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ORIGINAL ARTICLE

EFFECTS OF SELECTIVE COOLING OF SPECIFIC HUMAN BODY SURFACE AREAS ON SUBJECTIVE ASSESSMENT OF THERMAL COMFORT IN HOT CONDITIONS

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Introduction: The aim of the study was to determine whether changing the location of a selectively cooled body surface area in hot conditions, using a thermal stimulus of the same temperature and the same area and time of cooling, has an effect the on subjective assessment of thermal comfort.

Methods: The experiment was participated by 10 healthy men who were not accustomed to high temperatures. Conducting a unit study included: a 30 minute period of adaptation to the thermoneutral conditions followed by 45 minutes of exposure to hot conditions (40°C), including 30 minutes of an uncooled period and 15 minutes of selective cooling of the neck (series I) or sternum (series II) (stimulus temperature: 10-12°C). The thermal state of the body was evaluated three times using the Bedford test: in the 30th minute of adaptation to the thermoneutral conditions, in the 30th minute of exposure to high temperature and in the 15th minute of cooling in hot conditions. Assessment of thermal sensations in relation to the selectively cooled area (neck, sternum) and the assessment of thermal comfort in relation to the whole body were analyzed.

Figures: 4 • **References:** 21 • **Full-text PDF:** http://www.pjambp.com • **Copyright** © 2018 Polish Aviation Medicine Society, ul. Krasińskiego 54/56, 01-755 Warsaw, license WIML • **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education

Results: As a result of 15 minutes of cooling, a significant decrease in skin temperature in the neck region was obtained at the level of $\Delta Tsk_{NECK} = -2.2 \pm 0.1°C$ and sternum $\Delta Tsk_{STERNUM} = -1.8 \pm 0.1°C$. A positive effect on the subjective assessment of thermal comfort in the whole body was observed in 70% of the participants who cooled the neck area and in 40% of the participants who cooled the sternum area. The positive effect on thermal sensations caused by cooling the neck area was observed in 80% of the participants, and the positive effect of cooling the sternum area was observed in 50% of the participants.

Discussion: Selective cooling of the neck or sternum area in hot conditions positively improves thermal sensations. The local sensitivity of the skin to low temperatures is greater in the area of the neck than in the sternum. The improvement of subjective assessment of thermal comfort in relation to the whole body was greater after the application of selective cooling on the neck surface than on the sternum. Local cooling of the skin surface with a low-temperature stimulus (10-12°C) in hot conditions (40°C) does not cause the feeling of thermal discomfort.

Keywords: selective cooling, thermal comfort, thermal sensations, psychophysical state, bedford scale

INTRODUCTION

The thermal conditions of the environment in which military tasks are carried out (cockpit interior, hot climate zone), as well as using protective clothing (e.g. g-suits, helmets) adversely affect physiological processes and cognitive functions of a soldier's organism. The combined effect of these factors leads to severe thermal stress, overheating of the body, which can be seen both through subjective assessment and in relation to physiological reactions (increase in skin temperature Tsk, core body temperature Tc or heartbeat rate HR) [10,12]. In high temperature conditions (above 27°C), the learning ability and processes of memorizing and logical reasoning deteriorate, the level of concentration, perception and alertness (expressed as an increase in the number of errors) and the efficiency of problem solving also decreases, e.g. in mathematical calculations [5,14,16]. In addition, it has been shown that the human thermoregulatory system and sleep mechanisms are also strongly interrelated. If the ambient temperature is too high, it can significantly reduce the quality of sleep during the night, which has been confirmed by numerous tests. Poor sleep quality deteriorates motor coordination, cognitive performance, and affects brain functions related to risk-taking and cognition while awake [8,13,18,19]. As heat load indicators (Tsk, Tc, HR) worsen, so do the cognitive processes, as well as the subjective assessment of temperature and burden of physical work. In view of the existing threats to maintaining thermal comfort in a thermal balance state, it is extremely important to regulate the temperature of the body [14].

Thermal stimulation is perceived by the body as comfortable when the body temperature is maintained within the limits of physiological norms. However, the feeling of discomfort occurs when the internal thermal conditions deteriorate. Information about external thermal conditions reaches the body through signals transmitted from the skin's thermoreceptors, which are unevenly distributed on the body. Depending on the body's thermal state, every flow of stimuli in sensory processes from the skin surface to the central nervous system is described either as "comfortable" or "uncomfortable". It is interesting that the degree of intensity of these changes is not the same in all areas on the body. Research has shown that the local thermal sensations and the thermal comfort for the whole body are differentiated depending on the location of the thermal stimulus on the skin. For example, Arens et al. observed that the head and neck area is more sensitive compared to less sensitive limbs (shoulders, legs) or moderately sensitive other areas of the body (torso, back). In the experiment conducted by the Nakamura team, the participants exposed to hot conditions assessed cooling in the facial area as more effective than in the abdomen and thighs [1,15]. Thermal sensations received from the back, chest and pelvic area have a stronger effect on the change in comfort for the whole body than thermal sensations received from the palm and foot surfaces [2,7]. Hensel et al. observed that cooling one's hands in a warm environment invokes a feeling of cold in that particular part of the body, but the overall thermal sensation changes only slightly from “pleasantly warm” to “pleasant” [7]. Similarly, other studies have shown that cooling of limbs (hands, feet) has less effect on thermal comfort than torso areas, and that cooling of face and neck in hot conditions is the most comfortable [14,15,21].

Thermal comfort is a state of satisfaction of the body with the surrounding thermal environment, so it is not described as either cold or warm. In addition, this condition is not associated with a specific temperature value. The opinion and assessment of people in different environments constitute the basis for information on their state of thermal comfort. Subjective evaluation of the state of thermal comfort in relation to the whole body is characterized by intra-individual variability (everyone can perceive the surrounding thermal conditions in a different way). It depends on the personality, level of daily activity, degree of insulation of clothing and physical factors characterizing the environment. When cooling a specific area on the body, general well-being and subjective assessment of the state of comfort are improved. For example, using a PCM cooling vest improves the thermal sensations felt by the body and the skin moisture level assessment in hot (34°C) conditions [6]. We have also confirmed this in our own experimental studies. It is particularly beneficial to maintain thermal comfort in relation to the head surface. Studies have confirmed that head cooling is an effective way to reduce the level of thermal stress in the awake state and is most likely the result of significant heat loss by the head [4]. The Pallubinsky team reported that cooling only the face or face and armpits is also an effective way to improve thermal sensations and thermal comfort in a warm environment. External interference in the process of heat loss from this part of the body not only improves the subjective assessment of the thermal state, but also changes the assessment of the degree of inconvenience the performed work (fatigue level) [17]. Moreover, cooling the surface of the head area has a positive effect on heat load indicators, e.g. it reduces the heartbeat rate. Psychomotor performance, information processing, awareness and focus can also be improved, which often contributes to the decrease in the number of mistakes made. To sum up, the reduction of thermal stress influences the assessment of thermal comfort in a positive way, which may translate into the reduction of perceived fatigue and limitation of performance decrease [7,14]. Extending the body’s tolerance to high temperature by using a low temperature thermal stimulus can have a positive impact on the safety threshold of the tasks performed, especially in difficult and unfavorable environmental conditions. Therefore, the aim of the Military Institute of Aviation Medicine study was to determine to what extent the change of location of selective body surface cooling (neck and sternum) using the same thermal stimulus (10 - 12°C) on the same area (100 cm^2) and same duration (15 min) in hot conditions (40°C) differentiates the subjective assessment of thermal comfort.

MATERIAL AND METHODS

Participants in experimental research

The experimental group consisted of 10 healthy young men (n=10) aged 24.5 ± 0.5 years with the following anthropometric parameters: body weight 67.9 ± 1.8 kg, body height 1.73 ± 0.02 m, BMI: 22.72 ± 1.6 kg/m^2) not previously acclimated to high temperatures. All participants were admitted to the study by an occupational physician. In order to minimize the level of situational stress, participants were familiarized with the climate chamber exposure procedure and its physiological consequences. During the day preceding the experiment, the participants were obligated to maintain a hygienic lifestyle (application of dietary recommendations, not consuming alcohol and intoxicants). Before proceeding further, each of them agreed in writing to participate in the experiment.

Selection of the method of selective cooling

The selection of material and methods of selective cooling was based on the analysis of literature data and the results of own experiments. As a selective cooling method, “cooling pads” (cooling surface - 100 cm^2) were used, which were filled with non-toxic propylene glycol in gel form and a temperature of 10-12°C. The refrigerant was sealed in a welded plastic bag, which made for a sturdy and resistant container. This type of compress did not cause a feeling of humidity (as in the case of, for example, melting ice).

The “cooling pad” used has many beneficial properties: 1) the elasticity of the material ensures that, even after freezing, the “pad” adheres well to the body surface without sticking to the skin; 2) a non-toxic coolant (propylene glycol) with a very high specific heat of 3,38 J/(gK). The favorable heat transfer coefficient ensures that the heat is properly transferred from the surface of the body; 3) it does not constitute an additional load; 4) it does not limit the comfort of movement; 5) it is economical due to the possibility of repeated use (during operation there are no irreversible chemical changes in the gel, the cooling effect is always the same). However, the "pad" must be externally cooled in the refrigerator before use. In addition, they do not keep their temperature for long and they have a limited time of operation.

Organization of research

The experiment was conducted under an identical and reproducible environmental conditions, in autumn (September to October) at the Department of Aviation Physiology of the Military Institute of Aviation Medicine (WIML) in Warsaw. The research project was approved by the WIML Human Research Ethics Committee. Each unit test was started at the same time in order to minimize differences resulting from daily rhythm as much as possible. Each participant engaged in the experiment twice, with a 24-hour break between successive exposures.

Two series of unit tests were carried out. The "cooling pad" was applied to the skin surface in series I – in the neck area, in series II – in the sternum area. Each time, before application, the "pad" was cooled to 10-12°C and then, after drying with a cotton towel, it was fixed to a specific place (sternum or neck) using flexible tapes.

Physical characteristics of the environment

Both series I and II of the experiment were conducted in simulated conditions of a hot climate chamber of the Military Institute of Aero-medical Sciences. In both series constant and reproducible conditions of the chamber interior were maintained: air temperature Ta = 40 ± 0.5°C, relative humidity RH = 30 ± 1%, air flow velocity V = 1m/s.

Conduct of the unit study

All participants of the study started the experiment after a standard breakfast, proper placement of physiological indicators and baseline measurements (internal body temperature Tc, skin temperature of TskNECK and TskSTERNUM , heart rate HR, blood pressure BP). During the experiment, the participants were sitting, wore cotton shirts, shorts and sports shoes. Conducting a unit test included: 30 minutes adaptation to thermoneutral conditions (Ta = 21.0 ± 0.1°C; RH = 30 ± 1%) and 45 minutes of exposure to high temperature (climate chamber: Ta = 40 ± 0.5°C; RH = 30 ± 1%). During the 30 minute stay in the climate chamber, a "cooling pad" with a temperature of 10 - 12°C was applied for a period of 15 minutes near the neck (series I) or sternum (series II) area.

During the experiment (series I and II) the examined person filled in the Bedford test three times in order to subjectively assess the thermal state of their body based on the 7-point Bedford Scale in the following stages: in thermoneutral conditions - in the 30th minute of adaptation, and in simulated hot conditions - in the 30th minute of adaptation to high temperature, and in the 15th minute of selective cooling of specific body surfaces (neck or sternum). At the same time, the parameters of internal body temperature Tc and skin temperature Tsk were measured. On the Bedford Scale, 1 means "too cold" and 7 "too hot". The values of 3 - "pleasantly cool", 4 - "pleasant" and 5 - "pleasantly warm" are within the range of thermal comfort. Each time the participants assessed the thermal state of the whole body and the thermal sensation of the cooled area of the neck or sternum.

During exposure to simulated heat conditions the following physiological indicators were record-

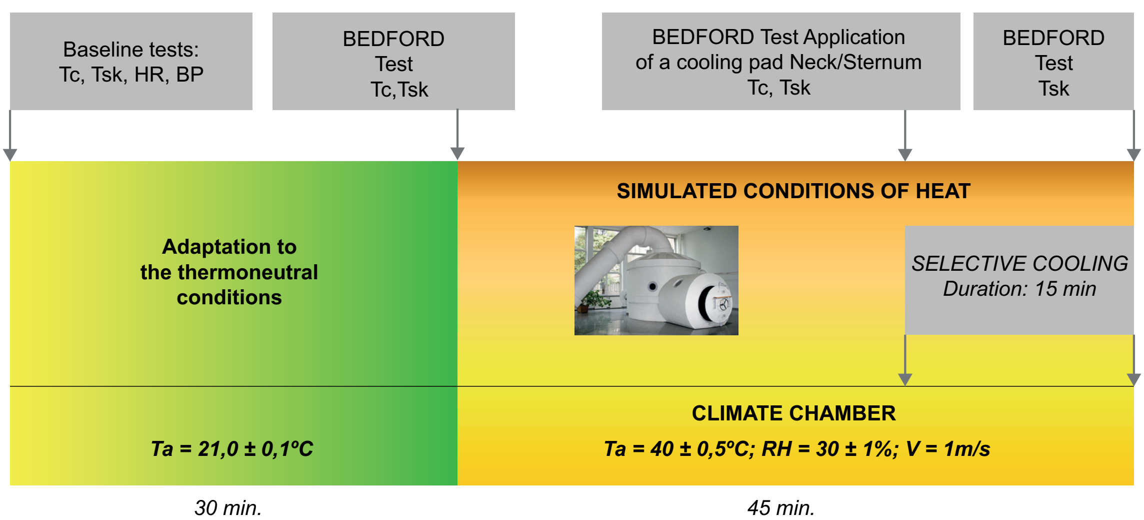

Fig. 1. The course of the unit test under thermoneutral conditions and simulated hot climate chamber conditions.

ed: body temperature (Tc) in the external ear canal using an electronic infrared thermometer, skin temperature (Tsk) using the Ellab thermocouple, a device equipped with humidity and temperature sensors, systolic and diastolic pressure (BP) measured using an electronic blood pressure monitor.

Statistical analysis of results

The values of parameters obtained as a result of cooling were related to the output values recorded at hot conditions before cooling. Changes in the analyzed psychological and physiological indicators were evaluated using the t-Student parametric test for dependent trials (assuming normality of distribution). The obtained data is presented as mean values ± SD. The significance of the differences was assumed at the level of $p<0.05$. The StatSoft Polska Statistica 6.0 statistical package was used to analyze the results.

RESULTS

Skin temperature

Under thermoneutral conditions, the core body temperature was maintained at the mean value of Tc = 37.1 ± 0.1°C, while the skin temperature reached the mean value of Tsk = 29.4 ± 0.2°C. During 30 minutes of exposure to hot temperature, the mean core body temperature value was Tc = 37.2 ± 0.1°C and the mean skin temperature value for the neck was TskNECK = 34.1 ± 0.1°C and was very close to the values obtained for TskSTERNUM = 34.3 ± 0.2°C. After applying selective body surface cooling (with the same temperature of 10-12°C, same area of 100 cm^2 and duration of 15 minutes) during exposure to high temperature (40°C) different levels of skin cooling were observed. (Fig. 2). The recorded mean Tsk value in the neck area was lower than in the sternum area (TskNECK = 31.9 ± 0.2°C; TskSTERNUM = 32.5 ± 0.1°C). As a result of 15 minutes of selective cooling, a significant decrease of the skin surface temperature in the neck area was obtained at the level of ΔTskNECK = -2.2 ± 0.1 °C and at the sternum surface ΔTskSTERNUM = -1.8 ± 0.1°C (differences at the level of statistical significance of $p<0.01$).

Thermal sensations and thermal comfort

In the 30th minute of adaptation to the thermoneutral conditions, the participants assessed the local thermal sensations in relation to the neck and sternum surface and the state of thermal comfort in relation to the whole body as "pleasantly cool - 3" on average, which was in the range of thermal comfort (according to the Bedford Scale). No significant differences were observed between the sensitivity of the skin of the two analyzed areas of the neck and sternum.

Then, in the 30th minute of exposure to high temperature (40°C), the participants assessed thermal sensations with respect to the neck and sternum area and thermal comfort with respect to the whole body as "too warm - 6" on average, which went beyond the range of thermal comfort (evoked a sense of discomfort according to the Bedford Scale). Again, no significant differences were found in relation to the areas of the neck and the sternum.

At high temperature (40°C), combined with a 15-minute selective cooling stimulus on the neck, 70% of the participants felt an improvement in the subjective assessment of the state of thermal comfort in relation to the whole body ("pleasantly warm - 5", which was in the range of thermal comfort). In the case of cooling of the sternum area, a similar improvement was observed in 40% of the participants. The remaining participants in both series of experiments did not feel any change in the thermal state and still described it as "too warm - 6" (30% of the participants using neck cooling, 60% of the participants using sternum cooling) (Fig. 3).

On the other hand, as a result of 15 minutes of local cooling in hot conditions, 80% of the participants described the thermal sensations in relation to cooling of the neck area as "pleasant - 4" and 50% of the participants gave the same assessment in relation to cooling of the sternum area. The other participants assessed the thermal sensation at an average level of "pleasantly warm - 5" (for the cooled neck area - 20% of the participants, for the sternum - 50% of the participants). None of the participants assessed the thermal sensation

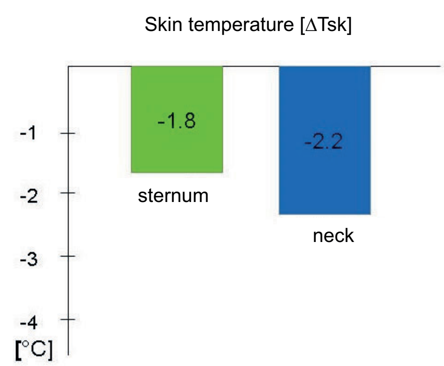

Fig. 2. Change of skin surface temperature (ΔTsk) as a result of 15 minutes of selective cooling of the neck and sternum in hot conditions (40°C) (cooling surface: 100 cm^2, stimulus temperature: 10-12°C).

as "too warm - 6" (baseline, in the climate chamber before the application of the "cooling pad"). Therefore, in hot conditions (40°C) with 15-minute cooling of selective areas of the body, a positive improvement in thermal sensations from "too warm - 6" to "pleasantly warm - 5" and "pleasant - 4" was observed in all participants. However, stronger sensations were observed in the cooled area of the neck than in the sternum, indicating a higher sensitivity of the skin in this area (Fig 4).

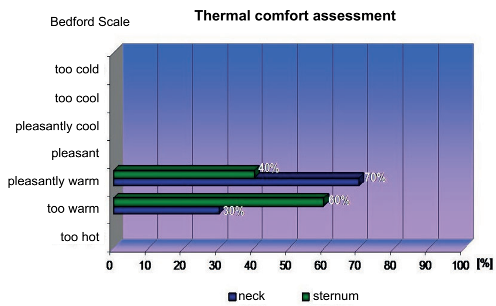

Fig. 3. Subjective assessment of thermal comfort after 15 minutes of selective neck and sternum cooling in hot conditions (40°C), based on Bedford test.

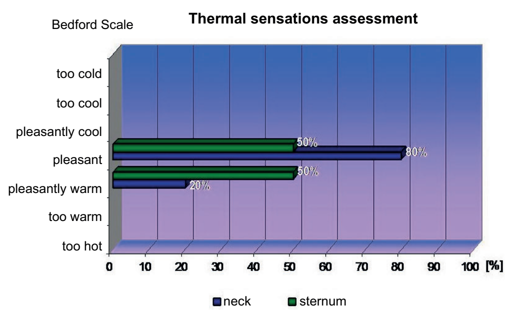

Fig. 4. Subjective assessment of thermal sensations obtained after 15 minutes of selective cooling, determined for the neck and sternum area at hot conditions (40°C), based on Bedford test.

DISCUSSION

Maintaining a constant body temperature within a narrow range (37 ± 0.5°C) is crucial for existence because of the internal organs and their proper functioning. In warm-blooded organisms, the range of fluctuations in body temperature, under different environmental thermal conditions, is variable for different areas of the body (in limbs, these changes are clearly visible). It is extremely important to maintain an adequate internal temperature in the head area because of the brain, which is particularly sensitive to heat. Nervous tissue tolerates temperatures only up to about 40.5°C, while organs located in the torso can tolerate internal temperatures of up to 42°C. Therefore, from a physiological point of view, the temperature in the head and neck area is of great importance. Removing excess heat by cooling selected areas of the body can lower the increase of skin temperature, internal temperature and heart rate. By positively influencing the physiological reactions of the body, cognitive processes and satisfaction with the thermal environment are improved as a consequence, which translates into better performance when performing tasks.

In the studies carried out in simulated hot conditions (40°C), body surface cooling of two body areas using the same thermal stimulus (10 - 12°C) on the same area (100 cm^2) and same duration (15 min) in hot conditions (40°C) was performed. Unit tests consisted of the following: series I - cooling of the neck area, series II - cooling of the sternum area. The aim of the study was to assess whether in these conditions the change of cooling location differentiates subjective thermal sensations and general thermal comfort of the body. In the scope of this issue, the change of local values of skin temperature (neck and sternum) and thermal sensations in relation to the selectively cooled surface and the state of thermal comfort determined in relation to the whole body were analyzed.

Prior to the application of a cooling stimulus, selected areas of the body were adapted to ambient temperature, first in a thermoneutral environment, and then to high temperature (simulated conditions of climate chamber). Then, in both cases, the local mean temperatures of the skin were similar. However, as a result of selective cooling in combination with exposure to high temperature (40°C), various local changes in skin temperature (ΔTsk) were observed in relation to cooled body surfaces (neck, sternum). In the neck area, the mean skin temperature decreased by ΔTskNECK = -2.2 ± 0.1°C and in the sternum area by ΔTskSTERNUM = -1.8 ± 0.1°C (Fig. 2). As a result of 15 minutes of cooling, the temperature of the skin surface in the neck area decreased more than in the sternum area. Thus, application of the cooling stimulus revealed a beneficial and significant decrease in skin temperature (ΔTsk) depending on the affected area (the place of application of the "cooling pad") (Fig. 2). The demonstrated significant changes in skin surface temperature in the analyzed body areas are a noticeable effect of thermoregulatory cooling probably caused by the existing differences in tissue vascularization and skin blood flow in the examined body regions.

The contribution of core body temperature to the thermoregulation process is more significant than skin temperature (on average 10 times more significant for sweat secretion and 4 times more significant for shivering thermogenesis). However, in the perception of thermal sensations, skin and body temperature are of equal importance [5]. Within a small range of changes of this parameter (close to neutral), thermal sensations do not change and the body experiences thermal comfort. Whole body thermal comfort is a stage of thermoregulation that allows the body to maintain optimal activity. In case of thermal discomfort (including pain, e.g. due to excessive cooling), the body inhibits its activity in order to concentrate the thermoregulatory mechanisms on the possibility of restoring the state of comfort. Studies have shown that thermal sensations on skin surface depend on the size of the stimulated area and the temperature of the stimulus [2,7,21].

In both series of selective body surface cooling (series I - neck, series II - sternum) a positive influence on the assessment of thermal state by the participants was shown. Under the heat conditions described above, thermal sensations were variable depending on the location of the cooled body surface. In the case of a low temperature stimulus in the neck area, the majority of participants (70%) experienced an improvement in the subjective assessment of thermal comfort for the whole body from "too warm - 6" to "pleasantly warm - 5". However, during cooling of the sternum area, a comparable change in comfort assessment was observed only in 40% of the respondents. At the same time, the thermal sensations assessed in relation to the cooled body area improved from "too warm - 6" to "pleasant - 4". 80% of the respondents felt stronger cooling sensations from the neck area, and only 50% from the sternum area (Fig. 3 and 4). Therefore, the improvement in the subjective assessment of the thermal conditions in relation to the whole body was clearly more pronounced after the application of selective cooling of the neck, rather than the sternum. The obtained results indicate an appropriate level of cooling, which could have contributed to the reduction of thermal stress levels in the body and at the same time did not cause the feeling of excessive cold and discomfort. Additionally, the aforementioned analysis of the change in skin temperature [ΔTsk] showed that the sensitivity of the body surface to low temperature stimuli in hot conditions is different in selectively cooled areas. On this basis, one might suggest that the neck area is more sensitive than the sternum. Therefore, the thermal sensations from the neck area have a greater effect on the overall thermal comfort of the body than the thermal sensations from the sternum area.

The above observations are consistent with the results of other studies. A team of scientists from the Waseda University of Tokyo lead by Mayumi Nakamura conducted an experiment in which four areas of the body (chest, abdomen, thigh, face) were heated and cooled [14]. Thermal sensations and thermal comfort were subject to analysis. It was observed that thermal comfort is dependent on the area in which the thermal factor was applied. In high temperature conditions (32.5°C) causing a general feeling of discomfort, local cooling of the face surface with 25°C water resulted in an improvement in general thermal comfort, while heating the face area at 42°C deepened the discomfort in relation to the whole body. However, in moderately cool conditions, both heating and cooling of the surface of the face did not have a significant effect on the general thermal sensations [14]. In other studies, researchers from the UC Berkley observed that the feeling of cold in the head area, in hot conditions is perceived by humans as "pleasant" or even desirable, and what is more, it positively influences the thermal comfort in relation to the whole body [20]. Belding et al. were among the first to demonstrate that the skin temperature on the face has a significant impact on the mechanisms of thermoregulation of the human body [3,17]. A warm thermal stimulus to the face in a warm environment resulted in a much higher rate of sweating than when heating other body surfaces. Also, facial heating at a lower ambient temperature induced vasodilation, while the same heating of the chest surface (in terms of the surface and intensity of stimulus) or more distant areas of the body (feet) did not produce visible effects [14,15,17].

It is possible that there is a special brain cooling system in humans, well known in animals (called "selective brain cooling"). Lowering the temperature of the head area (including the face, neck and neck) makes it possible to eliminate heat, the excess of which could contribute to brain tissue damage [11]. From a physiological point of view, the local action of the thermal factor (cold) may cause a local decrease in skin temperature (the effect of narrowing of small blood vessels in the skin), a change in thermal sensations from the body surface and thus positively influence the improvement of subjective impressions of the state of thermal comfort. Carrying out activities, maintaining physical activity and mental fitness in high temperature conditions with no cooling factors may cause excessive increase in the amount of heat accumulated in the body and, as a result, cause hyperthermia. Overheating poses a serious risk of impairing endurance and overall performance as a result of dehydration. A way to counteract and alleviate heat stress symptoms is to reduce the increase in thermal load through the implementation of favorable and efficient selective cooling systems. The method of selective cooling applied in the experiment proved to be helpful in alleviating thermal stress (which is evidenced by the improvement of mood, thermal comfort and thermal sensations). The sensed thermal stimuli were evaluated to varying degrees by the participants, depending on the selectively cooled parts of the body. In this respect, comparing the two analyzed areas, it can be concluded that under heat load caused by exposure to high temperature (40°C), cooling of the neck region reduces the adverse changes in physiological reactions in the form of an increase in skin temperature compared to the cooled area of the sternum. Using cold stimuli indirectly counteracts the negative effects an overheating body of a soldier. It improves both subjectively perceived thermal sensations and overall thermal comfort. In this aspect, the method of selective cooling of the body surface may play an important role in expanding the limits of tolerance of the human system and have a significant impact on the quality and effectiveness of operations performed in the hot climate zone, which in modern military operations is a particularly demanding condition for their implementation.

CONCLUSIONS

Under thermal stress conditions, the psychophysical state of the body determines, to a large extent, the feeling of thermal comfort and fatigue level. The changes concerning subjective physiological and psychological indicators analyzed in the paper confirm that:

1. When used as a selective cooling method in hot conditions (40°C), the local sensitivity of the skin to low temperatures is greater in the neck area than in the sternum area.
2. Selective cooling of the neck surface significantly improves the thermal sensation in relation to the cooled area of the body (80% of the participants evaluated their own thermal sensations in the neck area as “pleasant”- 4).
3. Selective cooling of the skin in the sternum area applied in hot conditions also improves thermal sensations determined in relation to the cooled body location (50% of the participants assessed the thermal sensations as “pleasant” - 4).
4. The improvement in the subjective assessment of thermal comfort in relation to the whole body was clearly more pronounced after the application of selective cooling on the neck surface compared to the cooled area of the sternum (in the case of the neck - 70% of the respondents, the sternum - 40% of the respondents assessed the comfort as “pleasantly warm” - 5).
5. Local cooling of the neck and sternum surface at a high temperature (40°C) with a low temperature stimulus (10-12°C) does not cause thermal discomfort (feeling of excessive cold).

AUTHORS’ DECLARATION:

Study Design: Anna Przewodzka, Anna Czerwińska; **Data Collection:** Anna Przewodzka, Anna Czerwińska; **Manuscript Preparation:** Anna Przewodzka, Anna Czerwińska; **Funds Collection:** Anna Przewodzka, Anna Czerwińska. The Authors declare that there is no conflict of interest.

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REVIEW ARTICLE

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DIVERTICULOSIS – THE CLINICAL AVIATION MEDICINE ASPECT AND AEROMEDICAL CONCERNS

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Abstract: This publication discusses the clinical aspects and aeromedical concerns of diverticular disease. A case of a 49-year-old supersonic aircraft pilot diagnosed with diverticulosis 19 years earlier served as an inspiration for this position paper. Upon consideration, particular attention was paid to the diagnostics, the likelihood of extreme flight factors influencing the course of diverticulosis and related prognostic implications. The conclusion contains an aeromedical disposition decision concerning highly maneuverable aircraft pilots diagnosed with diverticular disease resulting from the presented case and theoretical considerations.

Keywords: supersonic pilots, accelerations, high altitude

Figures: 3 • **References:** 30 • **Full-text PDF:** http://www.pjambp.com • **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education

INTRODUCTION

Diverticulosis of the colon is one of the most common disorders of the gastrointestinal tract in Western Europe [18,24]. The highest incidence of the disease occurs in Europe, USA and Australia. Studies show that the prevalence of diverticulosis increases with age. It is <5% in persons under 40 years of age, 30% in individuals 60 years old and 50-65% in persons aged 85 [16,17,19]. Due to this fact, this pathology is relatively rare in the age group of active highly maneuverable aircraft pilots. It should be noted, however, that the data concerning the occurrence of diverticulosis is likely to be underestimated due to the fact that in about 85% of cases the disease is asymptomatic [3]. The issue raised is of particular importance with regard to highly maneuverable aircraft pilots exposed to hypoxia, high-altitude gas expansion, acceleration, anti-G straining maneuvers and pressure breathing. So, it is connected with flight safety.

The development of aviation medicine and technology has led to a better understanding of the impact of extreme flight conditions on the human body. At the same time, progress in medical technology has led to more precise diagnostic tests for the pilots. Medical boards responsible for flight clearance may be presented with a dilemma as to whether recognize the severity of lesions as directly endangering flight safety, or if further flight service will have an impact on the progression of lesions and the development of possible complications. This uncertainty may involve clinically asymptomatic lesions in the spine, the cardiovascular system or the gastrointestinal tract. The exchange of knowledge and opinions concerning aviation medicine is beneficial from the point of view of aeromedical disposition decision and ethics.

An inspiration for this position paper came from a case of a 49-year-old supersonic aircraft pilot suffering from nonspecific complaints and unexpectedly diagnosed with diverticulosis (diagnosed by an x-ray with contrast medium in the intestine) 19 years ago. He was allowed to continue flying once the symptoms subsided. In February 2013, he was hospitalized due to clinical symptoms of diverticular disease (abdominal pain, elevated body temperature, increased leukocyte count and CRP) that required broad-spectrum antibiotic therapy. Six months later, he was hospitalized once again due to pain in the left iliac fossa without fever or elevation in laboratory markers of inflammation. Colonoscopy revealed multiple diverticula in the descending colon and sigmoid, along with discrete signs of inflammation in the vicinity of one of them. A 320-slice abdominal CT (0.5 mm helical scan layer thickness) performed after 2 weeks

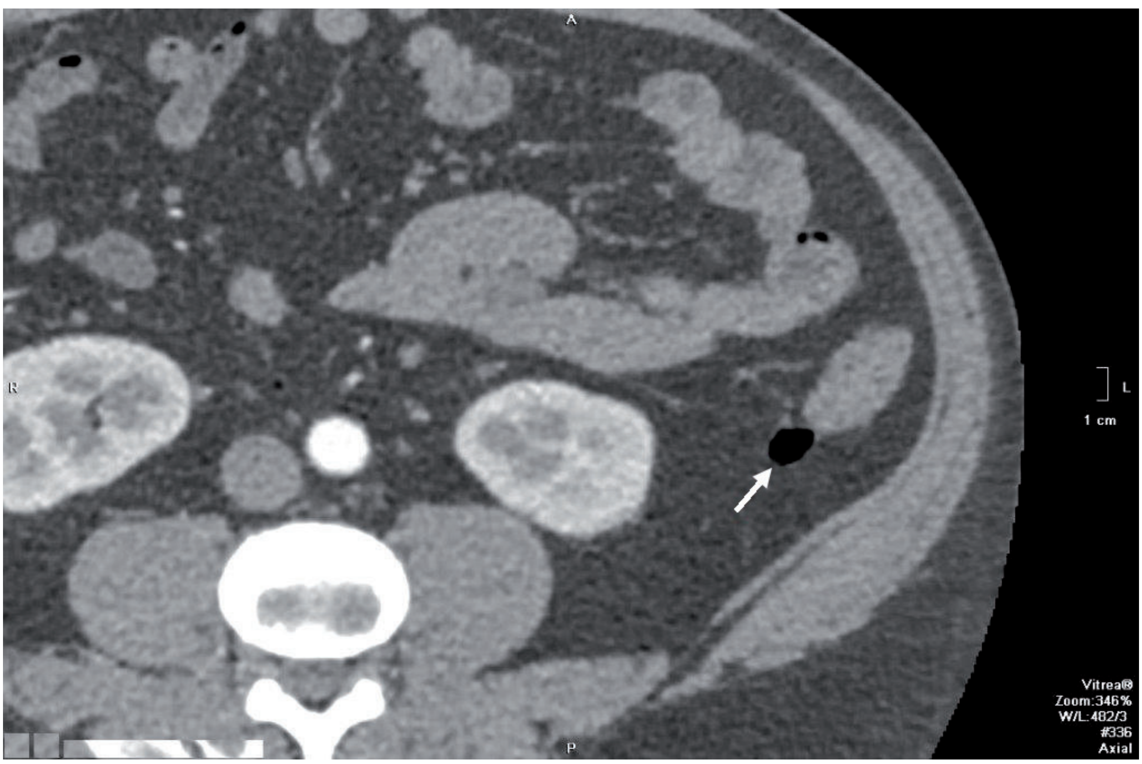

Fig. 1. The first type of diverticula with very thin walls (marked by the red arrow).

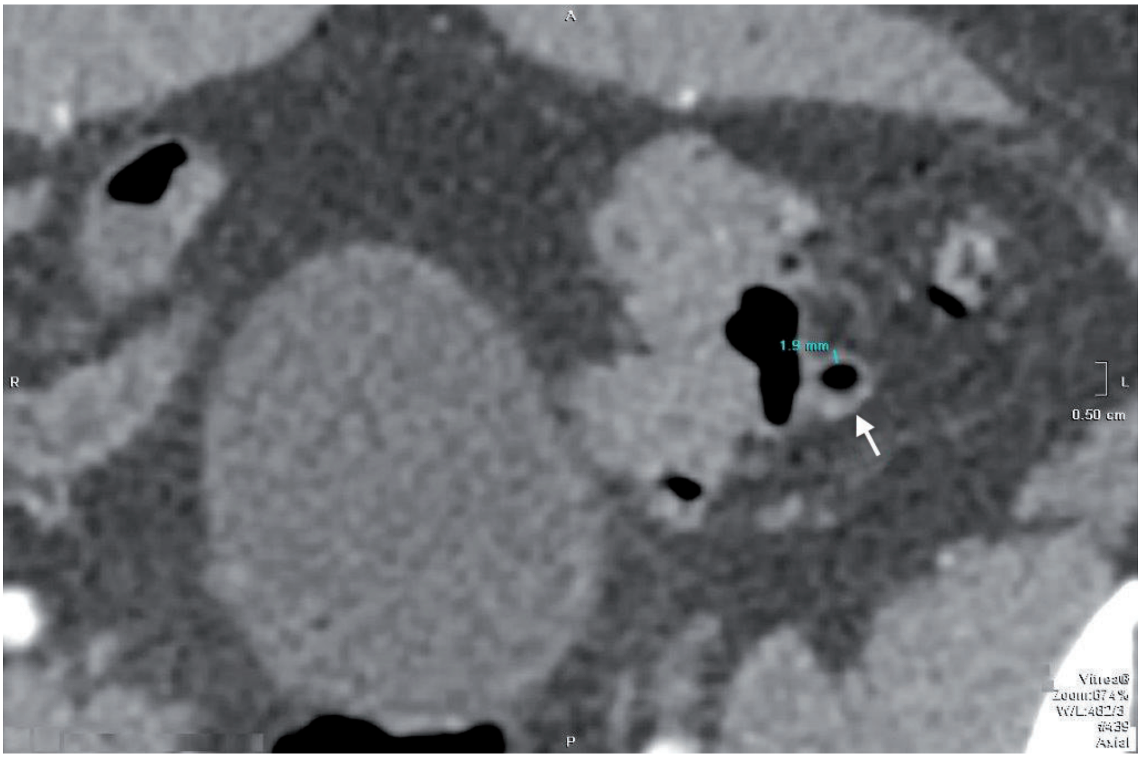

Fig. 2. The second type of diverticula with wall thickness of about 1.8-2 mm (marked by the red arrow).

of anti-inflammatory therapy, revealed numerous diverticula in the colon, without signs of inflammation. The diverticula were classified into one of three types based on the thickness of the wall (diverticula filled with fecal masses were not considered). The first type included diverticula with very thin walls that remained beyond the scope of the testing method (Fig.1). Approximate air volume in the largest one of them was 4.57 cm^3.

The second type were diverticula with wall thickness of about 1.8-2 mm (Fig. 2) and a maximum air volume of 0.5016 cm^3.

Third type of diverticula comprised of those with non-uniform wall thickness that represent a combination of the first two types (Fig. 3) and a maximum air volume of 1.274 cm^3.

The pathogenesis of diverticulosis is still unknown but multifactorial [10,20]. It is caused by the following: low-fiber diet, structural changes in the intestinal wall, increased intraluminal pressure, low physical activity, segmentation and disorders of bowel motility. Abnormal motility may be caused by changes in the number and location of intestinal cells of Cajal [21] as well as by abnormalities in neural transmission [2]. Genetic factors and the process of aging also play an important role [25]. A low-fiber diet leads to the formation of harder stools, which require stronger intestinal contractions and result in hypertrophy of the muscle. A longer intestinal transit time, muscle hypertrophy and severe contractions cause increased pressure in the intestinal lumen. As a result, intestinal mucosa is pushed out of the membrane in areas of reduced resistance (e.g., blood vessels penetrating the intestine) to form diverticula [9]. Diverticulosis most commonly involves pseudodiverticula, which consist of mucosa and submucosa [24]. True diverticula containing a muscle layer are very rare and are thought to be mostly congenital [9,24]. Diverticulosis arise most commonly in the descending colon, because its lumen is the smallest and the change in pressure caused by forceful contractions is the highest [24].

CT of the colon revealed 3 types of diverticula, based on the thickness of the wall. A hypothesis could be made that diverticula with thick walls (Fig. 2) contain a muscle layer and are, therefore, true diverticula. If this hypothesis holds true, another one could be stated, that is diverticula of mixed wall thickness (Fig. 3) are morphologically in transition from true diverticula (Fig. 2) to the typical thin wall diverticula (based on tomographic evaluation) found in diverticulitis (Fig. 1). It seems likely that the predisposing factors, particularly increased intraluminal pressure, gradually displace (quite possibly asymmetrically) the intestinal mucosa beyond the muscular layer. If this hypothesis were proved to be true, it would greatly help address the medico-ethical and aeromedical disposition decision concerning military

Fig. 3. The third type of diverticula - represents a combination of the first two types (marked by the red arrows).

pilots of highly maneuverable aircraft. Computer-based annual follow-up examination of the abdomen would provide insight into the possible advancement of diverticular morphological changes. Changes in the morphology of thick wall (true?) and "intermediate" diverticula into very thin-wall diverticula (typically pseudodiverticula), are associated with unfavorable and rapid progression of the disease, likely under the influence of extreme flight conditions. Such changes would signify an increased risk of potential perforation of the colon due to increased pressure in the abdominal cavity during flight. Both, acceptance or rejection of the hypothesis is difficult to prove. This would require follow-up computer testing of individuals with diverticulosis over a period of many years, which is impossible to carry out on a large group of pilots.

From a clinical viewpoint, the term "diverticulosis" represents the presence of asymptomatic diverticula in the colon confirmed with imaging studies, whereas "diverticular disease" is the presence of clinical symptoms.

Diverticular disease should be classified as [26]: [1] symptomatic uncomplicated diverticular disease: a single episode of non-specific symptoms, such as lower abdominal discomfort or abdominal pain, bloating, abdominal tenderness, constipation, diarrhea without any sign of inflammation (fever, neutrophilia, phlogosis of diverticula); [3] recurrent symptomatic uncomplicated diverticular disease: more than one attack per year of non-specific symptoms without signs of inflammation, or [5] complicated diverticular disease: abdominal symptoms associated with signs of inflammation.

A variety of complications may occur in the course of diverticular disease [15,28]. The most common one is diverticulitis. The pathogenesis of diverticulitis is not fully understood. However, it is thought that predisposing factors include: low-grade chronic inflammation, gut microbiota abnormalities, toxin exposure within the gut (arising from fecal retention) and intestinal ischemia. Diverticulitis usually follows an uncomplicated course (75%). In the remaining cases, it leads to the development of abscess, phlegmon, peridiverticular abscess or diverticular perforation with associated peritonitis [24]. Other complications of diverticulitis may include: narrowing and obstruction of the bowel, inflammation of the surrounding organs, fistulas, bleeding, liver abscess and sepsis [19]. Although diverticular disease is more common among elderly patients, a dramatic rise of its incidence is seen in the younger age groups [14]. Diverticular disease complications are most frequent in obese individuals on low-fiber diet, tobacco smokers, persons with chronic diseases, such as liver cirrhosis, diabetes, renal failure and especially those taking corticosteroids and immunosuppressive drugs [27]. Diverticulitis usually occurs in an acute or chronic form . The acute form involves a rapid onset and duration of symptoms for about 2 weeks. The chronic type is diagnosed when the symptoms are milder, recurrent and present for more than 6 months. Recurrence with an increased risk of complications occurs in 25% of patients with diverticulitis [30]. Diagnostic tests include blood counts, acute phase protein (CRP) concentration, CT evaluation or alternatively MRI or ultrasound imaging could be implemented [6,12,22]. Colonoscopy should be avoided in the course of acute diverticulitis due to increased risk of perforation but in case of bleeding treatment or chronic colitis, differential diagnosis colonoscopy is suggested [20]. Additionally, the large intestine is difficult to evaluate because of shrinkage, narrowing of the lumen and immobilization (fixation). Following the acute phase, a complete endoscopic examination must be performed to exclude other conditions, such as inflammatory bowel disease and cancer [24].

Diverticulitis affects the patient's quality of life. Recurrence prevention plays an important role. Recommendations include change in diet to increase the amount of fiber consumed, avoidance of foods that create excessive amounts of intestinal gas (carbonated water, carbohydrates, legumes, cabbage) and weight reduction. A change in lifestyle with increased physical activity also plays a vital role. Prophylactic pharmacotherapy remains open to debate [5,7] but rifaximin is suggested [13], efficacy of mesalazin is not confirmed.

THE AVIATION MEDICINE ASPECT

Under normal conditions, the gastrointestinal tract of a healthy individual contains a few hundred milliliters of free gas [1]. It is produced by fermentation of foods and its chemical composition (carbon, oxygen, hydrogen, nitrogen, methane, hydrogen sulphide) along with the amount accumulated, depend on a person's nutrition and the quantity of air swallowed with saliva and food (this is particularly true of individuals prone to aerophagia).

During the ascent, in the presence of decreased surrounding atmospheric pressure, the volume of gas in the gastrointestinal tract increases gradually and proportionately. The severity and intensity of the illness depend on the amount and rate of gas accumulation, its distribution within the gastrointestinal tract, the anatomic and functional condition of the intestine, the time elapsed since the last meal, the type and degree of abdominal wall tension and abdominal pressure.

Military training flights take place at heights of 6,000-12,000 meters. The airtight cabin of the aircraft maintains correspondingly lower air pressure (depending on the altitude) to reduce the effects of any sudden decompression. Rapid ascent and descent of an aircraft during military training operations causes the volume of intestinal gas to change rapidly. It should be noted that low cabin pressure and the use of technical devices protecting from hypoxia prevent only sudden decompression complications. The volume of gas in the gastrointestinal tract increases by 50% at 3,000 meters and by 100% at 7,000 meters, as compared to the original volume at sea level. An increase in gas volume in the gastrointestinal tract during decompression at higher altitudes would be correspondingly greater [11]. It should be emphasized that the impact of rapid decompression on the gastrointestinal tract depends not only on the parameters of decompression (the difference between the initial and final pressure in the cabin, their relative ratio and the duration of decompression) and the initial amount of gas in the intestine, but also on the functional state, and more importantly, the structural changes in the intestinal wall. Expansion of gas in the gastrointestinal tract leads to abdominal distension and elevation of the diaphragm. Distension of the stomach and the intestines causes a feeling of fullness and discomfort in the abdominal cavity [1].

In the course of diverticulosis, the greatest risk of complications associated with supersonic flight is due to increased pressure throughout the intestines and the abdominal cavity. This can cause extreme pain or even intestinal perforation, especially in the setting of a disease process. During rapid decompression, the expanding gas remains mostly in the same location. Thus, in cases of diverticula obstructed by fecal matter, a rapid increase in the volume and pressure of gas accumulated within the enclosed space takes place. Expansion of diverticula containing gas may lead to reflex contraction of the adjacent sections, making it difficult, or even impossible, to propagate and eliminate the gas by natural means.

The force of +Gz acceleration leads to a downward displacement of tissues and organs, especially those with a range of movement, such as the liver, the bladder and the intestines, resulting in an additional impact on abdominal pressure. Values of venous and abdominal pressure increase in a linear proportion to the rate of acceleration [8]. Additionally, rapid changes in pressure take place when changing the direction of acceleration in the Gz axis, especially during aerobatic maneuvers in the upside-down position: such as a barrel roll, reversed loop, inverted corkscrew and others. An additional increase in abdominal pressure during flight in a highly maneuverable aircraft is caused by Anti-G-Straining Maneuvers (AGSM) performed by the pilots and the pressure exerted by an abdominal pressure compensator, which is part of a pressure suit [29]. One of its tasks is to reduce the harmful effects of high-altitude meteorism.

An increase in intra-abdominal pressure is also stimulated by pressure breathing, resulting in lowering of the diaphragm and an increase in abdominal pressure [23]. The potential impact of vibrations occurring in aviation on diverticular disease is impossible to assess.

AERO-MEDICAL CONCERNS

Flight safety and aviator's wellness should be taken into account when conducting a medical assessment of a pilot of a super-maneuverable aircraft,. This includes the possibility of structural changes within the diverticula, an increase in the number of diverticula and possible progression of the disease forced by flight factors. Therefore, diverticulosis is an extremely important subject of medical certification and an equally important ethical and medical issue.

Computer test results of the presented case of diverticulosis / diverticular disease suggest that even originally true diverticula with thick walls may transform, under a longstanding influence of harmful factors, into thin-walled pseudodiverticula visible on a CT. There is no doubt that the discussed extreme factors affecting the pilot body, particularly significant and relatively rapid pressure changes within the colon, are a predisposing factor in the progression of morphological changes in diverticulosis of the bowel. Considering the above findings, along with a documented diverticular disease, we believe that pilots of supersonic aircraft should not be allowed to continue to fly.

Pilots may be able to continue their flying duty in cases of asymptomatic diverticulosis detected accidentally, e.g. during prophylactic endoscopy of the colon, provided that they undergo periodic CT screening, taking into account the progression of diverticular wall morphology discussed earlier in this document. Such position may be justified by the fact that the pilot discussed in this publication served in the air force with a diagnosed and asymptomatic diverticulosis of the colon for 19 years without any complications and the hypotheses presented in this work were not sufficiently proven. However, presence or development of diverticulitis with very thin walls, below 0.5 mm (beyond the capability of accurate CT assessment), in our opinion, should constitute a contraindication to flying highly maneuverable aircraft. For highly maneuverable aircraft pilot candidates, it may be worth considering performing CT screening of not only the spine, but also the abdominal cavity.

AUTHORS' DECLARATION:

Study Design: Lech Kopka, Ewelina Zawadzka-Bartczak, Łukasz Jałocha, Leopold Bakoń; **Data Collection:** Lech Kopka, Ewelina Zawadzka-Bartczak, Łukasz Jałocha, Leopold Bakoń; **Manuscript Preparation:** Lech Kopka, Ewelina Zawadzka-Bartczak. The Authors declare that there is no conflict of interest.

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REVIEW ARTICLE

DISORDERS OF THE ELECTRICAL CONDUCTION SYSTEM OF THE HEART - A SIGNIFICANT PROBLEM IN AVIATION MEDICINE

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Abstract: Disorders of the electrical conduction system of the heart are a relatively common electrocardiographic abnormality found during aviation medical examinations and one of the reasons for the loss of pilot licenses/licenses to fly. At the same time, the type of arrhythmia and/or cardiac conduction disorders alone usually does not provide a sufficient basis for the performance/continuation of certain professional duties. This paper discusses the pathogenesis of disorders of the electrical conduction system of the heart, types of arrhythmias, their classification, therapeutic and aviation medical certification procedure in some of them, and the possible prognosis in potentially harmless arrhythmias and/or conduction disorders registered in standard ECG, which require more detailed diagnostics in the flying staff population. It may turn out that they constitute certain restrictions or even contraindications to flying

Keywords: supraventricular arrhythmias, ventricular arrhythmias, atrioventricular blocks, intraventricular blocks, flying staff

Figures: 5 • **Tables:** 3 • **References:** 39 • **Full-text PDF:** http://www.pjambp.com • **Copyright** © 2018 Polish Aviation Medicine Society, ul. Krasińskiego 54/56, 01-755 Warsaw, license WIML • **Indexation:** Index Copernicus, Polish Ministry of Science and Higher Education

INTRODUCTION

Cardiovascular diseases are the most common cause of loss of flying licenses, out of which rhythm disorders constitute a significant percentage [24].

Disorders of the electrical conduction system of the heart are the most often easily recognizable changes in electrocardiographic recording. They concern electrophysiological phenomena resulting from disturbances in the production or conduction of stimuli in the heart.

Among arrhythmia and cardiac conduction disorders we distinguish sinus rhythm disorders, increased non-sinus stimulation, reentry phenomena, atrioventricular and sinoatrial blocks [7]. Traditionally, the simplest division of this pathology is to distinguish supraventricular and ventricular arrhythmias. Supraventricular arrhythmias (SAs) are: supraventricular extrasystoles, supraventricular tachycardia, atrial flutter and fibrillation. Ventricular arrhythmias (VAs) are divided into single (premature or substitute) and complex (couplets and ventricular tachycardias, ventricular flutter and fibrillation). For clinical purposes, taking into account the quantitative and qualitative aspects, VAs can be systematized according to several types of classifications.

Lowne's classification for quantitative and qualitative evaluation during a 24-hour Holter ECG recording:

1. Level 0 - no ventricular ectopic systoles
2. Level 1 - less than 30 ventricular ectopic systoles per hour
3. Level 2 - more than 30 ventricular ectopic systoles per hour
4. Level 3: 3A - various ventricular systoles
   3B - ventricular bigeminy
5. Level 4: 4A - couplets of ventricular systoles
   4B - salvos (3 and more consecutive systoles)
6. Level 5 - early premature ventricular systoles of the R/T type

Bigger's classification [29] additionally takes into account the presence or absence of organic heart disease and the assessment of the risk of sudden cardiac death. Depending on the coexisting factors, the same type of ventricular arrhythmia can be classified as mild, potentially malignant or malignant rhythm disorder (table 1).

Although Bigger's classification of VAs takes into account the coexistence of many factors, it has certain limitations. It does not include genetically conditioned heart diseases, in which there are VAs and a risk of sudden cardiac death in the absence of organic heart disease, such as in ion channelopathies: long QT syndrome, short QT syndrome, Brugada syndrome, catecholaminergic polymorphic ventricular tachycardia.

For certification and prognosis reasons, Breithard's division of ventricular arrhythmias [29] seems interesting, which apart from prognosis also includes the possibility of therapy.

Breithard's division:

1. Ventricular tachycardias in patients without structural heart disease:
   – with a curable cause: idiopathic right ventricular outflow tract tachycardia and idiopathic left ventricular tachycardia,
   – with an uncurable causee: long QT syndrome, short QT syndrome, catecholaminergic polymorphic ventricular tachycardia Brugada syndrome.
2. Ventricular tachycardia in patients with structural heart disease:
   – in ischemic and post-infarction conditions, treatable through revascularization or ablation,
   – in non-ischaemic cardiomyopathies (hypertrophic cardiomyopathy, dilated cardiomyopathy, arrhythmogenic right ventricular cardiomyopathy), which cannot be permanently cured.

It should be emphasized that a number of disorders of the electrical conduction system of the heart occur in clinically healthy individuals and are a variant of the norm depending on age. Examples are presented in table 2 [29].

In everyday clinical practice it is also important that arrhythmias may occur asymptomatically or in the form of a number of ailments, from mild

Tab. 1. Bigger's clinical division of arrhythmia.

	mild	potentially malignant	malignant
arrhythmia	PVC, nsVT	PVC, nsVT	sVT, VF, PVC, nsVT
heart disease	absent or minimal	present	present
LV dysfunction	absent	various degrees	present
SCD risk	minimal	various degrees	present

LV - left ventricle, nsVT - non-sustained ventricular tachycardia, PVC - premature ventricular contraction, SCD - sudden cardiac death, sVT - sustained ventricular tachycardia, VF - ventricular fibrillation

Tab. 2. Disorders of the electrical conduction system of the heart occur in clinically healthy individuals and are a variant of the norm depending on age.

20-30 years old	31-40 years old	41-60 years old	> 60 years old
nocturnal bradycardia >30/min	nocturnal bradycardia>40/min		
sinus arrhythmia	sinus arrhythmia	sinus arrhythmia	sinus arrhythmia
level I A-V block	level I A-V block	level I A-V block	
Wenckebach Phenomenon (most often during sleep)			
RR intervals shorter than 3s (most often during sleep)	RR intervals shorter than 2s (most often during sleep)	RR intervals shorter than 2s (most often during sleep)	RR intervals shorter than 2s (most often during sleep)
ventricular extrasystoles <50/24h, various shapes	ventricular extrasystoles <100/24h, various shapes	ventricular extrasystoles <100/24h, various shapes	
		supraventricular extrasystoles <100/24h	supraventricular extrasystoles <1000/24h
			supraventricular tachyarrhythmias

Tab. 3. List of disorders and impairments from the scope of disorders of the electrical conduction system of the heart in the assessment of physical fitness for air and ground flight assistance services and aviation engineering services.

Paragraph	Item	Sickness and disability	Health groups				
			Pilots			Cabin crew	Flight assistance staff
			IA	IB	IC	II	III
38	2	Myocardial disorders with arrhythmia or cardiovascular failure	N	N	N	N	N
	9	Acquired valvular heart diseases with symptoms of cardiovascular failure or cardiac arrhythmias	N	N	N	N	N
	15	Io atrioventricular block, block of the right or left bundle branch, focal blocks, single-branch or double-branch blocks of the bundle branch – at full cardiovascular capacity and without rhythm disorders	N/Z	N/Z	Z/N	Z/N	Z/N
	16	Pre-excitation syndrome	N	N	N	N/Z	N/Z
	17	IIo and IIIo atrioventricular blocks, multibranch blocks and other changes indicating failure or damage of the electrical conduction system	N	N	N	N	N
	20	Single functional extrasystole with full cardiovascular function	Z/N	Z/N	Z	Z	Z

Z - capable; N - permanently or temporarily uncapable

to severely affecting human functioning. In the case of military flying staff, this is of considerable importance, especially in the case of supersonic aircraft pilots performing tasks in extreme environmental conditions - during accelerations in the Gz+/- axis (mainly head and legs). Symptoms of arrhythmia depend on the frequency of ventricular rhythm, duration and individual sensitivity of the patient. The most common symptoms include: palpitations, fatigue, dizziness, chest discomfort, dyspnea, weakness or fainting [12].

Conduction disorders can be divided into three main groups: sinus node dysfunction (sinus bradycardia, Wenckebach-type sinoatrial block, Mobitz II-type sinoatrial block, sinus inhibition), atrioventricular blocks (Io block, Wenckebach Phenomenon - IIo block or Mobitz II - IIo block, block IIIo) and intraventricular blocks (block of anterior or posterior branch, block of the right or left bundle branch). The accompanying symptoms also depend on many factors, including the age of the patient, the presence of organic heart disease, the degree of physical activity and the type and degree of bradycardia.

Military pilots are a carefully selected group of people with an initial thorough assessment of the cardiovascular system, supplemented by ECG, echocardiography and electrocardiographic exercise tests. They are subject to routine, annual check-ups. Electrocardiographic monitoring of cardiac activity is also carried out during highly specialized examinations performed for the purpose of medical certification and/or in connection with the need to maintain the ability to serve in the air (examination in a low-pressure chamber, training increasing overload tolerance). It should be noted that CAs and/or conduction disorders in pilots, as in the general population, are most often detected accidentally. Such a fact usually results in suspension of the duties performed by the pilot until the etiology of cardiac arrhythmias is clarified, and if they are considered important and potentially reversible, also until their remission/cure. The role of the physician and the certifier is essential in this respect in order to ensure that appropriate vigilance is exercised in detecting heart rhythm disorders that may affect flight safety, especially in the case of single-person flights. The relevant provisions governing the matter of ability to perform tasks in the air in the army are included in the regulation of the Minister of National Defense (table 3) [33].

In civil aviation, people with symptomatic sinus node dysfunction, complete atrioventricular block, symptomatic symptomatic QT prolongation and implanted ICD are considered unable to fly [32]. Rhythm and conduction disturbances such as: periodic or permanent sinus dysfunction, atrial fibrillation or flutter, asymptomatic sinus inhibition, left bundle branch block, Mobitz 2-type atrioventricular block, tachycardia with broad or narrow QRS syndromes, pre-excitation syndrome, asymptomatic QT prolongation, suspected Brugada syndrome, additional cardiological evaluation is required for licensing.

DIAGNOSIS OF CAS IN PILOTS

Screening for cardiac arrhythmias includes: accurate patient history and non-invasive diagnostic tests such as an ECG, 24-hour Holter monitoring and an electrocardiographic exercise test. Detection of any of these arrhythmias requires further in-depth diagnostics.

The recording of the resting (12-lead) ECG may show a number of morphological abnormalities that suggest the presence of hereditary diseases that result in ventricular arrhythmias, such as channelopathies: LQTS, SQTS, Brugada syndrome, catecholaminergic polymorphic ventricular tachycardia or cardiomyopathies: hypertrophic or arrhythmogenic right ventricular cardiomyopathy. Other electrocardiographic changes may indicate a structural heart disease, e.g. bundle branch blocks, atrioventricular blocks, ventricular hypertrophy or pathological Q-waves. Supplementing screening with 24-hour ECG monitoring increases the chances of detecting any accompanying heart rhythm disorders. In routine ECG using the Holter method in healthy subjects premature ventricular contraction is found in 40 to 80% of examinations and is correlated with age. Complex tachyarrhythmias, such as couplets or ventricular tachycardias, are no longer as common. Premature ventricular contraction (PVC) is more common in people with structural heart disease. One of the most important problems in the diagnosis of VAs is their spontaneous variability. The highest repeatability is obtained when the Holter ECG monitoring is performed for at least 48 hours, especially in the case of the number of PVCs at above 300/day [3]. Electrocardiographic examination has too little sensitivity and specificity in detecting structural heart diseases to be a sufficient stand-alone diagnostic tool for aviation medical screening. This limitation of the ECG test itself, involving the diagnosis of heart disease, was found, among others, in a Japanese study on 176 military pilots aged 40-50 years. The addition of echocardiography to the standardized ECG also enabled the detection of significant left ventricular hypertrophy and left ventricular hypertrophy [26]. Echocardiographic examination is the most frequently performed imaging examination in cardiology due to its low cost and universal access. It enables detection of heart muscle diseases, acquired and congenital defects underlying or predisposing to the occurrence of arrhythmia. In order to exclude the background of ischemic arrhythmia, exercise tests are performed: electrocardiographic or imaging tests, and in many cases, coronary angiography using computed tomography. It should be noted that during the exercise test, various arrhythmias may appear, including potentially dangerous ones, such as the non-sustained ventricular tachycardia (observed in 4% of asymptomatic adults), although the mere fact of their occurrence is not associated with an increased risk of general mortality [25]. In doubtful situations, classical coronary angiography is always the decisive examination.

The legitimacy of exercise tests in pilots is reflected in the current guidelines of cardiological societies. This group has been distinguished as one of the few groups of low risk of cardiovascular diseases in which screening in the form of resting and exercise ECG is recommended [5].

Magnetic resonance imaging of the heart enables precise assessment of the size of the heart chambers, the left ventricular muscle mass and the ventricular function. It is a very good imaging method for diagnosing people with suspected cardiomyopathy. However, the best way to assess the location of the area in the heart responsible for the arrhythmia is by electrophysiological examination, which can also be used to determine the indications for ablation treatment or pacemaker implantation. In the case of ventricular arrhythmias, it is possible to document the development of ventricular tachycardia, assess the risk of its recurrence or sudden cardiac arrest, or loss of consciousness in selected patients with sus-

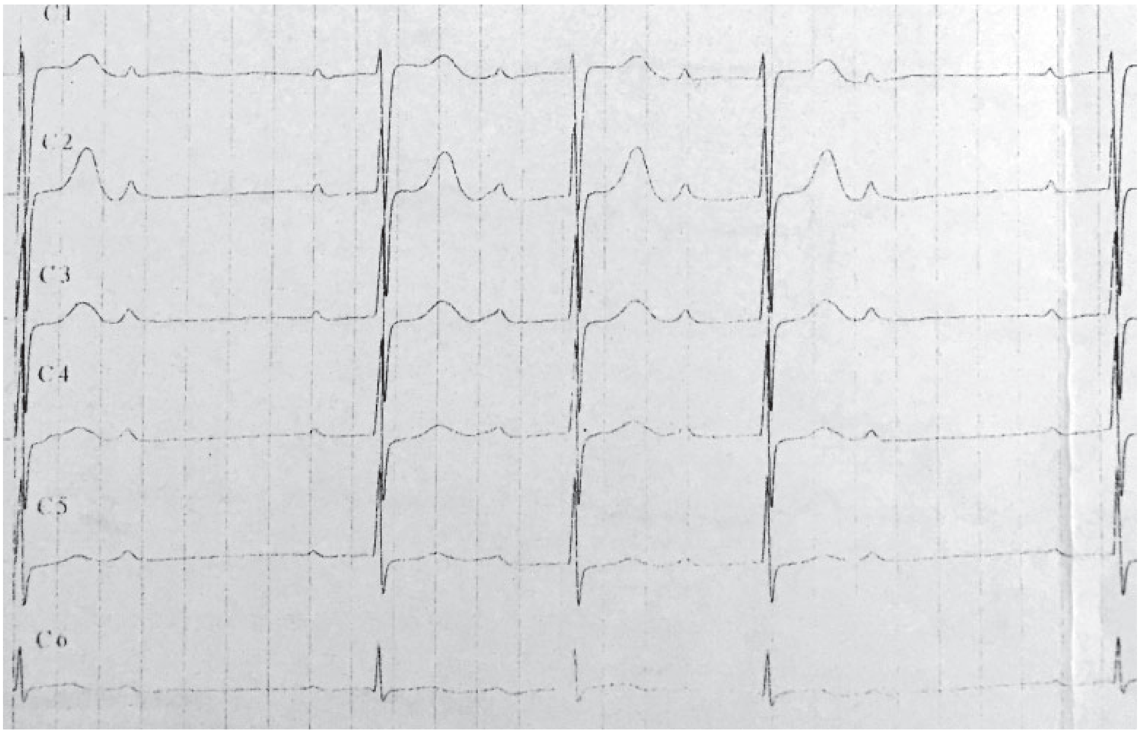

Fig. 1. Atrioventricular block of the second degree Mobitz type 1.

pected arrhythmia, and evaluate the indications for treatment with a cardioverter-defibrillator.

It should also be noted that standard diagnostic methods used to diagnose arrhythmias in pilots may not be sufficient. Pilots are subjected to high acceleration values during testing in a high-G centrifuge. During flight, accelerations in the head-leg direction – the so-called +Gz accelerations – are the most frequent. The influence of accelerations in the head-leg axis causes a number of hemodynamic effects as a result of displacement of a significant volume of blood circulating to the vessels of lower limbs, resulting in a decrease of venous inflow to the right half of the heart, decrease of stroke and minute volume and arterial pressure in vessels located above the heart. Increased sympathetic system tension and the release of more catecholamines change the electrophysiological parameters of the electrical conduction system and promote various cardiac arrhythmias [20]. Premature supraventricular and ventricular contractions and sinus arrythmia are the most common symptoms of +Gz acceleration, as well as complex arrhythmias such as paroxysmal supraventricular tachycardia, ventricular tachycardia or paroxysmal atrial fibrillation [17].

Sinus bradycardia and sinus arrythmia are often found in healthy individuals, especially those taking part in sports [10]. They remiss during the effort and are usually asymptomatic. In the case of fainting or losses of consciousness due to sinus bradycardia, sinus inhibition or sinus atrial block, further service in the air depends on the results of detailed cardiological diagnostics.

Extended PR interval, also called the atrioventricular block of the I degree, of above 200 ms but not exceeding 300 ms, is a variant of the norm in the group of young, trained people [9]. If the PR interval is greater than 300 ms, an additional test such as an exercise electrocardiogram test should be performed. If the PR interval is shortened as a result of increased catecholamine release, the flight crew members are allowed to continue flight service.

In the case of atrioventricular block of the second degree Mobitz type 1 (Wenckebach Phenomenon), asymptomatic, occurring at night, no further diagnosis is necessary (Fig. 1). However, if symptoms occur and/or it takes place during the day or when they first appear after the age of 40, further cardiological diagnosis is recommended. Most people with this disorder can work in the air without restrictions.

The Mobitz type 2 atrioventricular block of the second degree and the atrioventricular block of the III degree (total) are the reason for unfitness for flying until the cause is established. They may be paroxysmal, ischemic, inflammatory, electrolytic disorder- or drug-related. In most cases, however, they are an indication for the implantation

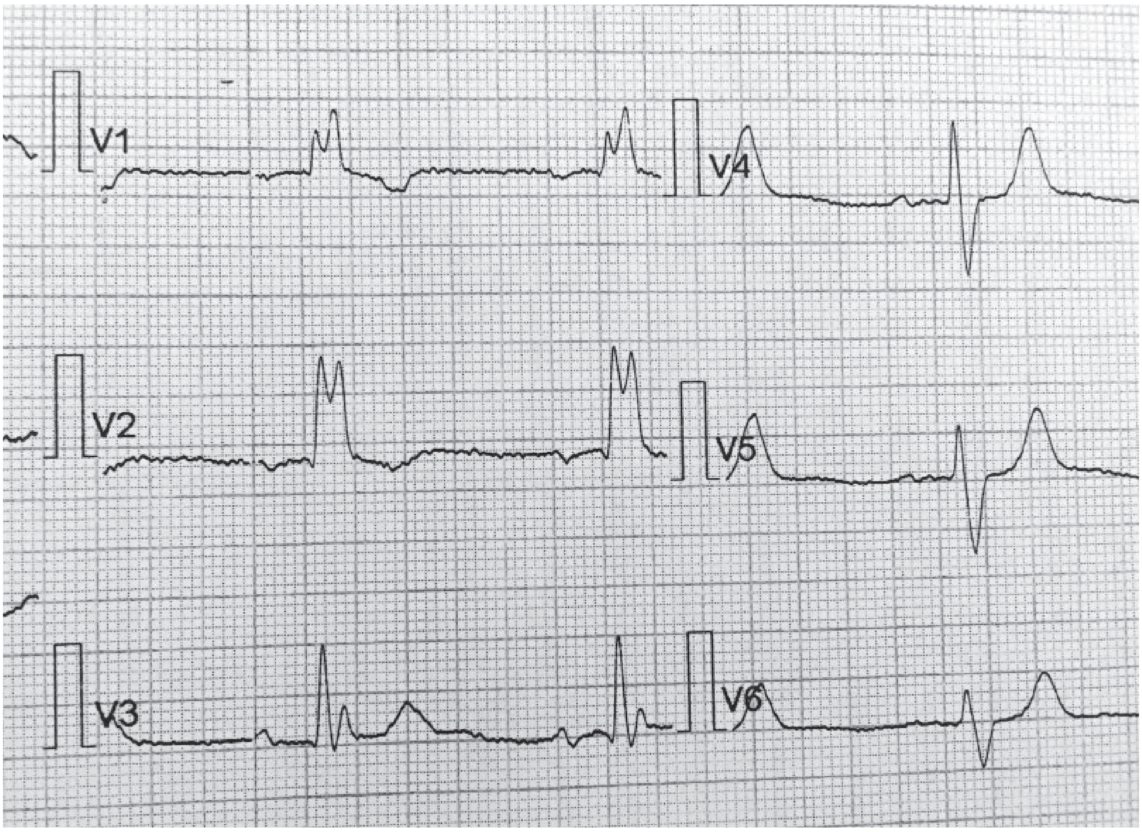

Fig. 2. Block of the right bundle branch.

of a cardiac stimulation system. Individuals with implemented pacemakers are considered unfit for flying due to the possibility of pacemaker failure and due to the influence of strong electromagnetic field present in airplanes, which may disturb the pacemaker operation [8]. In the case of persons not dependent on stimulators, there is a possibility to return to flying.

An incomplete block of the right bundle branch (Fig. 2) is a frequent change found in ECG in the general population as well as in the flying staff and does not require further diagnosis or restrictions at work [1]. The right bundle branch block requires additional tests for organic heart disease. In a 2003 study, which analyzed 2,700 military pilots for the presence of a complete block of the right bundle branch, the above disorder was detected in 36 of them. Therefore, they were subject to frequent cardiological controls with electrocardiographic exercise tests, scintigraphic exercise tests, echocardiography and in 12 cases coronary angiography [37]. In the period of observation lasting on average 11 years, no association was not found between the bundle branch block and worse prognosis. In most cases, it is not necessary to restrict the pilot license for RBBB persons.

The hemiblocks of the anterior (LAH) and posterior branch of the left bundle are most common in patients without organic heart disease [23]. Pilots with anterior block of left bundle branch have not been found to be at risk of cardiac events, sudden deaths, or progression to total bundle branch block or development of atrioventricular blocks [36]. In the case of persons of over 40 years of age, LAH may be associated with ischemic heart disease and it is therefore recommended to conduct examinations to rule it out. In the case of the posterior left bundle branch block, especially in combination with the right bundle branch block, cardiomyopathy and myocardial ischemia tests should be performed.

Left bundle branch block (LBBB) brings about the highest risk of coexistence of organic heart disease among intraventricular conduction disorders. The diagnosis of LBBB even in young patients is an indication for the performance of a broad cardiological diagnosis [21]. It may be a marker of ischemic heart disease, a result of long-lasting hypertension, aortic valve defect and cardiomyopathy [34], therefore, it is recommended to perform in this case an echo, Holter ECG, angio-CT of coronary arteries, and in some cases MRI. After the exclusion of cardiac structural disease, most of the flying staff are allowed to continue working, but more frequent cardiac checks are recommended.

Premature supraventricular extrasystoles (PSEs) are mild arrhythmias and do not require additional diagnostics if they are rare and do not cause symptoms. With the increase in the number of PSEs, there is a tendency to an increased risk of developing atrial fibrillation, starting from a small number of beats below 100 per day, to a significant increase in the number of arrhythmias. With the number of more than 1500 beats/24 hours, no further increase in the risk of atrial fibrillation was observed [15]. Based on similar observations, more frequent aviation medical examinations with numerous premature supraventricular extrasystoles and regular Holter monitoring to detect asymptomatic atrial fibrillation are recommended.

Supraventricular tachycardia (SVT) is a rhythm disorder occurring in approximately 0.3% of adults. There are 3 forms of this arrhythmia: AVNRT atrioventricular nodal reentry tachycardia (about 60% of SVT), AVRT atrioventricular reentrant tachycardia with concomitant additional atrioventricular conduction pathway (about 30% of SVT) and atrial tachycardia (10% of SVT) [27]. Atrial tachycardia (Fig. 3) often occurs in people with organic heart disease, hypertension, chronic pulmonary diseases, therefore it requires first of all diagnostics in order to detect the etiology of this disorder. AVNRT and AVRT are most common in healthy individuals (without coexisting structural heart disease). Detection of this arrhythmia results in the pilot being suspend in their work until the diagnosis is completed and further action is taken. A number of external factors may influence the occurrence of a seizure of supraventricular tachycardia, such as alcohol, caffeine, supplements taken, electrolyte disturbances or hyperthyroidism. In the case of an unstable supraventricular tachycardia attack without accompanying symptoms, further flight work is allowed, although in most cases with certain limitations. In other cases, treatment is necessary. Due to the lack of sufficient effectiveness of antiarrhythmic drugs and their effect on the heart, ablation is the treatment of choice for flying staff. The efficacy of this method of treatment in the case of AVNRT and AVRT reaches 95% [35]. Depending on the type of aircraft, most pilots can return to their previous tasks after this procedure. Limitations may appear when piloting highly maneuverable aircraft or single-seater aircraft.

In the presence of additional conduction pathways in the form of an additional muscle bundle, it is possible to stimulate the ventricle outside the physiological conduction pathways. In 98% of cases it is the bundle of Kent, while in the remaining 2% it is the Mahaim fibres. In ECG recording, the PQ interval is shortened below 120 ms and the presence of a delta wave is characteristic. If tachyarrhythmia symptoms are also present, then we are dealing with the Wolff–Parkinson–White syndrome (the WPW syndrome). In one study

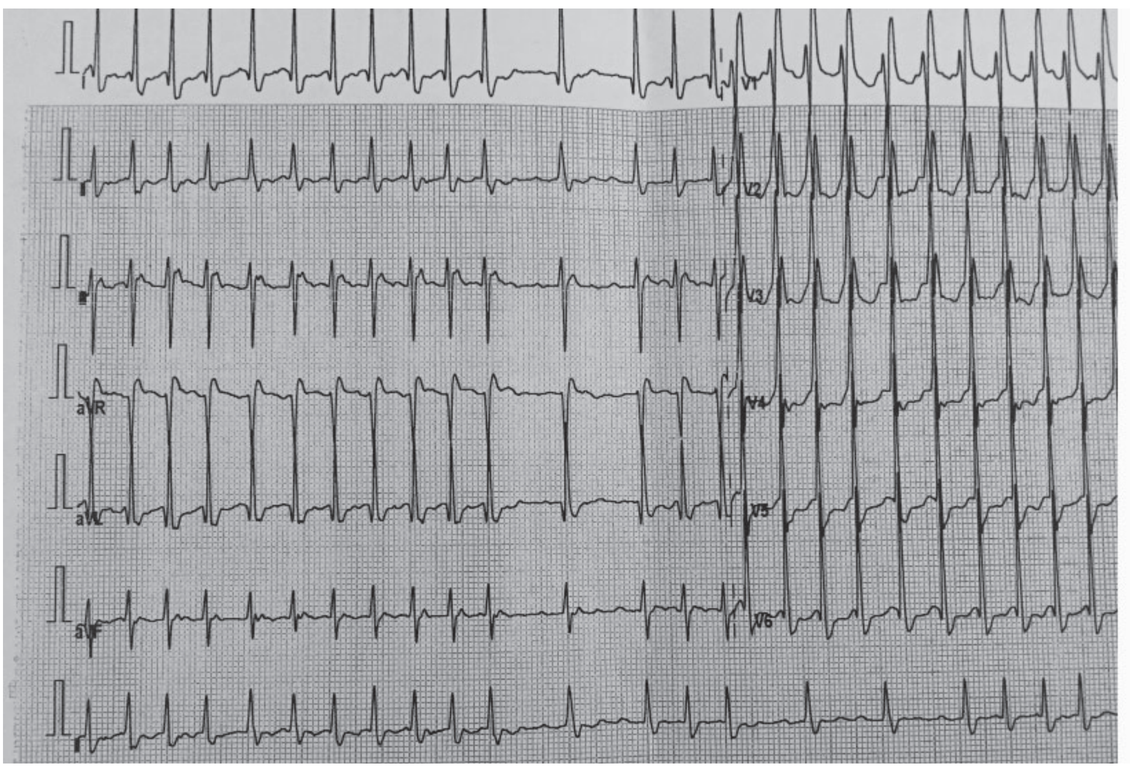

Fig. 3. Atrial tachycardia.

in a group of 238 military pilots with WPW syndrome, the risk of sudden cardiac death of 0.02%/year was found during the observation period of 22 years. The risk of supraventricular tachycardia was estimated at 1%/year [11]. The treatment of choice for flying staff with pre-excitation syndrome is ablation, the effectiveness of which in this disorder reaches over 98% with a very low risk of complications [4].

Atrial fibrillation (AF) is one of the most common arrhythmias found in flying staff. In a UK study published in 2012, the frequency of AF was 0.3%, found in all screening ECG performed among airmen [2]. The most common form is paroxysmal atrial fibrillation without coexisting structural heart disease, the so-called spontaneous atrial fibrillation [18]. In individual cases, atrial fibrillation seizures can be linked to an obvious factor such as alcohol or medication. Since atrial fibrillation may coexist with many diseases, including: valvular heart disease, ischemic heart disease, cardiomyopathy, hypertension, hyperthyroidism or pulmonary diseases, multidirectional diagnostics is necessary in case of its occurrence [19]. The majority of antiarrhythmic drugs used in AF: flecainide, propafenone, amiodarone, dronaderone and sotalol are contraindicated in people on air duty. Only b-blockers, used mainly for rhythm frequency control, are allowed in the group of transport aircraft and helicopter pilots. Due to their chronotropic negative effect and impairment of the pressure reaction, they are prohibited for pilots of highly maneuverable aircraft. For this reason ablation is the preferred method of treatment for flying staff. The most frequently performed procedure is pulmonary vein isolation, the efficacy of which is about 80% [13]. After ablation, a 6-month observation period is recommended to evaluate its effectiveness. After this period, if the arrhythmia does not recur, further service in the air may be allowed, especially in the case of subsonic planes, helicopters and multi-member crews.

Atrial flutter is a disease that may accompany atrial fibrillation or occur separately. It also has similar etiology and consequences. The efficacy of pharmacological antiarrhythmic treatment in atrial flutter is even lower than in AF, therefore ablation remains the treatment of choice in flying staff. The method of treatment of atrial flutter is effective in over 90% with a relatively low risk of complications not exceeding 1% [6].

Premature ventricular contractions (PVCs) are quite common arrhythmias (Fig. 4). It is found in about 2-7% of the population, and only in about 0.8% of pilots [39]. PVCs can occur as an isolated abnormality or as a symptom of a structural heart disease. Very numerous PVCs may lead to tachycardia-induced cardiomyopathy. The basic diagnostic examination in this arrhythmia is 24-hour Holter monitoring to assess the number of PVCs and the morphology of QRS syndromes. An exercise test is also recommended for all patients, during which the arrhythmia may be suppressed, which is considered a good prognostic symptom. In the case of frequent premature ventricular con-

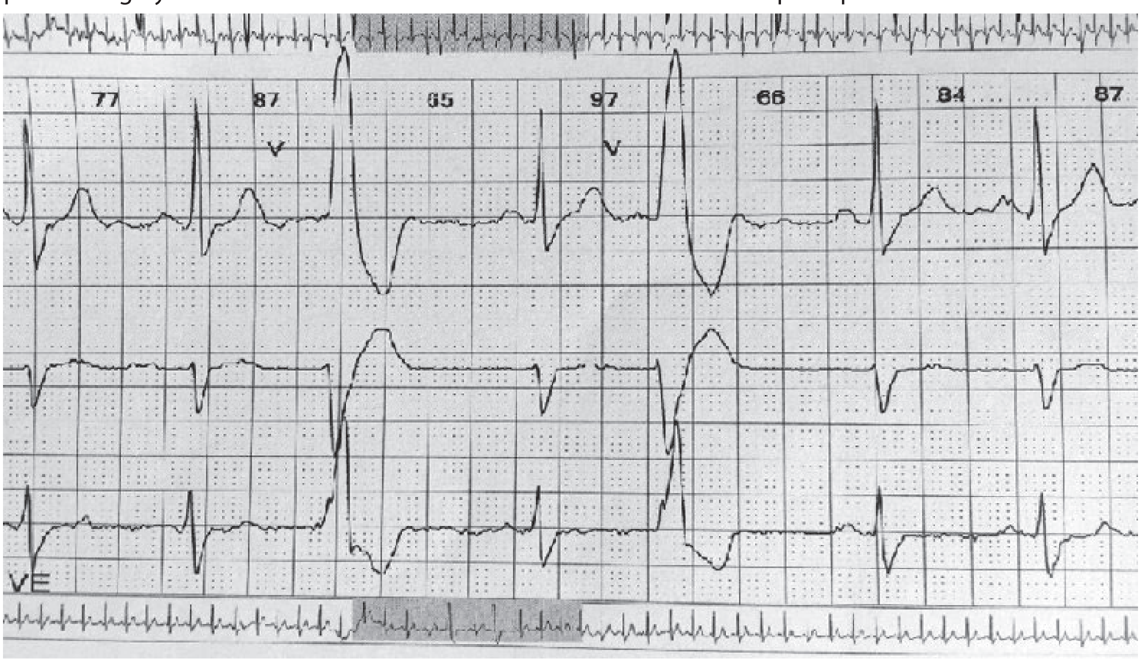

Fig. 4. Holter ECG record with 2 premature ventricular contractions.

tractions, magnetic resonance imaging of the heart towards arrhythmogenic right ventricular cardiomyopathy is also justified [30]. It is also recommended to perform angio-CT of coronary arteries, especially in patients over 40 years of age. Not very frequent premature ventricular contractions below 2% of the total number of asymptomatic beats are usually not contraindications for airborne service. With more severe arrhythmia, especially above 7.5% of the total number of contractions, a pilot may be allowed to fly in multi-member crews and on subsonic planes, transport planes and helicopters [16]. In the case of flying staff, PVC treatment is a choice between pharmacotherapy, mainly b-blockers, or ablation, which can lead to permanent remission or a significant reduction in arrhythmia. A study from 2015 showed 84% efficacy in the period immediately after ablation in individuals with numerous premature ventricular contractions (on average 20% of all contractions). After ablation, not only did the symptoms of arrhythmia disappear, but also in patients with tachycardia-induced cardiomyopathy, the release fraction improved significantly from 38% to 50% [22].

Ventricular tachycardia (VT) is an uncommon rhythm disorder in airmen (Fig. 1). 5). During 42 years, only 193 cases of non-sustained ventricular tachycardia and no case of sustained ventricular tachycardia were recorded in the US military aviation [14]. During the observation, symptoms such as fainting, pre-faint condition and sudden cardiac death were observed (in these cases ischemic heart disease, mitral valve prolapse syndrome and cardiomyopathy were diagnosed as the underlying cause) in only 9 persons. Ventricular tachycardia may occur in the course of many organic heart diseases and in ion channelopathies. There is also a form of idiopathic ventricular tachycardia, which can be diagnosed after excluding other causes. Idiopathic ventricular tachycardias include VT from the right ventricular outflow pathway and idiopathic left ventricular tachycardia. Due to the limitations in the use of antiarrhythmic drugs in aviation, also in idiopathic ventricular tachycardias, the treatment of choice is ablation, the efficacy of which is 85-90% shortly after the procedure and 75-80% in the long term [38]. After a successful ablation and observation period after the surgery, there is a possibility to restore the pilot to work.

The diagnosis of any channelopathy, e.g. Long QT Syndrome (LQTS), Short QT Syndrome (SQTS), Brugada syndrome (BrS), catecholaminergic polymorphic ventricular tachycardia, is the reason for a certificate of unfitness for working in the air. This is related to the risk of sudden cardiac death in the course of ventricular tachyarrhythmia: polymorphic ventricular tachycardia and/or ventricular fibrillation. The implantation of a cardioverter-de-

Fig. 5. ECG record of ventricular tachycardia during an exercise test.

fibrillator is recommended for people at high risk of sudden cardiac arrest. According to current ESC guidelines, such individuals include patients with hemodynamically intolerated VT without a reversible cause, and ICD implantation should also be considered in patients with recurrent sustained VT who are undergoing optimal conservative treatment [28]. However, this does not prevent arrhythmia, and thus prevent the ICD from discharging, making it permanently inoperable.

Early ventricular repolarization syndrome is quite a problematic issue for medical certification [31]. It is also associated with an increased risk of sudden cardiac death. The higher J-point departure is quite common in persons regularly participating in sports, hence early repolarization syndrome is recommended to be diagnosed only after a documented episode of idiopathic VF or polymorphic VT in individuals with early repolarization characteristics in ECG [28].

CONCLUSIONS

The detection of mild rhythm and conduction disorders usually does not give sufficient information on further prognosis and on the ability to continue performing the tasks of a pilot. To this end, extensive research is being carried out to establish the prognostic significance of seemingly harmless arrhythmias and conduction disturbances that would not constitute any restriction on the continuation of airborne activities in the non-airborne population.

Disorders of the electrical conduction system are one of the most frequently found abnormalities during qualification and control examinations during certification. Comprehensive diagnostics of the cardiovascular system allows to distinguish abnormalities in the ECG disqualifying pilots from further flying or to qualify them as mild and not threatening further work.

AUTHORS' DECLARATION:

Study Design: Michał A. Kurek, Ewelina Zawadzka-Bartczak, Katarzyna Barwińska, Daria Owsiak; **Data Collection:** Michał A. Kurek, Ewelina Zawadzka-Bartczak, Katarzyna Barwińska, Daria Owsiak; **Manuscript Preparation:** Michał A. Kurek, Ewelina Zawadzka-Bartczak, Katarzyna Barwińska, Daria Owsiak; The Authors declare that there is no conflict of interest.

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CASE STUDY

LOSS OF CONSCIOUSNESS DURING SPONTANEOUS LAUGHTER

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Source of support: Own sources

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Abstract: The patient reported to the Neurology Clinic because of tetanic seizures occurring during spontaneous laughter. The patient is 29 years old, right-handed, of proper body build and nutrition, free of cardiovascular and hormonal disorders, with regular menstrual cycle, a psychologist by education. During the last four weeks (November – December), she had five irregular, repetitive episodes of sudden generalized weakness, lasting up to 5 minutes, at different times of the day (except night time). In 2-3 minutes, each time a few seconds of a state of "zoning out" (loss of consciousness) occurred [5,12,15]. All episodes appeared during a dozen or more seconds of spontaneous laughter, when in the company of close ones. The patient was diagnosed with latent tetany on the basis of subjective and physical neurological examination, additional examinations, positive reaction to the treatment applied, and after excluding other medical causes.

Keywords: laughter, hyperventilation, tetany, loss of consciousness, QEEG

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INTRODUCTION

Laughter is produced mainly by the contraction of the facial muscles and the characteristic voice that usually accompanies it. It is often accompanied by more or less expressive, theatrical behavior depending on the temperament of the person, the purpose and the situation. Laughter has been described for centuries in various ways and forms, especially by writers and bards. Very often, people with a high self-esteem and a good humor are able to "infect" those in their company with laughter, making fun of their own weaknesses in particular. These people are the so-called spiritus movens. Laughter toned with mockery is aimed at abasement or humiliation – in such case everyone experiences it in their own way. Apart from a positive or unpleasant emotional charge, laughter can be a symptom of an illness or an illness itself. For example, a sardonic grin which accompanies tetanus is actually caused by the contraction of facial muscles exposing one's teeth in such an expression. Another example of illness-based laughter is paradoxical laughter (paragelia, gr. para – inappropriate, gelia – laughter) - a paroxysmal, spontaneous laughter of a very high intensity, unwarranted by the moment and situation. Very often it is difficult to control. It is seen by outsiders as indecency, lack of empathy, a kind of malice. Schizophrenia in adults and autism in children predisposes to such kind of laughter. Epilepsy can manifest itself through episodes of uncontrollable laughter, mainly in children [14,15]. In psychoorganic syndrome of postapoplectic or posttraumatic origin (cerebral contusion), individuals with weakened affect control mechanisms and pseudobulbar affect often experience episodes of uncontrollable laughter alternating with crying. Laughter may often trigger dyspnoea in patients with asthma (the author's experience from work in Emergency Ambulance Service). In children (emotional and bioelectrical immaturity of the brain), during spontaneous and/or expressive laughter, temporary sphincter dysfunctions (mainly of urinary bladder) are sporadically observed.

DIAGNOSTICS

Clinical condition

Patient I. O., maiden, age 29, only daughter, height 171 cm, body weight 76 kg, proper body built and nutrition, right-handed, free of cardiovascular and hormonal disorders, with regular menstrual cycle – 28/4. Currently at the end of 2nd phase of the menstrual cycle (24th day). She has not been pregnant and is not pregnant now (as of 4 December 2014). systematically undergoes gynecological check-ups (most recently two months ago – no problems were found). Not undergoing long-term treatment or have not undergone intermittent treatment (taking medication) or used specific diets within the last five months. No addictions. Academic teacher, psychologist by education. No family, social or legal conflicts. Full, logical, spontaneous communication. Natural, correct behavior. No history of significant past and present illnesses, especially head injuries, family and inherited diseases and other ailments was determined. Cares for good psychophysical fitness. Does body conditioning gymnastics and jogs (several kilometers) in her free time. Parents are healthy, with no significant past medical history or systemic disorders. She reported to the Neurology Clinic because of five irregularly repeated episodes over the last four weeks of sudden feeling of generalized weakness, with the impression of "being-close" to fainting, accompanied by formication around the mouth and fingers. With the tendency for fingers of both hands to become stiffened in a spread position. Lasting up to 5 minutes (?), at different times of day (except for night time). In 2-3 minutes, each time a few seconds of a state of "zoning out" (loss of consciousness) occurs. According to the reports of family and friends (witnesses), for a few seconds during an episode she barely reacts or does not react at all when spoken to, her eyes are open but the gaze is "absent", her lips are (slightly) tightened. Each time her complexion turns pale, but not cyan. Slight (?) tremor of upper limbs and lower limbs. Moisture level of the skin not increased. During an episode, she does not perform uncoordinated movements, no stereotypy, does not say any words and does not produce inarticulate vocal sounds. She does not foam at the mouth and does not demonstrate unconventional behavior. All the episodes, except for the fourth one (in order of occurrence), occurred in different places, always in the company of friends, in a good friendly mood (without substance use), interspersed with a lot of spontaneous, expressive laughter. Because of the known uncomfortable consequences of laughter (repetition of prodromal symptoms of the started laughter), despite self-control, the patient claims that she could not stop the process. It was followed by "forced uncontrollable laughter" until the rest of the course of the event was no longer registered by memory [12]. The state of forced laughter evoked in the patient's consciousness the feeling of fear/threat of the subsequent course of the starting episode. Only the "fourth" episode occurred when the patient was alone at home, in the evening. In a state of general well-being and complete relaxation, sitting (reclining position) and enjoying ordinary green tea, not using other substances. A sudden feeling of weakness with subsequent momentary "zoning out" occurred during "moderate" spontaneous laughter while watching comedy sketches on television.

After each episode, the patient had a slight buzzing sensation in the ears lasting for a few minutes, a feeling of uncertainty as to full visual and motor coordination and perception of the environment, accompanied by anxiety. She did not feel sleepy, tired, sore (without signs of lip biting, tongue biting) and did not indicate any temporary sphincter dysfunctions. She did not feel cold, hungry, thirsty, or have other urgent physiological needs. The patient says she sleeps regularly. She sleeps a min. of 6-7 hours at night. In case of every episode, she had a good night sleep, was rested and relaxed. Before and in the meantime, there were occasional social gatherings full of spontaneous laughter and excellent mood, and the patient had many other occasions to laugh spontaneously, but without a highly expressive, emotionally intensive, spontaneous laughter. The "series of laughter" in these cases were shorter in duration and did not exceed several seconds.

Diagnostic tests

The physical examination indicated: BP – 125/75 mmHg in the left upper limb and 124/73 mmHg in the right upper limb, HR – 78 bpm, vessels in both the upper limbs and the lower limbs well tensioned and filled, consistent with the heart activity. The skin is clean, properly tight and elastic, with no signs of increased dermatographic urticaria. Rhythmic heart activity, clear, loud sounds. Free breathing through the nose. Normal vesicular sound. No abnormalities in the lungs (no signs of edema). Thyroid gland was not palpable during examination. Tongue, oral cavity, uvula and throat – no abnormalities. Peripheral lymph nodes were palpable – no abnormalities. Palpation of abdominal organs excluded abnormalities. Costovertebral angle tenderness – negative on both sides. Romberg's test – negative. No abnormalities in cranial nerves and peripheral nerves. No Chvostek signs, Lust signs, Trousseau signs of latent tetany or pyramidal and extrapyramidal symptoms. Examination of the reaction to stimuli of eyes and hearing excluded abnormalities.

The patient was referred for additional examinations. Blood morphology, determination of ESR, INR with biochemical indicators (sugar, urea, creatinine, total bilirubin, liver function test, ALAT, ASPAT and GGT). Total HDL and LDL cholesterol, triglycerides, TSH, PTH, electrolyte levels; Na, K, Ca, Mg and Fe. Vitamins B12 and D3). General urinalysis. EEG, ECG, Cardiac and Thyroid ultrasound, EMG (ischemic test for tetany). Additional periodic examinations carried out two months ago: blood morphology, ESR, ECG and chest X-ray, the results of which were provided by the patient, show no abnormalities. It was recommended to minimize the intensity (expressiveness) of laughter in situations provoking and conducive to laughter. On the second day, a QEEG was carried out in the time before noon (9-10 o'clock). The patient was prepared for the test – she was well-rested, had breakfast, was in good psychological and physical condition. QEEG reading – borderline normal, with cardiac and muscular artifacts (Fig. 1a-1d).

Laboratory tests

So far, the patient has underwent the following additional examinations: 1) blood morphology (on 15 December 2014 – 8th day of menstrual cycle); ESR – 9 mm/h, INR – 1.1, RBC – 4.3 x 1012/l, WBC – 9.8 x 109/l, Hb – 8.9 mmol/l, blood sugar: 4.2 mmol/l, total bilirubin – 11 µmol/l, urea – 5.1 mmol/l, creatinine – 81 mmol/l, total cholesterol – 41 mmol/l, triglycerides – 0.91 mmol/l, Na –137 mmol/l, K – 4.9 mmol/l, Ca – 2.2m mol/l (lower limit), Mg – 0.8 mmol/l, Fe – 156µg/dl, TSH – 1.19 mlU/L, PTH – 5.1 pmol/l, vit. B12 – 465 ng/l, vit. D3 – 59 nmol. Other parameters within normal limits. 2) General urinalysis within normal limits. 3) ECE within normal range. EMG (26 January 2015) – ischemic test – low positive. Thyroid ultrasound (9 February 2015) – no noticeable abnormalities. Echocardiogram – the examination was not carried out.

TREATMENT

After the examinations, the following medications were recommended: 1) Calperos – 500 mg caps. at a daily dose of 2500 mg, according to the administering scheme |2-2-1| during a meal and 2) Tegretol CR 200, starting from ½ pill in the morning for three days. Then, increasing by ½ pill every three days, reaching a dose of 2 x 200 mg per day according to the administering scheme |1-0-1|. A check-up with the results of requested additional medical examinations (if possible) was scheduled in three weeks' time. After one month of taking the above medicines, the patient came in for a check-up in good general health, registering no complaints. In the meantime she was not ill, she did not take any other medicines than the above two – according to the recommended administering scheme. During this time, despite she was aware of the need of moderation in the intensity of spontaneous laughter, one episode occurred (after 3 weeks of treatment) with the same course as described above, when laughing her head off with her friends.

After 6 months since the last event, without the above mentioned symptoms, in July 2015, the patient stopped taking Calperos on her own. She continued treatment with Tegretol CR 200 at a daily dose of 400 mg (2 x 200 mg). Due to the disappearance of the symptoms, the patient stopped attending medical (neurological) appointments. The contact was limited to the provision of short telephone information on general health (approx. 1 x per quarter). In November 2016, she came in for a follow-up appointment – in general good health, registering no complaints and no episodes since the end of December 2014. A follow-up QEEG was carried out and the reading was within norm, showing no muscular artifacts, with cardiac artifacts. Results of some additional tests (October-November 2016); Ca – 2.4 mmol/l, Mg – 0.9 mmol/l, Mg – 0.9 mmol/l, vit. D3 – 79 nmol/l, TSH – 1.20 mlU/L. Other results of additional tests, i.e. blood morphology with "biochemistry", general urinalysis, ECG and chest X-ray – within norm. No results of the PTH levels. Gynecological consultation – no abnormalities. After consulting with the patient, gradual reduction of the amount of Tegretol CR 200 taken by ¼ every month (4 x ¼) was recommended. Telephone contact with the patient was maintained. The recent telephone call to the patient did not provide any negative information about her general state of health. The patient is feeling fine. She remembers about the moderation in spontaneous laughter and that "laughter can be no laughing matter".

QEEG examinations

Figures 1a to 1d illustrate selected fragments of QEEG No. 014150, recorded on 05 December 2014, on the 25th day of the patient's menstrual cycle, between 9 and 10 am. The EEG basic activity was maintained. The QEEG analysis is dominated

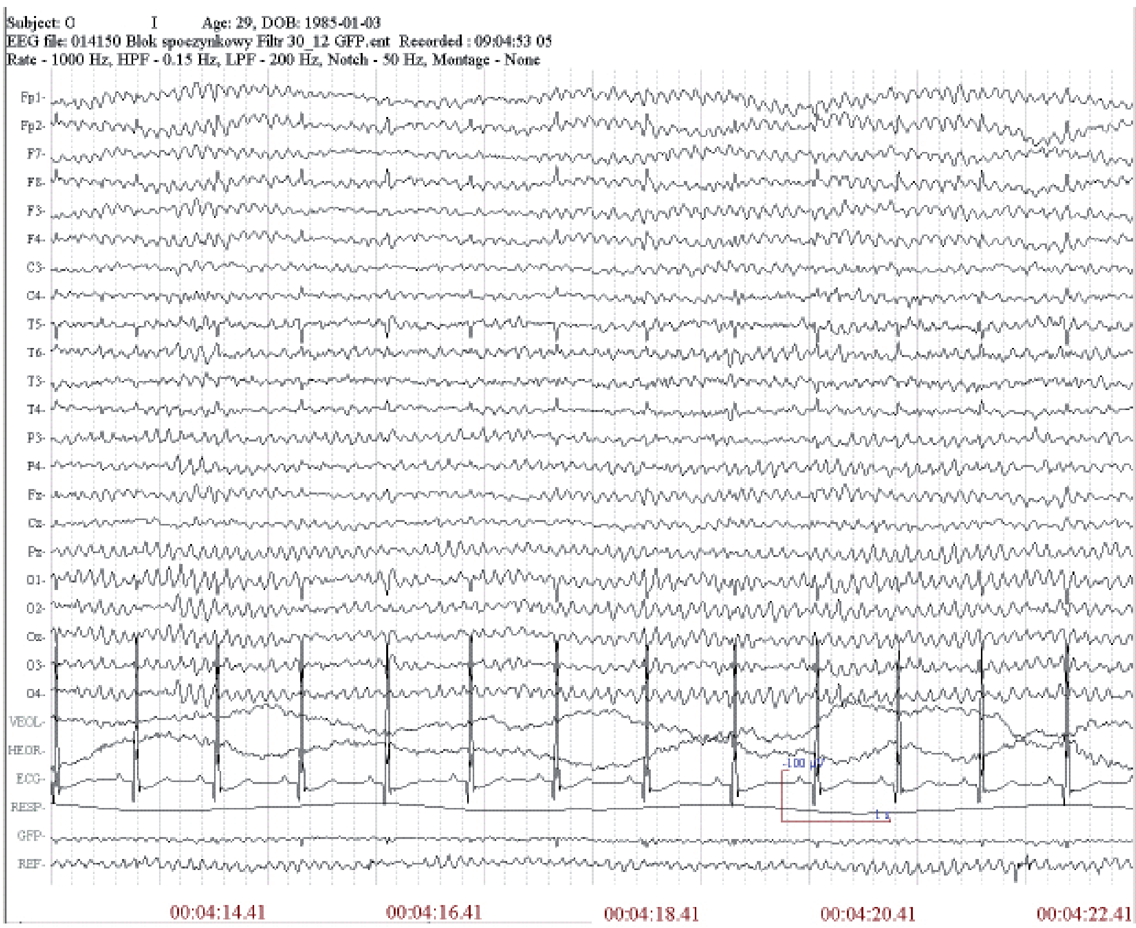


Fig. 1a. QEEG examination. Fragment of resting EEG No. 014150 of 5 December 2014

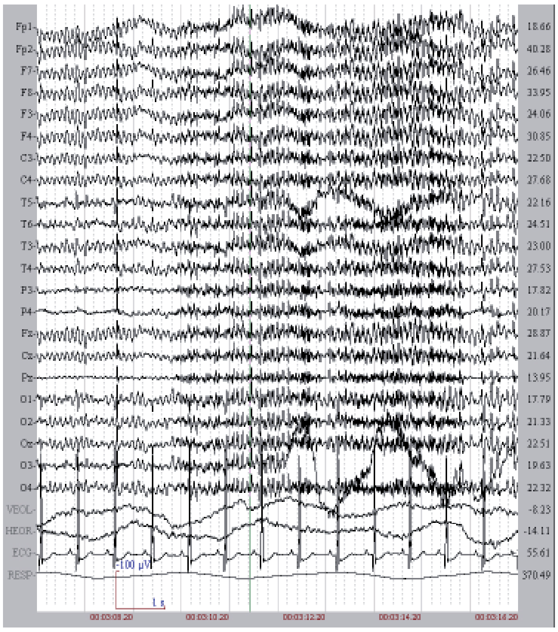


Fig. 1b. QEEG examination. Fragment of resting EEG No. 014150 of 5 December 2014. The beginning of a series of generalized muscular artefacts, EMG – similar.

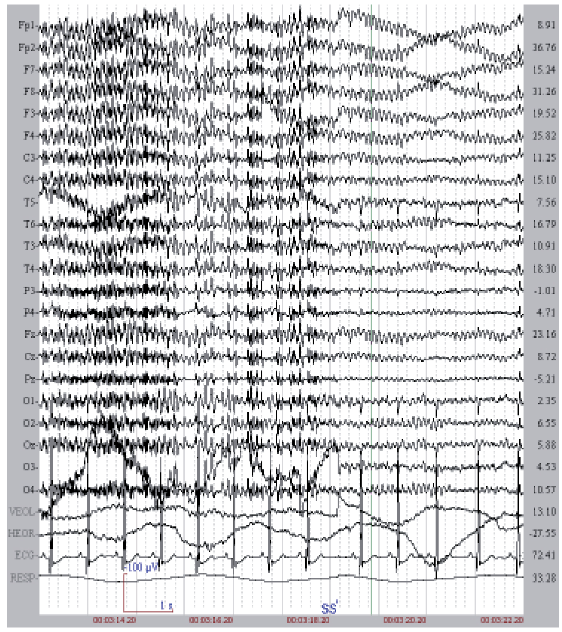


Fig. 1c. QEEG examination. Fragment of resting EEG No. 014150 of 5 December 2014. The end of a series of generalized muscular artefacts, EMG – similar, with subsequent (transient) acceleration of the alpha rhythm by 1.5-2 Hz.

by alpha rhythm of 9.8 Hz (8.5-9.5 Hz frequency range – visual assessment) with amplitude up to 30 µV and peaks up to 40 µV in the middle and posterior temporal areas of the left cerebral hemisphere and contains low voltage beta activity. Alpha activity maintained. Against this background, a few single waves of 7.5-8 Hz with an amplitude within the background, without seizure characteristics, were recorded in the front and middle temporal areas of the left cerebral hemisphere. Regardless of the above-mentioned changes, quite numerous muscular artifacts – series of very rapid generalized EMG waves were recorded – similar ones with amplitude up to 40 µV (fig. 1b, 1c, 1d). Figures 1b and 1c illustrate the beginning and end of a muscular artifact in the form of a generalized series of rapid EMG activity – similar. During hyperventilation (fig. 1d) the number of generalized fast wave series (EMG - similar) with amplitude <40 µV increased. After which in all leads an acceleration of the alpha rhythm by 1.5-2 Hz (fig. 1c), for 6-7 seconds occurs. After this time, the alpha rhythm normalizes, returns to the previous frequency, i.e. 8.5-9 Hz. Stimulation with single intermittent white light flashes, with a frequency of 2, 6, 12 and 18 Hz, did not trigger the bioelectric activity of the brain, it did not change the character of EEG recording. The EEG contains cardiac artifacts, consistent with heart activity.

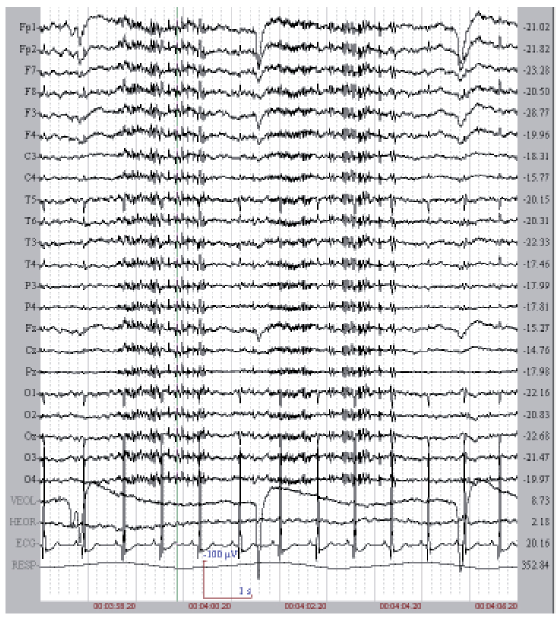


Fig. 1d. QEEG examination. Fragment of resting EEG No. 014150 of 5 December 2014. The beginning of hyperventilation. Generalized fast activity artefacts, EMG – similar.

Figure 2 illustrates a selected fragment of the follow-up QEEG No. 016070 examination carried out on 14 November 2016 between 10 and 11 a.m. on the 25th day of the menstrual cycle, due to the decision to gradually reduce the dose by ¼ over a four-month period until the complete discontinuation of the Tegretol CR 200 treatment, with the current daily dose of 400 mg (2 x 200 mg).

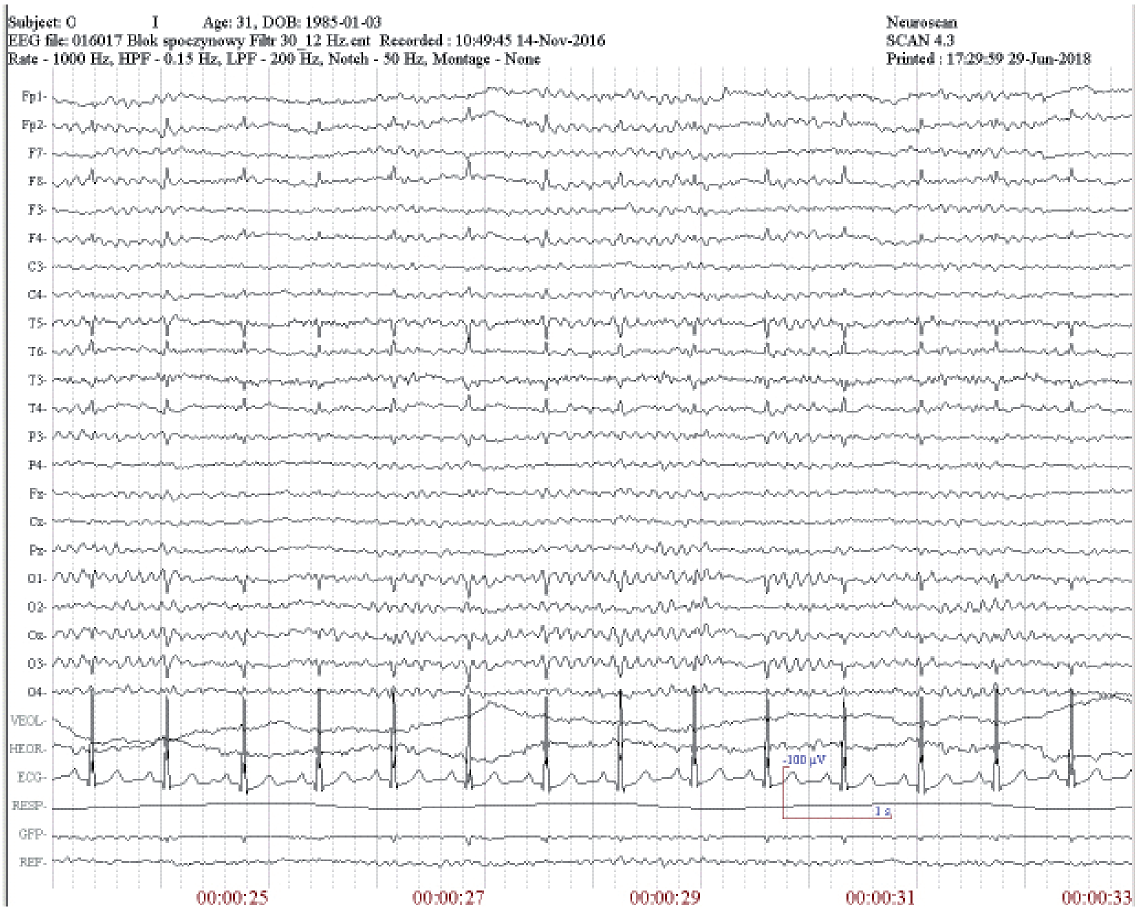


Fig 2. Fragment of follow-up EEG No. 016070 of 14 November 2016.

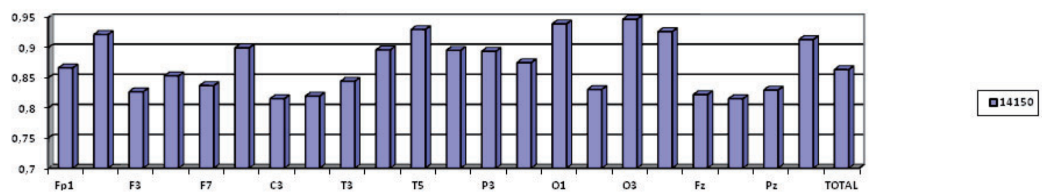


Fig. 3a. QEEG examination No 014150. Resting record. Pearsons' frequency analysis of the bioelectric brain signal (Aver Frequency Domain)

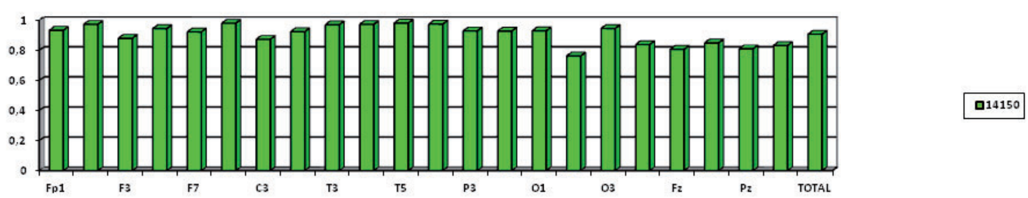


Fig. 3b. QEEG examination No 016017. Resting record. Pearsons' frequency analysis of the bioelectric brain signal (Aver Frequency Domain)

The EEG basic activity was maintained. The QEEG analysis is dominated by alpha rhythm of 9.8 Hz (8.5-9.5 Hz – visual assessment), amplitude up to 30 µV, with trace low-voltage beta activity. Alpha activity maintained. Hyperventilation and single intermittent white light stimulation (2, 6, 12 and 18 Hz) did not trigger the bioelectric brain function, it did not change the character

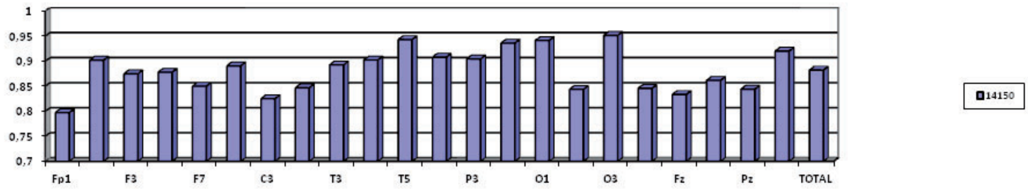


Fig. 4a. QEEG examination No. 014150. Resting record. Intra-Class Correlation analysis of the frequency of bioelectric brain signal (Aver Frequency Domain).

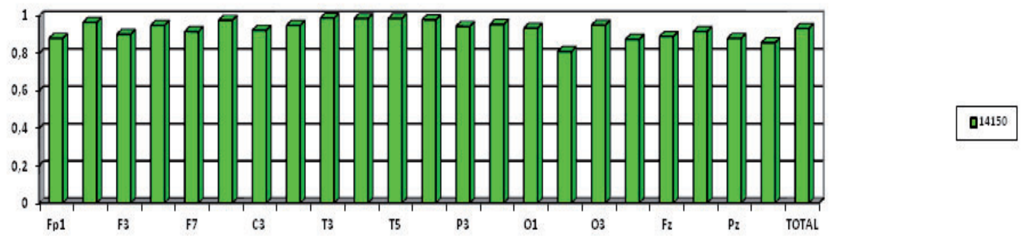


Fig. 4b. QEEG examination No. 016017. Resting record. Intra-Class Correlation analysis of the frequency of bioelectric brain signal (Aver Frequency Domain).

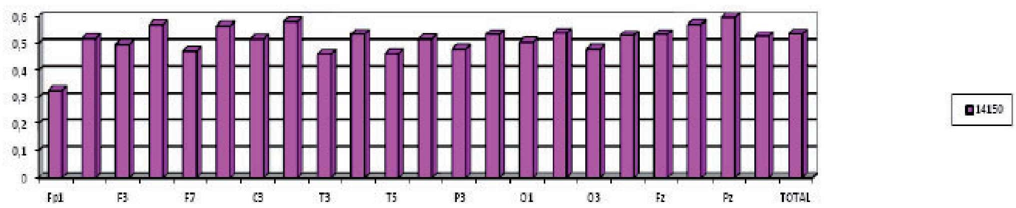


Fig. 5a. QEEG examination No. 014150. Resting record. Intra-Class Correlation analysis in the time domain (Aver Time Domain).

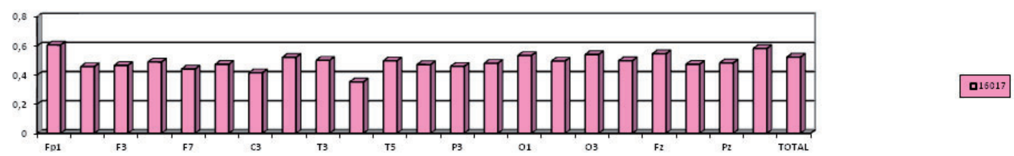


Fig. 5b. QEEG examination No 016017. Resting record. Analysis by Intra-Class Correlation method in the time domain (Aver Time Domain).

of the EEG recording. Despite the two-year gap between the QEEGs (carried out on the same day of the menstrual cycle, in the morning) the basic features of the dominant alpha rhythm did not change; 9.8 Hz and amplitude up to 30 µV. The character of cardiac artifacts has not changed as well over the two years. No muscular artifacts were recorded.

Pearsons' frequency analysis of the bioelectric brain signal – Aver Frequency Domain (fig. 3a, 3b). The values above the mean (TOTAL = 0.864) in the frequency domain occur in the right frontal region, temporal regions (left predominance) and occipital regions (left predominance). They are close to the maximum "unity" value („1").

Intra-Class Correlation analysis of the frequency of bioelectric brain signal – Aver Frequency Domain (fig. 4a, 4b). Highest correlation coefficient above average (0.882). Indicates in order; for the occipital region (l>p), temporal region (lj>p), parietal region (p>l) and right frontal.

Comparative analysis of resting QEEG results, before starting treatment and after two years of treatment, using two different methods, Pearsons (fig. 3a, 3b) and Intra-Class Correlation (fig. 4a, 4b), of the averaged brain bioelectrical signal frequency –Aver Frequency Domain, shows a def-

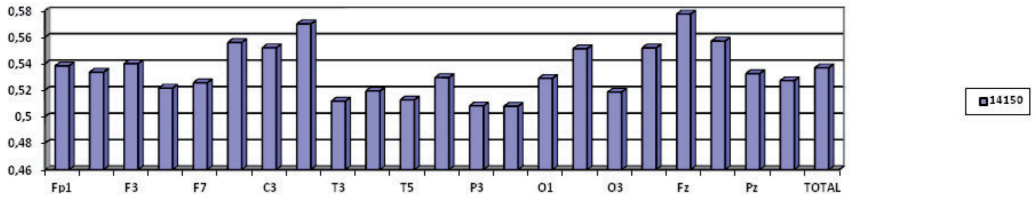


Fig. 6a. QEEG examination No. 014150. Resting record. Intra-Class Correlation analysis of signal power (Spectrum Power).

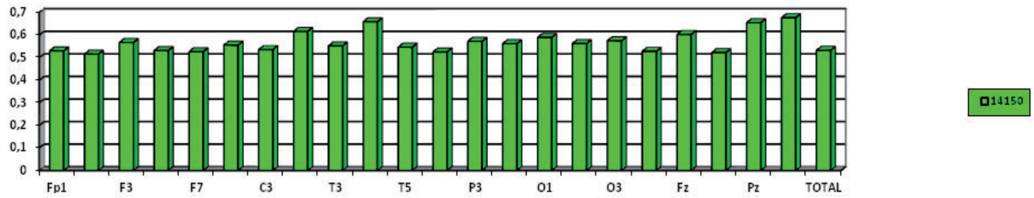


Fig. 6b. QEEG examination No. 016017. Resting record. Intra-Class Correlation analysis of signal power (Spectrum Power).

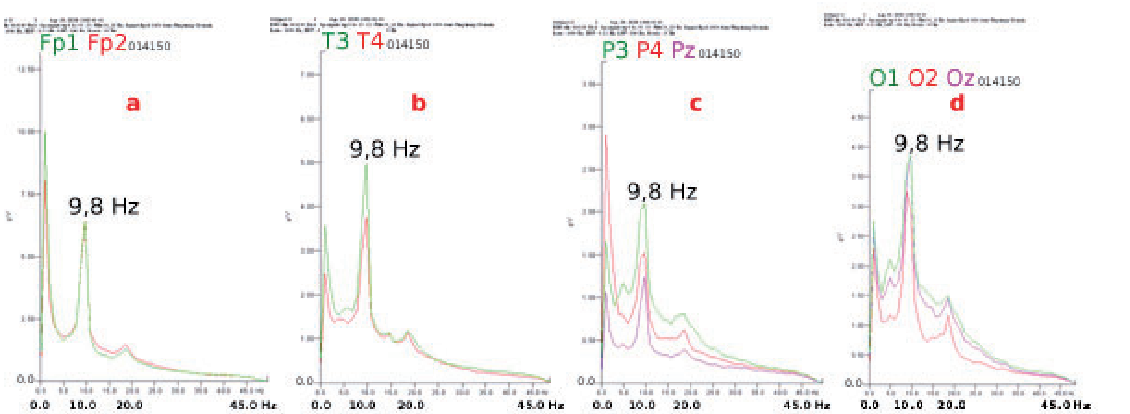


Fig. 7. QEEG no. 014150 in the frequency domain of the bioelectrical brain signal (Aver Frequency Domain). Resting records of selected regions.

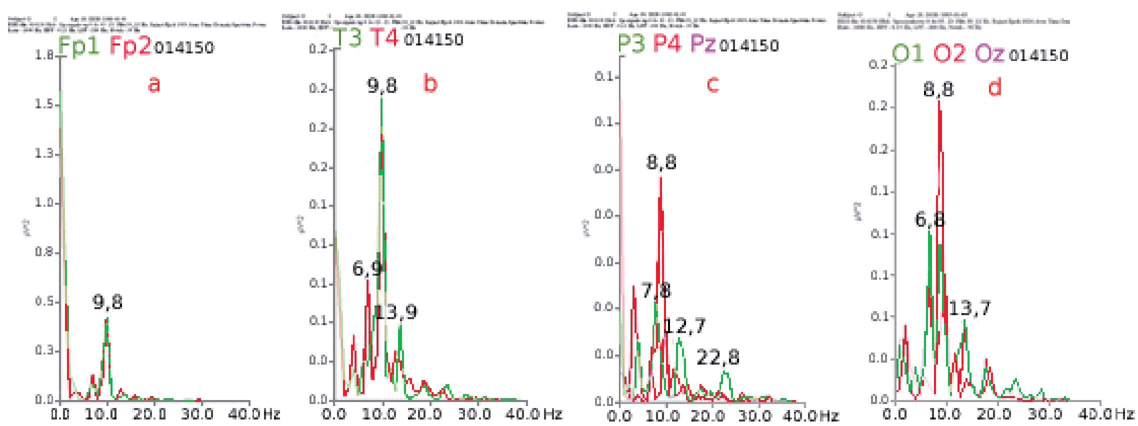


Fig. 8. QEEG examination No. 014150. Analysis of the power of signal bioelectric of the brain. Spectrum Power resting record of selected regions.

inite improvement in the activity – normalization of recorded brain bioelectrical frequencies in the follow-up examination carried out after two years. In most regions the signal value is higher than the average and close to the maximum, i.e. "1".

The lowest values of the correlation coefficient were found in the left frontal region. In other leads the values oscillate around the average of 0.536.

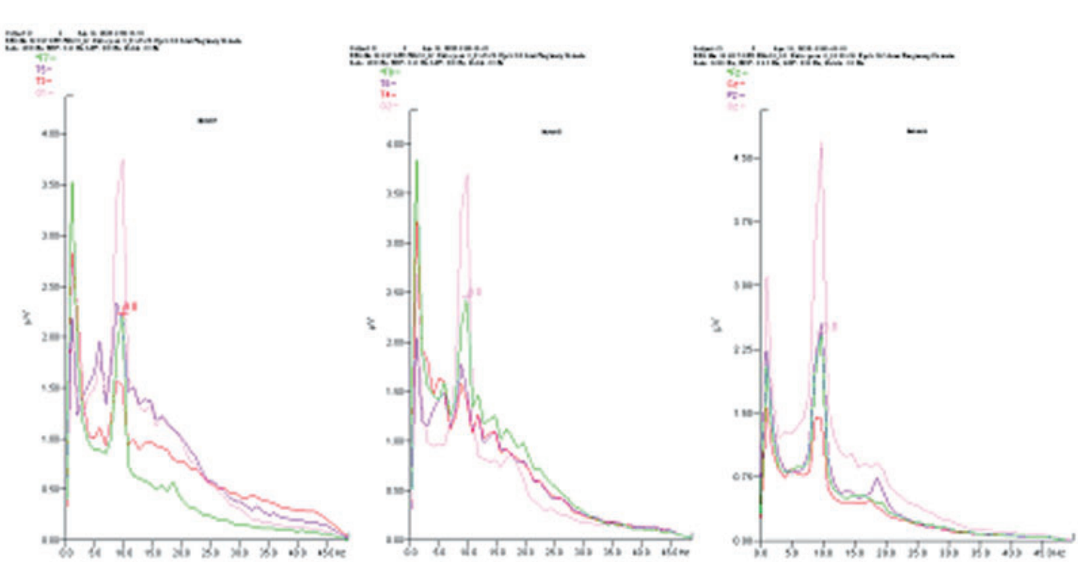


Fig. 9. QEEG examination no. 016017 – Aver Frequency Domain. Resting records of selected regions.

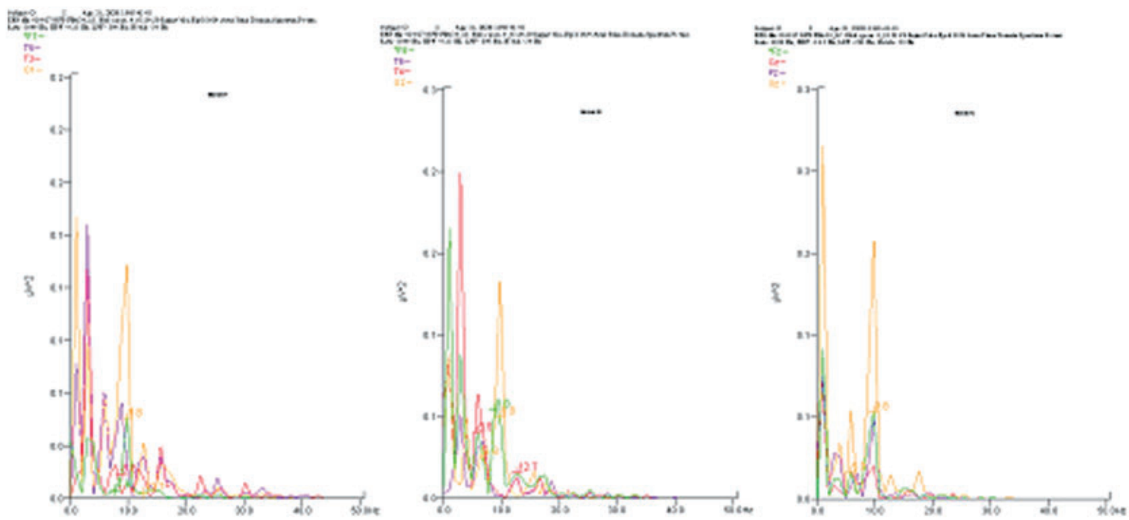


Fig.10. QEEG examination no. 016017 – Spectrum Power. Resting records of selected regions.

The lowest values were found in the right temporal region. In other leads the values oscillate around the average of 0.523.

The Intra-Class Correlation indicators of both QEEG results no. 014150 (fig. 5a) and no. 016017 (fig. 5b) in the time domain (Aver Time Domain) reach values slightly above 50% (0.536 and 0.523 respectively) and are close to each other. Significant improvement (by 50%) occurred in the left frontal region.

The average values of the Intra-Class Correlation indicators of both QEEG results no. 014150 and no. 016017, in the range of bioelectric signal power, are almost the same (0.536 and 0.531 respectively). In the first QEEG examination – no. 014150 (fig. 6a), brain bioelectric signal power of less than 50% of the average value was recorded in the middle area. Temporal region except the middle temple of the left cerebral hemisphere and the parietal region of the brain. In the other areas (anterior and posterior), the bioelectric signal power of the brain reaches more than 50%. In the follow-up QEEG examination no. 016017 (fig. 6b), in all regions of the brain, the bioelectric signal power is above 50% and is close to each other, stabilization has occurred. This may indicate, among other things, that the treatment has a positive effect. Significant improvement (50%) is observed in the frontal area of the left and the entire central area.

Figures no. 7 and 8 present graphical analysis of the frequency and power of the bioelectric signal in the first QEEG examination no. 014150 carried out before starting treatment, during the occurrence of the episodes of weakness accompanied by a temporary loss of consciousness, during spontaneous laughter. The analysis of bioelectric signal frequency does not indicate any significant differences in transverse and longitudinal leads of the two hemispheres. Signal power analysis for all QEEG topolocalization leads shows a reduction in power with a shift to lower (>6 Hz) and higher (>13 Hz) frequencies, in the middle and rear area (temporal, central, parietal and occipital areas). In the front and rear area, the dominant signal power coincides with the dominant frequency of 9.8-8.8 Hz.

Figure no. 9 and 10 present a graphical analysis of the frequency and power of the bioelectric signal in the QEEG follow-up examination after 23 months during the Tegretol CR 200 treatment (2 x 200 mg). After a period of 22 months from the last episode of collapsing, accompanied by a temporary disturbance of consciousness, during a spontaneous laughter. The analysis of bioelectric signal frequency does not indicate any significant differences in transverse and longitudinal leads of the two cerebral hemispheres, also in comparison with the results of the analysis of the first QEEG examination No. 014150, before the beginning of treatment. The signal power analysis for all

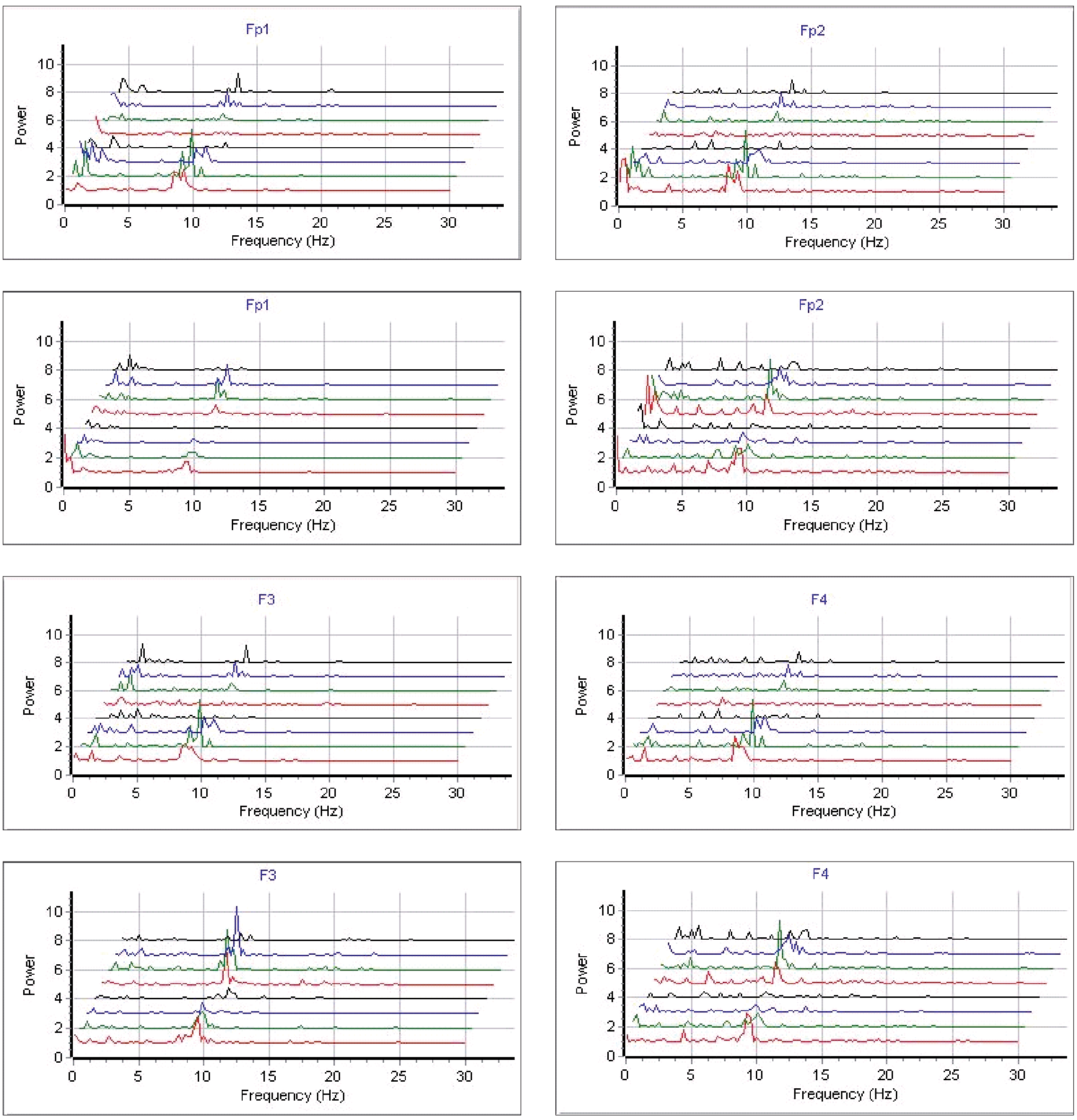
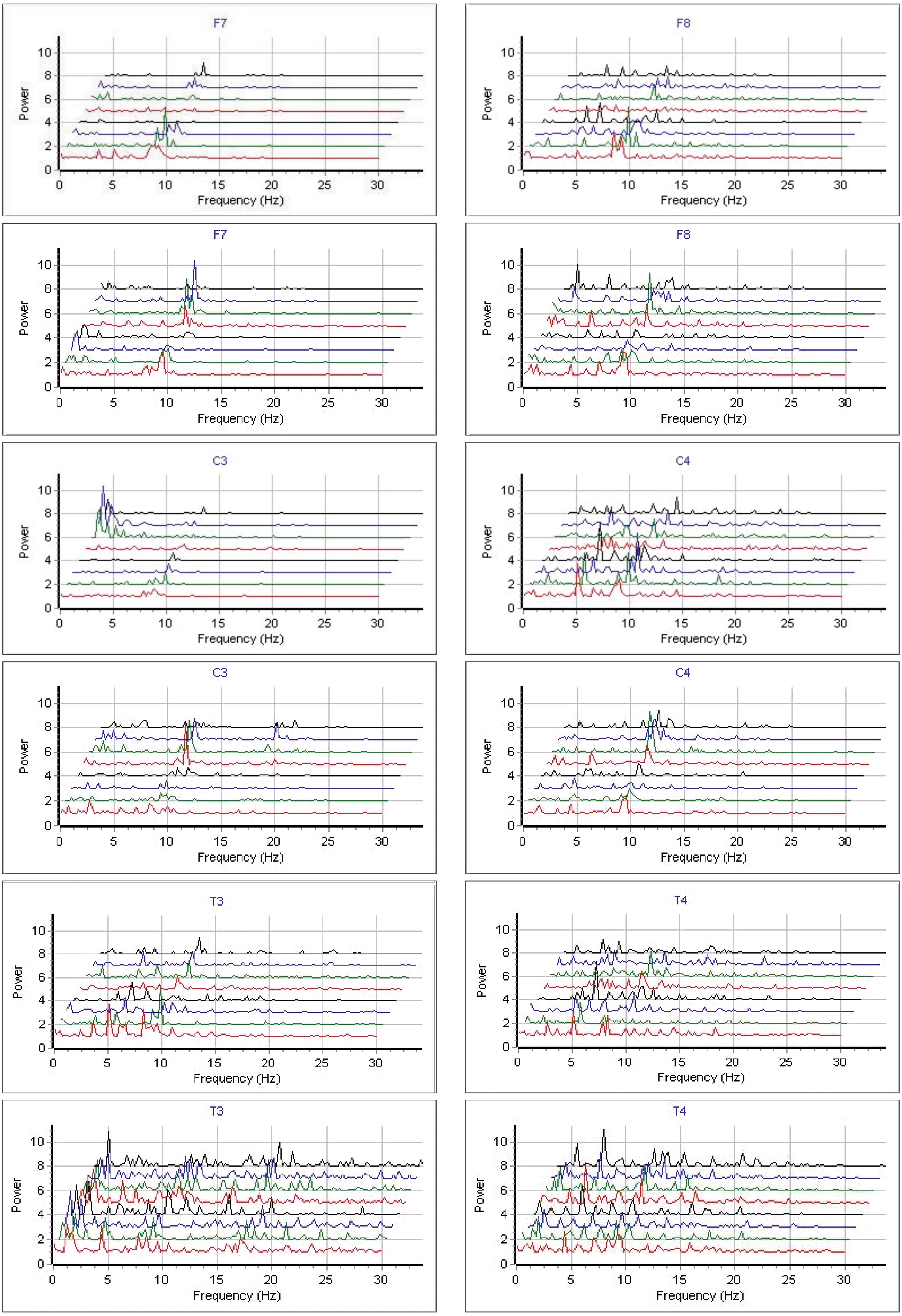


Fig. 11. Comparative time-space analysis of power and frequency of bioelectrical signal for individual brain regions (22 leads) of resting QEEG no. 016017 (top Figures – after treatment) with resting QEEG no. 014150 (homologous regions in bottom Figures – before treatment).



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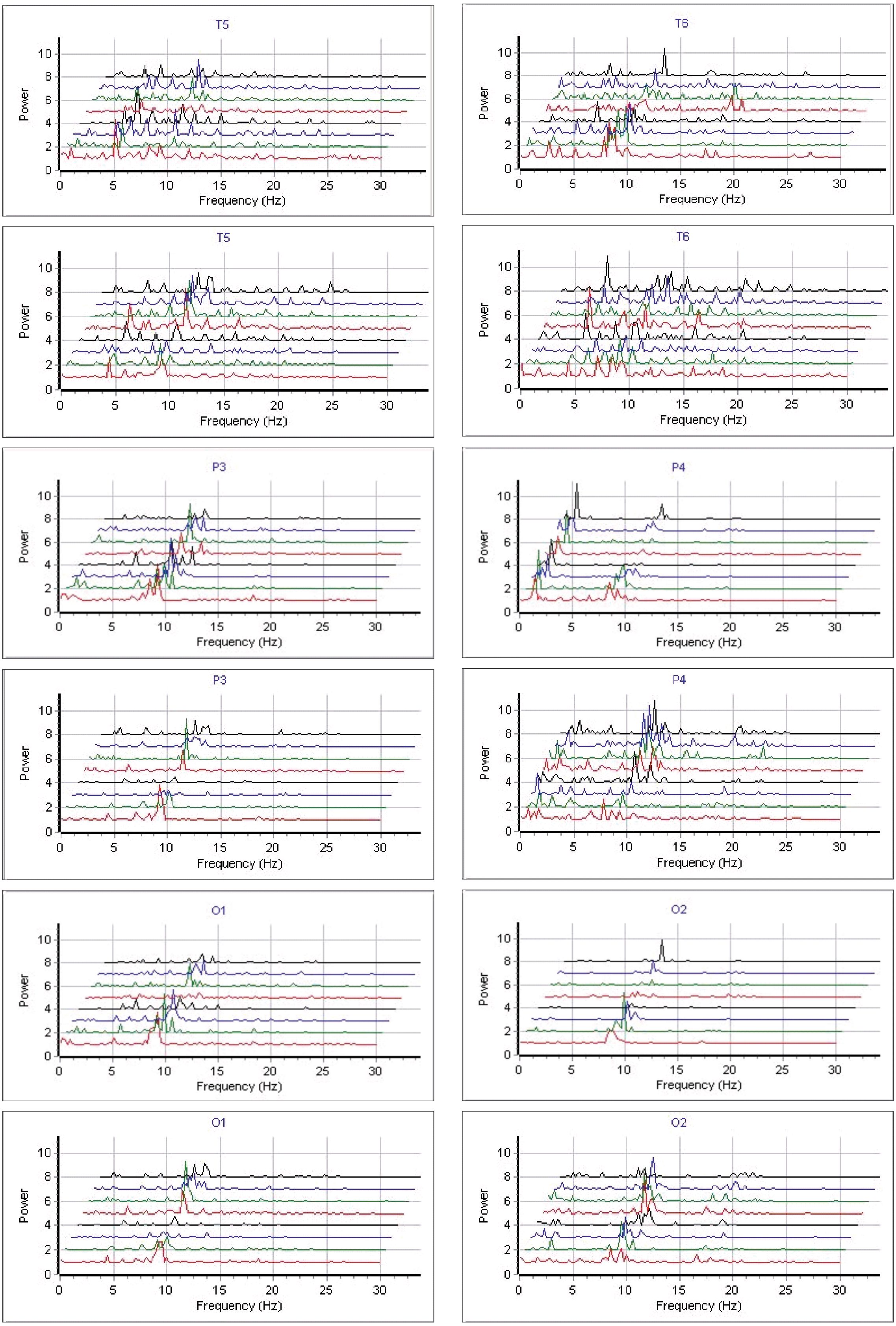

Fig. 11. Comparative time-space analysis of power and frequency of bioelectrical signal for individual brain regions (22 leads) of resting QEEG no. 016017 (top Figures – after treatment) with resting QEEG no. 014150 (homologous regions in bottom Figures – before treatment).

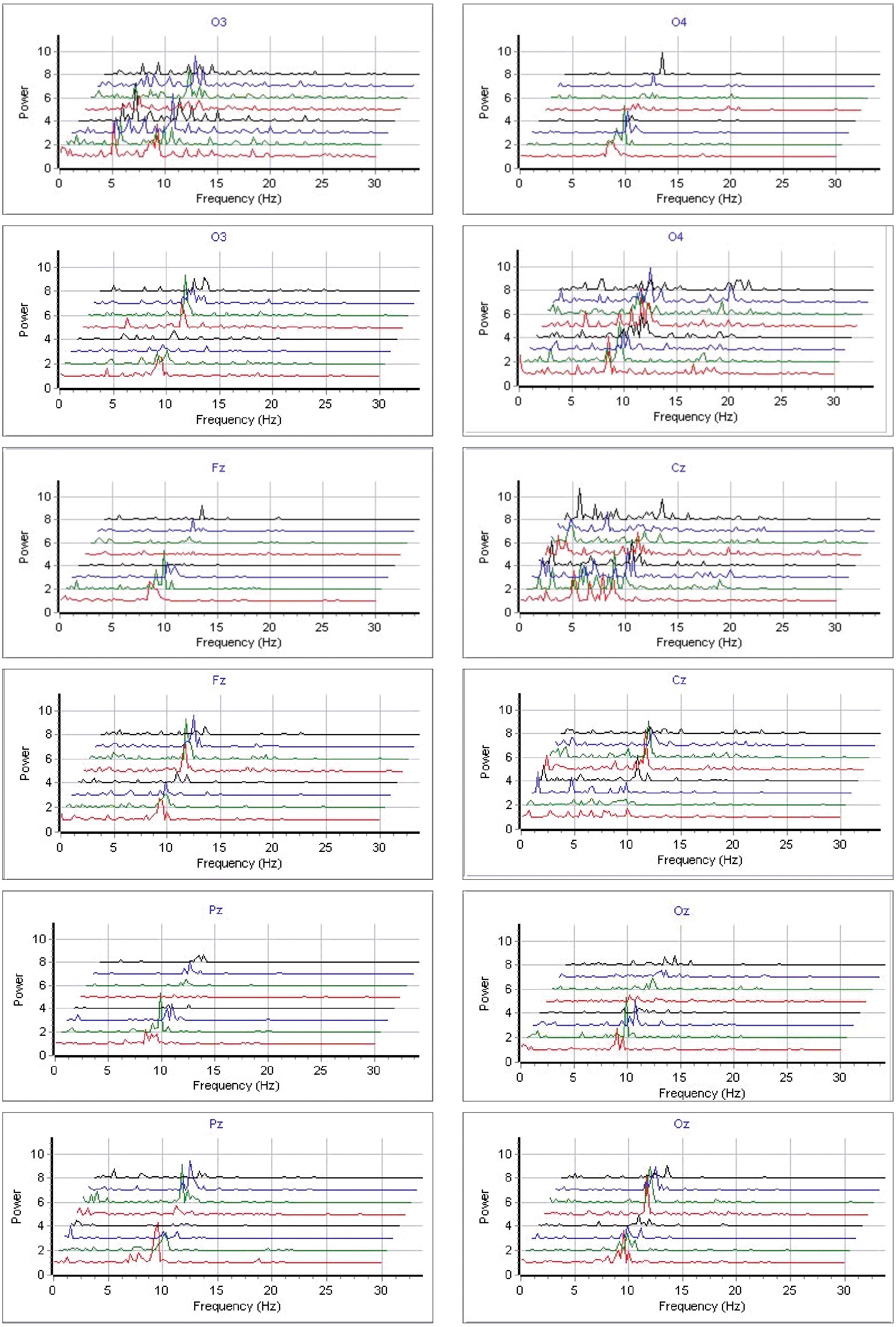

Fig. 11. Comparative time-space analysis of power and frequency of bioelectrical signal for individual brain regions (22 leads) of resting QEEG no. 016017 (top Figures – after treatment) with resting QEEG no. 014150 (homologous regions in bottom Figures – before treatment).

QEEG topolocalization leads shows that the power is consistent with the dominant frequency. The significant power range of the brain bioelectric signal narrowed from 6-23 Hz (first QEEG examination no. 014150 before starting the treatment) to 6-18 Hz. In addition to the graphical EEG recording, objective mathematical analyses confirm the improvement of bioelectrical brain activity. This may indicate a positive influence of the treatment on the normalization (organization) of the bioelectric activity in the patient's brain.

Another method used – time-space analysis of power and frequency of bioelectrical signal of the brain (fig. 11), shows an objective positive improvement in EEG results, especially in the middle and rear area of the brain.

SUMMARY

After a period of 23 months during which the patient was taking Tegretol CR 200 (2 x 200 mg per day), follow-up QEEG was performed in November, on the same day of the menstrual cycle as the first examination. QEEG examination No. 016070 (fig. 2), was performed following a decision to gradually reduce the dose of Tegretol CR from 400 mg per day by ¼ per month until complete discontinuation of the treatment. In the period of 23 months (from the end of December 2014 to 16 November 2016) no episodes of fainting with accompanying loss of consciousness, or other similar symptoms occurred. Throughout this period, the patient felt fine, had no ailments and functioned normally. The analysis of follow-up QEEG no. 016017 indicated a dominant alpha rhythm of 9.8 Hz (8.5-9.5 Hz - visual assessment), amplitude up to 30 μV, with a trace low-voltage beta activity. Alpha activity maintained. Hyperventilation and single intermittent white light stimulation (2, 6, 12 and 18 Hz) did not trigger the bioelectric brain function, it did not change the character of the EEG recording.

Despite the two-year gap between the QEEGs (carried out on the same day of the menstrual cycle, in the morning) the basic features of the dominant alpha rhythm did not change (9.8 Hz and amplitude up to 30 μV) [10]. The character of cardiac artifacts has not changed as well over the two years. No muscular artifacts were recorded in the follow-up QEEG examination. Due to the fact that there were no complaints, the patient had previously stopped the Calperos treatment on her own (after > half a year of taking). Comparative statistical analyses using Pearsons and Intra-Class Correlation (fig. 3-6) in the domain of frequency, time and power of brain bioelectrical signal and medical imaging in the range of averaged frequency, time and power of brain bioelectrical signal (fig. 7-11) indicated significant improvements in the recording of brain bioelectrical activity in all the methods.

Preventive inclusion of Tegretol in the treatment was guided by the patient's intense lifestyle, especially social life, the nature of her professional work (classes with students), lack of complete assessment of the events (by the leading neurologist), revealing certain symptoms indicating the possibility of the patient's insubordination, which was confirmed during the treatment. The psychological examination was abandoned (the patient is an academic teacher, practicing as a psychologist).

During the case diagnosis tetany, epilepsy and cardiac disorders were considered [4,5,7,11]. Based on the analysis of the patient's symptoms and additional tests, the most important criteria suggest latent tetany. Young age (29 years), sex, physiologically unfavorable period (beginning of the menstrual cycle), season (autumn-winter), low sunlight exposure. A shortage of sunlight reduces the body's natural production of vit. D and has a negative effect on the bioelectrical activity of the brain. Paroxysmal weakness with accompanying loss of consciousness, preceded by a feeling of numbness around the mouth, tingling and numbness of upper and lower limbs – especially fingers (tendency to stiffening), paling of the skin without cyanosis. Preceding a dozen or few dozen seconds of parahyperventilation in the course of spontaneous, expressive laughter [3,6,8,8,12,13]. Lower limit values of PTH, Ca, Mg, vit. D [9,11,16]. Ischemic test – low positive and the QEEG results (objective multiple mathematical analyses) [1,2,10]. The variety of mathematical methods used for the analysis of the EEG results was aimed at the maximum possible exclusion of causes of the above-mentioned episodes other than tetany, using a small number of QEEG (two examinations).

AUTHORS' DECLARATION:

Study Design: Stanisław Dec; **Data Collection:** Stanisław Dec; **Manuscript Preparation:** Stanisław Dec; **Funds Collection:** Stanisław Dec. The Author declares that there is no conflict of interest.

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CHRONICLE

REPORT ON THE PARTICIPATION IN THE XXXII INTERNATIONAL SCIENTIFIC CONGRESS OF THE POLISH SOCIETY OF SPORTS MEDICINE, WROCŁAW (POLAND), 12-13 OCTOBER 2017

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Source of support: Own sources

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On 12-14 October 2017, in the capital of Lower Silesia, the XXXII International Scientific Congress of the Polish Society of Sports Medicine took place. It was also an opportunity to celebrate the 80th anniversary of sports medicine in Poland under the slogan "Challenges for the future". Historical beginnings of the formalized organization of sports doctors in Poland date back to 10 February 1937, when the First Congress of Polish Sports Doctors took place, during which the organization was established under the name of the Association of Sports Doctors (Stowarzyszenie Lekarzy Sportowych). In 1961, at the 9th Congress of the Association of Sports Doctors, the name was changed to the Polish Society of Sports Medicine (Polskie Towarzystwo Medycyny Sportowej), so that it could be joined by doctors of other specialties, dealing with the field of science concerning physical culture and specialists of other disciplines of knowledge dealing with sport and physical activity.

This great anniversary of the esteemed Society was attended by many distinguished guests from Poland and abroad, representing Polish and international sports organizations and research institutes, as well as centres specializing in sports medicine counselling. The Congress was also attended by representatives of research institutions dealing with the care of athletes, as well as specialist medical centres, qualifying candidates for various sports disciplines. Moreover, during the Congress,

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presentations of medical equipment used for diagnostics and health rehabilitation of athletes were provided.

The scientific partners of the Congress were several scientific societies, including, among others: International Federation of Sports Medicine (FIMS), European Federation of Sports Medicine Association (EFSMA), Polish Arthroscopic Society, Polish Society for Obesity Research, Polish Society of Spine Surgery, Polish Society of Physiotherapy, Polish Society of Family Medicine, Polish Hyperbaric Medicine and Technology Society, Polish Muscles, Ligaments and Tendons Society, Łódź Branch of the Polish Genetic Society.

The jubilee Congress was also attended by representatives of the Polish Academy of Sciences. Thus, the Committee of Rehabilitation, Physical Education and Social Integration of the Polish Academy of Sciences was represented by its president – Prof. Krzysztof Klukowski, M.D., PhD. The patronage of the Congress was taken by the President of the Polish Society of Sports Medicine – Andrzej Bugajski, M.D., PhD and the Director of the Central Sports Medicine Center, Chairman of the Medical Committee of the Polish Olympic Committee –Hubert Krysztofiak, M.D., PhD.

The sessions of the Congress were a multidisciplinary meeting of doctors, rehabilitators, psychologists, representatives of science of nutrition and wellness, as well as trainers and coaches. After the official welcome of the guests and participants of the Congress, inaugural presentations of representatives of international sports organizations as well as artistic performances took place. The substantive part of the Congress consisted of lectures during specialist sessions, poster sessions and workshops presenting the aspects of practical care of athletes and physically active people, doing or engaged in recreational physical activity.

Foreign lecturers who came to Wrocław and spoke during plenary sessions included: Prof. Fabio Pigozzi – President International Federation of Sports Medicine FIMS, Dr Andre Debruyne – President European Federation of Sports Medicine Associations EFSMA, Prof. Martial Saugy from the Center of Research & Expertise in Anti-doping Sciences, University of Lausanne (Switzerland), Prof. Ulrich Schneider from the Centre for Regenerative Medicine, Tegernesee (Germany), Prof. Keiko Ikemoto from the Fukushima Medical University (Japan), Dr Zbigniew Brodziński from the Dubai Bone & Joint Centre MBR University Medical Cluster (UAE), Dr William Galway from the Hospital for Special Surgery in New York (USA), Dr Helmut Diers – Visiting Professor from the Johannes Gutenberg University Mainz (Germany), University Medical Centre Department of Orthopedics and Orthopedic Surgery Biomechanics & Motion Analysis.

In the next part of the Congress, papers during specialist sessions were delivered by representatives of Polish and foreign specialist medical centres and scientific centres: Poznan University of Physical Education, Eugeniusz Piasecki in Poznań, Jerzy Kukuczka Academy of Physical Education in Katowice, University of Physical Education in Warsaw, Gdańsk University of Physical Education and Sport, Jozef Pilsudski University of Physical Education in Warsaw Faculty in Biala Podlaska, University School of Physical Education in Wrocław, Central Sports Medicine Centre, MARKMED Rehabilitation Centre, Maria Sklodowska-Curie Institute – Oncology Centre in Warsaw, Centre of Rehabilitation and Medical Education in Wroclaw, Centre for Regenerative Medicine in Tegernsee (Germany), Paediatric Centre in Sosnowiec, Centre of Rehabilitation and Medical Education in Wroclaw, eMKa Med Medical Centre in Wroclaw, Regional Centre of Sports Medicine SPORTVITA in Bydgoszcz, Institute of Biomedical Engineering, Dresden University of Technology (Germany), Polish Institute of Sport in Warsaw, Mossakowski Medical Research Centre of the Polish Academy of Sciences in Warsaw, Department of Neurosurgery in Sosnowiec, St. Luke's Clinic in Bielsko-Biała, Ministry of Sport and Tourism of the Republic of Poland, Ministry of Health of the Republic of Poland, Józef Rusiecki Olsztyn University College, Wiktor Dega Orthopaedic and Rehabilitation Clinical Hospital in Poznan, University of Medical Sciences, Medical Centre in Pabianice, Lublin University of Technology, Gdansk University of Technology, Regional Military Aviation Medicine Commission in Warsaw, LEKMED Hospital in Warsaw, District Hospital of Orthopedics and Trauma Surgery Piekary Slaskie, Stationary Rehabilitation Centre in Zgorzelec, Medical University of Silesia, Wroclaw Medical University, University of Lausanne (Switzerland), University of Wroclaw, Medical University of Łódź, University of Zielona Góra, University of Rzeszów, Jan Kochanowski University in Kielce Norbert Barlicki University Teaching Hospital No. 1 of the Medical University in Łódź, University of Warsaw, Medical University in Lublin, Jagiellonian University Medical College in Cracow, Cardinal Stefan Wyszyński University in Warsaw, Medical University in Warsaw, St. Barbara Specialist Province Hospital in Sosnowiec, Military Institute of Aviation Medicine in Warsaw, Higher School of Physiotherapy in Wroclaw, Karol Marcinkowski Provincial Clinical Hospital in Zielona Góra, Hospital for Special Surgery in New York (USA), University of Computer Science and Skills in Lodz, Medical Team of the Polish Football Association, Centre for Orthopedics and Rehabilitation ENEL-SPORT in Warsaw.

The substantive part of the session was opened by the Olympic Session, chaired by Robert Korzeniowski, MA – multiple Olympic champion, world and European champion. Following sessions conducted by eminent specialists concerned: 30 years of anti-doping research in Poland, sport of disabled people, sports and medical certification in Poland, 80 years of sports medicine in Poland (1937-2017), physical activity in the prevention of chronic diseases, regenerative surgery in traumatology and sports orthopaedics, modern diagnostics in sports medicine, physical activity in the prevention of neurodegenerative diseases, modern techniques for treatment of spinal injuries, physical activity in the context of nutrition and diabetes, sports rehabilitation, pro-health sport in the context of physical activity, medicine of sports and travel in old age, genomics, proteomics and biomedicine. There was also a debate on diabetes problems and criteria for returning to physical activity and doing sport after treatment of selected injuries to the locomotor system.

During the poster sessions, the results of research conducted in various areas of sports activity, lifestyle, satisfaction with physical recreation, diagnostic and rehabilitation procedures after injuries resulting from physical activity were presented, with a suggestion of solutions.

The aspect of importance of psychophysical condition for the effective performance of aviation professions was presented by the author team of Zdzisław Kobos from the Department of Psychology, Work and Stress at the Cardinal Stefan Wyszyński University in Warsaw and the Regional Military Aviation and Medical Commission as well as Lt. Col. Rafał Wójcik, M.D., from the Centre for Aviation Medicine of the Military Institute of Aviation Medicine in Warsaw. The presented paper concerned the relationship between physical activity and satisfaction with life among airline pilots and cabin crew. With regard to the aviation professions, the speakers discussed the unfavourable aspects of staying in the aircraft cabin for many hours, in a non-ergonomic position and aspects related to the exposure to G-force or vibration. They emphasized that after many years of working in such non-physiological conditions, various health problems may appear. Therefore physical activity should be a preventive action, carried out through targeted training during the time spent outside the cockpit.

The Congress showed the multidisciplinarity of research and activity of the interdisciplinary environment dealing with sport, physical recreation and individual physical activity.

To sum up, it should be emphasized that the reports presented during the Congress by the researchers covered a very wide range of issues of physical activity, competitive as well as amateur and recreational. During the three-day debate, 17 thematic sessions were conducted, during which 64 papers were delivered, 18 research-describing posters were presented and 5 workshops were conducted.

Our participation in the Congress allowed us to become acquainted with interesting research of specialists from many disciplines of knowledge dealing with physical activity and its evaluation for the purposes of judicial decisions and opened new areas of cooperation in the field of maintaining and improving the psychophysical condition of aviation personnel. Substantive contacts were also established in the field of rehabilitation and biological regeneration, as well as scientific cooperation in conducting medical and psychological examinations during specialist trainings and procedures during treatment and fitness camps.

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REPORT ON THE RHINOFORUM 2017 CONFERENCE, WARSAW (POLAND), 31 NOVEMBER – 2 DECEMBER 2017

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For the 15th time Prof. Antoni Krzeski organized the annual "Festival of Polish Rhinology", as he calls it – Rhinoforum 2017, formerly known as the Rhinological Forum.

It is an international conference, during which Polish ENT specialists and rhinologists have been meeting for years with an international group of experts in the field of diagnostics and treatment of the nose and sinuses diseases. This year's lecturers were specialists from Great Britain, Czech Republic, United States, Netherlands, Belgium, Germany and Portugal. As always, the intensive program included 3-day sessions – from Thursday, November 30th to Saturday, December 2nd.

Thursday's session was opened by Prof. Krzeski. At the autopsy table he performed a cadaver demonstration of endoscopic surgery of paranasal sinuses. The presentation was commented by Prof. Paweł Stręk from Kraków, and its partners were: Karl Storz Endoscope, CEMED Medical Education Centre as well as Luxmed Group. After the presentation, the participants shared their focus among parallel sessions. Practical workshops on the experiences of Prof. Philippe Eloy from Belgium in the treatment of inverted papilloma and individual approach to a patient with chronic sinusitis presented by Prof. Robert Kern from the United States.

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At the same time, there was a very interesting session conducted by dr Marcin Strabużyński, a family doctor and dr Eliza Brożek-Mądry, an otorhinolaryngologist, devoted to headaches. Within a time limited by the schedule, the lecturers managed to present the differential diagnosis of headaches of neurological origin – dr Izabela Domitrz, and the basics of conservative and invasive treatment performed by an experienced "pain specialist" anaesthesiologist – dr Małgorzata Malec-Milewska. In the second part of the session, an interdisciplinary discussion with the presentation of cases of patients with headache/face pain was conducted. Dr Strabużyński presented patients from his family medicine practice and their specificity, while dr Brożek-Mądry, presented patients from her practice as an ENT specialist. The main aim of the session was to provide listeners with knowledge on how to differentiate headaches related to sinuses from other types of headaches based on history, clinical examination and basic diagnostic methods.

Friday was opened by Prof. Krzeski who welcomed all participants, especially the national consultant for otorhinolaryngology – Prof. Henryk Skarżyński, who congratulated "Antoś" on his success in organizing the annual RhinoForum over the last 15 years, which contributed to the current level of rhinology development in Poland. The inaugural lecture of Prof. Huizing from the Netherlands attracted the attention of listeners interested in the eternal dilemma of nasal surgery – function versus form. Professor emphasized that one follows the other, but we should never sacrifice the function to improve the form. Most participants agreed. Subsequent lectures engaged participants in the subject of genetic background and biology of the chronic sinusitis – professors Phillipe Eloy from Belgium and Robert C. Kern from the USA. Afterwards, a round table discussion was held on a very current topic of personalized diagnostics and treatment of chronic sinusitis. Cases of difficult patients presented by Prof. Kern and dr Brożek-Mądry, were discussed and debated by the panellists in the context of new reports from the literature on the research programmes of new drugs such as Omalizumab and Depilumab. These are modern drugs from the group of monoclonal antibodies aimed at disrupting immunological pathways activated in allergic diseases and chronic sinusitis. Unfortunately, I have not heard of any Polish centres conducting research on these drugs and having their own experience with them.

After a tasty lunch I participated in the session on sinuses moderated by Prof. Claire Hopkins with a series of interesting lectures, among others, on the conservative treatment of sinus diseases, or pros and cons of repeated surgery of paranasal sinuses. In the next session held by the English team, Peter Andrews shared his experience in the surgical correction of perforation of the nasal septum, and James Tysome in the first attempts to treat Eustachian tube obstruction with balloonplasty. Since Friday morning, parallel to the lectures described above, workshops on rhinoplasty under the guidance of dr Michał Krawczyński, a paediatric session, a session on the treatment of nosebleeds were held and lectures by our colleagues from the Czech Republic on their experiences in the surgery of the lacrimal canaliculi and orbit took place. For obvious reasons, I could not participate in them.

Saturday morning was opened by our colleagues from Great Britain and Egypt with lectures on treatment of complications of endoscopic sinus surgery and basics of endoscopic surgery of skull base. Then, the lead was taken by a team from Kraków under the direction of Prof. Lucyna Mastalerz and Prof. Paweł Stręk, who gave interesting lectures on allergological novelties in the field of rhinology and, which is becoming a tradition of RhinoForum, the topic of the postnasal drip. Prof. Radosław Śpiewak delivered an interesting presentation on various nasal contact sensitizers, i.e. type 4 hypersensitivity mechanisms, including nasal steroid drugs. During the discussion after the presentation I raised the issue of cross-reaction between various steroid preparations and possible hypersensitivity to the active substance itself vs. the medium or carrier of the drug. Dr Andrzej Dymek, presented his extensive experience in the diagnosis and treatment of laryngopharyngeal reflux, in particular with the diagnosis of pH in the throat by means of a special throat pH probe, which is a liquid-air probe, which means that it is able to read the pH value not only from saliva or gastric acid, but also from the patient's respiratory air. The fact that dr Dymek, and his wife run their practice in a small centre in Strzelce Opolskie, and it is a unique feat in Poland, and that he published a textbook on laryngeal-pharyngeal reflux, the first complete description of this issue in the national literature, deserves special recognition. As for Saturday sessions, I was not able to participate in parallel lectures on the treatment of snoring and the treatment of lacrimal canaliculi congenital diseases in children.

In conclusion, I can say that this year's RhinoForum surprised me and my colleagues from the Department of Otolaryngology of the Military Institute of Aviation Medicine with a relatively large emphasis placed on the diagnosis and conservative treatment of diseases of paranasal sinuses. However, in my opinion, this is due to the fact that after a period of intensive development of endoscopic techniques in the treatment, we have reached a certain limit of possibilities that it gives. There is a growing group of patients with chronic diseases of sinuses, after two, three or even more surgeries that do not bring them relief, but only additional mutilation and suffering. These people need new, individually tailored diagnostic and treatment methods to bring relief to their suffering noses. Regardless of the progress and changes taking place in the global and Polish rhinology, patients can be appeased knowing that the participants of RhinoForum 2017 "will celebrate their glory and share their pain", as one of the colleagues from Great Brain described it, which I think is an accurate description of our struggles in the field of rhinology.

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Acknowledgements. List all contributors who do not meet the criteria for authorship, such as technical assistants, writing assistants or head of department who provided only general support. Describe their role. Financial and other material support should be disclosed and acknowledged.

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Article with published erratum

Koffler D, Reidenberg MM. Antibodies to nuclear antigens in patients treated with procainamide or acetylprocainamide [published erratum appears in N Engl J Med 1979;302:322-5]. N Engl J Med 1979; 301:1382-5.

Article in electronic form

Drayer DE, Koffler D. Factors in the emergence of infectious diseases. Emerg Infect Dis [serial online] 1995 Jan-Mar [cited 1996 Jun 5];1(1):[24 screens]. Retrieved 25 January 2013 from: http://www.cdc.gov/ncidod/EID/eid.htm.

Electronic resource

Health on the net foundattion code of conduct (HONcode) for medical and health websites. 1997; Retrieved 9 January 2013 from https://www.hon.ch/HONcode

Article, no author given

Cancer in South Africa [editorial]. S Afr Med J 1994;84:15.

Book, personal author(s)

Lazarus RS, Folkman S. Stress, appraisal and coping. New York: Springer Publishing Co.; 1984.

Book, editor(s) as author

Norman IJ, Redfern SJ, eds. Mental health care for elderly people. New York: Churchill Livingstone; 1996.

Book, Organization as author and publisher:

Institute of Medicine (US). Looking at the future of the Medicaid program. Washington: The Institute; 1992.

Chapter in a book

Charzewska J, Wajszczyk B, Chabrom E, Rogalska-Niedźwiedż M. Aktywność fizyczna w Polsce w rożnych grupach według wieku i płci. In: Jarosz M, ed. Otyłość, żywienie, aktywność fizyczna i zdrowie Polaków. Warszawa: Instytut Żywności i Żywienia; 2006:317-339.

Conference proceedings

Kimura J, Shibasaki H, eds. Recent advances in clinical neurophysiology. Proceedings of the 10th International Congress of EMG and Clinical Neurophysiology; 1995 Oct 15-19; Kyoto, Japan. Amsterdam: Elsevier; 1996.

Conference paper

Bengtsson S, Solheim BG. Enforcement of data protection, privacy and security in medical informatics. In: Lun KC, Degoulet P, Piemme TE, Rienhoff O, eds. MEDINFO 92. Proceedings of the 7th World Congress on Medical Informatics; 1992 Sep 6-10; Geneva, Switzerland.

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