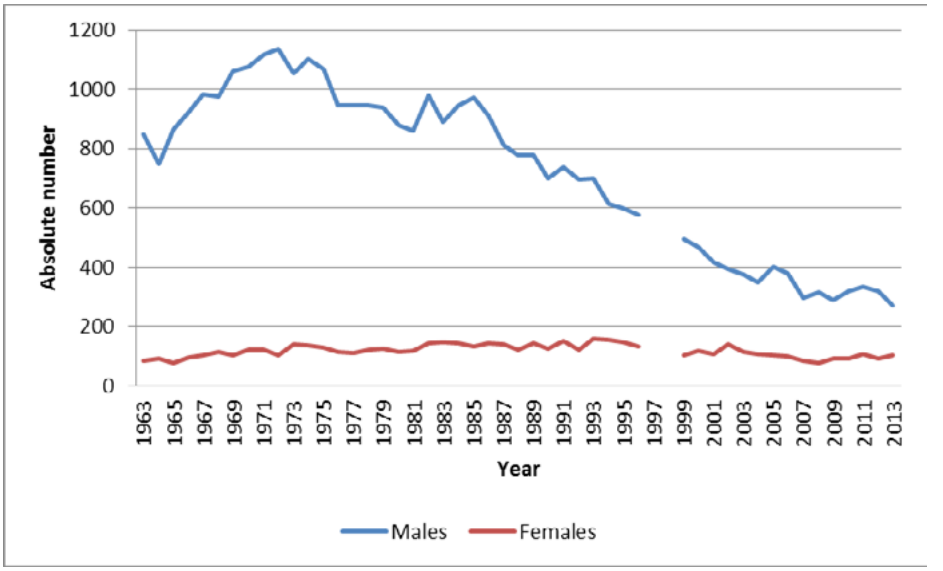

Figure 5. The number of absolute incidence of lip cancer morbidity in Poland in the years 1963–2013

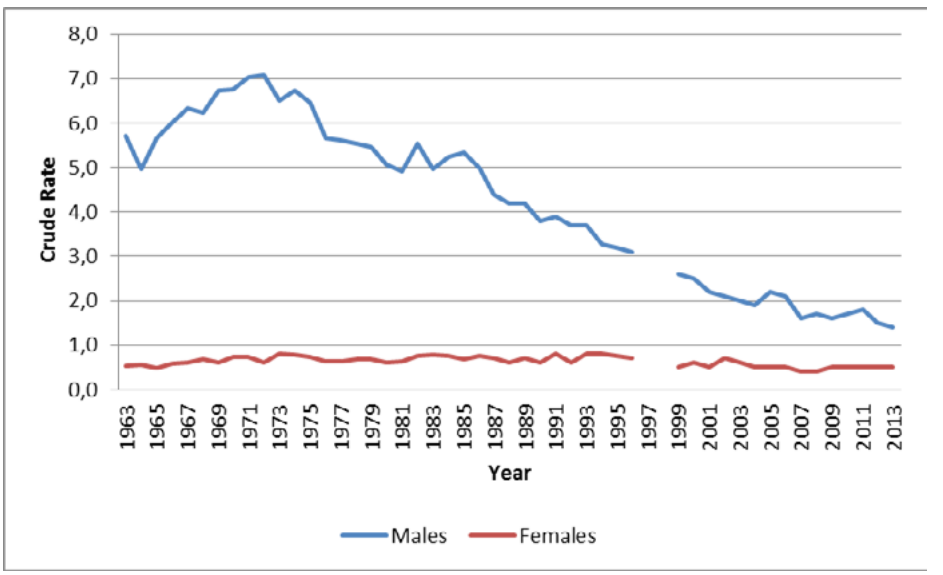

Figure 6. The incidence rate of lip cancer in Poland in the years 1963–2013

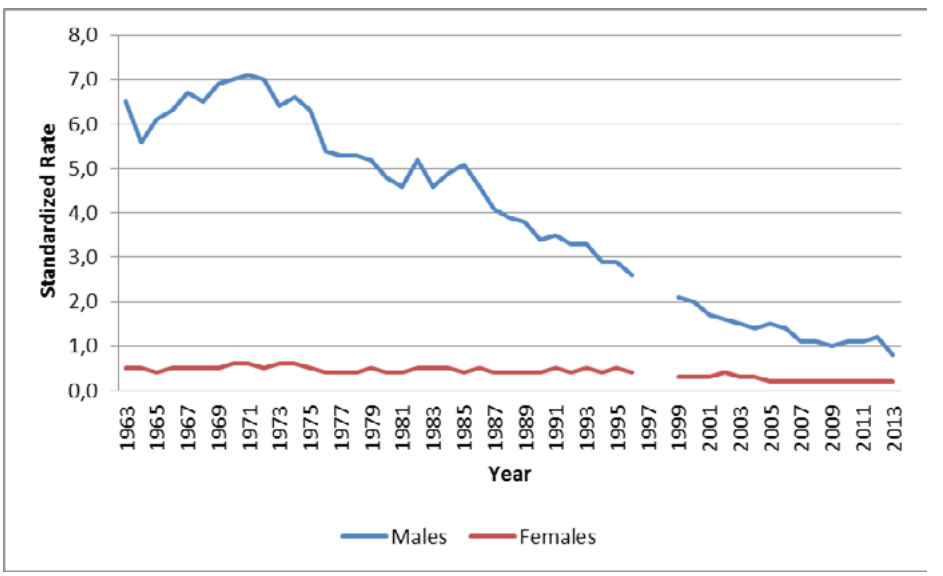

Figure 7. Standardized incidence of lip cancer in Poland in the years 1963–2013

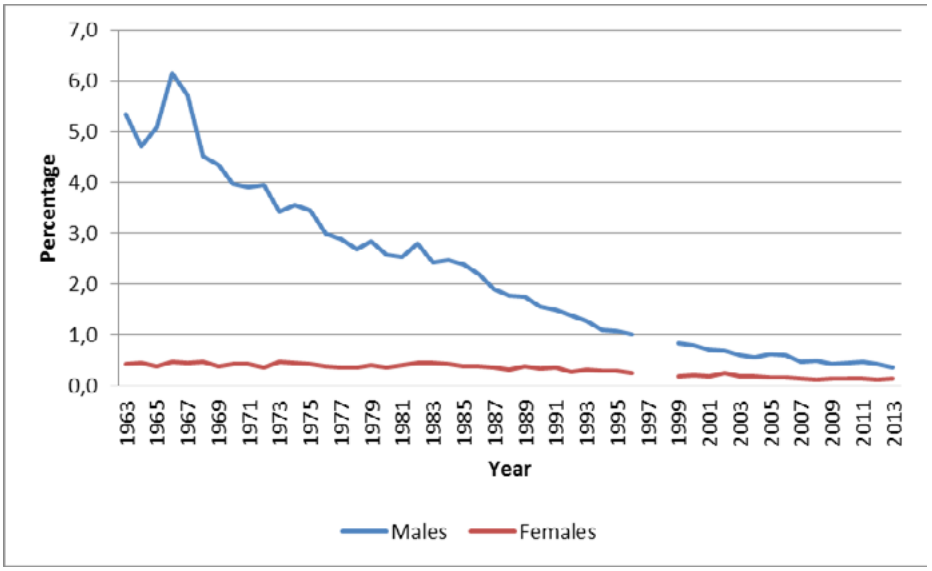

Figure 8. The percentage of lip cancer morbidity in Podkarpacie in the years 1963–2013

Discussion

Over the 50 years analyzed, the absolute count of lip cancer morbidity both in Podkarpackie and Poland decreased significantly – especially in men. The incidence in men in Podkarpacie decreased over 50 years almost 3 times (2.9) and in Poland, more than 3 times (3.2). These figures, however, do not reflect the real dynamics expressed in the absolute count for the top morbidity, comparing to which the decrease in incidence results for Podkarpacie is almost 3.7 and 4.2 times for the Poland. A clearer picture is obtained from the presentation of these changes based on the percentage. In 1963 in Podkarpacie, lip cancer morbidity in men amounted to 8.1% which is 3rd place among cancer morbidity, immediately after gastric cancer and lung cancer. The percentage for women was 0.7% (20th place). At the same time, in Poland it was the 4th disease in terms of morbidity in men with the percentage of 5.4%. The percentage for women was 0.4% (29th place). In 2013, the morbidity in men in Podkarpacie was 0.6% which is the 24th disease in terms of incidence and in women it was 0.2% – 47th. In Poland, lip cancer was 34th, 0.3% in men and in women 50th, 0.1%.

Geography of cancer incidence has been the subject of numerous publications which results indicate greater morbidity in the eastern part of the country.[10-12] Therefore, a comparison of the results obtained for Podkarpacie with the trends in other regions of Poland seems interesting. In the year 1999 when new administrative division was adopted – the highest incidence ratio in men 6.9/100 thousand was registered in the Świętokrzyskie province. In turn, the lowest values of 0.4/100 thousand and 0.8/100 thousand were registered in the Lubuskie and Pomeranian provinces, respectively. In 2013, the highest incidence rate – 2.9/100 thousand were registered in the Świętokrzyskie province and the lowest in the Kujawsko-Pomeranian and West Pomeranian provinces. Regarding the incidence among women in 1999, the highest incidence rate was registered in the Świętokrzyskie province – 1.3/100 thousand, followed by the Wielkopolska and Opole provinces. In 2013, in turn, the highest value of 1.3 /100 thousand were registered in the Opole province and subsequently in the Świętokrzyskie province 1.2/100 thousand.[9,13]

Regional differences in cancer incidence are obvious phenomenon in epidemiology. It is evident both in countries with a large population and diversity of geographical area as Poland or France and in relatively small countries in terms of area and population as Slovakia or Switzerland. For example, in 2009 in France, the incidence in men was 0 in the department of Isere, and in the departments of Loire-Atlantique and Vendee it was 2.8/100 thousand.[14] In turn, in Switzerland, the incidence in men was 0 in the cantons of St Gallen, Appenzell, Glarus and Graubunden, while 0.6/100 thousand for Zurich.[14] Therefore, the above observations for Poland and Podkarpacie were referred to the data for Slovakia and the Country of Prešov neighboring Podkarpacie.

In Slovakia in 1978, the incidence rate was 7.1/100 thousand for men and after reaching the peak value of 7.9/100 thousand in 1982, it has systematically decreased to 2.3/100 thousand in 2009. In women in 1978, a rate of 1.2 /100 thousand was recorded and a peak incidence of 1.5/100 thousand was in 1990, followed by a decrease to 0.3/100 thousand in 2004, and a rise again to 1.1/100 thousand in 2009. These values are higher in comparison to Poland, where in 1978 the incidence rates for men were 5.6/100 thousand and for women – 0.6/100 thousand. On the other hand, comparing the trends to the data available in Slovakia, i.e. until 2009,

it must be noted that both the incidence in 2009 in men – 1.6/100 thousand and in women 0.5/100 thousand did not reach so high values as in Slovakia over the period 1978-2009.[3,14]

For the county of Prešov bordering Podkarpacie, the incidence rate for men in 2003 were 3.6/100 thousand and 0.7/100 thousand for women – while in Podkarpackie they amounted to 3.0/100 thousand for men and 1.5/100 thousand for women. In 2009, the rates in the region amounted to 2.3/100 thousand in men and so they were similar to that of Podkarpacie, which amounted to 2.4/100 thousand. The incidence rate for women were 1.0/100 thousand and were higher than in Podkarpacie where it was 0.7/100 thousand for women.[3,15-21]

These comparisons, apart from the presentation of data characterizing the morbidity trends in the region, certainly also allow reference to the situation in their country and other provinces. It seems that especially in the mapping of health needs, signaling regional differences can be significantly useful in the development of regional health programs. In 1999 in Poland, the differences in the incidence of lip cancer in men ranged from 0.4/100 thousand (Lubuskie) to 6.9/100 thousand (Świętokrzyskie).[13] After 14 years in 2013, the spread decreased significantly from about 0.5/100 thousand (Kuyavian-Pomeranian) to 2.3/100 thousand (Świętokrzyskie).[9] Therefore, only constant analysis of trends in cancer morbidity and mortality can be the basis for effective health organizations in the field of oncology both on the country and regional level.

Conclusion

1. A steady decline in the lip cancer morbidity was recorded in Podkarpacie since 1982 for men and 1983 for women. These trends for Poland have been observed since 1972 for men and 1993 for women.
2. Within 5 decades, proportions in women/men morbidity underwent significant change from approximately 1:10 in 1963, both in Podkarpackie and Poland, to 1:4.6 in Podkarpacie and 1: 2.6 in Poland in 2013.
3. During the studied period, the percentage of lip cancer morbidity in Podkarpacie, despite the decrease in the number of cases, was higher than the percentage for both men and for women in Poland.
4. The incidence of lip cancer in Poland, in comparison to Slovakia, is characterized by a lower incidence rate both in men and women.
5. The incidence of lip cancer in Podkarpacie compared to Prešov shows decreasing trends for both sexes and the incidence in women in Podkarpacie is significantly lower.
6. Only constant monitoring of trends in cancer morbidity in the regions will enable the efficient organization of health care in this area.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.6

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 39–44

ORIGINAL PAPER

Jan Gawełko [1(ABCDEF)], Marek Cierpiał-Wolan [3(BCDE)], Andrzej Kawecki [1(BCDE)], Justyna Podgórska-Bednarz [2(DEFG)]

Comparative analysis of the incidence of Oropharyngeal cancer and Laryngeal cancer in the region of south-eastern Poland from 1980 to 2013

[1] University of Rzeszow, Institute of Nursing and Health Sciences.
[2] University of Rzeszow, Institute of Physiotherapy
[3] Provincial Statistical Office in Rzeszów

ABSTRACT

Introduction. The incidence of head and neck cancers in Poland demonstrated a general tendency to stabilize in the last two decades. However, a global phenomenon in the change of morbidity structure in terms of the specific anatomical location is observed, which will probably increasingly apply also to Poland.

Aim. The aim of the study was to present the changes that have occurred in the structure of the incidence of oropharyngeal cancer in comparison to laryngeal cancer in the period from 1980 to 2013, in the region of south-eastern Poland and the whole country.

Material and methods. A retrospective analysis of the incidence due to the head and neck organ cancer in 1980-2013 in the region of south-eastern Poland and the whole country was performed based on demographic data from the Provincial Statistical Office in Rzeszow and Podkarpackie Cancer Register as well as the Department of Epidemiology, Oncology Centre in Warsaw.

Results and conclusion. In the last three decades, the percentage of laryngeal cancer incidence in women (13% vs 18%) as well as oropharyngeal cancer (18.2 % vs 21.6%) was lower in Podkarpacie than in Poland overall. The incidence of oropharyngeal cancer in men in Podkarpacie was lower in the analyzed period than in Poland overall, and only in the last 3 years of observation has it reached a value close to the average for the country. The incidence of laryngeal cancer in men showed a dramatic downward trend both in Poland and in the Podkarpacie province, whereby both in terms of incidence rates and standardized rates and percentages – it is far more pronounced in the analyzed province.

Keywords. oropharyngeal cancer, laryngeal cancer, incidence.

Corresponding author: Jan Gawełko, tel. +48 603 754 301, +48 872 11 09, email: jangawelko@o2.pl, Instytut Pielęgniarstwa i Nauk o Zdrowiu, Al. mjr. W. Kopisto 2a, 35-310 Rzeszów

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 4.10.2016 | Accepted: 14.03.2017
Publication date: June 2017

Gawełko J, Cierpiał-Wolan M, Kawecki A, Podgórska-Bednarz J. *Comparative analysis of the incidence of Oropharyngeal cancer and Laryngeal cancer in the region of south-eastern Poland from 1980 to 2013*. Eur J Clin Exp Med. 2017;15(1):39–44. doi: 10.15584/ejcem.2017.1.6

Introduction

After a period of dynamic increase, mainly in the 70s and 80s of the last century, the incidence of the head and neck cancers in Poland demonstrated a tendency to stabilize in the last two decades.[1-3] The phenomenon observed in Western Europe and the United States is a change in the structure of morbidity in terms of specific anatomical locations of cancer in the head and neck. This incidence of typical squamous cell cancers dependent on exposure to e.g. tobacco smoke, is decreasing. The most common tumor in this group is laryngeal carcinoma. At the same time, the number of human papilloma virus (HPV) dependent cancers is increasing. Typically, they are located in the oropharynx and the oral cavity.[4-8] HPV dependent cancers as compared to typical head and neck organ cancers are a distinct disease entity. In general, they occur in younger people, often those with high socio-economic status, that are usually fit. HPV dependent cancer is characterized by molecular alterations, greater susceptibility to chemotherapy and radiation and a better prognosis.[9-13] The increasing role of HPV infection with gradually decreasing importance of traditional etiopathogenetic factor of squamous cell carcinoma in the head and neck area, that is exposure to tobacco smoke and alcohol, results in a worldwide trend to change the structure of disease localization, which probably applies also to Poland.

Aim of the study

The aim of this study is to present the changes in the structure of oropharyngeal cancers incidence compared to the laryngeal cancers in 1980–2013 in the region of south-eastern Poland and across the country.

Material and methods

A retrospective analysis of the incidence due to the head and neck organ cancer in 1980–2013 in the region of south-eastern Poland, including from 1980–1998 the areas of former Krosno, Przemysl, Rzeszow and Tarnobrzeg provinces, and since 1999 – the area of the present Podkarpackie province.

Using conventional statistical methods, based on demographic data from Provincial Statistical Office in Rzeszow and Podkarpackie Cancer Register – incidence rates and structure indicators (percentage) for the carcinomas located in C01, C09, C10 and C32 in ICD10 were calculated. The calculation of standardized rates for the region of south-eastern Poland was possible since 1999, due to changes in the administrative division of the country. Based on the published data of the Department of Epidemiology, Oncology Centre in Warsaw, similar data for Poland were compiled.

In 1997–1998, due to strikes in Health Care, cancer reports were not filled in, therefore, there is no data available for this period for both Poland and the south-eastern Poland, which was marked on the charts.

Results

In 1980–2013, in the region of south-eastern Poland, 10,046 cases of the head and neck cancer were registered, including 8,341 in men (87%) and 1,707 in women (13%). In this group 4,029 new cases of laryngeal cancer were registered, including 3,716 in men (92.2%) and 313 in women (8.0%). The absolute number of new cases per year in men, which was increasing from the 60's and was 77 in 1980, reached its peak of 164 cases in 1990 and then gradually decreased to 84 in 2013. The incidence among women in 1980 was 8 and reached a highest value of 19 cases in 2002 and then a decrease in the number of cases to 11 in 2013 was recorded. In the region of south-eastern Poland, incidence rates among men in the analyzed period increased from 7.8/100 thousand in 1980 to 15.1/100 thousand in 1990, and then it gradually decreased to 8.1/100 thousand in 2013.

Among women, the incidence rate increased from 0.8/100 thousand in 1980 to 1.3/100 thousand in 1990 and 1.8/100 thousand in 2002, then it dropped to 1.0/100 thousand in 2013. The standardized coefficients which, due to changes in the administrative division of the country, were possible to calculate for the region since 1999, amounted to 7.1/100 thousand for men and decreased to 5.4/100 thousand in 2013. Standardized coefficients for women were 0.5/100 thousand and 0.7/100 thousand, respectively.

The percentage of laryngeal cancer in men in relation to all malignancies in the province - increased from 3.8% in 1980 to 6.0% in 1990. Then it steadily decreased to 1.9% in 2013. The percentage for women grew from 0.4% in 1980 to 0.7% in 2002. Then it decreased to 0.3% in 2013[3,14]. In Poland, 180,285 cases of head and neck cancers were registered in 1980–2013 including 147,917 in men (82%) and 32,368 in women (18.0%).

For Poland, the absolute number of new cases of the laryngeal cancers totaled 81,032 in 1980-2013, including 72,724 (89.7%) in men and 8308 (10.3%) in women. The incidence of laryngeal cancer in men per year, which was steadily growing since the 60's and 70's, rose from 1,916 in 1980 to 2,720 in 1993. Then it decreased to 1,913 in 2013. The incidence in Polish women rose from 174 in 1980 to 321 in 2013 with the highest absolute number of cases – 330 diagnosed in 2003. The incidence rate increased in men from 11.1/100 thousand in 1980 to 14.5/100 thousand in 1993. Then it declined to 10.3/100 thousand in 2013.[15-18]

Incidence rate in women increased from 1.1/100 thousand in 1980 to 1.7/100 thousand in 2003 respectively and oscillated from 1.4/100 thousand to 1.6/100 thousand in 2013. Standardized incidence ratios for men were 10.5/100 thousand in the 1980s reaching 13.3/100 thousand in 1982 and 13.1/100 thousand in 1993. Then it gradually decreased to 6.5/100 thousand in 2013. Standardized incidence ratios for women were 0.8/100 thousand

in 1980 reaching 1.2/100 thousand in 1992, 1993, 1995 and 2000 and then they gradually decreased to 0.9/100 thousand in 2013.

The percentages were 5.6% in males in 1980 and 2.5% in 2013. In women, they amounted to 0.6% and 0.4%, respectively.[16-18]

According to ICD-9, which was in force in the period 1980-1997, oropharyngeal cancer was labelled with a code 146. In current ICD-10, it was marked with the code C10, however, it is commonly accepted to use the clinical definition of the oropharynx including the base of the tongue, the soft palate, tonsils and the throat, that means the sites with the following codes C01, 09, and 10.

According to this definition in the region of south-eastern Poland in 1980–2013, a total of 1,093 cases were registered, of which 895 (81.8%) were men and 198 (18.2%) were women. The incidence of this group of cancers increased in the period in question from 15 to 66 in men, while in women between 1980 with 11 cases and 2013 with 10 cases – only 3 times more cases than 10 were registered. This resulted in an increase in the incidence rate in men from 1.5/100 thousand in 1980 to 6.2/100 thousand in 2013. The incidence rate in women in 1980 was 1.1/100 thousand and in 2013 it amounted to 1.0/100 thousand.

Standardized incidence ratio for males was 0.9/100 thousand in 1999 and it increased to 4.6/100 thousand in 2013. Standardized incidence ratios for women were 0.2/100 thousand and 0.5/100 thousand, respectively. At the same time, the percentage changed from 0.7% to 1.5% in men and 0.6% to 0.3% in women.[3,14,15]

In the same period in Poland a total of 23,303 cases of this group of cancers were recorded, of which 18,268 (78.4%) in men and 5035 (21.6%) in women.

The absolute number of cases of oropharyngeal cancers (C01, C09, and C10) in men in 1980 in Poland was 286 and until 2013 it increased to 1,146 cases. The incidence in women increased from 102 in 1980 to 386 in 2013.The incidence rate in males were 1.6/100 thousand in 1980 and 6.1/100 thousand in 2013 and in women 0.6/100 thousand and 2.0/100 thousand, respectively.

Standardized coefficients for men amounted to 1.6/100 thousand in 1980 and 4.1/100 thousand in 2013. Standardized coefficients for women in Poland amounted to 0.5/100 thousand in 1980 and 1.2/100 thousand in 2013.

The percentage of cases in men increased from 0.8% in 1980 to 1.5% in 2013. The percentage in women increased from 0.3% in 1980 to 0.5% in 2013 (1.5–12, 17–29). In this group, significantly varied dynamics of disease in individual sites was also found.[16-18]

Discussion

Head and neck tumors in the analyzed period were 6th in terms of cancer incidence both in Poland and in the region of south-eastern Poland.[3,14] Although laryngeal cancer for many years were a major concern in this group of cancers, cancer of the oral cavity and oropharynx are becoming a subject of interest in the last decade.

Analyzing trends in the incidence of these cancers, the differences between the region of south-eastern Poland and Poland at large became visible. In Podkarpacie and in Poland, a decreasing trend in the incidence of laryngeal cancer in men is clearly visible, however, in terms of incidence rate and standardized coefficients and percentages it is far more pronounced in Podkarpacie. A decreasing tendency in the incidence in men is visible in Podkarpacie since 1991, while in Poland since 1994.

However, among women the tendency of decreasing incidence is observed in Podkarpackie where both incidence rate and percentage are lower than for Poland. This bears similarities to other regions close to the eastern border, where in the neighboring regions of Lublin and Świętokrzyskie incidence in women shows similar trends to Podkarpacie, and increased incidence was recorded only in the Warmia-Mazury region.[3,16-18]

Overall in Poland, since 1999, a slow but steady upward trend is recorded in the incidence in women; the absolute number of cases increased in the period by nearly a half, and the incidence rate increased by nearly 1/3.

These phenomena demonstrate great diversity not only among countries but also among regions. For example, in France in 2009, the differences in the incidence between regions in men ranged from 7.0/100 thousand to 13.4/100 thousand and in women from 0.2/100 thousand to 1.7/100 thousand.[19] In Poland, in 1999–2013, in half of the regions was recorded an increase in the incidence of laryngeal cancer in women, with the highest values of the incidence rate found in Kuyavian-Pomeranian, Lubuskie, Lodz, Pomerania, Silesia, Wielkopolska regions.[16-18]

On the other hand, in the estimation of the incidence in European countries in 2012 the values for laryngeal cancer for men averaged 8.8/100 thousand with the lowest figures for Iceland 2.2/100 thousand and the highest for Hungary 16.6/100 thousand. European average for women was estimated at 0.8/100 thousand with the highest incidence in Albania 2.7/100 thousand and the lowest for Finland and Belarus 0.2/100 thousand.

In this context, it is interesting to compare the results with the trends for neighboring countries. In the Czech Republic, incidence rates of laryngeal cancer in men amounted to 9.4/100 thousand in 1980 and after peak with 10.4/100 thousand in 1996 and 2003 and 2004 they returned in the following years to the value of 9.8 to 8.8/100 thousand, thereby presenting a relatively stable trend below 10.0 / 100 thousand, which was slightly lower than in Poland.[20] The opposite tendency was registered in the Czech Republic in women. While in 1980, the incidence was 0.6/100 thousand, in subsequent years a slow growth trend was registered and since 2009 it remained above 1.1/100 thousand until 2013. The similarity to the

trend among women in Poland is worth noting although the range of values are 1/3 lower.[3,16-18,20]

On the other hand, in Slovakia, the incidence of the laryngeal cancer in men decreased from 14.6/100 thousand in 1980 to 9.6/100 thousand in 2012, therefore, it is a lower value than in Poland - with a similar downward trend.[19] The incidence in women in Slovakia was 0.3/100 thousand in 1980 and reached 0.7/100 thousand in 2012. Thus increasing incidence tends are observed, although the coefficients were more than twice lower than in Poland.[3,16-19] In Prešov District in Slovakia, neighboring Podkarpacie, incidence rate for laryngeal cancer in men increased from 9.7/100 thousand in 2003 to 11.6/100 thousand in 2009 – which is an opposite trend than that of Podkarpacie, and the incidence rate for women from 0.7/100 thousand rose to 1.0/100 thousand – which is also an opposite trend than in Podkarpacie where at the same time it decreased from 1.5/100 thousand to 1.0/100 thousand.[3,21-28]

Analyzing the cancer in the oropharynx that is C01, C09, and C10, we attempted to relate the results to the neighboring provinces, Poland and other countries in a similar way as in the case of the larynx. Assessing morbidity in terms of its location C01, C09 and C10 is a subject of further changes in 1997 due to ICD revision from 9 to 10. This factor is always associated with difficulties in the interpretation of new definitions and not only in relation to cancers of the head and neck. In 1963–1997 the location "tongue" with a code 141 did not distinguish locations C01- tumor of the base of the tongue and C2-malignant neoplasm of other and unspecified parts of the tongue, which were created in ICD10. Therefore, the first years after the change of location, definitions were affected with too low registration of location C01 since C02 was easier to interpret. Regardless of this fact, the completeness of the registration was affected by strikes in Health Care in 1997–1998 when, among others, cancer reports were not filled in, therefore, the system of cancer registration was shuttered not only during strike, but also years after it.

This issue is extensively discussed in the literature from 1999–2005.[17,18] The above values of the analyzed three decades for Poland and Podkarpacie – similar laryngeal cancer do not fully reflect the differences between various regions. In Świętokrzyskie, the incidence increased from 2.0/100 thousand in 1999 to 4.8/100 thousand in 2013 for men and from 0.4/100 thousand to 0.5 for women – although in the past few years these rates exceeded 1.0/100 thousand.[17,18,31-34] In the Lublin region, the incidence of oropharyngeal cancers (C01,09,10) increased from 1.0/100 thousand in 1999 to 3.7/100 thousand in males, and from 0.1/100 thousand to 0.5/100 thousand for women.[17,18,35-41]

In the Czech Republic these tumors (C01, 09, 10) showed in 1980-2013 more than a fourfold increase in the incidence in men from 1.9/100 thousand to 8.5/100 thousand and in women five-fold from 0.5/100 thousand to 2.5/100 thousand.[19] Increasing incidence trend both in men and women was thus significantly higher than in Poland.

In Slovakia, the incidence rate in 2003–2009 increased in males from 8.5/100 thousand to 11.5/100 thousand and in women from 0.7/100 thousand to 1.6/100 thousand.[20-27] Thus they were also higher than in Poland, for both men and women.

In the district of Prešov, incidence increased in men from 6.9/100 thousand in 2003 to 11.5/100 thousand and in women from 0.7/100 thousand to 1.0/100 thousand in 2009.[20-27] The incidence was thus higher in that region than in Podkarpacie both in men and women.

The above discussion documents besides presentation of the figures also familiar data on the geography of cancer. Significant differences between individual countries and also very important regional differences make it an important source material for healthcare organizations in the region.

Conclusion

1. The incidence of cancer of the head and neck over 3 decades shows that the proportion of cases in women in Poland was higher than in Podkarpackie (18% vs 13%) similar to the laryngeal (10.3% vs 8.0%) and oropharyngeal cancers (21.6% vs 18.2%).
2. In laryngeal cancer, a trend of decreasing incidence in men is visible in Podkarpacie since 1991, and overall in Poland since 1994.
3. In Poland, a visible steady upward trend in throat cancer in women is observed; the absolute number of cases increased in the period by nearly half, the incidence rate increased by 1/3, and in the years 1999–2013 in half of regions an increase in laryngeal cancer rate in women was observed.
4. In Podkarpacie, in women, both the incidence rate and percentage of laryngeal cancer are lower than in Poland overall, similar to other provinces close to the eastern border, where in Lublin and Świętokrzyskie regions similar incidence trends in women to Podkarpacie are observed and an increase in the incidence was recorded only in the Warmia-Mazury region.
5. Oropharyngeal cancer incidence in Podkarpacie in men was, in the analyzed period, lower than for Poland overall, and only in the last 3 years of observation it reached a value close to the average for the country.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.7

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 45–49

ORIGINAL PAPER

Edyta Mikołajczyk [1(ABCDFG)], Beata Ligęza [2(BCEFG)], Agnieszka Jankowicz-Szymańska [3(ADEFG)]

The effect of hippotherapy on postural balance

[1] Section of Kinesitherapy, Department of Physiotherapy, University of Physical Education Krakow, Poland
[2] The Foundation for People with Disabilities, Stróże, Poland
[3] Section of Physical Education, Department of Health Sciences, State Higher Vocational School, Tarnow, Poland

ABSTRACT

Introduction. Impaired motor control in children with infantile cerebral palsy (ICP) frequently leads to mobility limitations.

Aim. The aim of the study was to assess the effect of hippotherapy on maintaining postural balance and gait in children with ICP.

Material and methods. A total of thirty children with spastic diplegia, aged 8-13 years, participated in the study. All children took part in a two-week hippotherapy program. The Tinetti and Timed Up and Go (TUG) tests were used to investigate the quality of their postural balance and gait. All tests were performed before and after therapeutic horseback riding.

Results. After the two weeks of therapy, a statistically significant ($p<0.05$) improvement in balance maintenance and gait performance was observed in all children.

Conclusion. 1. Hippotherapy sessions significantly improved the level of postural balance in children with ICP.
2. Equine-assisted therapy (EAT) positively affected the quality of gait and significantly decreased the risk of accidental falls in children who participated in the rehabilitation program.

Keywords. cerebral palsy, hippotherapy, balance

Introduction

Rehabilitation of children who suffer from infantile cerebral palsy (ICP) constitutes one of the core elements in the therapeutic process. ICP is one of the most frequently prevailing paediatric neurological disorders which present challenges to physiotherapists. Due to the above-mentioned disorders, new methods supporting the process of revalidation of this dysfunction are sought for. ICP is not a disease; it is rather a set of symptoms resulting from a brain injury in pregnancy, labour or the perinatal period. A diversity of symptoms accompanying ICP, mainly disturbances of maintaining postural balance during movement, may result in chronic muscle imbalance and lead to increased disability with age. Impaired postural control belongs to one of the most serious locomotion problems of children with ICP which cause limitations in performing everyday activities.[1] That is why the process of treating persons with ICP requires a diverse

Corresponding author: Edyta Mikołajczyk, Zakład Kinezyterapii, Akademia Wychowania Fizycznego, Al. Jana Pawła II 78; 31-571 Kraków, tel. 12 683 11 67, email: edytamiko@gmail.com

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 4.12.2016 | Accepted: 14.03.2017
Publication date: June 2017

Mikołajczyk E, Ligęza B, Jankowicz-Szymańska A. *The effect of hippotherapy on postural balance*. Eur J Clin Exp Med. 2017;15(1):45–49. doi: 10.15584/ejcem.2017.1.7

attitude, and the main target of rehabilitating impaired locomotion should consist in improving motor skills and accomplishing the best possible functional independence of those persons through increasing their control of locomotion and posture. Rehabilitation of a child with ICP should commence as soon as possible, and it should be conducted in a complex way, taking into account its subsequent developmental phases.[2-4] Many various methods and treatments, modified and improved over the years, are used in rehabilitating children with ICP, e.g. neurophysiological methods, such as the NDT, Vojta method or a sensory therapy, through which the greatest possible level of functional independence of a child participating in the rehabilitation program is expected.[5,6] Hippotherapy belongs to one of the rehabilitation methods with a multipurpose, interdisciplinary approach. Equine-assisted rehabilitation of disabled persons should also comprise other areas of medicine and rehabilitation, including psychology, pedagogy, hippology, hippotherapy, physical culture and horse riding.[7,8]

Hippotherapy affects physical, cognitive, social, mental, and behavioural and communication spheres and that is why it is used to rehabilitate persons with ICP, Down syndrome, autism, multiple sclerosis and traumatic brain injury, muscular dystrophy and postural deformities, difficulties in learning and in sensory disturbances. It is a therapeutic method successfully used in children, and according to the 2009 data of the Polish Central Statistical Office, there were more than 180,000 disabled children in Poland, out of whom every third child experienced locomotion problems.[9,10]

Hippotherapy encompasses activities which target at restoring fitness and health by interactions with horses and by horseback riding. Different movements of the horse present challenges to the rider to promote different postural responses, which among others affect their muscle tone, control of the head and neck posture, postural balance, stability of the trunk and performance of the limbs. The above-mentioned physical benefits of therapeutic work with horses are possible thanks to the:

- pelvic movements of the horse while walking, which are similar to the pelvic movements of a man during a leisurely walk
- length and the number of steps performed by a horse per minute, which are similar in length and the number of steps of an adult man
- temperature of the horse's body, which is 37.5°C–38.5°C, and affects restoration of normal muscle tone
- and repetitive, rhythmic movements of the human body while riding a horse, which stimulate hormonal secretion affecting stimulation of the vegetative system.[11]

The rider's reception of motor stimuli caused by the rhythmical gait of a horse and their responding to them are the main targets of hippotherapy sessions. According to Strumińska, the general aims of hippotherapy include the stimulation of the psychomotor development of the child, i.e.: improvement of the eye-hand coordination, development of self-reliance and the ability to maintain organised activity and to focus on given tasks, improvement of locomotion, a decrease in postural balance disturbances and improvement of defensive reactions, relaxation and weakening of neurotic reactions and an increase in high self-esteem.[12]

Therapeutic effects caused by the horse gait were confirmed by many research projects.[7,13,14]

Aim of the study

The aim of the study was to assess the quality of postural balance and gait in children with ICP who participated in the hippotherapy program.

Material and methods

A total of 30 children, including 19 girls and 11 boys, with ICP (the spastic diplegia CP) within intellectual norm participated in the study. Participant age fell within the age bracket of 8–13yrs. Children, based on a physiatrist's recommendation, were qualified for hippotherapy sessions. Participants were included in the study group based on the following criteria: suffering from a mild form of *hemiplegia spastica* or *diplegia spastica* of ICP, medical certificates from orthopaedists or neurologists confirming the lack of contraindications against hippotherapy, possibility of independent locomotion and communication. Children with severe ICP and those with intellectual disability making communication impossible were not qualified for the study. All 30-minute hippotherapy sessions were conducted daily from Monday to Friday by a highly qualified therapist at the Hippotherapy Centre in Stróże, and the therapeutic horseback riding program lasted for two weeks. Tests and the equine-assisted therapy were conducted in March 2016. During the two week hippotherapy program children did not participate in any other therapies. Participants' parents and legal guardians gave their informed consent for the participation of their children in the study.

The following research tools were used in the study.

The Timed Up and Go Test (TUG) to assess dynamic balance and the risk of accidental falls. The mobility test consisted in performing specific motor activities, such as standing up from a sitting position on a chair, walking for 3 meters, turning back and covering the same distance back to the chair and sitting down on it. The time of performing the task correctly was taken as the test score. Participants were assessed according to the protocol modified for the needs of persons with ICP, i.e.: commands were repeated several times during the performance of the test, the chair used in tests was equipped with a back rest but it did not have arms, the measuring

of the time did not commence at the moment of hearing the "get ready and go!" command but at the moment of raising buttocks from the chair, and it ended when the participant sat back on the chair.

The test was conducted three times and the attempt with the shortest time in seconds was recorded in the test chart. The path of the walk was three metres long and it was marked by the starting line before which a chair stood, and the finish line behind which the participant was supposed to turn back and return to the chair. The participant sat on the chair before commencing the test. At that time a physiotherapist explained the task to them, demonstrated its performance and conducted a preliminary attempt to verify whether the task performance had been understood.

Balance and gait quality were assessed by means of the Tinetti test, which consisted of two parts. Part one assessed postural balance and included nine tasks: 1) maintaining balance in a sitting position on a chair, 2) standing up, 3) an attempt at standing up from a sitting position on a chair, 4) maintaining balance immediately after assuming a standing position (for the initial five seconds), 5) maintaining balance while standing, 6) pushing (the participant stood with their feet kept as close together as possible, and the physiotherapist delicately pushed them by nudging the participant's chest three times with their palm), 7) a pushing test in standing with the eyes closed, 8) turning around 360 degrees, and 9) sitting down.

The maximum score in the balance test was 16.

The gait part of the test consisted of seven parts and assessed the following: 1) the gait initiation (once the command was heard), 2) the length and height of the step, 3) the symmetry of the step, 4) the step flow, 5) the path of the gait (assessed within the distance of approximately 3m; a deviation of 30 cm was recorded), 6) the trunk posture (it was checked whether the participant wobbled while walking), and 7) the foot placement when walking (heels wide apart or touching).

The maximum score in the gait test was 12 points. The final result consisted of the score for each section of the test and the overall test score.

Statistical analysis

The statistical analysis of the results was conducted by means of Statistica v.10. The Shapiro-Wilk test was used to assess distribution of the variables under analysis. Because the variables met the criteria for a normal distribution, the significance of differences was assessed by means of the t-Student test for dependent samples. The level of significance was accepted at $\alpha = 0.05$.

Results

Based on the statistical analysis of the Tinetti test assessing postural balance, it was discovered that the mean score before the therapy was 9.03 pts, and after the hippotherapy program it was 10.83 pts. The therapy conducted statistically significantly ($p < 0.05$) improved the score in the test and the mean difference was 1.8 pts (Table 1).

Based on the gait assessment part of the Tinetti test, it was observed that the mean score before the therapy was 7.6 pts, and after the therapy it was 8.57 pts. A statistically significant difference ($p < 0.05$) was found between the scores obtained in the gait assessing part before and after the therapy. The therapy implemented significantly improved the score in the test and its mean score difference was 0.97 pts (Table 2).

Based on the Tinetti test conducted before hippotherapy, 15 out of a total of 30 participants had a high risk of falls, 14 were prone to a fall, and 1 child had a low risk of a fall. After the two weeks of hippotherapy, the comparison of general results of the Tinetti test revealed a statistically significant improvement ($p < 0.05$) since only 11 participants had a high risk of falls, 9 were prone to a fall, and 10 participants had a low risk of falls. The mean result before the therapy was 16.63 pts, and after the therapy it was 19.40 pts. Those differences were statistically signif-

Table 1. Tinetti test – balance assessment part; comparison of scores before and after therapy

Body balance	n	$\bar{x}$	SD	Maks	Min	$\bar{x}_{1-}\bar{x}_{2}$	t	p
1 before therapy	30	9,03	4,00	14	0	-1,8	-7,761	0,000
2 after therapy		10,83	3,99	16	0			

Table 2. Tinetti test – gait assessment part; comparison of scores before and after therapy

Gait evaluation	n	$\bar{x}$	SD	Maks	Min	$\bar{x}_{1-}\bar{x}_{2}$	t	p
1 before therapy	30	7,6	3,50	12	0	-0,97	-5,491	0,000
2 after therapy		8,57	3,46	12	1			

Table 3. General result of Tinetti test – comparison before and after therapy

Tinetti Test	n	$\bar{x}$	SD	Maks	Min	$\bar{x}_1 - \bar{x}_2$	t	p
1 before therapy	30	16,63	7,30	26	1	-2,77	-8,537	0,000
2 after therapy		19,40	7,13	27	1			

Table 4. Timed Up and Go Test – comparison before and after therapy

Timed Up and Go Test	n	$\bar{x}$	SD	Maks	Min	$\bar{x}_1 - \bar{x}_2$	t	p
1 before therapy	30	11,97	4,75	26	7	1,03	5,477	0,000
2 after therapy		10,93	4,33	25	6			

icant ($p < 0.05$). The hippotherapy program significantly improved the general result of the test and the mean difference was 2.77 pts (Table 3).

The statistical analysis of the TUG test revealed that the mean score before the therapy was 11.97 s, and after the therapy it was 10.93 s. Rehabilitation consisting of hippotherapy sessions significantly shortened the performance time of the TUG test ($p < 0.05$), and the mean difference was 1.03 s (Table 4).

Discussion

Sensory deficits typical of ICP, including vision and proprioception problems, can cause postural and balance disturbances which may considerably affect the performance of locomotor tasks. Stable posture is essential for the performance of more and more complex motor tasks, and for the coordination improvement. Hippotherapy can be used in such cases in which it brings the results which could not be accomplished by means of other physiotherapy methods, or as a rehabilitation supporting therapy.[15] It covers extensive activities which aim to improve postural and balance control in children with ICP, and it may improve performance of everyday activities, self-reliance and the quality of life of those children.[16] The ability to control body posture is the most important part of motor abilities.[17]

The results of the authors quoted coincided with our results, which confirmed the effectiveness of hippotherapy reflected in improved balance and gait in children with ICP who participated in the two-week hippotherapy program. Other researchers from different research centres reported in their studies that both long-lasting hippotherapy programs and single hippotherapy sessions significantly improved static and dynamic balance, and gait in children with diagnosed balance deficits. A six-week hippotherapy program, consisting of sessions conducted twice a week per 45 minutes, significantly improved postural balance and everyday functioning in children aged 5–16yrs.[18] An eight-week hippotherapy program significantly improved the gait speed and length, and pelvic kinematics in children with ICP.[19] Equine-assisted therapy improved the quality of body posture, muscle tone and postural balance in children with severe spasticity of ICP.[20] The study of Maćkow et al., revealed that a single hippotherapy session may significantly move the point of the centre of gravity (COG) in the frontal plane, and it may affect the mean speed of oscillation in the sagittal plane in children with ICP. [21]The study of Manikowska et al., also discovered beneficial effects of a single hippotherapy session on the temporal and spatial gait parameters in children with ICP. The speed of gait significantly increased after a single hippotherapy session and the remaining parameters came close to the reference values for a given age. The step length was the only parameter which got worse, but those changes were not of statistical importance.[22]

The studies of many authors, as well as our studies, revealed that hippotherapy improved postural balance and gait, but we still lack research which would assess the long term effects of hippotherapy after the completion of the program. Based on such findings, it would be possible to determine the best duration time of the hippotherapy program and its sessions in order to maintain the effects for as long as possible.

As it is known, damaged brain tissue does not regenerate and the accomplishment of many motor skills is possible only through compensation. This process needs to be directed extremely skilfully because by providing adequate stimuli it is possible to create, consolidate, retain and make anticipated motor activities automatic. In the process of rehabilitating a child with ICP we strive to work out such motor skills which – despite brain damage – would maximally be similar to proper motor patterns, would prevent contractures and secondary deformities

in the osteoarticular system and would avert retaining pathological locomotor patterns. Rehabilitation, using therapeutic properties of the horse and hippotherapy, may improve balance and muscular coordination, as well as sensory integration and motor skills. Hippotherapy may beneficially affect the central nervous system and locomotor patterns trained during the therapeutic horse riding and it may improve locomotor patterns of the child in their everyday activities.[1]

Study Limitations

The study is limited by the lack of comparing its results to the controls. However, the effects observed encourage us to further research.

Conclusion

1. Hippotherapy significantly improved postural balance in children with ICP.
2. Equine-assisted therapy positively affected the quality of gait and significantly decreased the risk of accidental falls in children who participated in the rehabilitation program.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.
Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.8

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 50–58

ORIGINAL PAPER

Agnieszka Lintowska [1(ABCDEFG)], Artur Mazur [2(ADF)]

Adaptation of a Polish version of the National Youth Tobacco Survey Questionnaire. A pilot study

[1] Department of Public Health, Faculty of Health Science, Wroclaw Medical University
[2] Institute of Nursing and Health Sciences, Faculty of Medicine, University of Rzeszow

ABSTRACT

Introduction. In today's world, tobacco is the most common cause of morbidity and mortality and is associated with unhealthy behavior. Poland is among the countries with high rates of smoking, and occurrence of tobacco related diseases. Tobacco use by children and adolescents is a serious public health problem because of the immediate and long-lasting harmful effects on health. A large group of current smokers begin smoking during youth. The goal of the work was to culturally and linguistically adapt, and test and pre-evaluate a Polish version of the National Youth Tobacco Survey (NYTS), which identifies and monitors trends in tobacco use among young people.

Materials and methods. The test was administered by a test-retest method in 2015 with participation of 47 (25 girls and 22 boys) people aged 17–18. Respondents filled out the questionnaire twice within two weeks. The compliance percentage of individual test items and correlations between individual items in repeated measurements were evaluated.

Results. More than seventy percent have reliability ratios at very high or high levels with twenty five percent at moderate levels.

Conclusion. The tested Polish version of the NYTS questionnaire may be used in adolescent studies.

Keywords. validation study, smoking questionnaire, tobacco, youth, attitude

Introduction

In the modern globalized world, the most common reason for the occurrence of sickness and death of an otherwise healthy human being is tobacco usage. It can be directly avoided by quitting the use of any kind of tobacco product, yet this seems to be not so easy. The World Health Organization (WHO) estimates that over 1 billion people are using cigarettes world-wide, and 5 million deaths each year are registered due to the smoking habit.[1] If current trends continue, the number of deaths due to tobacco use will rise up to 10 million every year, according to the WHO.[2] The region of the European Union reports epidemiological data indicating that sicknesses caused by tobacco are responsible for 650 thousands deaths per year among Europeans, whereas Poland accounts for 100 thousand of these deaths every year. It is important to emphasize that Poland is among 14 countries that host half of all smoking people living in the world. A high rate of smoking, along with Poland, are the nations of Bangladesh, Brasil, China, Egypt, India, Mexico, Philippines,

Corresponding author: Agnieszka Lintowska, Department of Public Health, Faculty of Health Science, Wroclaw Medical University, e-mail: agnieszka.lintowska@umed.wroc.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 21.12.2016 | Accepted: 07.03.2017
Publication date: June 2017

Lintowska A, Mazur A. *Adaptation of a Polish version of the National Youth Tobacco Survey Questionnaire. A pilot study*. Eur J Clin Exp Med. 2017;15(1):50–58. doi: 10.15584/ejcem.2017.1.8

Russia, Thailand, Turkey, Ukraine, Uruguay, and Vietnam. These countries suffer high health and economic consequences in direct connection with the unhealthy behavior of using tobacco.[3]

Multicenter, nationwide Poles Health Condition Examinations (WOBASZ) administered during the years 2003–2005 demonstrated that 42% men and 25% women smoked tobacco on a regular basis, yet significant interregional differences in this area were observed. The highest number among men was observed in the Podlaskie and Malopolskie regions (42% and 34%), and the lowest in the Podkarpackie region (14%). The average number of cigarettes smoked per day was high as well as among men and women (18 and 14 cigarettes).[4]

Research carried out among Polish children and teenagers showed a significant percentage of tobacco users are in puberty. The cyclical study, Health Behavior in School-aged Children (HBSC), showed a growth of tobacco smoking among Polish teenagers in the last decade of the 20th century. Since the beginning of the 1990's, the percentage of smoking among 13 years old girls increased from 3% to 10% and in 15 year old girls from 16% to 28%.[5] This trend was observed to slow down in the following years and the percentage of smoking 15 years old girls went down to 20%.[6,7] The results were also confirmed by the Global Youth Tobacco Survey (GYTS) taken among middle school students (aged 13–15) in Poland in the years 1999, 2003, and 2009.[8] These statistics reaffirm that smoking is one of the most urgent problems of public health.

Tobacco use among children and teenagers is a serious problem of public health considering the immediate and long-lasting harmful health consequences such as a higher risk of asthma, cardiovascular diseases, chronic cough, chronic obstructive airway disease (COPD), and cancer. Numerous studies have demonstrated a meaningful higher risk of developing the above mentioned diseases later in the life of smoking adolescents as compared to their non- smoking peers.[9–12] Using tobacco during one's early years has an impact on physical development, and may lead to mood disorders.[13] WHO data shows that vast majority of smokers start to use tobacco before entering adulthood. Almost a quarter of all smoking teenagers in the world had their first cigarette before reaching an age of 10 years.[2] Young people using tobacco are more vulnerable to use of other psychoactive substances such as alcohol and drugs, and exposed to more risky behavior when compared to their peers.[14] Source literature points out that the chances of successfully quitting among those who started to smoke before turning 16 years old where half as good as those who started later in life.[15]

Exposing children and teenagers to passive tobacco smoke by adults (parents, caregivers, etc.) is another serious public health problem. This so-called passive smoking can cause sicknesses like pneumonia, bronchitis, cough and breathing problems, asthma, otitis and a higher risk of neurobehavioral disorders as well as circulatory diseases later in the life. Numerous studies show that smoking parents or close caregivers increase the risk of tobacco using by the children in the future.[12,16]

In order to design activities necessary for prevention of smoking among children and teenagers, facilitators that cause one to start smoking, resulting in regular usage of tobacco products, should be identified first. Many of the facilitators have been already identified. However, taking into consideration fast changes in modern life, which continually offers new stimuli, products and trends, there is a great need for a dynamic diagnosis of the predictive factors influencing the beginning of tobacco product use and later regular smoking by teenagers.

The American National Youth Tobacco Survey (NYTS) questionnaire was designed to identify and to monitor trends concerning exposure to the use of tobacco by teenagers. Studies pursued with the NYTS deliver information on tobacco usage predictive factors, monitor usage in different products, and results are being used for design and application of practical preventive programs for teenagers according to the regulations of the Healthy People 2020 strategy.

The first study to use the NYTS questionnaire was in the USA in 1999, subsequently followed in 2000, 2002, 2004, 2006, 2009, and 2011. After 2011, the test has been administered every year. Areas that are analyzed in the survey are concerned with the spreading usage of tobacco products by the teenagers, knowledge and attitude towards smoking tobacco, anti and pro-smoking activity exposure (e.g. companies producing tobacco products), adolescent access to tobacco products, and nicotine addiction.[17]

Aim of the study

Aim of this study was to culturally and linguistically adapt and pre-evaluate a Polish version of the National Youth Tobacco Survey (NYTS) questionnaire.

Material and methods

The NYTS questionnaire consists of an introduction and a main section containing questions about tobacco. The introduction explains the purpose of the study, ensures that the respondent's overall anonymity is maintained and that the study could be discontinued at any time without any consequences. The main part of the questionnaire consists of an instruction section and an American version of 81 questions.

The questionnaire for respondents consists of the following sections:

1. Socio-demographic data
2. Smoking cigarettes
3. Smoking cigars
4. Using snuff
5. Using a tobacco pipe
6. Use of other tobacco products

7. Addiction to tobacco
8. Exposure to pro-tobacco activities
9. Tobacco warning labels
10. Cessation of smoking and use of other tobacco products (smoking cessation)
11. Attitudes towards the use of tobacco products
12. Home environment and tobacco

The questionnaire contains two test item formats: question or statement. The measurement scales on which the respondent can respond to on the individual test items in the following sections are categorical scales and are divided into nominal, ordinal and Likert's scale of responses. So the questionnaire consists of both scales with a metric response and nonmetric measures.

The questionnaire is most often used for research in the group of adolescents of an age that corresponds to the level of last classes in primary and secondary schools in Poland. The study is conducted with use of the auditing questionnaire. Respondents complete the questionnaire in paper form in the presence of the researcher. The entire procedure, including handing out the instructions and collecting questionnaires at completion, takes about 45 minutes. The NYTS version of the survey from 2012 (approved and used by the American Academy of Pediatrics AAP), was used. The owners have given permission to use this questionnaire to conduct the survey. At this stage, there was no request for approval made to the Bioethics Committee, because they were small-scale surveys, and did not constitute medical research (eg controlled clinical trials for the diagnosis, treatment of diseases or physiological, biochemical and pathological processes in the human body). Currently, the Bioethics Committee is proceeding on approval of subsequent studies for a wider group of respondents.

Work on the cultural adaptation of the questionnaire began with the translation of the original US version of NYTS 2012 in accordance with international recommendations for the adaptation of tests and questionnaires.[18] First, two independent translators translated the original English questionnaire into a target language (foreword translation). Initially, the transcription method was used for this purpose, which is characterized by a maximum accuracy of translation, with identical graphic form, question form and content. The planned intercultural comparisons of the results of the study were discussed. However, after a preliminary study (n = 14), a translation method was chosen, which is characterized by the maximum accuracy of the translation, but allows modifications in cases where the literal translation is incomprehensible.[19] This decision was made due to problems with understanding the questions reported by the respondents during the preliminary research. However, the original form of the questionnaire and question formats were retained in their entirety. The next step was to back-translate the Polish version into English and compare it with the American version of the survey. During the translation, questions about racial and ethnic origin were removed from the first section, «Socio-demographic data,» because of the different structures of American and Polish societies in this respect. Unlike American society, Polish society is not multicultural and multiethnic, so there is no need to address questions in this regard. Thus, the Polish version of the questionnaire eventually contained 79 entries.

Proper pilot studies were conducted in October and November 2015 in the Wroclaw district. They were made in an adolescent group aged 17–18 (n = 60) including 36 girls and 24 boys. Respondents were secondary and high school students. The final analysis included 47 complete first and second measurement questionnaires. The study was conducted by the auditor questionnaire, which was completed by the respondents for up to 45 minutes. In the case of a preliminary assessment of the questionnaire, a study group of between 30–40 persons is recommended.[18]

The reliability of the questionnaire was measured using the retest method where a two-week gap was used between the first and second (repeated) measurement. The decision on interval time between studies in the same group was made on the basis of recommendations of methodologists on the nature of the studied concepts and literature of the subject.[20] The percentage compliance of the questions in the first and second measurements was assessed using the following compatibility criteria: excellent (90% – 100%), good (75% – 89%), medium (60%-74%), poor (<60%). Correlations between the individual test positions in the repeated measurements were then analyzed. Depending on the measurement scale, rhoSpearman which takes values from -1 to + 1 (> 0.4 medium, > 0.7 very good, > 0.9 excellent) , tau b- Kendala, which is from -1 to +1, kappa Cohna from -1 to 1 (> 0.41 medium, > 0.61 good, > 0.81 very good, 1.0 excellent) were used. A significance of correlation was assumed at $p \leq 0.05$. The internal consistency using Cronbach's alpha was estimated (for scales where it was possible), which takes values from 0 to 1. It is believed that a value above 0.7 represents the correct scale accuracy.[21–23] Data was analyzed using the IBM SPSS version 23.

Results

The first questionnaire was completed by 60 respondents comprized of 36 girls and 24 boys of age 17–18. 53 respondents (91%) fully completed the questionnaire. 52 people completing the first assessment also completed the second one. Only those who fully completed first and second survey were included the evaluation of the NYTS questionnaire. There were 47 (× 2) fully completed questionnaires submitted by 25 (53.2%) women and 22 (46.8%) men. The average age of this group was 17.23 (SD = 0.428) years old with a median of 17 years old.

Within the group of respondents, 10 people (23.3%) have smoked more than 100 cigarettes. Basing on the literature, this amount is considered to qualify them as a group

Table 1. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Smoking cigaretes section'

Section: Smoking cigarettes	Percentage agreement % (n)	rho Spearman r	tau b- Kendala Tb	Kappa Cohena	p
1 – Item 5	85 (40)	0.954			< .0001
2 – Item 6	93 (44)	0.838			< .0001
3 – Item 7	83 (39)	0.861			< .0001
4 – Item 8	80 (38)	0.914			< .0001
5 – Item 9	80 (38)	0.843			< .0001
6 – Item 10	76 (36)	0.984			< .0001
7 – Item 11	85 (40)		0.959		< .0001
8 – Item 12	91 (43)		0.993		< .0001
9 – Item 13	89 (42)		0.965		<,0001
10 – Item 14	78 (37)		0.961		< .0001
11 – Item 15	62 (29)			0.680	= 0.301
12 – Item 16	91 (42)			0.810	0.000
13 – Item 17	85 (40)			0.722	0.000
14 – Item 18	91 (43)			0.784	0.000
15 – Item 19	89 (42)			0.744	0.000
16 – Item 20	89 (42)			0.677	0.000

in high risk of smoking tobacco in future. Thus, 23.3% of respondents are qualified. The rest of the examined respondents have either never smoked before (n = 11) or they have smoked up to 20 cigarettes (n = 24) or they have smoked more than 20 but less than 100 cigarettes (n = 2).[24]

The reliability of the questionnaire was analyzed by percentage agreement by a test re-test method and correlation coefficients of the individual item level. Tables 1–11 present test results.

Table 1 presents percentage agreement, correlations and significance regarding smoking cigarettes. This section shows sixteen positions, consisting of six in the Likert scale, six in nominal scale and four in the ordinal scale. Four positions characterized a very good percentage agreement (90% – 100%), eleven positions good (75% – 89%), one medium (60% – 74%). Correlations between repeated measurements are characterized by high indicators from Tb = 0.993 do Kappa = 0.677. All correlations (excluding no.11 p = 0.301) are under the assumed statistical significance level $p \leq 0.05$.

Table 2 presents percentage agreements, correlations and significance regarding smoking cigars. Two positions show very good percentage compatibility (89% – 100%), four show good percentage compatibility (75% – 89%). Correlations between repeated measurements are characterized by medium high indicators from a r = 0.904 do Kappa = 0.465. All correlations are under the assumed statistical significance level of $p \leq 0.05$.

Table 3 presents percentage agreement, correlations and significance regarding using snuff. This section shows six positions, consisting of three in the Likert scale, one in the nominal scale and three in the ordinal scale. Four positions are characterized by a very good percentage agreement (90% – 100%), two positions good (75% –89%). Correlations between repeated measurements are characterized by excellent indicators and very good from Kappa = 1 to r = 0.672. One position shows (4) significance over that assumed at $p \leq 0.05$ (p = 0.312) but with high percentage agreement.

Table 4 presents percentage agreement, correlations and significance regarding the use of tobacco pipes. Sec-

Table 2. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in 'Smoking cigars section'

Section: Smoking cigars	Percentage agreement % (n)	rho Spearman r	Tau b- Kendala Tb	Kappa Cohena	p
1- Item 21	78 (37)	0.904			< .0001
2 - Item 22	93 (44)	0.741			< .0001
3 - Item 23	85 (40)	0.992			< .0001
4 - Item 24	91 (43)		0.693		= 0.024
5 - Item 25	80 (38)			0.465	0.000
6 - Item 26	80 (38)			0.579	0.000

Table 3. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Using snuff section'

Section: Using snuff	Percentage agreement % (n)	rho Spearmana r	tau b- Kendala Tb	Kappa Cohena	p
1 - Item 27	89 (42)	0.911			< .0001
2 - Item 28	93 (44)	0.672			< .0001
3 - Item 29	83 (39)	0.799			< .0001
4 - Item 30	96 (45)		0.680		= 0.312
5 - Item 31	100 (47)			1	0.000
6 - Item 32	100 (47)			1	0.000

Table 4. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'A pipe with tobacco section'

Section: A pipe with tobacco	Percentage agreement % (n)	rho Spearman r	tau b- Kendala Tb	p
1 - Item 33	85 (40)	0.637		< .0001
2 - Item 34	89 (42)		0.817	= 0.023

Table 5. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Other tobacco products section'

Section: Other tobacco products	Percentage agreement % (n)	Kappa Cohena	p
1 – Item 35	61 (28)	0.620	= 0.204
2 – Item 36	59 (27)	0.51	0.000
3 – Item 37	62 (29)	0.478	0.000
4 – Item 38	76 (36)	0.742	0.000

Table 6. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Addiction to tobacco section'

Section: Addiction to tobacco	Percentage agreement % (n)	rho Spearman r	tau b- Kendala Tb	p
1 – Item 39	91 (43)	0.787		< .0001
2 – Item 40	93 (44)	0.775		< .0001
3 – Item 41	87 (41)		0.972	< .0001
4 – Item 42	83 (39)		0.857	< .0001

tion shows two test positions: one in the Likert scale, one in the nominal scale. Both positions show good percentage compatibility (75% – 89%). Correlations between repeated measurements are characterized by high indicators from r = 0.637 to Tb= 0.817 levels. All correlations are under the assumed statistical significance level of $p \leq 0.05$ (one position is $p < 0.0001$ and the next $p = 0.023$).

Table 5 presents percentage agreement, correlations and significance regarding other tobacco products. This Section shows four test positions, all are in the nominal scale. One position shows good percentage agreement (75% – 89%), two positions show medium (60% – 74%), with one poor (< 60%). Correlations between repeated measurements are characterized by good indicators from a kappa = 0.478 to kappa = 0.742 levels. All correlations (excluding no. 1) are under the assumed statistical significance level of $p \leq 0.05$.

Table 6 presents percentage agreement, correlations and significance regarding addiction to tobacco. This section shows four test positions, 4 in the Likert scale, the rest in the ordinal scale. Both positions show very good percentage agreement (90% – 100%), next good one (75% -89%). Correlations between repeated measurements are characterized by high indicators from r = 0.775 to Tb = 0.972 levels. All correlations are under the assumed statistical significance level of $p \leq 0.05$.

Table 7 presents percentage agreement, correlations and significance regarding exposition to tobacco products. The section shows nine test positions, consisting of six in the ordinal scale and three in the nominal scale. One position has a very good percentage compatibility (90% – 100%), three positions have a good compatibility (75% – 89%), four have moderate (60% – 74%) and one has weak (< 60%). Correlations between repeated measurements are characterized by medium and high indicators from

Table 7. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Exposure on tobacco section'

Section: Exposure on tobacco	Percentage agreement % (n)	tau b- Kendala Tb	Kappa Cohena	p
1 – Item 43	83 (39)	0.524		< .0001
2 - Item 44	64 (30)	0.750		< .0001
3 - Item 45	62 (29)	0.566		< .0001
4 - Item 46	83 (39)		0.493	0.000
5 - Item 47	93 (44)		0.478	0.000
6 - Item 48	74 (35)	0.877		< .0001
7 - Item 49	53 (25)	0.530		< .0001
8 - Item 50	64 (30)	0.669		< .0001
9 - Item 51	83 (39)		0.725	0.000

Table 8. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Warning label section'

Section: Warning label	Percentage agreement % (n)	tau b- Kendala Tb	p
1 – Item 52	83 (39)	0.903	< .0001
2 - Item 53	68 (32)	0.804	< .0001
3 - Item 54	80 (38)	0.919	< .0001
4 - Item 55	87 (41)	0.830	< .0001

Table 9. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Smoking cessation section'

Section: Smoking cessation	Percentage agreement % (n)	tau b- Kendala Tb	p
1 - Item 56	83 (39)	0.958	< .0001
2 - Item 57	87 (41)	0.969	< .0001
3 - Item 58	93 (44)	0.985	< .0001
4 - Item 59	87 (41)	0.958	< .0001
5 - Item 60	96 (45)	0.989	< .0001
6 - Item 61	96 (45)	0.998	< .0001

a Kappa = 0.478 to Tb = 0.877 levels. All correlations are under the assumed statistical significance level $p \leq 0.05$.

Table 8 presents percentage agreement, correlations and significance regarding warning labels on tobacco products. All questions are evaluated on a nominal scale. Three positions show good percentage compatibility (75% – 89%), one shows moderate (60% – 74%). All correlations between repeated measurements are characterized by very high indicators from a Tb = 0.804 to Tb = 0.919. All correlations are under the assumed statistical significance level of $p \leq 0.05$.

Table 9 presents percentage agreement, correlations and significance regarding quitting smoking. The section shows six questions, all in the ordinal scale. Three positions show very good percentage compatibility (90% – 100%), the remaining three show good (75% – 89%). Correlations between repeated measurements are characterized by high indicators from a Tb = 0.958 to Tb = 0.998 levels. All correlations are under the assumed statistical significance level of $p \leq 0.05$.

Table 10 presents percentage agreement, correlations and significance regarding attitude towards smoking. Section shows sixteen test positions, 10 in the Likert scale, 4 in the ordinal scale, 2 in the nominal scale. One position shows very good percentage compatibility (90% –100%), three show good (75% – 89%), eleven show moderate (60% – 74%) and one shows weak (< 60%). Correlations between repeated measurements are characterized by high indicators from a Kappa = 0.548 to r = 0.998 levels. All correlations are under the assumed statistical significance level of $p \leq 0.05$.

Table 11 presents an analysis of percentage agreement, correlations and significance in the section household and smoking. This section consists of two questions in a nominal scale. First position is characterized by a very good percentage compatibility (90% – 100%), the other one has good compatibility (75% – 89%). Correlations between repeated measurements are characterized by a high indicator kappa = 0.931 in the first case, and kappa

Table 10. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Attitude and susceptibility to smoking section'

Section: Attitude and susceptibility to smoking	Percentage agreement % (n)	rho Spearmana r	tau b– Kendala Tb	Kappa Cohena	p
1 – Item 62	72 (34)	0.758			< .0001
2 – Item 63	68 (32)	0.793			< .0001
3 – Item 64	66 (31)		0.863		< .0001
4 – Item 65	72 (34)	0.770			< .0001
5 – Item 66	68 (32)	0.689			< .0001
6 – Item 67	91 (43)	0.998			< .0001
7 – Item 68	83 (39)			0.747	0.000
8 – Item 69	66 (31)	0.760			< .0001
9 – Item 70	70 (33)	0.760			< .0001
10 – Item 71	72 (34)	0.828			< .0001
11 – Item 72	72 (34)		0.751		< .0001
12 – Item 73	76 (36)	0.803			< .0001
13 – Item 74	66 (31)		0.866		< .0001
14 – Item 75	47 (22)		0.720		< .0001
15 – Item 76	87 (41)			0.548	0.000
16 – Item 77	70 (30)	0.778			< .0001

Table 11. Agreement (per questionnaire item) between questionnaires (test-retest reliability) as indicated by intraclass correlation and percentage agreement (agree) in the 'Home environment and tobacco section'

Section: Home environment and tobacco	Percentage agreement % (n)	Kappa Cohena	p
1 – Item 78	96 (45)	0.931	0.000
2 – Item 79	78 (37)	0.529	0.000

Table 12. Internal consistency (Cronbach's alpha) of the subscales (n = 47) for smoking susceptibility, attitudes toward smoking, and media messages about smoking

Subscales	Positions number	α Cronbacha	p
Trying tobacco in various form	7	0.801	< 0.0001
Susceptibility to tobacco use	7	0.859	< 0.0001
Opinion on tobacco	9	0.850	< 0.0001
Awareness of danger connected with tobacco use	5	0.708	< 0.0001
Exposition to pro- and anti-smoking initiatives	7	0.732	< 0.0001

= 0.529 in the other. Both correlations are relevant statistically at the taken criteria of $p \leq 0.05$.

Additionally, an analysis of structures of internal thematic groups, which consisted of questions with the same measurement scale was performed.

The analysis of two answer question groups showed that they fathom one thematic field which has been called "Trying tobacco in various forms". In the questionnaire, the field is represented by seven questions: 6, 22, 28, 39, 40, 76, and 79 (Table 14). Another group of questions with a metric scale of answers consists of sixteen questions on a four point scale. These questions form two thematic fields (7 and 9 questions respectively) called "susceptibility to tobacco use" and "opinion on tobacco." The next group of 5 questions with metric scales of five point answers, create another thematic group called "Awareness of danger connected with tobacco use." Another group consists of seven questions with a six point scale answers and create a group called "exposition to pro- and anti-smoking initiatives." The rest of the questions did not create any other consistent thematic groups which would be connected with the type of measurement scale (Table 12).

Discussion

Due to the ever-increasing use of tobacco by children and young people in both developed and developing countries, we have a serious problem in public health: not only pediatric diseases but rather an epidemic in pediatrics. Health Behaviour in School-aged Children (HBSC) has been introduced in European countries. The program also monitors tobacco prevalence. In the USA, the NYTS study has been conducted since the late 1990s. The Tobacco FreeInitiative (TFI) is run by the Global Tobacco Survey (GYTS).[25] So it would appear that we have a lot of tools and data for comparative analysis, drawing conclusions and planning effective interventions yet that is not the case. Important comparisons between countries and continents are difficult due to the different methodology of the individual studies, and despite the language adaptations of some tools, in many situations, they lack their own versions that need to undergo a full linguistic adaptation process. This problem was reported by the authors of the Chinese version of the GYTS, who noted that despite the translation of English into French, Arabic and Spanish, they lack cultural adaptation in the countries where they use the language.[26] However, it is noticed that most of the questionnaires use similar statements or questions in the study of tobacco prevalence, attitudes, exposure to passive smoking, and marketing susceptibility by children and adolescents. The construction of the GYTS questionnaire is quite similar to the NYTS and perhaps the NYTS questionnaire was the basis of its construction. What differentiates these tools is the range of age groups to which they are addressed. The NYTS survey examines children and adolescents from 9 to 19 years of age, and the GYTS is in the 13–15 age range. The number of test items is also different. The NYTS questionnaire is 81 items and the GYTS 56.[17,27] Also, the coverage of the NYTS area is considerably higher than the GYTS. Because no cultural adaptation of NYTS was found, the results of this initial Polish adaptation to cultural adaptations of very similar questionnaires including GYTS were reported. By analyzing the literature on the adaptation of this type of research tool, we can see the authors main difficulty. The translation of the English version into Mandarin (Chinese version) required a radical change in the design of some items, but also the removal of 15 of them from the final version.[26] The adaptation of the Polish version of the NYTS has not encountered so many problems during translation. Although the authors are still thinking about correcting some of the test items of the Polish NYTS tool, it was not necessary to remove as many questions. Only questions about the ethnic origin of the respondent, which in the multicultural American society are standardized, have been removed.

The authors of the tobacco questionnaire adaptation most often use the test-retest method, cotinine blood test, self-exacerbation of exposures to smoking or addiction, interviews.[26–28] Pre-made adaptation of the NYTS test questionnaire revealed that the items are of quite good stability. The correlation between repetitive measurements is high, and the percentage repetition in most cases is also high. For example, it can be observed that the first section of cigarette test items shows similar repeatability as the items from this area in Chinese adaptation of GYTS – very good and good (75% – 100%). The questions in this section and in NYTS and GYTS are the same: Have you ever tried cigarettes, even 1–2 puffs?, How old were you when you tried cigarettes?, How many cigarettes did you smoke in the last 30 days?, How many cigarettes have you smoked within 1 day of the last 3 days? Similar indicators can also be observed by comparing the consistency of questions with the same measurement scales that form the thematic groups. In the Iranian version of the Global School-based Student Health Survey questionnaire, which has only a small smoking section but similar construction to NYTS, similar levels of indicators have been demonstrated.[28]

The adapted version of the NYTS also showed a satisfactory degree of coherence of the inner group of items forming sub-themes and at the same scale of measurement. Thus subscale «Trying tobacco in different forms» has an alpha index of 0.801, subscale «Tobacco susceptibility» 0.859, subscale «Tobacco opinion» 0.85, subscale «Thinking about health risks from tobacco» 0.708, subscale «Exposure to pro and anti-tobacco activities» .732. In the Chinese adaptation of GYTS, the Cronbach alpha level in the «Tobacco Tax» subscale is also high, it is 0.94.[26] The questions that are alike in this subscale are similar in both surveys, for example: if one of your best Friends offered you a cigarette, would you smoke?

The NYTS questionnaire also includes other sections of questions such as the smoking section of cigars, cigarillos, etc., using snuff, using tobacco pipes, other tobacco products, tobacco addiction, tobacco product warning labels, tobacco and the quitting smoking section. Questions in these sections mostly meet high repetition criteria, both repetition percentages and correlations of repetitive measurements. In the section on smoking attitudes, which consists of 16 items, almost all (15) meet high repetition criteria. The last section of questions about the home environment in the context of tobacco presents good and very good repeatability indicators.

Conclusion

In this study, satisfactory reliability ratios were demonstrated in adaptation of the cultural NYTS questionnaire by the test-retest method. Somewhat more than seventy percent of test items have a very high or a high level, twenty five percent of a moderate level, and three items did not meet the assumed level of statistical significance, but showed a moderate level of compliance. The tested Polish version of the NYTS questionnaire may be preused in adolescent studies. Therefore, more research is planned on a larger group of respondents.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.9

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 59–65

REVIEW PAPER

Paweł Linek

Could changes in the ultrasound image of the muscles of the lateral abdominal wall be seen as a sign of muscle activity? A narrative review

Department of Kinesitherapy and Special Methods in Physiotherapy, The Jerzy Kukuczka Academy of Physical Education, Katowice, Poland

ABSTRACT

Aim. Currently, ultrasonography (USG) is used to study changes occurring in the lateral abdominal wall muscles (LAM). Here, the question that naturally arises is whether a change in the thickness of the ultrasound image can be identified with a change in muscle activity. Therefore, the purpose of the present work is to: 1) undertake an analysis of available publications exploring the relationship between electromyography (EMG) and USG; 2) define the USG measurement of each LAM; 3) identify gaps in the literature.

Material and methods. The databases MEDLINE, POL-index and Google Scholar were used to search the literature. We used a combination of terms (in Polish and English) containing the abbreviated and full names of the following expressions: ultrasound, electromyography and external oblique muscle, internal oblique muscle, or transverse abdominal muscle.

Results. Nine publications fulfilled the conditions for inclusion in the analysis. These used different methodologies and test conditions, making it difficult to interpret the results of individual works. The majority demonstrated poor or no correlation between EMG and USG measurements.

Conclusion. Changes in the thickness of the LAM using USG should not be equated with a change in muscle activity. To avoid misinterpretation, one should avoid the term "muscle activity" in evaluating changes in the thickness of the LAM. It is recommended that the terms "thickness change" or "morphological change" be used in the assessment of this phenomenon, which is closely related to real changes in USG imaging, expressing a more complex phenomenon than a mere change in bioelectrical potential.

Keywords. ultrasonography, electromyography, lateral abdominal wall, muscle activity, muscle morphology

Corresponding author: Linek Pawel, Department of Kinesitherapy and Special Methods in Physiotherapy, The Jerzy Kukuczka Academy of Physical Education, 40-065, Mikolowska 72B, POLAND, phone: +48 661 768 601, e-mail: linek.fizjoterapia@vp.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 21.12.2016 | Accepted: 16.02.2017
Publication date: June 2017

Linek P. *Could changes in the ultrasound image of the muscles of the lateral abdominal wall be seen as a sign of muscle activity? A narrative review*. Eur J Clin Exp Med. 2017;15(1):59–65. doi: 10.15584/ejcem.2017.1.9

Introduction

The lateral abdominal wall muscles (LAM) have been the subject of numerous research papers in different academic facilities. This is probably due to the release of studies that assign an important role to these muscles in the stabilization of the lumbar spine and pelvis,[1,2] as well as LAM testing techniques becoming more common. In the study of this area of the body, each LAM – the oblique external (OE) abdominal, the oblique internal (OI) abdominal and the transverse (TrA) abdominal – should be analysed separately, because each of these is assigned a somewhat different role in lumbar-pelvic stabilization.[3,4] Therefore, there are additional equipment requirements to allow for separate analysis of the characteristics of each LAM.

The most common and best known tool for measuring muscle activity is electromyography (EMG), which expresses muscle activity using the change in electric potential. The resulting EMG signal is the result of the stimulation of muscle fibres by the potentials of the nervous system.[5] In this way, the EMG signal allows the time of activation of a muscle, the duration of muscle activity and the level of intensity of this activity to be determined.[6] Scientific research uses two types of EMG electrodes, superficial (sEMG) or deep (dEMG), which provide different research capabilities. The main feature differentiating the two techniques of research is the method of collecting EMG signals from the muscles. The sEMG electrodes receive potentials from above the surface of the muscle using outer electrodes placed on the skin, while dEMG analyses individual motor units using deep intramuscular electrodes. In the case of the LAM, the requirement for separate testing of individual muscles, as well as the need for detailed analysis of the TrA muscle (the most deeply situated muscle, considered the most important in the stabilization of the lumbar and pelvic region) makes dEMG the only appropriate technique; in this case, sEMG is useless as a test method. While the dEMG method offers selective assessment of individual LAM, it is an invasive method of study, which carries some risk of infection. It is also time consuming and hence is difficult to use in clinical studies concerning a larger population.

The tools that appear to combine features of sEMG and dEMG are magnetic resonance imaging (MRI) and ultrasound imaging (USG), which are non-invasive, safe, permit the collection of information through the skin (as is the case of sEMG), as well as allowing independent assessment of individual muscles (as is the case with dEMG). Although the LAM results acquired through MRI and the USG are highly correlated with each other,[7] MRI has a number of restrictions (time consuming, high cost, special conditions), as a result of which USG seems to be the preferable research tool since it does not suffer from such restrictions.

In 2006, the term "rehabilitative ultrasound imaging" (RUSI) was introduced and the procedures for the morphological assessment of muscles (including LAM) were defined.[8] In addition, work on determining (in consultation with the World Federation for Ultrasound in Medicine and Biology) the educational framework for physical therapists regarding the use of USG in rehabilitation has commenced. This led to the further expansion of the use of this measurement tool in scientific research and physical therapy.[9–11]

However, in the case of EMG evaluation, we consider the electric potential, expressed in millivolts, while USG (as well as MRI) provides information on the LAM characteristics in millimetres (mm) or centimetres (cm), which sometimes gives rise to a degree of controversy and raises questions about the way we should define the phenomenon investigated. The available literature usually refers to an individual measurement of LAM using USG in terms of thickness,[12–19] size[15,20] or cross-section,[21] while the analysis of the two measurements in different situations (e.g. one measurement at rest and the other during some physical activity, e.g. the movement of the limb) is usually defined as the activity,[22–24] a thickness change,[12,13,25,26] or the rate of contraction[15,27] in OE, OI and/or TrA muscles during a motor task.

The high correlation between the results of MRI and USG[7] means that USG can be considered an appropriate tool for defining the shape of the LAM. The shape is an important structural element and in this case the term "morphology" can be used; in relation to living organisms, this refers to the "construction", or "shape". Therefore, it is reasonable to use terms such as the "thickness" or "morphology" to identify the results of TrA, OI and OE analysis. Moreover, these terms have been established in the scientific literature for a long time. However, there is less consistency in the analysis of the two measurements evaluating changes in the thickness of the muscle in USG images. Researchers have acknowledged that the change in thickness during a specific motor activity (to resting) is probably a more clinically useful and diagnostically helpful analysis rather than the resting thickness alone.[25,28] The question that arises here is whether a change in the thickness of the USG image can be identified definitively with a change in muscle activity.

Aim of the study

This narrative review attempts to find an answer to this question. Therefore, the purpose of the present study is to: 1) analyse available works exploring the relationship between EMG and USG; 2) define USG measurement for each LAM; 3) identify gaps in the literature currently available.

Method

Works concerning the study of the relationship between USG and EMG of the OE, OI and TrA muscles were considered for evaluation. Of these works, only articles in which both tools were tested at the same time were finally

included in the analysis. Two electronic databases (MEDLINE and POL-index), as well as the Google Scholar search engine, were used to find the articles. We used a combination of terms containing the abbreviated and full terms of the following expressions: USG, EMG, OE, OI, TrA and/or lateral abdominal wall muscles, taking into account their respective wording in Polish and English. All works were accepted, regardless of the age, gender, origin or health of the subjects. The search was restricted to only articles available in Polish and/or English.

An analysis was undertaken of the scope of the titles and the content of the abstracts. Articles clearly indicating a lack of connection with the issue were immediately rejected. The complete texts of the remaining articles were analysed in detail. Lists of references of these papers were also examined to check for the possible omission of relevant articles.

Results

Nine research papers met the conditions for inclusion in this analysis.[29–37] All of these analysed the relationship between EMG (sEMG or dEMG) and the thickness of the OE, OI and/or TrA in the USG images during different types of contraction and/or motor activity. The detailed characteristics of the individual works are presented in Table 1.

Hodges et al.'s [37] paper demonstrated curvilinear growth between the EMG signal and the thickness of the OE ($r = 0.23$; $p = 0.43$), OI ($r = 0.84$; $p < 0.01$) and TrA ($r = 0.90$; $p < 0.01$) during isometric tension. However, it was found that the measurement of the thickness of OI and TrA was linear for changes in EMG only in the range of 12–23% of the maximum volitional contraction. In another work, which also assessed the isometric contraction of LAM, but somewhat differently, Ferreira et al.[33] demonstrated a strong correlation between EMG and USG for TrA ($r = 0.85$; $p < 0.01$) and OI ($r = 0.74$; $p < 0.01$) and a weak correlation for OE ($r = 0.28$; $p = 0.22$).

Other works have examined the correlation between the results of EMG and USG while drawing in the lower abdomen (the abdominal drawing-in manoeuvre – ADiM). In the first, McMeeken et al.[36] obtained a linear and strong relationship between the EMG signal and the change in thickness of TrA ($r^2 = 0.87$; $p < 0.001$) at all levels of EMG activity at any contraction. On the other hand, Brown and McGill[34], studying OI and OE, did not find any relationship with EMG during either the isometric contraction or ADiM. Moreover, Tahan et al.[32] did not observe any dependence of OI or TrA in the EMG or USG signals. Detailed analysis of individual cases in the research conducted by Whitaker et al.[31] showed that the relationship between EMG and USG is inconsistent and the coefficient of determination is low during ADiM ($r^2 = 0.00–0.13$) and the active straight leg raise (ASLR) ($r^2 = 0.00–0.18$).

In the paper by John and Beith[35], a relationship between EMG and the change in the thickness of OE in the USG image was demonstrated only for isometric trunk rotation, although this relationship differed among individual patients ($r^2 = 0.28–0.92$). For ADiM, the relationship was not significant and differed among the subjects ($r^2 = 0.02–0.74$). In a recently published study, Rabello et al.[30] demonstrated radically different relationships between the change in thickness of the OE and the EMG signal (for example: $r = -0.90–0.92$ for flexion of the trunk; $r = -0.83–0.93$ for the trunk rotation to the left) during isometric contractions in three directions (anterior flexion of the trunk, lateral flexion of the trunk, rotation of the trunk to the left) and in the range 0–50% for maximum shrinkage. The final publication considered, by Blanchard et al.[29] also revealed a lack of relationship between EMG and the thickness of TrA and OI in the USG image ($R^2 < 0.13$) during deadlift and the Valsalva manoeuvre.

Discussion

The review of the literature clearly shows that the relationship between bioelectric activity and the change in the thickness of the USG image for LAM depends on the type of examination. Taking into consideration the work by McMeeken et al.[36], it can be concluded that a change in the thickness of TrA in the USG measurement during ADiM reflects the activity of the muscle. Unfortunately, another study contradicts this type of dependency[31]. A similar inconsistency affects the other research works listed, with significant between-subject discrepancies in the degree of correlation of USG and EMG, even within a single research paper. Thus, it is the responsibility of researchers to select the studies considered credible to confirm their assumptions. As can be seen, researchers wishing to consider the evaluation of changes in the thickness of LAM as an expression of their activity will find works that confirm this phenomenon.[36,37] However, opponents of the argument for such a relationship can find arguments in other scientific works.

This narrative review is the result of emerging problems with the proper identification and qualification of changes occurring during USG examination of the LAM. An intuitive assumption is that size of the muscles changes during contraction as individual muscle fibres are shortened. The type of contraction (isometric, concentric, eccentric) should not matter, because every change in muscle length entails a change in its size. In the case of the LAM, this change will relate to the thickness. However, the lateral abdominal wall is a specific site, where the activity of the individual muscles of which it is composed may induce or inhibit changes in the thickness of the other muscles. A good example here is the OE muscle, which can be squeezed by the muscles that are located deeper during various motor tasks, making it impossible to obtain a thickness that reflects a real change in activity in the USG image. Thus, the force generated in a single muscle affects the adjacent muscles, especially if they are inclined relative to each other.[34] This may

Table 1. The relationship between electromyography and ultrasonography of the lateral abdominal muscles

Study	Participants	Subject position	Muscle state or task	US examination	EMG examination	Results
Hodges et al. 2003 (OE, OI, TrA)	healthy males 27 – 45 lat/years	Sitting on a reclining chair with the hips flexed to 30°	Isometric contraction	B – mode (normalization to rest thickness)	dEMG	Nonlinear increases in TrA, OI, OE thickness up to 22% MVC
McMeeken et al. 2004 (TrA)	healthy subjects 29 – 52 years	supine	Abdominal drawing-in maneuver	M-mode (per cent thickness change to rest position)	dEMG	linear increases in TrA thickness up to 80% MVC
John and Beith, 2007 (OE)	healthy subjects 24,5 mean age	Crook lying position	trunk rotation and abdominal drawing-in maneuver	M-mode (per cent thickness change to rest position)	sEMG	linear increases during only trunk rotation in 21 participants
Brown and McGill, 2010 (OE, OI)	healthy males 25,2 mean age	sitting on a kneeling chair	Abdominal drawing-in maneuver and abdominal brace	B-mode (per cent thickness change to rest position)	sEMG	lack of significant dependence
Ferreira et al. 2011 (OE, OI, TrA)	10 healthy and 10 LBP Mean age – 30 years	Supine, hip flexed 50° and knee flexed 90°	Isometric contraction at low-load knee flexion and extension	?-mode (normalization to rest thickness	dEMG	Significant dependence nly for TrA and OI
Tahan et al 2013 (TrA, OI)	healthy subjects 18 – 42 years	Crook lying position	Abdominal drawing-in maneuver with and without pelvic floor muscle	B-mode (normalization to rest thickness)	sEMG	lack of significant dependence
Whittaker et al 2013 (OE, OI, TrA)	participants Mean age – 30 years		Abdominal drawing-in maneuver with and active straight leg rise	B-mode (per cent thickness change to rest position)	dEMG	lack or very low significant dependence of TrA and OI
Rabello et al 2015 (OE)	18 male Mean age – 25 years	sitting	forward flexion, right side flexon, left side rotation of the trunk	M-mode (per cent thickness change to rest position)	sEMG	non-consistent dependence
Blanchard et al 2016 (TrA, OI)	11 participants Mean age – 20 years	standing	Deadlift and Valsalva maneuver with or without belt	M-mode (change in thickness)	sEMG	lack dependence of TrA and OI

also explain the improbable findings that are sometimes recorded (e.g. in [30]), showing a reduction in the thickness of OE in the USG image, together with an increase in the EMG activity of the muscle.

The systematic review published by Koppenhaver et al.[38] in 2009 indicated that the relationship between EMG and USG depends on the intensity and strategy of the contraction. This review, which only takes into account works on LAM, updated with research produced recently, also indicates that the degree of connection of measurements of the thickness of the LAM in USG images depends on the intensity and the type of contraction, as well as the measurement tools used. Recognizing EMG as the gold standard for examining muscle activity, it should be emphasized that the LAM constitute a challenge for this research tool.

Hence, analysis of the literature must take into account the possible inaccurate estimation of the EMG signal, which could also be a reason for low dependence with USG in the individual studies. Namely, in the case of dEMG, the electrodes injected analyse a small number of motor units, rather than providing a more global assessment using superficial electrodes (sEMG). In the case of the LAM, we may suspect a regional variation of activation (activity) within a single muscle. The research conducted by Urquhart et al.[39] provided evidence of morphological differences between the regions in the OE, OI and TrA muscles, which indicates their variable function. In previously published studies, the dEMG measurement was obtained from an area that differed from that in USG imaging; based on the suggestions made by Urquhart et al., this helps explain the lack of or weak relationships between these research tools.

On the other hand, the use of sEMG to assess LAM significantly impedes the ability to separate the signal into those derived exclusively from OI and TrA. Studies comparing sEMG and dEMG for TrA measurement clearly indicate a weak correlation, which is probably caused by interference (the collection of additional signals) coming from the adjacent muscles during sEMG.[40] Thus, the results of the works examined in this review in which the EMG assessment of the OI and TrA muscles was obtained using superficial electrodes provide little cognitive value in terms of changes in the thickness of the muscles in USG images. In general, researchers acknowledge that EMG analysis of individual LAM using superficial electrodes is rather susceptible to interference from the surrounding muscles.[41,42] In addition, changing the activity of the LAM involves changing their shape in all dimensions and often causes a displacement of these muscles (especially of the TrA muscle). In USG examinations, the head in a sense follows the contracting muscle belly, while the electrode placed during sEMG examination does not do so. It should also be noted that the location of the LAM is not the same in all people as elderly patients and subjects with abdominal obesity often have a more lateral location of the LAM (Linek et al., 2016, unpublished observations). This will cause significant measurement errors if the electrodes in the sEMG examination are placed in locations where the LAM should be "by the book", rather than where they are actually located, both at rest and during any physical activity. Thus, the bioelectric potentials can be collected from structures other than those the researchers plan to examine.

A lack of or a weak relationship between EMG and USG in the analysis of the LAM does not necessarily prove that the changes in USG images do not relate to the activity of these muscles. Logically, the change in the geometry (thickness) of the muscle is an expression of its activity (changing its shape), but this change cannot be unambiguously identified with activity understood from the point of view of EMG as the electric potential difference. This is evidenced by the research analysed, albeit this should be treated with caution as in the case of EMG examination of the OI and TrA muscles, the use of deep electrodes does not provide activation (activity) information for the whole muscle and the use of superficial electrodes provides imprecise information about the actual state of these muscles. However, the evidence seems sufficient to conclude that USG is not the right tool to assess the activity of OE as there might be insufficient conditioning of this muscle to increase its thickness through the actions of the deeper muscles.

With the current state of knowledge, one must therefore move away from the understanding of changes in the morphology (thickness) of the LAM, as examined using USG, as the only source of information concerning the activity of these muscles. Changes in the thickness of the muscle illustrate the combined effect of many biomechanical factors, as well as neuromuscular control.[31] Indeed, muscle activity is reflected by only one of all these factors.[43] There are also suggestions that the changes in the geometry of muscles measured by means of USG correspond to real changes in their function compared to other research tools.[44] Therefore, it seems reasonable for changes in the thickness of the LAM in USG imaging not to be described as muscle activity. However, where such a term is used, it should clearly be explained that this activity is understood as a change in thickness. To avoid possible misinterpretation, however, it would be better to use a term that really captures the phenomenon investigated for changes in the morphology (thickness) of the LAM in USG imaging, namely "thickness change" or "morphological change". Researchers will be able to express this change in thickness/morphology in various ways (e.g. as a percentage) and this value will describe a much more complex phenomenon than bioelectric activity, including the impact of intra-abdominal pressure and tension and contraction or stretching of the surrounding tissue.[45,46]

The current literature evaluating the relationship between EMG and USG of the LAM is very meagre and considers rather limited research material. This review has shown that over the last few years, this type of research

has seen participation from less than 130 subjects. Among these, the vast majority were healthy individuals in a quite narrow age range. In addition, in the majority of studies, the authors used different research methodologies in terms of the measurement tools applied, as well as the motor tasks performed, further hindering the ability to draw any common conclusions. It should also be noted that in some of the studies, the methodology used does not allow reliable inference in terms of the results obtained and thus it seems unreasonable to use surface electrodes to evaluate the EMG of the TrA muscle. On the other hand, recognizing the variability of different functional fibres of the LAM, deep electrodes should be located as close as possible to the location of the USG head as dEMG is the optimal tool for the assessment of deeply-located small muscles. Therefore these aspects should be taken into account when designing further research in this area of scientific exploration.

Conclusion

Changes in the thickness of the individual lateral wall muscles using ultrasound imaging should not be equated with a change in their activity. According to current knowledge and to avoid misinterpretation, one should avoid the term "muscle activity" during the evaluation of changes in the thickness of the lateral abdominal wall muscles. It is recommended that the terms "thickness change" or "morphological change" be used in the assessment of this phenomenon; these are more closely related to real changes in the ultrasound image and thus express a more complex phenomenon than a mere change in bioelectrical potential.

Acknowledgement

The author would like to acknowledge and thank Prof. dr hab. Edward Saulicz for the inspiration to conduct research using ultrasound imaging, as well as numerous discussions that contributed to the creation of this publication.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.10

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 66–70

REVIEW PAPER

Andżelina Wolan-Nieroda [(ABFG)], Andrzej Maciejczak [(ABFG)], Agnieszka Guzik [(BFG)], Grzegorz Przysada [(FG)], Justyna Wyszyńska [(FG)], Ewa Szeliga [(FG)]

Cervical spine injuries in Poland – epidemiology, divisions, and causes

Institute of Physiotherapy, Faculty of Medicine, University of Rzeszów

ABSTRACT

Aim. The aim of the study was to review the literature on the prevalence of cervical spine injuries divided between the level of the injury and the causes of fractures.

Material and methods. A review of Polish and foreign literature was performed. The following databases were searched: PubMed, Medline, Science Direct, Termedia, and Polish Medical Bibliography.

Literature analysis. In Poland the incidence of spinal injuries, including damage to the cord, is estimated at the level of 25–35 persons per one million of the population, half of these being cervical spine injuries. More than one in three of all spinal injuries affect the atlantoaxial and occipital area. It is estimated that axis fractures occur in up to 40% of the cases involving cervical spine injury. Odontoid fractures constitute 10–15% of all cervical spine fractures. Hangman fractures account for 20% of vertebral fractures. Cervical spine injuries more frequently occur in males than in females, and the relevant rates for males are from 1.5 to 2.7 times higher. The most common causes of cervical spine injuries include road traffic accidents, accounting for 33 to 75% of the cases, falls from heights (15–44%) and sports injuries (4–18%). Cervical spine injuries are most often diagnosed in subjects over thirty years of age. Such injuries most commonly are related to the second, fifth and sixth cervical vertebrae. On the other hand damage to the first and second cervical vertebrae is often observed in the same patients who are found with injury to lower cervical vertebrae (approx. 9% of the cases). In the group of advanced age subjects the most frequent cervical spine injuries are axial fractures and they are diagnosed in 15% of adult patients with cervical spine fractures.

Keywords. epidemiology, cervical spine, injury

Corresponding author: Andżelina Wolan-Nieroda, Institute of Physiotherapy, Faculty of Medicine, University of Rzeszów, ul. Warszawska 26A, 35-205 Rzeszów, tel.: 17 872 19 20

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 20.12.2016 | Accepted: 14.02.2017
Publication date: June 2017

Wolan-Nieroda A, Maciejczak A, Guzik A, Przysada G, Wyszyńska J, Szeliga E. *Cervical spine injuries in Poland – epidemiology, divisions, and causes*. Eur J Clin Exp Med. 2017;15(1):66–70. doi: 10.15584/ejcem.2017.1.10

Introduction

In the structure of the cervical spine, we can distinguish two basic sections differing in terms of anatomy and range of motion. These are the atlantoaxial and occipital area as well as the section between C3 and C7 vertebrae. These sections supplement each other which enables such movements as pure lateral bending and pure rotation, as well as bending and extension of cervical spine. The joints between occipital bone, atlas (C1) and axis (C2) contain no intervertebral disks, and are characterized with a well-developed ligament system. The lower part of the spine comprises the area between C3 and C7 vertebrae containing intervertebral disks. In terms of biomechanics cervical spine can be divided into four functional parts including: atlanto-occipital joint, atlantoaxial joint, C2/C3 joint and the lower spine from C3 to C7. Each of the above sections differs in terms of morphology, kinematics, and cervical spine mobility.[1,2]

Aim of the study

The main aim of the study was to review the literature on prevalence of cervical spine injuries divided due to the level of the injury and the causes of fractures.

Method

A review of Polish and foreign literature was performed. The following databases were searched: PubMed, Medline, Science Direct, Termedia, and Polish Medical Bibliography.

Literature analysis

In Poland the incidence of spinal injuries, including damage to the cord, is estimated at the level of 25–35 persons per one million of the population, half of these being cervical spine injuries.[3] According to Kiwerski, spinal injuries occur in males 5-6 times more often than in females, and he explains that this is linked with men's greater activity in daily and professional life, and their greater propensity to engage in risky behaviours.[3-5] Likewise, Mirvis claims such injuries affect males 6 times more often,[6] Flanders – 4–6 times more often,[7] and Blacksin– 4 times more often.[4] Siemianowicz et al. carried out a retrospective assessment of 112 patients after cervical spine injury and reported male/female ratio of 2.86. The above reports were related to all spinal injuries, except for the study by Siemianowicz et al. which focused on cervical spine injuries exclusively. Interestingly, studies published in the period from 1999 to 2003 identified lower disproportion between men and women related to cervical spine injury, the relevant rates for males being 1.5 to 2.7 higher than those for females.[8] Literature review allows a conclusion that spinal injuries are most often incurred by people in the age group of 25–45.[8-12] This may be explained by the fact that this is the most productive period involving the greatest activity in personal and professional life.[8]

Occipital condylar fracture

Occipital condyle fractures are rare cranio-cervical injuries. Their incidence is 0.4–0.7% of all patients suffering trauma. The main causes of these fractures are road traffic accidents. Occipital condyle injuries are rarely diagnosed in X-rays due to overlapping shadows of the facial skull, occipital bone, and occipital condyles. Thin layer CT scan of the head with upper cervical section in patients with suspected traumatic cranio-cervical injuries is elective medical examination. Two systems of classification of occipital condyle fractures are distinguished. The classic Anderson-Montesano classification divides occipital condylar fractures into three types according to morphological criteria. Type I includes comminuted (burst) fracture without or with minimal displacement of fragments caused by axial load, Type II is a basioccipital fracture which extends to occipital condyles. These types of fractures are stable. Type III is avulsion fracture of the condyle due to avulsion of condyle by the alar ligament and is unstable. Tuli proposed the modification of the above classification, which was based on criteria of instability and damage to C0 – C1 – C2 complex in the CT scan or magnetic resonance imaging (MRI). Type I is a stable undisplaced occipital condyle fracture. Type II A is a displaced occipital condyle fracture without the instability of the C0-C1-C2 complex. Type II B is an unstable occipital condyle fracture confirmed by CT or MRI.[13-14] In 2012, a new system of classification of occipital condylar fracture was published, in which fractures were divided into unilateral or bilateral as well as with or without accompanying atlanto-occipital dislocation.[15] Since that type of fracture is rare, there is no established medical conduct. Tuli type I fracture does not require external immobilization. Type II A fracture is treated with hard collar, whereas Type II B fracture requires surgical fixation or halo vest external fixation. The time of immobilization in the halo orthosis ranges from 8 to 12 weeks. Internal occipital-spine fixation is indicated in cases of pronounced dislocation or fracture with concomitant compression of the spinal artery, spinal cord, or cranial nerves.[16-19]

Atlas fracture

The incidence of atlas vertebral fracture is 5-10% of all vertebral fractures. In 40% of cases it is accompanied by other fractures in this segment, mainly with fracture of the other vertebrae. Spinal cord injury due to the injury to the C1 vertebrae is very rare because the spinal canal is wide at this level. Landells and Petegham Atlas Fractures Classification distinguishes three types of fractures. Type I is a fracture due to extensive mechanism where fracture fissure is limited to a single arch and does not exceed the atlas equator. Type II fractures include both atlas arches and exceed its equator. The fracture mechanism is compression due to crushing of C1 arch between the occipital condyles and the lateral masses of the rotator. Jefferson burst fracture belongs to these types of fractures. Type III fracture occurs due to the

action of the compression force with an asymmetric head position. This injury involves unilateral lateral mass and atlas arch. Atlas fractures are usually treated conservatively. In case the transverse ligament is injured, internal stabilization and arthrodesis should be applied.[1,19,20]

Axis fracture

More than one in three of all spinal injuries affect the atlantoaxial and occipital area.[12] Axis fracture account for 10–15% of cervical vertebral fractures in the adult population. The most common cause of injuries are falls that occur more frequently in the elderly and road traffic accidents involving young people. Axis fractures are divided depending on the affected part of the vertebra. We can distinguish the following C2 fractures: odontoid fracture, bilateral isthmus and pedicle fracture (known as Hangman's fracture), axis pedicle fracture (non-odontoid, non-hangman's).[2] Axis fractures constitute 10-15% of all cervical spine fractures in adult populations. The most common causes of injuries include falls, more frequently affecting senior citizens, as well as road traffic accidents, with particularly high rates among young people. Odontoid fractures of axis most often occur through the mechanisms of extension, and less frequently flexion.[2,21-27] Bilateral isthmus and pedicle fracture is commonly referred to as Hangman's fracture. This type of injury accounts for 20% of axis fractures. It was described for the first time in 1866 by Haughton, who identified the damage in convicts executed by hanging.[28-30] The same mechanism of hyperextension causing a fracture may occur as a result of cervical spine injury. In studies focusing on cervical spine injury, Hangman's fractures constitute the second largest group (7%), after odontoid fractures (13%).[29] The main causes of isthmus and pedicle fractures include transport accidents and falls from heights. Hangman's fracture most often occurs through the mechanisms of extension.[2] It is also assumed that the main cause of Hangman's fracture may be a direct trauma, e.g. fall onto one's face from a bicycle, or an indirect trauma such as violent jerking causing one's head to be suddenly pulled backwards during car accident.[31] Fracture of the axis vertebral body usually belongs to stable fractures. Instability is rare and arises in case of C2 / C3 subluxation or as a result of an accompanying C1 fracture. Treatment of the vertebral body fracture usually involves external fixation in the hard collar or halo vest.[1,20] Siemianowicz et al. observed the largest number of cervical fractures within C5 vertebra (24.2%), followed by C2 (20.2%).[8] The same author reported similar findings in another study where fractures of C5 represented 24.8%, and those in C2 19.3% of the cases.[10] Jankowski et al. most frequently observed odontoid fracture of the axis.[12,32-39]

Age and incidence of cervical spine injuries

Review of the literature suggests that cervical spine injuries are most often diagnosed in subjects over thirty years of age. Such injuries most commonly are related to the second, fifth and sixth cervical vertebrae. On the other hand damage to the first and second cervical vertebrae is often observed in the same patients who are found with injury to lower cervical vertebrae (approx. 9% of the cases). It is estimated that axis fractures most often occur in subjects over 70 years of age. In the group of advanced age subjects the most frequent cervical injuries are axial fractures and they are diagnosed in 15% of adult patients with cervical spine fractures. In young individuals axis fracture results from trauma involving greater force therefore injuries of this type are mainly caused by transport accidents and falls from significant heights. In older individuals it is just the opposite and the fracture may be invoked by small amount of force during a fall from a bicycle or a fall from one's own height.[24] Pankowski et al. showed that incidence of cervical fractures is the same in the age groups of 21–40 and 41–60, yet if we only take males into account cervical fractures are most common among subjects aged 21–40.[12] Siemianowicz et al. in their study reported the greatest number of patients with cervical spine fractures in the age group of 25–45, and the second most numerous was the group in the age range of 46–65 years. The above studies suggest a high rate of cervical fractures among people over 40 years of age.[10]

Causes of cervical spine injuries

According to Kiwerski, road accidents are the most common cause of cervical injuries, accounting for 33 to 75% of the cases. Other frequent causes are falls from heights (15–44%), sports injuries (4–18%), and, less often, gunshots and wounds inflicted with a sharp tool. Diving headfirst to water was identified as a cause in nearly 11% of the cases. The category of causes defined as "falls from heights" included falls from tree or ladder, falls from roof, and falls into earthworks. The group of "road accidents" included car and motorbike accidents, knock-downs and others.[3,5,8,10,12,32,40] Kiwerski claims that it is important to consider the environment in which the accident happens. Falls from heights account for 56.1% of spinal injuries in rural areas, and for 31.9% of the cases in urban areas. Accidents which are far more common in rural environments include falls from ladder, tree or roof, and those more common in urban areas involve falls from stairs, into earthworks, suicidal attempts, jumps from heights, or diving into water. In urban environment the predominant causes of injuries include road accidents (41.1%), with the most frequent car accidents and knock-downs. Motor-bike accidents are more frequent in rural areas.[5]

Kwolek et al. observed that males aged 21–40 and those over 40 are more at risk of falls from heights. Cervical injuries due to road accidents were most often identified in patients ranging in age from 21 to 50.[41] As it was mentioned before, cervical spine fractures in young people are most often induced by high amount of force, which

mainly occurs during road accidents. A car accident may induce hyperextension or sudden, excessive flexion. Seat belts provide protection for the chest and stabilize the torso yet they also contribute to increased dynamics of head movements with respect to torso and consequently to a risk of cervical vertebrae dislocation.[3] Analysis of road accidents in Poland in 2013 shows that male drivers aged 25–39 were most often both perpetrators and victims of such accidents in the relevant period. Accidents by fault of pedestrians were less frequent, and they were caused mainly by older men, over 39 years of age.[42]

Neurological consequences of cervical spine injury

It is also necessary to point out neurological consequences resulting from the accidents described above, and leading to spinal injuries. It is possible to distinguish three groups: patients with symptoms of paralysis; patients with motor paresis; patients with no significant neurological impairment (including those with paraesthesia, sensory impairments, with no loss in muscle strength). According to Kiwerski, the degree of neurological impairments depends on the location of spine injury. Paralyses are found in almost 50% of the patients with cervical injury, while no significant neurological problems are observed in less than 15% of the cases. It was observed that the most severe neurological consequences were associated with thoracic spine injuries. In this case paralyses are estimated to affect 70% of the patients while no neurological complications are found in 17% of the cases. Following injuries to thoracolumbar spine 47% of the patients are found with paralyses and 28% with no neurological impairments. The least pronounced neurological consequences are associated with lumbar spine injuries (paralyses – 23%, no neurological losses – 32%).[3,5,43-48]

Summary

Cervical spine injuries are a serious problem that most often affects people at a young age. Cervical spine injuries mainly affect men both in Poland and in the world. The most common causes of spinal injuries are road traffic accidents, falls from height and sports injuries. The cervical spine fractures can lead to serious neurological consequences that can result in physical disability.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.11

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 71–77

CASUISTIC PAPER

Agnieszka Guzik [(ADFG)], Bartłomiej Chwaszcz [(ABDF)], Mariusz Drużbicki [(ABD)], Andżelina Wolan-Nieroda [(FG)], Justyna Wyszyńska [(FG)]

The assessment of the impact of myofascial training on postural control – a case study

Institute of Physiotherapy, Faculty of Medicine, University of Rzeszów

ABSTRACT

Introduction. A sedentary lifestyle with lack of physical activity contributes to deteriorated balance among healthy young people. Physical activity is import_ant since it stimulates neuromuscular junctions that control body posture, especially at younger age, when greater postural sway may be observed in stabilography compared to adults. Proper work of individual muscle groups is import_ant to maintain proper balance. Abnormal muscle tone can lead to dysbalances that make it difficult o maintain a stable posture in a variety of conditions.

Aim. The aim of the study was to evaluate the effect of a training cycle consisting of stretching of the ilopsoas, rectus femoris, gluteus maximus, hamstring and rectus abdominis, and eccentric training of the above mentioned muscles to improve static and dynamic balance.

Methods. Oobjective and qualitative-subjective were used to assess the results in a man aged 22 yrs. Postural control was tested twice in the patient with the Neurocom International Inc. SMART EquiTest device under static conditions without visual control and with dynamic visual surrounding and unstable support surface. Automatic postural reflexes were also evaluated. In addition, clinical tests were performed.

Results. Myo-fascial training, which included eccentric training combined with lower limb and trunk stretching improved the postural control in the subject.

Keywords. balance, eccentric muscle work, qualitative methods, stretching, quantitative methods

Introduction

Currently, a sedentary lifestyle and physical inactivity contribute to deteriorated balance among young healthy people. The human balance system is extremely important in everyday activity. The ability to maintain balance or postural control in the upright position is based on continuous loss and regaining of balance and the primary goal of this system is to maintain the center of gravity within the support surface defined by the foot contour. The ability to maintain and control static and dynamic balance is a necessary condition for independent functioning in everyday life.[1-3]

Corresponding author: Agnieszka Guzik, Institute of Physiotherapy, Faculty of Medicine, University of Rzeszów, Warszawska 26A, 35-205 Rzeszów, Poland, tel.: 17 872 19 20, fax: 17 872 19 30, E-mail: agnieszkadepa2@wp.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 10.12.2016 | Accepted: 14.03.2017
Publication date: June 2017

Guzik A, Chwaszcz B, Drużbicki M, Wolan-Nieroda A, Wyszyńska J. *The assessment of the impact of myofascial training on postural control – a case study*. Eur J Clin Exp Med. 2017;15(1):71–77. doi: 10.15584/ejcem.2017.1.11

Research shows that the ability to maintain body balance in standing is varied across age groups. The results of stabilography tests indicate an increased range of sway in children, while the reduction in postural sway in adolescents and adults. Interestingly, it is also accepted that there is no difference in the sway tested with stabilography in adults and the physically active elderly, which emphasizes the beneficial effect of physical activity on postural stability.[4] Balance control and position of the body in space are associated with the function of the vestibular system, the visual system, the cerebellum, and the proprioreceptors are also conditioned by the motor function of the musculoskeletal system.[5] It is essential that physical activity stimulates neuromuscular junctions through which body posture is controlled. A study by Mraz et al. presented an example in elderly people.[4] However, it is also important at a younger age, as greater body sway may be observed in stabilography tests compared to adults. Good balance requires both work of fast twitch muscles such as rectus femoris, iliopsoas, biceps femoris, semimembranosus and semitendinosus which when overloaded can increase resting tonus while decreasing their length as well as tonic muscles such as gluteus maximus, rectus abdominis, which when overloaded may react with weakening and reduced tonus. Disturbed muscle tone in the above mentioned muscles can lead to dysbalances that make it difficult to maintain a stable posture in a variety of conditions.[6-8]

The purpose of the paper was to evaluate the impact of a training cycle consisting of stretching of iliopsoas, rectus femoris, gluteus maximus, hamstrings and rectus abdominis, and eccentric training of the above mentioned muscles, followed by stretching for static and dynamic balance, assessed by quantitative methods – objective and qualitative-subjective in a man aged 22.

Case description

A 22 year old man was enrolled in the study. The subject was diagnosed with weaker (but within normal range) control during static and dynamic balance tests and Unilateral Stance Test (Figure 1) in Dynamic Computer Posturography. The subject did not do any physical activity or stretching regularly. He was a healthy person, without any traumas or diseases that could affect the outcome of the test. The patient had a balance test assessment twice - before and after a 10-day training cycle using both quantitative - objective methods - SMART EquiTest and subjective clinical tests. The study was carried out in the Laboratory of Human Motor Organ Pathophysiology in the Center for Medical and Natural Sciences Research and Innovation, the University of Rzeszow. Postural stability under static conditions without visual control and with dynamic visual surrounding and unstable support surface was tested by means of the Neurocom International Inc. SMART EquiTest. This also allows for testing the effects of visual, vestibular and somatosensory stimuli on balance, and to test the power and coordination of automated postural responses. The device consists of a dynamic posturographic platform (dual force plate) capable of evaluating the ground reaction forces under stable and dynamic conditions by means of controlled motion (sagittal motion) and horizontal shift. The second part of the device is the patient's cab integrated with the platform to create the conditions of the moving visual environment (the environment moves according to the patient's postural responses). The patient's control of body balance is hindered during the test because of impossibility to stabilize the eyes at a stable point.

Figure 1. Evaluation of the subject in Computerized Dynamic Posturography

The following tests were used to evaluate the subject: the Sensory Organization Test (SOT) and the Unilateral Stance Test. The Sensory Organization Test allows assessment of the sway of the center of gravity with open eyes and then closed under static conditions (stable ground), on stable ground with moving cabin environment, on unstable ground with fixed environment and eyes opened at first and then without visual control and with open eyes with unstable ground and moving environment. In a SOT test, the movements of the ground and the environment is consistent with the patient's body sway. The SOT test allows objective detection of abnormalities in three sensory systems of the patient responsible for postural control: somatosensory, visual and vestibular. The eyes, feet, and joints of the patient are provided with false information (through the

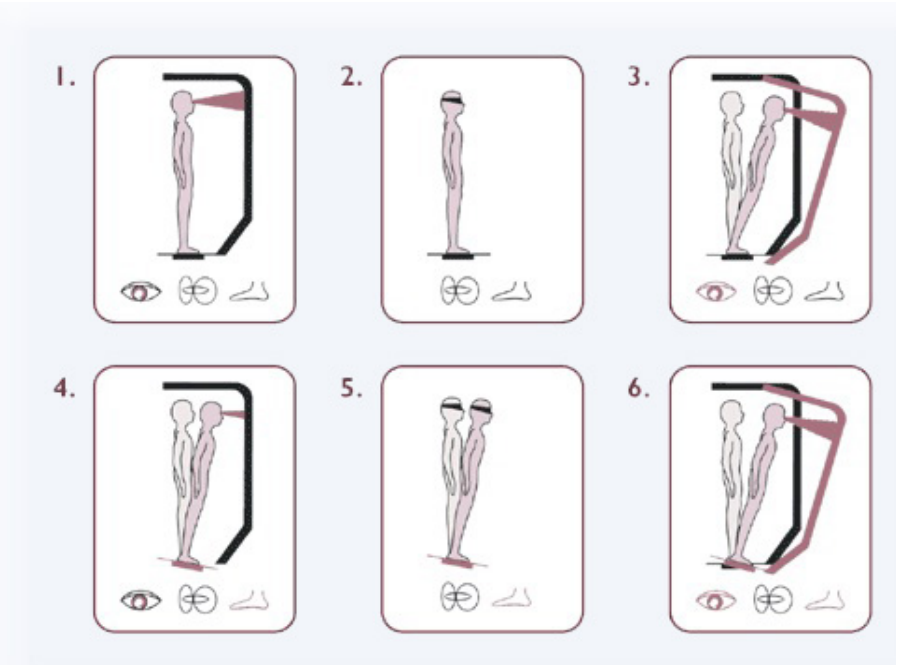

Figure 2. Sensory Organization Test

movement of visual environment (the cab) and/or the ground) as shown in Figure 2. The Unilateral Stance Test evaluates the sway of the subject while standing on one leg both with open and closed eyes.[9]

In addition, the following tests or clinical tests were performed on the subject: 1) Romberg test performed in standing position with feet together and upper limbs flexed to the angle of 90° in shoulder with extended elbows and forearms in supination, 1 min with eyes open and 1 min with eyes closed; 2) Babiński-Weil test consisting of continuous two steps forward and two steps backward with closed eyes for 1 minute, the outcome measure is the angle between the initial and final setting of the tested person; 3) Unterberger's stepping test, consisting of 50 steps with high elevation of the lower limbs with closed eyes with the test measure being the angle between the initial and the final position of the tested person; 4) the pointing test of Barany in which the investigator and the subject stand face to face with the upper limbs outward (90° flexion in the shoulder joints) pointing at each other's index fingers, then the subject closes the eyes and makes flexion of the upper limbs to 180°, next attempting to return to the previous position to point again with the index finger to the investigator's fingers, the test measure is the distance between the subject's and examiner's fingers after the test; 5) Hamstring contracture test with the patient in a long sit with one knee flexed against the chest held with the arm on the same side and attempts to touch the toes of the extended leg with the fingers of the other arm, the outcome measure is the distance from the finger 3 to the hallux of the lower limb; 6) Rectus femoris contracture test in supine with lower legs outside the couch, the patient draws one lower limb to the trunk, in the case of muscle contracture he flexes the hip joint of the other limb, the outcome measure is the distance of the popliteal space from the edge of the couch after the test.[10,11]

The training cycle lasted 10 days. In the first five days, the subject performed stretching of the iliopsoas, rectus femoris, gluteus maximus, biceps femoris, semitendinosus, semimembranosus, and rectus abdominis. From the sixth day to the end of the training cycle, the subject performed both stretching and eccentric inhibition exercises of the aforementioned muscles. Exercises were performed in the following starting positions: prone, supine, long sit, kneeling, and four-point kneeling and standing. Exercises were performed daily in the evening.

Results and discussion

SOT test showed that the test result was within the general norm for the subject's age and height (Figure 3 – Composite column). However, a closer examination of the individual components of the SOT test, showed balance problems in three test components. Trials below the norm are marked red. Trials within the norm were marked green. The norm is presented by gray columns in the chart background. Figure 3 shows the results on the computer screen connected to the device.

Table 1 shows the numerical results of the SOT test performed before the training cycle. The mean result for each test component of three trials was also calculated. All results are given in a numerical scale from 1 to 100, but the results are different for each test component, as illustrated in Figure 3.

After the training was completed, a re-examination was carried out. All the results obtained in the second test were within the norm set out for the subject (Table 2).

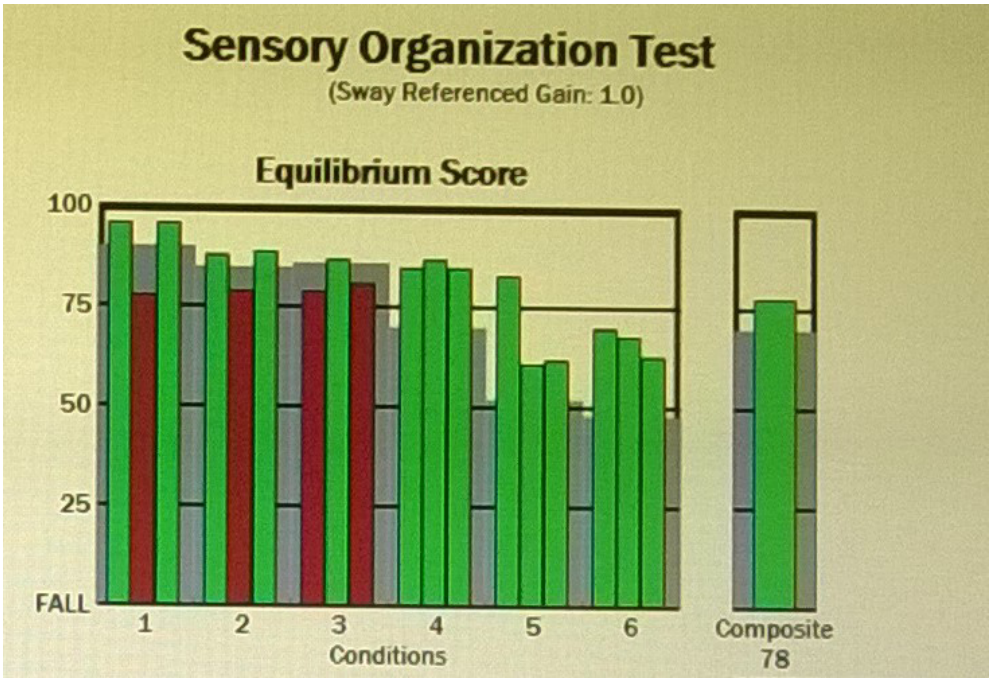

Figure 3. SOT test – before the training cycle

The comparison the results of the SOT test in both examinations demonstrated that five out of six test components improved significantly. In the second examination, a worse test result was obtained only during a test with closed eyes and unstable ground. It is worth noting that during the test on a stable ground also without visual inspection the result was improved (Figure 4).

Analyzing the results of the Unilateral Stance test in the first trial regarding maintaining balance in one leg standing with visual control and without it, a much greater "center of gravity" sway was noted than in a follow-up examination after the training cycle. These differences are illustrated in Figures 5 and 6, and Table 3 based on them. Individual components of the Unilateral Stance test improved significantly in the follow-up examination. It can be concluded that the training cycle has a positive effect on postural control while standing on one leg. Both lower leg and abdominal muscles training can contribute to this (mean results in Table 3 rounded to 0.1).

In addition to double balance assessment with the use of the modern SMART EquiTest device, clinical tests were also performed twice before and after the training cycle in the subject. Table 4 illustrates the

Table 1. SOT test – before the training cycle

SOT test	Trial I	Trial II	Trial III	Mean result (accuracy 0.1)
Eyes open, stable ground and environment	96	78	96	90
Eyes closed, stable ground and environment	88	79	89	85.3
Eyes open, unstable environment	79	87	81	82.3
Eyes open, unstable ground	85	87	85	85.6
Eyes closed, unstable ground	83	61	62	68.6
Eyes open, unstable ground and environment	70	68	63	67

Table 2. SOT test – after the training cycle

Test number	SOT test	Trial I	Trial II	Trial III	Mean result (accuracy 0.1)
1	Eyes open, stable ground and environment	96	94	97	95.6
2	Eyes closed, stable ground and environment	96	94	95	95
3	Eyes open, unstable environment	92	92	92	92
4	Eyes open, unstable ground	93	91	92	92
5	Eyes closed, unstable ground	60	55	66	60.3
6	Eyes open, unstable ground and environment	85	87	80	84

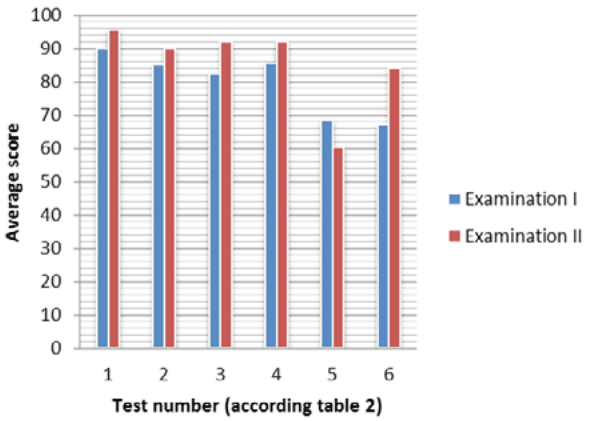

Figure 4. Comparison of mean SOT test results in the examinations I and II

results obtained by the subject in individual tests before and after the training. The results of Romberg test were the same in both examinations, with no significant body sway at 1 minute with open eyes and 1 minute with closed eyes. However, the examination with the SMART EqiuTest showed that while standing with open eyes and closed eyes on a stable surface, the subject obtained worse results in the first examination. The results of Babiński-Weil test and Unterberger's stepping test were better in the second examination. It can be concluded that the training positively influenced the results of these tests. The pointing test of Barany was the same in both examinations. Hamstring contracture test and Rectus femoris contracture test were better in the second examination, which may be due to the stretching cycle. Training positively influenced the outcome of clinical trials, in particular improved muscle flexibility (Table 4).

The presented results suggest that applied musculoskeletal therapy, consisting of eccentric work of the trunk and lower limb muscles and the stretching of these muscles positively influenced the dynamic and static balance of the subject. Similarly, Miyake et al. pointed out that stabilization exercises positively influence the dynam-

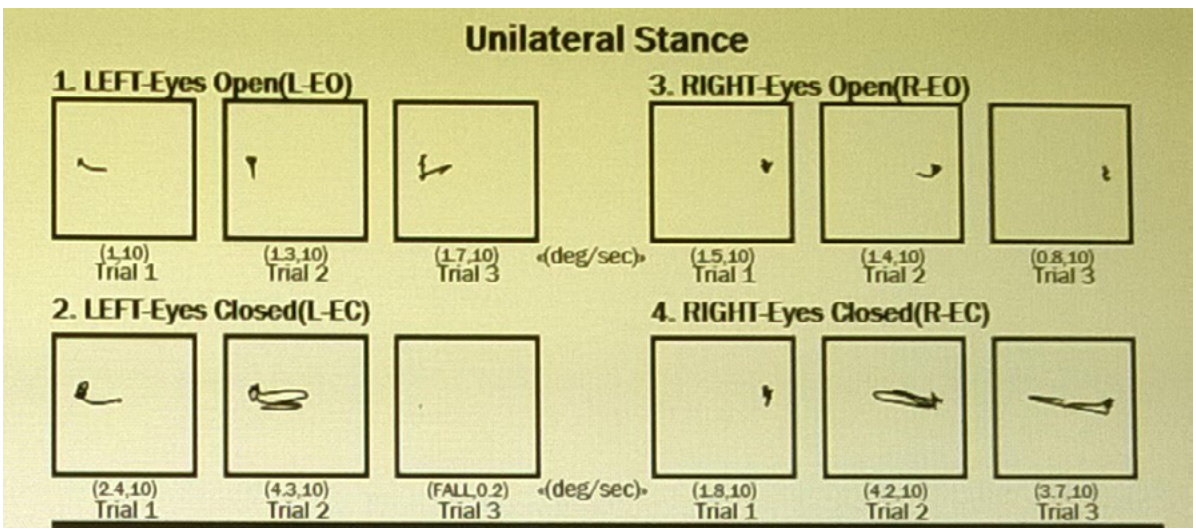

Figure 5. Center of gravity sway in examination I of Unilateral Stance Test

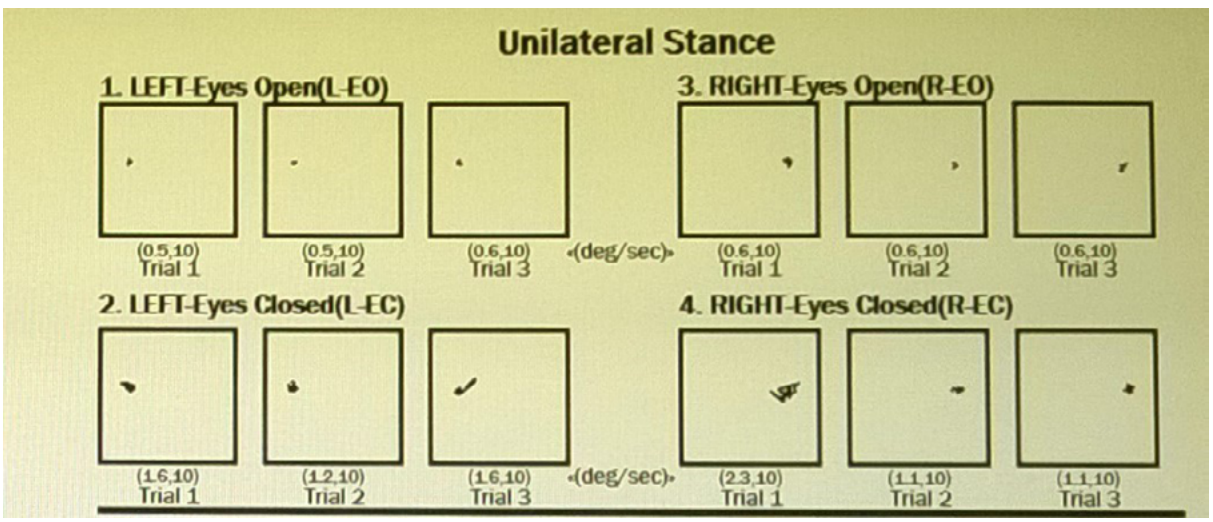

Figure 6. Center of gravity sway in examination II of Unilateral Stance Test

Table 3. Center of gravity sway in examinations I and II of Unilateral Stance Test

Test	Examination I (3 Trials)			Mean result	Examination II (3 Trials)			Mean result	Mean difference
Left LL, EO	1.0	1.3	1.7	1.3	0.5	0.5	0.6	0.5	0.8
Left LL, EC	2.4	4.3	---	3.4	1.6	1.2	1.6	1.5	1.9
Right LL, EO	1.5	1.4	0.8	1.2	0.6	0.6	0.6	0.6	0.6
Left LL, EC	1.8	4.2	3.7	3.2	2.3	1.1	1.1	1.5	1.7

LL – lower limb, EO – eyes open, EC- eyes closed

Table 4. The results of clinical tests in I and II examination

Test	Examination I	Examination II
Romberg test	1 min/1min	1min/1 min
Babiński-Weil test	30°	10°
Unterberger's stepping test	15°	5°
The pointing test of Barany	UL-L: 1cm UL-R: 1cm	UL-L: 1cm UL-R: 1cm
Hamstring contracture test	UL-L: 11,5cm UL-R: 12cm	UL-L: 3cm UL-R: 4cm
Rectus femoris contracture test	LL-L: 4cm LL-R: 5cm	LL-L: 1cm LL-R: 0.5cm

UL – upper limb, LL – lower limb

ic balance of the body.[12] In our study, however, attention was not paid to clenching of the fists or masticator muscles, which may have an impact on the improvement of balance.[13] In light of the observation and analysis of scientific reports, balance seems to be an intrinsic part of overall fitness and training of the body.[12-15] Research show that postural stability can be increased through a variety of training plans. It is important, however, to train the right muscles - those responsible for maintaining stability and balance at the moment of sway. Heleno et al. demonstrated that a five-week training program consisting of sensory exercises improves postural stability in young athletes.[16] As shown Miyake et al. showed this type of workout can also affect the stability of the torso facilitating the operation with the upper limbs, and therefore multi-tasking, referred to as skill – the highest level of the motor control determinants.[14] In addition, the modern SMART EqiuTest device used in the study proved to be a more reliable source of data than clinical tests. Numerous studies indicate that the use of this type of advanced quantitative methods of evaluation based on advanced computer systems provides accurate, complex analysis of imbalances, their causes, and the planning and monitoring of treatment.[17-19]

Conclusion

Myo-fascial training which included eccentric exercises combined with lower limb and trunk stretching improved the postural control in the subject. The case presented proves that the SMART EquiTest from Neurocom International Inc. allowed for a static and dynamic balance assessment with a high sensitivity much more accurate than the human eye, and a subjective assessment of the investigator in clinical tests. A larger sample and using more tests should be employed to draw far-reaching conclusions.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.12

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 78–81

CASUISTIC PAPER

Katarzyna Ura-Sabat [1(ABFG)], Wojciech Domka [1(AFG)], Marta Gamrot-Wrzoł [2(FG)], Krzysztof Szuber [1(FG)]

Tumor of the pharynx – an unexpected diagnosis

1. Clinical Department of Otorhinolaryngology, Fr. Chopin Clinical Voivodeship Hospital in Rzeszów
2. ENT Department in Zabrze, Medical University of Silesia

ABSTRACT

Introduction. Head and neck haemangiomas occur quite rarely. These are benign lesions, often involving the pharynx and larynx. They almost always pose a diagnostic and therapeutic problem.

Case description. This paper describes the case of an asymptomatic internal carotid artery aneurysm manifested by a throat tumour. A 78-year old woman with sudden deafness and vertigo was additionally diagnosed with a throat tumour. After radiological diagnosis of a haemangioma, the patient refused surgery. This article presents diagnostic methods and various types of treatments for head and neck haemangiomas. Attention was paid to the possibility of serious complications when deciding on surgical intervention of haemangiomas without a confirmed diagnosis.

Conclusion. Suspicion of head and neck haemangiomas necessitates using all available diagnostic methods. The treatment plan should take into account the pace of progression, the patient's age and co-morbid conditions.

Keywords. head and neck, haemangioma, diagnosis, treatment.

Introduction

Tumours occurring in the throat and larynx can be categorized as either malignant or benign. Benign lesions can be further sub-categorized based on their cell of origin into vascular, epithelial, neuroendocrine, and intramuscular.

Vascular tumours of the head and neck are quite rare.[1-5] They represent a diverse group of lesions, both morphologically and clinically. Due to the location of these lesions, they cause cosmetic defects and in some cases, due to their location and/or size, can lead to life-threatening conditions.[6] In 1982, Mulliken and Głowacki introduced the biological classification of vascular lesions of the skin and soft tissues, dividing them into two groups:

— Haemangiomas: benign vascular tumours occurring in children with a proliferative phase during infancy that abruptly diminish in early-childhood. They appear in the neonatal or early-infancy period. They are characterized by a sharp increase in

Corresponding author: Katarzyna Ura-Sabat, 35-055 Rzeszów, ul. Chopina 2, tel. + 48178666362, fax: + 48 178666361, e – mail: urka23@wp.pl

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 14.01.2017 | Accepted: 14.03.2017
Publication date: June 2017

Ura-Sabat K, Domka W, Gamrot-Wrzoł M, Szuber K. *Tumor of the pharynx – an unexpected diagnosis*. Eur J Clin Exp Med. 2017; 15(1):78–81. doi: 10.15584/ejcem.2017.1.12

incidents in the first year of life and a period of involution in older children. Haemangiomas are more prevalent in females [1:6 (Male:Female)] .[6]

— Vascular malformations: benign tumour-like lesions, resulting from abnormal vascular tissue morphogenesis. These can be further subdivided into capillary malformations, venous malformations, arterial malformations, arteriovenous malformations, lymphatic malformations and mixed vascular malformations. Although they are congenital anomalies, they may be asymptomatic until puberty and may even go undetected into adulthood. They are present at the time of birth, grow proportionally with the baby and they never regress. The incidence rate among men and women are similar with a 1:1 male to female ratio.[6]

The most common symptoms associated with vascular tumours include hoarseness, foreign body sensation in the throat, haemoptysis, choking, dysphagia, periodic haemorrhages and dyspnoea. They may also be asymptomatic.

Haemangiomas of the larynx often become dark red masses, covering the larynx epithelium and the piriform sinus. Lesions attributed to the vascular malformations have the appearance of a tumour coated in an unchanged mucous membrane or skin, resulting in posterior pharyngeal embossing and distortion or asymmetry of palatal tonsils. They may take the form of a pulsating tumour along the jaw.[7-11]

Approximately 60% of all haemangiomas are located in the head and neck. They are most commonly found in the pharynx and less so in the larynx. In adults they usually involve the glottis and epiglottis, while in children the area of the infraglottic cavity.[6,10-13]

Haemangiomas located on the extraocular internal carotid artery are the least common and most often occur in congenitally-linked cases. Other causes may include injury, atherosclerosis, infection, iatrogenic traumas (ex. tonsillectomy, adenectomy), and fibro-muscular dysplasia.[12-14]

Case Study

In 2012, a 76-year old female patient reported to the Otolaryngology Clinic at the Clinical Provincial Hospital No. 1 in Rzeszów due to sudden hearing loss, accompanied with dizziness. Her symptoms persisted for several days. The patient had previously been treated for ischemic heart disease (undergoing a CABG in 2007), hypertension and depression. Laryngological examination on the day of her admission revealed: nasal septum deviation, which impaired its permeability, preserved pearl grey tympanic membranes, a mobile and symmetrical tongue, small cryptic tonsils and a normal larynx. A tumour was clearly visible on the back of the right side of the throat. It was covered in an unchanged mucous membrane, 3 × 2 cm (Figure 1).

The patient denied having any problems with swallowing, choking, foreign body sensation in the throat or pain.

During her stay at the clinic, in addition to treating her hearing loss and dizziness, a diagnostic imaging CT scan of the neck was performed (Figure 2). The clinical note stated: "the right side of the internal carotid artery is elongated and forms a tight bend towards the medial surface at the level of the C1-C2 vertebrae causing a prominence on the posterior lateral wall of the mouth and throat. There were no pathological structures in this area. Numerous calcified atherosclerotic plaques in the

Figure 1. Throat tumour on the admission (2012)

Figure 2. CT scan

Figure 3. Follow up (2016)

right internal carotid artery are not causing significant morphological narrowing (about 30%)".

The patient was informed about the diagnosis of an aneurysm and the possibility of surgical treatment, to which she did not consent. A follow-up was conducted 4 years later, in 2016, and it showed a posterior tuberous structure of the same size as had previously been observed, and covered in an unchanged mucous membrane (Figure 3). The patient reported a feeling of an obstructed throat and periodic pain radiating to the right ear. She did not observe any bleeding, haemorrhaging or trouble breathing. She also did not report problems during food intake.

Discussion

Thrombotic vesicular cancers are rarely diagnosed. In addition to the posterior wall of the throat, soft palate and palatine tonsils, they are also found on the base of the tongue an in the parotid gland. Sometimes they may be mistakenly interpreted as esophageal varices.[15] They take the form of dark red tumours of varying sizes.

Internal carotid artery (ICA) aneurysms are also rarely observed in the practice of laryngology. Causes of ICA aneurysms may include: atherosclerosis, fibro-muscular dysplasia, traumas, surgical procedures (ex. removal of tonsils), and infections. They most often occur in the proximal segment of the artery. They can present asymptomatically as in the case described here, but they are more often accompanied by swallowing disorders, hoarseness, feeling of a foreign body in the throat, haemoptysis, choking while eating or sore throat.[10,14] These tumours require very precise diagnosis. Due to the often significant asymmetry of the tonsils of the palate or the posterior wall of the throat, they should be differentiated from other neoplasms.[14,16] Haste to qualify patients for surgery can pose a threat to their health or even their life. Diagnostic methods for haemangiomas include: Doppler ultrasonography, angiography and MR angiography. They allow for accurate determination of the size of the lesion, its relation to large arteries and the point of departure in the case of aneurysm lesions. Fine-needle biopsies are contraindicated because of the high risk of profuse bleeding.[17-18]

In the case of minor vascular changes, observation is recommended, whereas major changes which may cause bleeding, airway obstruction or cosmetic defects may require more radical approaches, such as multidisciplinary surgical treatment or radiation therapy.[17-19] Conservative treatments include local or general administration of glucocorticoids. According to Bilewicz, the effectiveness of such treatment is about 30%.[10] The operative interventions include the use of CO_2 laser, potassium titanyl phosphate (KTP) laser, cryosurgery, harmonic scalpel, or radiotherapy. Up to now, there has been no uniform schema for the surgical treatment of haemangiomas due to their rarity and relatively wide variety.[2]

For giant vascular tumours, a tracheotomy is often recommended before surgery. The treatment of internal carotid artery aneurysms, may involve the resection of the vessel and its surrounding connective tissue or intravascular embolization with detachable coils.[20] Allergic reactions, advanced atherosclerotic lesions and abnormal vascular connections are contradictions to embolization treatment.

In the case of superficial and small tumours, laser therapy offers high efficacy of between 77 and 100%.[19,20]

Radiotherapy (40 Gy total dose in 20 fractions) is rarely used, usually after ineffective glucocorticoid treatment and in the case of massive tumours that are ineligible for surgical intervention. By qualifying a patient for

radiotherapy, one must consider the risk of secondary tumour development. Radiation therapy can effectively reduce tumour mass by up to 30% without significant complications.[8,17-18]

Wang *et al.* believe that an effective, safe surgical method is the use of the harmonic scalpel. According to the authors, this method is less invasive, reduces the duration of the surgery, reduces the risk of bleeding during surgery and reduces the probability of tumour re-growth during a 2 year follow-up.[2]

Each type of tumour of the pharynx or larynx requires very thorough diagnostic investigation. A pulsating tumour is an indication of the lesion's vascular nature. When deciding on how to deal with vascular pharynx and larynx tumours, one should consider the pace of progression, the age of the patient, and co-morbid conditions.[10,14]

The authors wish to emphasize the need for accurate tumour diagnosis, especially in the case when pulsating tumours are observed. Of course, it is necessary to communicate the nature of the malady to the patient, all treatment options and the possible complications of the surgical intervention. This should raise the clinician's awareness of the possibility of vascular lesions and the subsequent consequences regarding the patient's health and life, as well as of potential medicolegal allegations against the medical team in case of complications.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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© Wydawnictwo UR 2017
ISSN 2544-1361
doi: 10.15584/ejcem.2017.1.13

http://www.ejcem.ur.edu.pl/en/
European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 82–86

CASUISTIC PAPER

Miłosz Ambicki [1(ABCDFG)], Robert Brodowski [1(BCD)], Marta Mucha [1(FG)], Małgorzata Migut [1,2(AFG)], Adam Malawski-Róg [1(BCD)], Wojciech Stopyra [1(BCDF)], Bogumił Lewandowski [1,2(ABCDF)]

Drug–induced gingival overgrowth after cyclosporin A therapy

[1] Clinical Department of Maxillo-Facial Surgery, Frederic Chopin Provincial Specialist Hospital in Rzeszów
[2] Department of Emergency Medicine, Faculty of Medicine, the University of Rzeszów

ABSTRACT

Introduction. Drug–induced gingival overgrowth is a condition caused by side effects of treatment with one of three types of drugs: phenytoin (used in epilepsy treatment), cyclosporin A (used in transplantology after allogeneic organ transplants) and calcium channel blockers (in the treatment of hypertension). Gingival overgrowth leads to the development of inflammation within the gums and periodontium, reduced comfort in a patient's life, and consequently even loss of teeth.

Aim. The aim of this study was to present the issue of drug–induced gingival overgrowth based on a review of the literature and observations of patients treated in the Clinical Department of Maxillo-Facial Surgery, Frederic Chopin Provincial Specialist Hospital in Rzeszów.

Case description. Massive gingival overgrowth requires surgical management. Attention should be paid to multidisciplinary cooperation in case of patients qualified for a transplant. It is also import_ant to qualify and evaluate the state of the oral cavity prior to the implementation of immunosuppressive medication, instruction of patients on oral hygiene and removal of the outbreaks of infection.

Keywords. drug-induced gingival overgrowth, cyclosporin a, gingivitis, transplant

Introduction

Gingival overgrowth is caused by both external as well as intrinsic etiological factors. Clinical symptoms include enlargement of the volume of the vertical and horizontal dimensions of the gingival margin and gingival papilla. It is the result of one of two distinct pathological processes. On the cellular level, it corresponds to a hypertrophy that causes overgrowth and enlargement in size and volume of individual cells without increasing their number, and hyperplasia – overgrowth, which leads to enlargement of tissues or organs by increasing the number of cells. The clinical picture in both of these processes is similar. Histopathological examination allows us to discriminate between them. Overgrowth in the oral cavity may occur in the form of acute or chronic lesions. They may be focal, located only in the anterior or lateral portion of the gingival garland or have generalized character occupying significant part of the alveolar process of the maxilla and alveolar part of the mandible. Advanced lesions may include 1/3 of the tooth crown

Corresponding author: Bogumił Lewandowski, Department of Emergency Medicine, Faculty of Medicine, the University of Rzeszów

Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

Received: 14.01.2017 | Accepted: 14.03.2017
Publication date: June 2017

Ambicki M, Brodowski R, Mucha M. *Drug–induced gingival overgrowth after cyclosporin A therapy*. Eur J Clin Exp Med. 2017;15(1):82–86. doi: 10.15584/ejcem.2017.1.13

height or over 1/2 of its size. Additionally, they can be complicated with the presence of plaque.[1,2]

Initially, overgrowth lesions start in the area of the gingival margin and gingival papilla, then spread to the periodontium and the surrounding tissues. Apart from local factors such as tartar, plaque and bad hygiene, gingival overgrowth may result from side effects of drugs and chronic treatment.[3,4]

Overgrowth and inflammatory gingival lesions may be caused by anti-epileptic drugs (Hydantoin derivatives), immunosuppressive drugs such as cyclosporin A, and drugs used in treatment of hypertension (calcium channel blockers). Drug–induced gingival overgrowth depends on the type of medication used, the age of the patient (more often in children and adolescents) and location (more often affects gums in the area of the front teeth) [3]. First symptoms appear about 3 months after the initiation of treatment with a given drug. Drug–induced gingival overgrowth is a multifactorial response. Local factors such as plaque and biofilm associated with about 750 types of bacteria aggravate the overgrowth and maintain inflammation.[5–7]

The pathomechanism of drug–induced gingival overgrowth is not fully explained and dependent on the type of medicine. In the case of hydantoin derivatives (used in the treatment of epilepsy), the intensification of the process is related to the metabolism of adrenal cortical hormones. Fibroblasts metabolize testosterone to 5-alpha-dihydrotestosterone. Chronic use of phenytoin increases the metabolic activity of the cell resulting in an increased production of collagen, inhibition of the activity of collagenase and tissue inhibitors of metalloproteinase.[8] Genetic factors are also important – drugs that cause drug–induced gingival overgrowth are metabolized by cytochrome p450 enzymes, which are characterized by high genetic variability.[9] Research on genes responsible for HLA leukocyte antigen coding confirmed the theory of HLA-DR2 antigen influence, which is found much more commonly in patients with moderate or severe drug-induced gingival overgrowth than HLA-DR1.[10,11]

Cyclosporin A is a cyclic polypeptide (undecapeptide) isolated from the Tolypocladium inflatum fungus in the first phases of antibiotic research.

Due to its immunosuppressive activity, it was first used in patients in 1978 after kidney transplants as well as in the treatment of many conditions with autoimmune components.[12] The main indication for its use is prevention of rejection of allogeneic organ transplants. In vitro studies show that cyclosporine A causes increased collagen mRNA synthesis, in particular, pro collagen type 1.The main tissue metabolite of cyclosporin A, OL-17, reacts with fibroblasts thus leading to excessive cell proliferation and increased synthesis of proteins.[9,13] The most commonly observed side effects during cyclosporin therapy apart from gingival overgrowth include hirsutism, hand tremor, impaired renal function, hepatic dysfunction, gastrointestinal disorders and increase of blood pressure.[14–16] Epidemiological and experimental studies have shown that combined cyclosporin A and nifedipine therapy may intensify gingival overgrowth. Nifedipine, which is often used in the treatment of hypertension, has an undesirable effect on the periodontinum and gums as it can exacerbate gum overgrowth.[5] The third group of drugs causing gingival overgrowth are calcium channel blockers (e.g. nifedipine, amlodipine, verapamil) used mainly in the treatment of hypertension. Patomechanism is related to inhibition of the transition of the cell to the state of apoptosis, which in consequence leads to macroscopic tissue hypertrophy. Calcium deficiency in epithelial cells leads to production of BCL2 protein inhibiting apoptosis and in excess, to the production of Bax protein acting in the opposite way.[9]

Treatment of drug–induced gingival overgrowth depends on the degree of progression of the disease. In most cases, conservative treatment is used. Conservative methods (mainly periodontal) are professional hygienisation procedures, use of local anti-inflammatory and antibacterial drugs, and dental plaque control by the patient. Some authors claim that these treatments allow for reduction of surgical treatment by up to 50%.[17] Surgical methods are used in cases of advanced overgrowth that hinder nutrition, food intake, causing difficulties in speech and maintaining oral hygiene. These states are often associated with painful bleeding in the oral cavity and the occurrence of abscesses caused by the spreading infections. Surgical treatment eliminates completely the potential outbreak of infection in the oral cavity and allows forming a normal physiological gingival contour which consequently improves the hygiene and aesthetics of the oral cavity. It also has a positive effect on the well-being and quality of the patient's life after surgery. Gingival overgrowth treatment uses traditional surgical methods or methods applying modern techniques such as lasers, electric knives or cryotherapy.[5,9,13]

In everyday practice, almost every doctor can encounter patients who use various chronic drug therapies, including more and more frequently, immunosuppressive treatment after organ transplants. An example of an immunosuppressive drug widely used in transplantology is cyclosporin A.

The aim of this study was to present the issue of cyclosporin A induced gingival overgrowth based on the observations of three patients recently treated after kidney transplant and a literature review as an example of oral complications. This issue seems interesting to most practitioners because of the interdisciplinary nature of the procedure.

Case I

The patient J.S. aged 68 was admitted to the Department of Maxillo-Facial Surgery, Frederic Chopin Provincial Specialist Hospital in Rzeszów due to massive gingival overgrowth complicated by chronic inflammation. During the interview it was found that the first limited gingival overgrowth appeared about 13 years before and it was characterized by slow growth. Overgrowth was accompanied by pain, problems with food intake, repeated bleeding, inflammation and pus effusion. It has been established during the interview that, since kidney transplantation, the patient has been using cyclosporin A for 13 years. His history included brain stem stroke 14 years before. He had type II diabetes and hypertension for several years. The oral examination revealed massive dark-pink gingival overgrowth in the upper dental arch in the area of teeth 17 to 27 (Figure 1a.) and the lower arch in the section of 36 to 46 covering more than half of the vertical dimension of teeth crowns (Figure 1)

In addition, pathological mobility of teeth 43, 44, 33, 34, 11, 13, 14, 15, 17, and 23 was found with abundant dental plaque and subgingival plaque. Teeth 26 and 27 did not show the characteristics of increased mobility. Pus content was present in the pathological periodontal pockets. Odor from the mouth (fetor ex ore) was noticeable. The pantomogram revealed bone defects typical of advanced periodontinum diseases affecting the alveolar part of the maxilla and alveolar process of the mandible. The patient was qualified for removal of the pathological overgrowth of gingival tissues and local gingivoplasty, which consisted of modeling the alveolar process of the maxilla and the alveolar part of the mandible which enables future prosthetic treatment. The postoperative course was uneventful. Postoperative wounds healed correctly. Immediately after surgery the patient did not follow the medical recommendations to use products facilitating high level of oral hygiene. During subsequent outpatient inspections the patient was motivated to use and maintain proper oral hygiene. At the end of the treatment, despite the recommendations, the patient did not decide to make prosthetic restorations. The patient remained in outpatient follow-up for a period of 1 year. During follow-up after 3, 6 and 12 months after surgery no relapse was observed.

Case II

The patient M.M. aged 59 was admitted to Department of Maxillo-Facial Surgery, Frederic Chopin Provincial Specialist Hospital in Rzeszów due to the overgrowth of the lower gingiva. He did not report any pain. This patient was immunosuppressed with cyclosporin A for 13 years after kidney transplantation. During the interview he also reported treatment with nitrendibin for hypertension. He noticed gingival overgrowth about a year

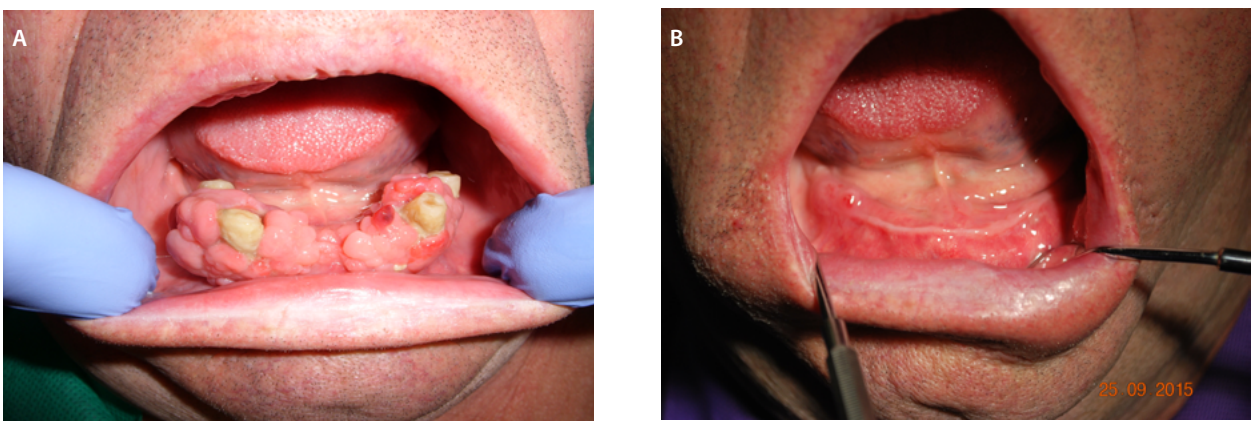

Figure 1. Patient J. S. Massive lower gum overgrowth (A). State after surgery (B).

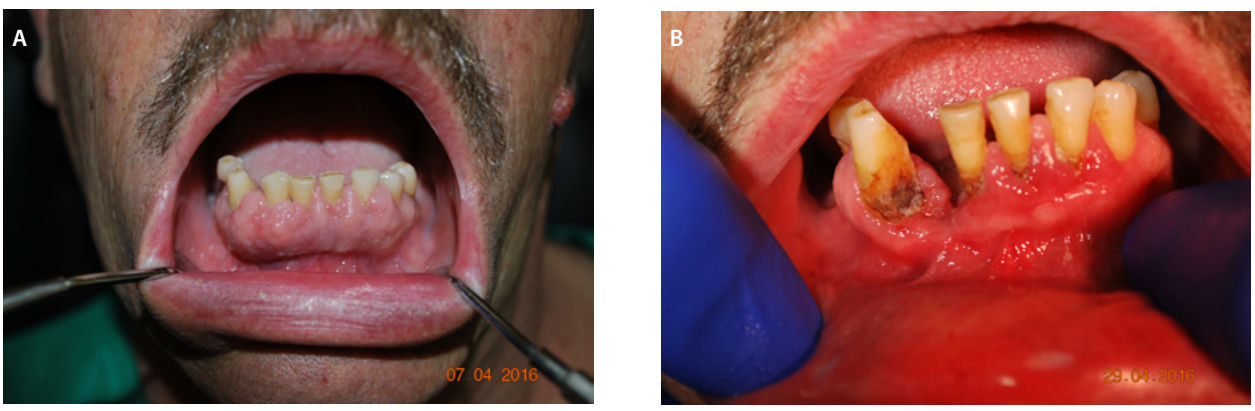

Figure 2. Patient M.M. Massive upper gum overgrowth. (A) – state before surgery, (B) – state after surgery

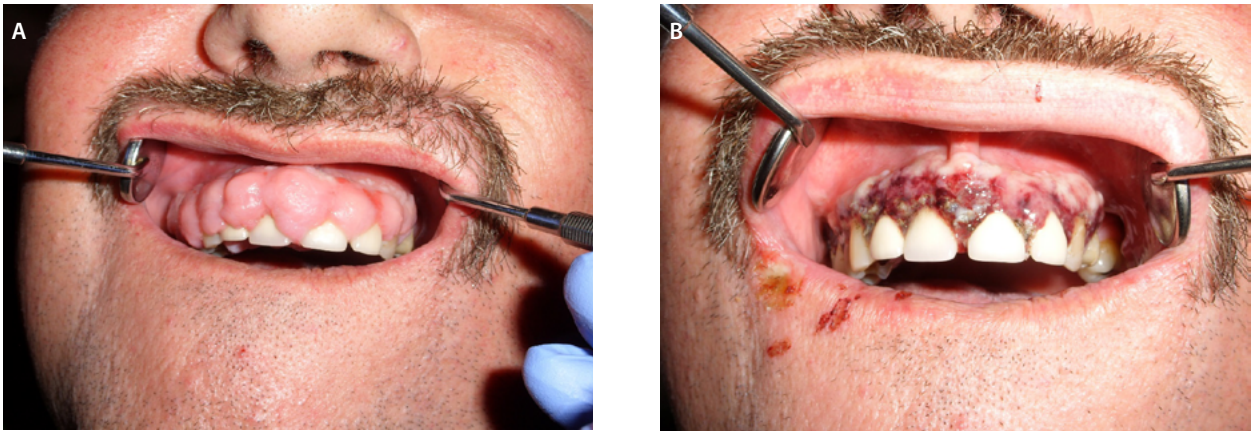

Figure 3. Patient P.K. Massive upper gum overgrowth. (A) – state before surgery, (B) – state after surgery – healing wounds

ago that coincided with an increased dose of cyclosporin A (125 mg to 340 mg/day). In addition, the patient was diagnosed with tuberculosis of the urinary tract. A clinical examination revealed the overgrowth of lower gingiva locally from 33–44 covering half the height of the teeth crown. No active inflammation was found. The panoramic X-ray revealed horizontal cavities of bone of the alveolar part of the mandible and the alvealar process of the maxilla characteristic of periodontal conditions. The patient was qualified for surgical removal of gingival overgrowth with gingivoplasty of the alveolar part of the mandible in sections 33–44. The surgery was planned in a way to ensure proper prosthetic restoration and rehabilitation of the chewing organs. The Patient postoperative course was uneventful. Wounds healed by granulation. No local recurrence was found at the follow up after 3 months, and after 1 year.

Case III

The patient P.K. aged 41 came to appointment at the Outpatient Maxillo-Facial Surgery Cliinc due to fibro-nodular overgrowth of gingival papillas and gingiva covering the alveolar process of the maxilla observed for about 1 year. Swelling proceeded slowly up to the size that caused the patient concern. He did not observe any bleeding, inflammation and pain. According to the interview, he took the immunosuppressive drug cyclosporin A for 8 years due to renal transplant. During examination it was observed that overgrowth included 3 tooth crowns on the vestibulo-labial side and the hard palate causing not only difficulty in food intake and chewing but also disturbed his smile aesthetic. (Figure 3)

On the basis of history and physical examination, drug–induced overgrowth and nodular lesions within gingiva associated with cyclosporin A was diagnosed. The patient was qualified for the removal of overgrowth with gingival garland modeling under general anesthesia. The course of the treatment was uneventful. After the surgery, the patient reported pain which was relieved with analgesics. On the second day he was discharged and referred for outpatient follow-up. Fig. 3B presents the local state after treatment during wound healing.

Conclusion

The mechanism of gingival overgrowth is not fully understood. Discontinuation of pharmacotherapy may cause local changes to regress, however, discontinuation of cyclosporin A therapy is not possible and its replacement with another immunosuppressive drug, e.g. tacrolimus, does not result in overgrowth regression. Special attention should be paid to the health of the oral cavity before starting cyclosporin or other immunosuppressant therapy.

The presence of periodontal conditions, their degree of their severity, poor oral hygiene, and the presence of caries, especially before cyclosporin therapy, predispose a patient for gingival overgrowth, which requires surgical treatment almost exclusively.

Multidisciplinary cooperation of transplantologists, dentists, periodontists and maxillofacial surgeons during both the pre and post-transplant period is necessary because it can reduce complications and side effects resulting from immunosuppressive treatment in patients after organ transplants.

Compliance with ethical standards

Conflict of interest: The authors declare that they have no conflicts of interest.

Funding: None

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ISSN 2544-1361

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European Journal of Clinical and Experimental Medicine
Eur J Clin Exp Med 2017; 15 (1): 87–90

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