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*Zarząd Polskiego Stowarzyszenia Pacjentów Uzdrowiskowych*

# Calcaneal Spur: Clinical Problem, Physical Therapy Analysis

## Ostroga piętowa – problem kliniczny, analiza postępowania fizykalnego

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### SUMMARY

**Introduction:** Plantar fasciitis, also called calcaneal spur, is a progressive degenerative condition occurring regardless of age or sex, with heel pain as the first symptom. Calcaneal spur develops over a period of many months or years. Risk factors include overweight or obesity, past injuries, lower limb length discrepancy, foot defects or ill-fitting shoes. Physical therapy is a crucial part of calcaneal spur treatment.

**Aim:** To assess the most common risk factors for calcaneal spur as well as the efficacy of physical therapy and its effects on the quality of life.

**Material and Methods:** The study group consisted of 40 patients with calcaneal spur treated at the Rehabilitation Centre of the Health Care Facility in Pińczów. Before and after treatment, the patients underwent a physical examination and history-taking, completed a survey and rated their pain on a pain assessment scale, and participated in a painless walking distance test. The data were statistically analysed.

**Results:** The results showed that risk factors significantly contribute to the development of calcaneal spur and that there is a strong relationship between time from diagnosis and period of improvement after treatment. Physical therapy reduced or eliminated pain in the study patients, improved their ability to ambulate, and increased their quality of life.

**Conclusions:** Physical therapy is a crucial part of calcaneal spur treatment.

**Key words:** calcaneal spur, clinical presentation, physical therapy

### STRESZCZENIE

**Wstęp:** Zapalenie rozciągna podeszwowego, czyli tzw. ostroga piętowa, jest postępującym schorzeniem o charakterze zwyrodnieniowym. Choroba występuje w każdym przedziale wiekowym, niezależnie od płci. Pierwszym objawem jest ból w okolicy pięty, a proces tworzenia się ostrogi z pewnością trwa wiele miesięcy lub lat. Do jej rozwoju przyczynia się kilka czynników ryzyka: nadmierna masa ciała, przebyte urazy, nierównomierna długość kończyn dolnych, wady stóp lub niewygodne obuwie. Postępowanie fizykalne jest podstawowym elementem w leczeniu schorzenia.

**Cel:** Ocena najczęściej występujących czynników ryzyka występowania ostrogi i skuteczności leczenia fizykalnego oraz jego wpływu na poprawę jakości życia chorych.

**Materiał i metody:** Grupę badawczą stanowiło 40 chorych z ostrogą piętową leczonych w Pracowni Rehabilitacji Zespołu Opieki Zdrowotnej w Pińczowie. U chorych przed i po leczeniu przeprowadzono badanie podmiotowe i przedmiotowe, wykorzystano kwestionariusz ankiety i skale oceny bólu, oceniono dystans bezbólowego marszu. Uzyskane dane poddano opracowaniu statystycznemu.

**Wyniki:** Wyniki badań wykazały, że występowanie czynników ryzyka ma ogromny wpływ na występowanie schorzenia oraz istnieje ścisła zależność między czasem jaki minął od zdiagnozowania choroby, a okresem czasu poprawy po leczeniu. Postępowanie fizykalne miało wpływ na zmniejszenie lub ustąpienie doznań bólowych, poprawę lokomocji oraz jakości życia chorych.

**Wnioski:** Postępowanie fizykalne jest podstawowym elementem w leczeniu chorych z ostrogą piętową.

**Słowa kluczowe:** ostroga piętowa, obraz kliniczny, postępowanie fizykalne

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### INTRODUCTION

Approximately 60% of the population experience foot problems. Foot defects develop due to a lack of balance between ligament, capsule, and muscle endurance and loading of these structures. The foot has a very complex anatomy with 32 muscles, 26 bones, 120 ligaments, and nerves and blood vessels, all with specific functions. Heel pain is one of the

most common foot symptoms. Calcaneal spur affects 15% of the population and develops not only in the elderly, but also in young and middle-aged individuals. 50% of heel pain cases are found to be associated with the presence of calcaneal spur. This condition affects an estimated 20% of people over the age of 40 years. Severe heel pain is the first clear symptom; it appears during longer walks or at the start of

loading, disturbing the gait pattern and reducing the patient's functional status and quality of life [1-6].

Foot anatomy is inextricably associated with its function. Overall, the feet are strong and flexible and constitute the foundation of the body. They support the body's weight not only when a person is standing on one or both feet, but also during walking or jumping. The diagnostic work-up of the foot should always be based on precise examination methods. Foot assessments usually involve biometric, biomechanical, radiographic, and physical methods. Typically, a plantogram, podoscope, scanner etc. are used to assess the feet under static conditions while dynamometric platforms and mats with sensors are used under dynamic conditions. Moreover, the plantar load distribution pattern provides very valuable information about the shape and function of the foot both under static and dynamic conditions.

The name "calcaneal spur" refers to degenerative changes in the region of the medial process of the calcaneal tuberosity, leading to the development of a bone growth, which causes plantar fasciitis and pain that limits or prevents movement (Figure 1).



**Figure 1.** Calcaneal spur: lateral radiograph  
**Rycina 1.** Ostroga piętowa: radiogram boczny

Calcaneal spur is caused by inflammation at the site where the structure that contracts and relaxes during every step attaches to the calcaneal bone. The structure is irritated by wearing ill-fitting shoes and by repeated injuries or overload. Excessive body weight causes marked longitudinal arch flattening, which in turn stretches the plantar fascia like a bow string and leads to the development of a bone growth (spur). When the growth is large enough, it starts to irritate the plantar fascia, especially its attachment to the calcaneal tuberosity and the surrounding soft tissues, resulting in chronic inflammation. Consequently, patients experience heel pain that limits or prevents movement [5,6,7,8]. The causes of the development of the bone growth have not been fully elucidated; however, overload or injury in the heel region is believed to be the main cause, particularly when it leads to frequent episodes of inflammation and to calcification of foot ligaments (plantar fascia).

## ETIOPATHOGENESIS

The plantar fascia is a band of connective tissue that plays an extremely important role during gait and carries a large proportion of the extreme load generated during various types of movement. Calcaneal spur develops over a period of many weeks, months or years and the nature of the process is the same as in the case of areas of bone attachments of various ligaments, where microinjuries are common.

## CLINICAL PRESENTATION

In the initial stage of the disorder, the patient experiences heel pain and foot stiffness, which worsen with the first steps taken after getting out of bed or when standing for long periods of time. The pain improves when the patient "walks it off", but worsens again in the evening. The second stage of the disorder is caused by long-term inflammation in the plantar fascia (plantar fasciitis) and starts to affect the calcaneal tuberosity.

## DIAGNOSIS

Heel pain radiating to the posterior part of the foot suggests so-called Haglund's deformity, which is usually hereditary and develops as a result of deformation of the heel where it is in contact with the Achilles tendon. Tarsal tunnel syndrome has similar manifestations; it is usually associated with pain, numbness, and tingling on the medial part of the ankle joint, radiating to the plantar surface of the foot only. Achilles tendinitis or inflammation of the Achilles tendon attachment also cause heel pain, but located more posteriorly than inferiorly. Finally, difficulty lifting one's heel, or inability to lift it, on one side may result from the tibialis posterior insufficiency.

Heel pain may be also present in the course of various systemic disorders, such as psoriasis or Reiter's syndrome, where plantar fasciitis is bilateral, usually in young men. Another dynamic part of the examination, which may help assess the situation, consists in testing how the adipose tissue glides over the plantar fascia; abnormalities mean that the presence of adhesions is highly probable. The Achilles tendon should be examined and any excessive Achilles tendon tension should be ruled out. Moreover, the examiner should attempt to squeeze the calcaneal tuberosity (medial and lateral surface of the calcaneus) in order to rule out any fractures. The result of this test is positive in fatigue fractures and calcaneal tuberosity palpation produces pain on compression; if this happens, bone scintigraphy is necessary.

Pain in patients with symptoms involving the plantar surface of the foot is very commonly caused by damage to the plantar fascia; consequently, the diagnostic work-up should be based on an ultrasound. An ultrasound helps assess the structure of the plantar fascia and other tissues in the plantar region of the foot and allows for dynamic assessment of the behaviour of the plantar fascia, which is very important when it comes to distinguishing between some cases of a partial and total tear (Table 1).

However, a radiographic examination should also be used as it helps rule out other unusual disorders, which can sometimes be even more serious than damage to the fascia.

**Table 1.** Symptoms of heel pain on palpation**Tabela 1.** Objawy bólu pięty podczas badania palpacyjnego

Diagnosis	Anatomical location of pain
Plantar fasciitis	The proximal attachment of the plantar fascia near the medial calcaneal tuberosity.
Heel fat pad syndrome	Region of the plantar fat pad.
Calcaneal periostitis	Diffuse pain on the plantar, medial, and lateral edge of the calcaneus.
Tibialis posterior tendon disorder	Over the medial region of the metatarsus near the navicular bone, may radiate proximally outside the medial malleolus.
Peroneus muscle tendon disorder	Lateral surface of the calcaneus and the peroneal tubercle.
Tarsal tunnel syndrome	Diffuse pain on the plantar surface of the foot; may radiate distally, causing tingling, burning, and numbness on the base of the foot only (not on the dorsal surface).
Inflammation of the medial calcaneal nerve	Well localised pain of the anterior half of the plantar subcutaneous fat layer and the medial surface of the calcaneus; does not radiate to the distal part of the foot.
Inflammation of the lateral calcaneal nerve	Heel pain radiating laterally, more poorly localised than the type described above.
Fatigue calcaneal fracture	Diffuse pain over the entire calcaneus; positive calcaneal tuberosity squeeze test.
Inflammation of the calcaneal process	Generalised pain over the posterior surface of the calcaneus, particularly on the sides, in patients with an immature skeleton.
Generalised arthritis	Poorly localised pain, usually involving the entire subcutaneous fat layer of the heel.

## PHYSICAL THERAPY AND REHABILITATION

Physical therapy and rehabilitation in patients with calcaneal spur are aimed at eliminating inflammation, mainly through the introduction of physical therapy procedures [9-16].

Physical therapy used in this disorder may be divided into three phases. The first phase focuses on analgesic and anti-inflammatory effects. The recommended physical therapy procedures include iontophoresis with anti-inflammatory drugs, ultrasound therapy, and local cryotherapy. Additionally, patients may wear shoes adjusted to foot anatomy and physiology and use soft insoles under the heel. Whirlpool massage of the lower limbs is also used as supportive treatment.

In the second phase, after pain reduction, treatment aims to restore the mobility, flexibility, and muscle strength of the foot. The physical therapy procedures listed above are continued; if they are not effective, shockwave therapy and laser therapy are initiated.

Extracorporeal shockwave therapy (ESWT) uses shockwaves generated by an electrical pulse and focused by thousands of small crystals in the applicator head. The machine produces shockwaves of compressed air. The shockwaves penetrate tissues up to 4-7 cm. The pressure in the tissue reaches 2 to 5 bar and the waves are applied at the frequency of 1-22 Hz. The procedures improve tissue metabolism and blood supply, increase collagen production, reduce muscle tension, and eliminate pain.

High Intensity Laser (HIL) Therapy uses infrared wavelengths. A photomechanical wave is generated in the tissues, which increases metabolism, eliminates pain, has anti-inflammatory effects, reduces oedema, dilates blood vessels, stimulates DNA synthesis through phytohemagglutinin stimulation, increases fibroblast activity, activates phagocytosis, and eliminates inflammation. Pulse frequency is set at 1 to 100 Hz, treatment

duration is calculated based on total energy and power, and the energy is supplied in J.

The last phase of treatment consists in an analysis of gait and other activities that may contribute to the development of plantar fasciitis. Kinesthetic sense exercises of varying difficulty levels are used.

## AIM

To present the role of risk factors for calcaneal spur, clinical presentation, and the efficacy of physical therapy in a group of 40 patients treated at the Rehabilitation Centre of the Health Care Facility in Pińczów in 2017.

## MATERIAL AND METHODS

The experimental part of the study analysed the influence of risk factors on the development of calcaneal spur, the type of physical therapy used in the patients, and treatment efficacy. A physical examination was performed, history-taking was conducted, and painless walking distance was tested on a 10-point scale before and after treatment. The patients received physical therapy in the form of ultrasound therapy, cryotherapy, laser therapy, and kinesiotherapy.

Statistical methods. The data collected from the assessments were statistically analysed using the Statistica PL software. The arithmetic mean was calculated, as were variances of individual  $\bar{x}$  values from the arithmetic mean of the sample. The hypotheses were verified using a chi-square test. Pearson's C coefficient was calculated based on the previously calculated  $\chi^2$  chi-square coefficient. The statistical significance level was set at  $p < 0.05$ .

## RESULTS

The study assessed a total of 40 patients diagnosed with calcaneal spur. The majority of study patients were female (28 women, 70%, vs. 12 men, 30%) (Table 2-12, Figure 2-3).

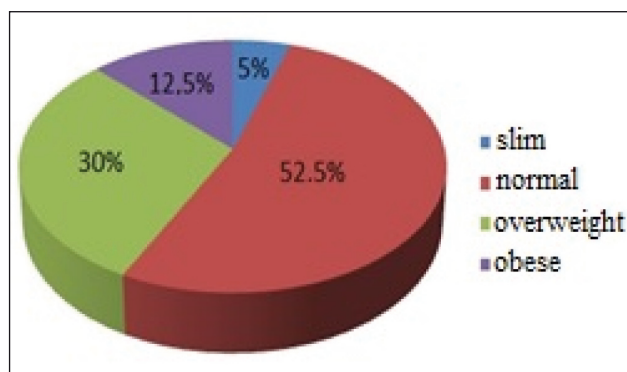
**Table 2.** Sex of study patients

**Tabela 2.** Płeć badanych pacjentów

	No. of answers	% of answers
Female	28	70
Male	12	30
Total	40	100

Most study patients were aged 40-60 years (22 patients, 55%); 11 patients were older than 60 years (27.5%), with only 5 people aged between 20 and 40 years (12.5%) and 2 patients under 20 years of age (5%).

When asked about their body mass, more than a half of the participants described it as normal (21 patients). 12 individuals described themselves as overweight, 5 as obese, and 2 as slim.



**Figure 2.** Body mass of study patients

**Rycina 2.** Masa ciała badanych pacjentów

The majority of patients had or used to have jobs that required them to walk a lot (22 patients, 55%); 10 people (25%) worked in a standing position and only 8 people (20%) had sedentary jobs.

The vast majority of study patients reported no current or past cases of calcaneal spur in their families (37 patients, 92.5%). Only 3 people (7.5%) had a family history of this disorder.

Almost half of the participants were diagnosed with calcaneal spur 6-10 years before the study (19 patients, 47.5%). 11 patients (27.5%) had less than a 5-year history of calcaneal spur and 7 patients (17.5%) had been diagnosed 11-20 years before they joined the study. Only 3 people (7.5%) had had calcaneal spur for more than 20 years.

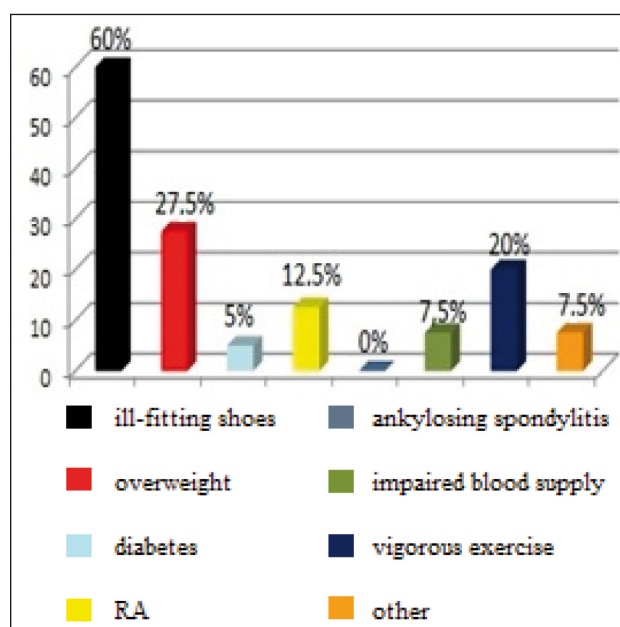
A vast majority of the participants (29 people, 72.5%) had unilateral calcaneal spur; the rest of study patients (11 people, 27.5%) had bilateral calcaneal spur.

Most study patients (26 people) reported no ankle or foot injuries in the past; however, 13 patients did mention past injuries.

The most common symptoms reported by study patients included pain (36 people, 90%), foot stiffness (24 people, 60%), heel swelling (14 people, 35%), and redness (3 people, 7.5%).

Almost all study patients (32 people, 80%) had lower limb defects. 18 participants (56.3%) had flat foot and 13 (40.6%) complained of lower limb length discrepancy. Several individuals (8 people, 25%) had varus or valgus knee and 2 people (6.3%) had calf muscle contractures. 1 patient (3.1%) had other lower limb abnormalities. Few patients (8, 20%) had no lower limb defects.

When asked about risk factors that may contribute to the development of calcaneal spur, most patients (24 people) listed ill-fitting shoes. Other risk factors mentioned by the patients were overweight (11 participants), vigorous exercise (8 participants), rheumatoid arthritis (5 participants), and impaired blood supply (3 participants). Few patients (2 participants) listed comorbid diabetes.



**Figure 3.** Risk factors that may contribute to calcaneal spur development

**Rycina 3.** Czynniki ryzyka, które mogą przyczynić się do rozwoju ostrogi piętowej

In most study patients (25, 62.5%), pain usually occurred in the morning. 11 patients (27.5%) complained of pain during the day and only 4 patients (10%) experienced it at night.

The largest group of study patients (18 cases, 45%) usually experienced pain in the central part of the heel. 8 patients (20%) reported pain usually occurring above the heel (near the Achilles tendon) and 7 (17.5%) between the heel and the toes.

When asked about previous treatments, study patients listed physiotherapy (26 patients, 65%), pharmacotherapy (20 patients, 50%), and corticosteroid injections (9 patients, 22.5%).

Study patients were usually treated with physiotherapy procedures targeting calcaneal spur once a year (17 patients, 42.5%). 9 participants (22.5%) underwent rehabilitation once every 2 years and 7 patients (17.5%) reported less frequent rehabilitation. Only 3 patients (7.5%) underwent such procedures several times a year.



Improvement after treatment was usually reported within 2 weeks after the procedures (17 patients, 42.5%); some patients experienced improvements during treatment (10 patients, 25%) or more than 2 weeks after the end of rehabilitation (8 patients, 20%). A significant improvement after the first procedure was seen only in 3 individuals (7.5%).

**Table 3.** Period of first improvement

**Tabela 3.** Okres pierwszej poprawy

	No. of answers	% of answers
After first procedure	3	7.5
During treatment	10	25
Within 2 weeks after procedures	17	42.5
More than 2 weeks after procedures	8	20
There was no improvement	2	5
Total	40	100

The beneficial effects of physical therapy persisted for 1-2 years in approximately half of study patients (21 patients, 52.5%), for 6 months to one year in 13 patients (32.5%), or more than 2 years in 4 patients (10%); the rehabilitation was ineffective in 2 participants (5%).

Study patients were asked to rate their pain levels before rehabilitation on a scale from 0 to 10, where 0 meant no pain and 10 meant unbearable pain. Surprisingly, as many as 16 participants complained of severe pain (6-8). Others described the pain they experienced as moderate (3-5; 14 patients) or mild (1-2; 7 patients). 3 patients suffered from unbearable pain (9-10).

**Table 4.** Pain assessment before rehabilitation

**Tabela 4.** Ocena bólu przed rehabilitacją

	No. of answers	% of answers
Mild (1-2)	7	17.5
Moderate (3-5)	14	35
Severe (6-8)	16	40
Unbearable (9-10)	3	7.5
Total	40	100

Another pain assessment was carried out after rehabilitation and its results were used to evaluate the efficacy of physiotherapy in study patients. A surprising number of patients (25 individuals, 62.5%) described their post-rehabilitation pain as mild (1-2); 13 patients reported no pain (0; 32.5%) and only 2 patients (5%) still experienced moderate pain (3-5).

**Table 5.** Pain assessment after rehabilitation

**Tabela 5.** Ocena bólu po rehabilitacji

	No. of answers	% of answers
No pain (0)	13	32.5
Mild (1-2)	25	62.5
Moderate (3-5)	2	5
Severe (6-8)	0	0
Unbearable (9-10)	0	0
Total	40	100

To further analyse the efficacy of physiotherapy in study patients, the participants were asked to assess their painless walking distance before rehabilitation so that it could be compared with the post-rehabilitation result. More than half (21 patients, 52.5%) were able to walk no more than 5 metres without pain; other patients reported the painless walking distance to be almost 2 metres (14, 35%), approximately 10 metres (3, 7.5%), or more than 10 metres (2, 5%).

**Table 6.** Painless walking distance before rehabilitation

**Tabela 6.** Odległość bez bólu przed rehabilitacją

	No. of answers	% of answers
Less than 5 m	14	35
5-10 m	21	52.5
10-20 m	3	7.5
More than 20 m	2	5
Total	40	100

After treatment, more than half of the patients (21, 52.5%) were able to walk the distance of approximately 10 to 20 metres without experiencing pain. The painless walking distance increased to more than 20 metres in 13 patients (32.5%); only 4 people (10%) were still able to walk no more than 5-10 metres and 2 people (5%) experienced pain before they managed to cover the distance of 5 metres.

**Table 7.** Painless walking distance after rehabilitation

**Tabela 7.** Bezbolesny dystans chodzenia po rehabilitacji

	No. of answers	% of answers
Less than 5 m	2	5
Less than 10 m	4	10
Approx. 10-20 m	21	52.5
More than 20 m	13	32.5
Total	40	100

Study patients were asked to list the aspects of their lives that were influenced by the rehabilitation. The answers included reduced pain (35 patients), better overall well-being (30 patients), increased exercise tolerance (23 patients), reduced stiffness (6 patients), and improved balance (3 patients); 2 patients did not report any effects of rehabilitation.

**Table 8.** Aspects of life influenced by rehabilitation

**Tabela 8.** Aspekty życia związane z rehabilitacją

	No. of answers	% of answers
Improved balance	3	7.5
Reduced stiffness	6	15
Reduced pain	35	87.5
Increased exercise tolerance	23	57.5
Better well-being	30	75
No effects	2	5

Study participants were asked to rate their pain levels before and after rehabilitation. Pain was rated on a scale from 0 to 10, where 0 meant no pain and 10 meant unbearable pain.

Mean pain level was 5.35 points before treatment and 1.13 points after rehabilitation (difference 4.22 points). The confidence interval calculated for the results allows for concluding (with a 95% probability) that mean pain was between 4.95 and 5.75 points before treatment and between 0.9 and 1.36 points after treatment.

**Table 9.** Pain before and after treatment

*Tabela 9. Ból przed i po leczeniu*

	Before	After
Mean value	5.35	1.13
Difference in means	4.22	
Standard deviation	2.53	1.02
Difference in standard deviations	1.51	
Confidence interval for the mean	4.95-5.75	0.9-1.36
Minimum	1	0
Maximum	10	5

The significance level was 0.05 for all the tests performed.

The study analysed the effects of rehabilitation on pain levels assessed in a VAS scale. A chi-square independence test was used.

**Table 12.** Correlation between time from diagnosis and period of improvement after treatment. A chi-square independence test was used

*Tabela 12. Korelacja między czasem od diagnozy a okresem poprawy po leczeniu. Zastosowano test niezależności chi-kwadrat*

Duration of improvement after treatment	Time from diagnosis				Total
	Less than 5 years	6-10 years	10-20 years	More than 20 years	
0.5-1 year	2	7	3	1	13
% column	18%	37%	43%	33%	
1-2 years	7	8	4	2	21
% column	64%	42%	57%	67%	
More than 2 years	1	3	0	0	4
% column	9%	16%	0%	0%	
No improvement	1	1	0	0	2
% column	9%	5%	0%	0%	
Total	11	19	7	3	40

The test revealed a significant difference ( $p < 0.0001$ ) in pain levels between the pre- and post-rehabilitation assessment. The rehabilitation resulted in a significant pain reduction.

The study also analysed the effects of rehabilitation on the ability to ambulate, based on the painless walking distance before and after treatment. A chi-square independence test was used.

The test revealed a significant difference ( $p < 0.0001$ ) in the ability to ambulate between the pre- and post-rehabilitation assessment. Before rehabilitation, more than half of study patients (53%) reported a painless walking distance of less than 5 metres; the ability of study patients to ambulate was significantly improved after rehabilitation.

**Table 10.** Effects of rehabilitation on pain assessed in a VAS scale

*Tabela 10. Wpływ rehabilitacji na ból oceniany w skali VAS*

	Before rehabilitation		After rehabilitation		Total
	N	%	N	%	
No pain	0	0%	13	33%	13
Mild pain	7	18%	25	63%	32
Moderate pain	14	35%	2	5%	16
Severe pain	16	40%	0	0%	16
Unbearable pain	3	8%	0	0%	3
Total	40	100%	40	100%	80

**Table 11.** Impact of rehabilitation on painless walking distance

*Tabela 11. Wpływ rehabilitacji na dystans bezbólowy marszu*

	Before rehabilitation		After rehabilitation		Total
	N	%	N	%	
Less than 2 m	14	35%	0	0%	14
Less than 5 m	21	53%	2	5%	23
Approx. 10 m	3	8%	4	10%	7
More than 10 m	2	5%	21	53%	23
More than 20 m	0	0%	13	33%	13
Total	40	100%	40	100%	80

The test did not reveal any significant correlation between duration of the disorder and period of improvement ( $p = 0.8871$ ).

## DISCUSSION

Plantar fasciitis, or calcaneal spur, is an increasingly common painful condition that impairs gait and patient functioning.

Straburzyńska-Lupa believes that obesity and the related considerable load carried by the plantar fascia are crucial risk factors. Ziaja et al. reported that concomitant lower limb defects contribute to the development of calcaneal spur. A close correlation was found between limb length discrepancy and flat foot and the incidence of calcaneal spur.

Riddle et al. presented findings confirming the high anti-inflammatory efficacy of ultrasound therapy and laser therapy in the plantar fascia. Their research showed that a combination of these treatments with cryotherapy and magnetic field therapy is very beneficial.

The research conducted by the authors of the present study clearly shows that physiotherapy is the most effective treatment in calcaneal spur patients and that pharmacotherapy should only be used as supportive treatment. Physiotherapy has beneficial effects with respect to improving the ability to ambulate and overall well-being of patients. Most importantly, it allows for fast elimination of pain; the mean value reported by study patients in pain assessment questionnaires improved by more than 4 points, which was a statistically significant result.

Sieroń et al. pointed out the beneficial effects of magnetic field therapy, particularly with respect to the ability to ambulate and overall well-being. According to Paprocka-Borowicz, cryotherapy used in calcaneal spur patients not only has analgesic and anti-inflammatory effects, but also significantly reduces plantar fascia stiffness.

A comparison of the results of the present study with the above findings reported by other authors clearly shows that the only way to prevent recurrence and improve the quality of life in calcaneal spur patients is to conduct comprehensive rehabilitation and eliminate the risk factors. Appropriate prevention, physiotherapy, patient education, and exercises performed at home help slow down, and often even prevent, the development of this disorder, which contributes to a better quality of life.

## CONCLUSIONS

1. Calcaneal spur is a difficult clinical problem.
2. There is a close correlation between the number of risk factors present and the development of calcaneal spur as well as between time from diagnosis and the duration of improvement after rehabilitation.
3. After treatment, the pain resolved and patients had better physical examination results.
4. Rehabilitation had beneficial effects on the quality of life of study patients and reduced their disability levels, and its effects were maintained for a long period of time.

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The Authors declare no conflict of interest

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article

# Treatment Peculiarity of the Chronic Trophic Ulcers with Different Pathogenic Mechanism

## Leczenie cech specyficznych przewlekłych owrzodzeń troficznych o różnym mechanizmie patogennym

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### SUMMARY

**Introduction:** Trophic ulcers of the lower extremities are an unresolved problem of modern medicine. The treatment of this pathology requires new methods that optimize care regimens and improve patients' quality of life.

**Aim:** The study to improve efficacy of treatment of the patients with trophic ulcers of the lower limbs with consideration to pathogenesis.

**Materials and Methods:** The study included 32 patients with chronic venous disease C6 (1<sup>st</sup> group) and 31 with diabetes mellitus type 2, moderate severity, compensation stage with diabetic foot syndrome II stage according to Wagner's classification (2<sup>nd</sup> group). In addition to basic therapy in both groups photodynamic therapy was added at the first stage of the study, and at the second stage plasma rich in growth factors was prescribed.

**Results:** At baseline evaluating of the chronic venous disease demonstrates that a total score in patient of the 1<sup>st</sup> group was 20,9 points on a modified VCSS scale; after two weeks – 15,71 points (improvement by 24.83%), and 6 weeks after – 9,72 points (improvement by 53.49%). In patients with DM (2<sup>nd</sup> group) at the baseline a total score average was 13,91 points according to S(AD)SAD-1 scale; after 2 weeks – 12,29 (improvement by 11,65%), after 6 weeks – 6,39 points (improvement by 54,06%).

**Conclusions:** The inclusion of photodynamic therapy and plasmatherapy in complex therapy in both groups led to a significant improvement of the healing process and helps to reduce the depth and area of the wound surface. However, the wound healing in patients in group 2 was slower.

**Key words:** diabetes mellitus, chronic venous disease, trophic ulcers, photodynamic therapy, autologous plasma

### STRESZCZENIE

**Wstęp:** Wrzody troficzne kończyn dolnych stanowią nierozwiązany problem współczesnej medycyny. Leczenie tej patologii wymaga nowych metod, które zoptymalizują schematy opieki i poprawią jakość życia pacjentów.

**Materiał i metody:** W badaniu wzięło udział 32 pacjentów z przewlekłą chorobą żylną C6 (1 grupa) i 31 z cukrzycą typu 2, o umiarkowanym nasileniu, z zespołem stopy cukrzycowej na II etapie wyrównania według klasyfikacji Wagnera (2 grupa). Oprócz podstawowej terapii w obu grupach na pierwszym etapie badania dodano terapię fotodynamiczną, a na drugim etapie zalecono podanie osocza bogatego w czynniki wzrostu.

**Wyniki:** W początkowej ocenie stopnia nasilenia choroby żył wykazano, że całkowity wynik u pacjenta z pierwszej grupy wynosił 20,9 punktów w zmodyfikowanej skali VCSS; po dwóch tygodniach – 15,71 punktów (poprawa o 24,83%) i po 6 tygodniach po – 9,72 punktów (poprawa o 53,49%). U pacjentów z DM (2 grupa) na początku badania całkowity wynik wynosił 13,91 punktów zgodnie ze skalą S (AD) SAD-1; po 2 tygodniach – 12,29 (poprawa o 11,65%), po 6 tygodniach – 6,39 punktów (poprawa o 54,06%).

**Wnioski:** Włączenie terapii fotodynamicznej i plazmaterapii do kompleksowej terapii w obu grupach doprowadziło do znacznej poprawy procesu gojenia i pomogło zmniejszyć głębokość i obszar powierzchni rany. Jednak gojenie się ran u pacjentów w grupie 2 było wolniejsze.

**Słowa kluczowe:** cukrzyca, przewlekła choroba żylna, owrzodzenia troficzne, terapia fotodynamiczna, osocze autologiczne

## INTRODUCTION

According to World Health Organization, diabetes mellitus (DM) affects about 422 million people worldwide [1]. About 20% of people with DM develop trophic ulcers (TU) that lead to amputation in 4-10% [2]. In patients with chronic venous disease (CVD), TU are found in 2% of adults, and in patients older than 65 years of age, this figure rises to 3-6% [3].

Treatment options of trophic disorders of any etiology includes local treatment of the wound defect, pathogenic therapy, and surgery. Autodermoplasty and surgical treatment are widespread in the management of TU. Despite the efficiency of these methods, in some clinical situations they cannot be used, and in 25-40% of cases they lead to complications such as skin necrosis, rejection and lysis of autodermal flaps [4]. In 11% of patients, surgical treatment is associated with 2-4 cases of relapse within 1 year. A particular problem is the treatment of patients of advanced age; such treatment is long term and has insensitive to the therapy. That is why recently there is an increasing interest in developing and advancing the methods of TU treatment with the aim to improve the healing process and prevent relapses.

### AIM

The aim of the study to improve efficacy of treatment of the patients with trophic ulcers of the lower limbs with consideration to pathogenesis.

## MATERIAL AND METHODS

The study involved 63 patients, 32 with chronic venous disease C6 EpAsPr (1<sup>st</sup> group) and 31 with diabetes mellitus type 2, moderate severity, compensation stage with diabetic foot syndrome II stage according to Wagner's classification (2<sup>nd</sup> group).

Basic therapy in both groups included wound defect debridement, antibiotic therapy (according to the results of wound discharge microbiological examination), vasoactive agent, compression stockings of different compression grades, topical treatment (ointment compositions considering the phase of trophic ulcer healing). In the 2<sup>nd</sup> group compensation of glycemia was achieved through the use of oral hypoglycemic agents and insulin [5, 6].

Considering the chronic character of trophic ulcers, patients of both groups was prescribed with photodynamic therapy (PDT) at the first stage of the study. PDT was performed with laser machine "Lika-Surgeon M" (Photonica - Plus, Cherkasy, Ukraine) with wavelength of 660 nm in a continuous regiment. The power of 0,8-1,5 W and fluence of 20-30 J/cm<sup>2</sup> was used. Energy density for 1 procedure was 300 - 450 J depending on the size of the wound defect area. Methylene blue 1% aqueous solution was used as a photosensitizer. This treatment course included 8 procedures, which were performed every other day.

Plasmatherapy was added to the next stage of the complex treatment to stimulate epithelialization. 18 ml of blood from the patient's cubital vein was centrifuged at 3000 rev/minute, and 12 ml of autologous plasma rich in growth factors was obtained. Luer lock 3.0 ml syringe with interchangeable needle of 30 G 0.3x4 mm was used for intradermal injection up to 4

mm depth (into the reticular layer of the dermis) with 5 mm interval by the peripheral margins of the wound according to epithelialization zone edges. Needle of 30 G 0.3x13 mm was used to the profound (4-6 mm) administration of plasma in direction from the periphery to the center. The intradermal injections course included 4 procedures once a week.

To evaluate results, clinical severity score VCSS was used in the 1<sup>st</sup> group; and the S(AD)SAD classification was used in the 2<sup>nd</sup> group at the baseline (VCSS-1; SAD-1), after two weeks (VCSS-2; SAD-2), and 6 weeks after the treatment (VCSS-3; SAD-3).

VCSS score evaluates the following attributes: pain, varicose veins, venous edema, skin pigmentation, inflammation, induration, number, size, and duration of active ulcers, and compressive therapy on a scale of 0-3. These items were scored in terms of severity on a 3-point rating scale ranging from 0 (absent) to 3 (severe) with a maximum score of 30 [7].

S(AD)SAD classification (Size (Area, Depth), Sepsis, Arteriopathy, Denervation) includes 4 categories, 2 points for each, with a maximum score of 30 points that characterize the most severe condition [8]. Size (0 - skin intact; 2- <1 cm<sup>2</sup>; 4 - 1-3 cm<sup>2</sup>; 6 - >3 cm<sup>2</sup>) and depth of the wound surface (0 - skin intact; 2- superficial - involving skin and subcutaneous tissues but not reaching to tendon, periosteum or joint capsule; 4 - penetrating to tendon, periosteum or joint capsule; 6 - involving bone or joint spaces), infection process (0 - no infection; 2- surface infection, indicated by slough or exudate, but without clinical suspicion of cellulitis or osteomyelitis, also tinea pedis; 4 - cellulitis; 6 - osteomyelitis), and angiopathy were evaluated by using ankle-brachial index (ABI) where 1 point was for 0.7-0.9, and 2 points - for ≤ 0.6; neuropathy was evaluated by using neurological deficit score (NDS): a score of 0 indicated no neuropathy, a score of 1 moderate neuropathy, and a score of 2 severe neuropathy.

The ulcer surface area was evaluated by using LesionMeter app for electronic devices that precisely measures the wound surface area and creates data base. Measurements were performed at the baseline and at each next visit of the patient to allow estimate the progression of epithelialization. A standard bank card placed near the ulcer was used for scaling during photographic record. Digital information and graphics images obtained were saved automatically in separate folders.

Statistical analysis was performed with Windows 10 - Office Professional Plus software (Agreement ID: V0731528) with the use of parametric and non-parametric methods of variation statistics. Shapiro-Wilk test was applied to test normality of parameters in the study. Two-sample Student's t-test was used to determine the significantly changed between groups with a probability mean of 0.05. Relative changes method was used to compare ulcers healing dynamics in two groups.

## RESULTS

Baseline evaluating of the vein disease severity demonstrate that a total score severity VCSS in patient of the 1<sup>st</sup> group was 20,9 points on a modified VCSS scale; after two weeks - 15,71 points (improvement by 24.83%), and 6 weeks after - 9,72 points (improvement by 53.49%) (Table1).

**Table 1.** VCSS evaluation of ulcers healing dynamics in the 1<sup>st</sup> group

Group	Pain	Varicose veins	Venous edema	Skin pigmentation	Inflam-mation	Induration	Number of active ulcers	Size of active ulcers	Duration of active ulcers	Compressive therapy
At baseline	2.94	2.06	2.09	1.97	2.88	2.06	1.06	1.97	2.78	1.09
2 weeks	0.94	2.06	0.81	1.97	1.00	1.09	1.06	1.97	2.78	2.03
6 weeks	0.06	2.06	0.03	1.97	0.03	0.03	0.13	0.13	2.78	2.50

**Table 2.** Relative percentage changes in the 1<sup>st</sup> group according to VCSS dynamic

Group	Pain	Varicose veins	Venous edema	Skin pigmentation	Inflam-mation	Induration	Number of active ulcers	Size of active ulcers	Duration of active ulcers	Compressive therapy
2 weeks	-68.09	0.00	-61.19	0.00	-65.22	-46.97	0.00	0.00	0.00	85.71
6 weeks	-97.87	0.00	-98.51	0.00	-98.91	-98.44	-88.24	-93.65	0.00	128.57

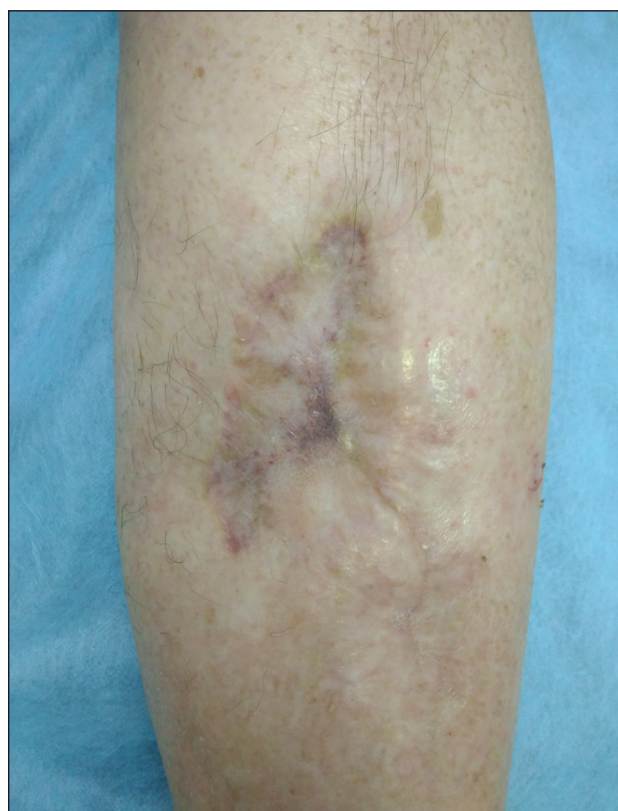
The clinical status in patients with CVD (1<sup>st</sup> group) was improved due to reduction of pain syndrome from 2,94 to 0,94 point (2 weeks), from 0,94 to 0,06 point (6 weeks); venous edema - from 2,09 points (lower leg or thigh) to 0,81 point (foot or no venous edema) in 2 weeks, from 0,81 to 0,03 point in 6 weeks; induration from 2,06 to 1,09 point (2 weeks), from 1,09 to 00,03 point (6 weeks); inflammation - from 2,88 to 1 points (2 weeks), from 1 to 0,03 point (6 weeks). Totally, effectivity of combine

treatment with PDT and plasmatherapy in the 1<sup>st</sup> group was confirmed with method of relative percentage changes (Table 2).

No statistically significant reduction of the ulcer surface area at the first stage was observed in patients of the 1<sup>st</sup> group ( $p \geq 0.05$ ). Surface area reduction 6 weeks after the treatment has revealed 0 point (no active ulcers) in 28 patients, while in the remaining 4 patients, the size of active ulcers was of 1 point (Figure 1, 2).



**Figure 1.** Ulcer in a Patient with Chronic Venous Disease C6 EpAsPr, view at baseline



**Figure 2.** Ulcer in a Patient with Chronic Venous Disease, view in 6 weeks after combined treatment

**Table 3.** S(AD)SAD evaluation of ulcers healing dynamics in the 2<sup>nd</sup> group

Group	Size of the wound surface	Depth of the wound surface	Infection proces	Angiopathy	Neuropathy
At baseline	4.26	2.00	3.81	1.94	1.90
2 weeks	4.26	2.00	2.19	1.94	1.90
6 weeks	2.00	1.81	0.00	1.10	1.48

**Table 4.** Relative percentage changes in the 2<sup>nd</sup> group according to S(AD) SAD

Group	Size of the wound surface	Depth of the wound surface	Infection proces	Angiopathy	Neuropathy
2 weeks	0.00	0.00	-42.37	0.00	0.00
6 weeks	-53.03	-9.68	-100.00	-43.33	-22.03

In patients with DM (2<sup>nd</sup> group), clinical severity on S(AD) SAD-1 scale was evaluated at the baseline, a total score average score was 13,91 points; after 2 weeks – 12,29 (improvement by 11,65%), after 6 weeks – 6,39 points (improvement by 54,06%) (Table 3).

Improvement of clinical status in patients of the 2<sup>nd</sup> group was achieved through the reduction of the infection process from 3,81 to 2,19 points (2 weeks); from 2,19 to 0 point (6 weeks).

On first stage, there was no significant change in the figures of area (average score 4,26 points) and depth of the ulcer defect (average score 2 points) and also in manifestation of angio- and neuropathy ( $p \geq 0.05$ ).

Sensorimotor disorders evaluated on NDS scale showed moderate neuropathy at 1,9 points (index on NDS scale was 5-13 points) vs 1,48 point after 6 weeks (Table 4). simultaneously angiopathy has reduced from 1,94 to 1,1 point (ABI as  $\geq 0.7-0.9$ ).

Use of the plasmatherapy at the second treatment stage (2-6 weeks) has improved the healing of the wound area from 4,26 to 2 points and depth from 2 to 1,81 points (Figure 3, 4), which has been demonstrated by method of relative percentage changes (Table 4).

## DISCUSSION

Social significance of chronic trophic ulcers of any etiology lies in decrease physical and professional activities, reduced quality of life, and in patients with diabetic foot syndrome – in the increased number of amputations, disability, and death rate. Comorbid nature of trophic ulcers of the lower limbs caused by various pathogenic mechanisms leads to chronicity of the process and long-term recurring.

There is not enough information to compare the mechanisms and indicators of the healing of trophic ulcers in diabetes mellitus and chronic venous diseases; and there is no exact statistics on the combination of two diseases.

According to different authors [9-12] an average trophic ulcer healing time with adequate therapy is about 20-48 weeks. Long-term administration of antibiotics is sometimes

**Figure 3.** Ulcer in a Patient with Type 2 Diabetes Mellitus, view at baseline**Figure 4.** Ulcer in a Patient with Type 2 Diabetes Mellitus, view in 6 weeks after combined treatment

ineffective; especially in diabetes mellitus patients. 25-50% of ulcers of the lower limbs do not heal completely for 6 months, and the rate of non-traumatic amputation reaches 10-15% [13-16].

The study found that the process of re-epithelialization of the wound surface and the transition to the granulation

phase in patients of 1<sup>st</sup> group was 62.5% faster compared to 2<sup>nd</sup> group, and epithelialization was 45% faster in 1<sup>st</sup> group compared to the patients of 2<sup>nd</sup> group.

## CONCLUSIONS

The duration of trophic ulcers healing process is related to not only the localization of the ulcer defect, its depth, area, and persistence, but also to pathogenic mechanism that has caused trophic ulcers. A combined treatment regimen with PDT at the first stage of ulcer healing and plasmatherapy at the second stage may be considered as the supplementary approach to traditional regimens to improve treatment algorithm.

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## Conflicts of interest:

The Authors declare no conflict of interest

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# The Effect of the Aqueous Suspension of *Chlorella Vulgaris* on Functional Systems in Healthy People

## Wpływ wodnej zawiesiny *Chlorella vulgaris* na układy funkcjonalne u zdrowych ludzi

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### SUMMARY

**Introduction:** There is a growing interest in biologically active food additives based on natural, environmentally friendly components. One of the most promising products in this area are biological additives created using the green freshwater alga *Chlorella*. Due to the high content of biologically active substances in it, the possibility of its use in preventive and therapeutic purposes was being considered.

**Aim:** The aim of the study was to study the effect of the course of taking an aqueous suspension of a living culture of chlorella (*Chlorella vulgaris*) on the organism of healthy people.

**Material and Methods:** The study involved 30 clinically healthy people, aged 17 to 66 years, 10 men and 20 women. The subjects took an aqueous suspension of live chlorella of *Chlorella vulgaris* strain IGF No. C-111 at a concentration of 19-34 million cells/ml, in an amount of 500 ml per day. The course of administration was 28 days. Before and after completion of the course, the following studies were carried out: anthropometry, a study of body composition, a study of physical performance (PWC<sub>170</sub> test), a general blood test, and a biochemical blood test.

**Results:** At the end of the course of administration, the vast majority of the subjects noted improvement in well-being. An increase in the hemodynamic efficiency of physical activity was recorded as well as increasing the immune properties of blood. No changes in lipid metabolism were observed.

**Key words:** *Chlorella vulgaris*, hemodynamics, blood, immune system, lipid metabolism

### STRESZCZENIE

**Wstęp:** Obecnie rośnie zainteresowanie biologicznie aktywnymi dodatkami do żywności opartymi na naturalnych, przyjaznych dla środowiska składnikach. Jednym z najbardziej obiecujących produktów w tym obszarze są suplementy biologiczne tworzone przy użyciu zielonej glony słodkowodnej *Chlorella*. Ze względu na wysoką zawartość substancji biologicznie czynnych rozważa się możliwość jej zastosowania w celach profilaktycznych i terapeutycznych.

**Cel:** Celem pracy było zbadanie wpływu przebiegu wodnej zawiesiny żywej kultury chlorelli (*Chlorella vulgaris*) na organizm zdrowych ludzi.

**Materiał i metody:** W badaniu wzięto udział 30 klinicznie zdrowych osób w wieku od 17 do 66 lat, 10 mężczyzn i 20 kobiet. Badani pobrali wodną zawiesinę żywego szczepu *Chlorella vulgaris* IGF nr C-111 w stężeniu 19-34 milionów komórek/ml w ilości 500 ml dziennie. Przed i po zakończeniu kursu przeprowadzono następujące badania: antropometria, badanie składu ciała, badanie sprawności fizycznej (test PWC170), ogólne badanie krwi i biochemiczne badanie krwi.

**Wyniki:** Pod koniec leczenia znaczna większość pacjentów zauważyła poprawę samopoczucia. Odnotowano wzrost skuteczności hemodynamicznego wsparcia aktywności fizycznej, a także zwiększenie właściwości odpornościowych krwi. Nie zaobserwowano zmian w metabolizmie lipidów.

**Słowa kluczowe:** *Chlorella vulgaris*, hemodynamika, krew, układ odpornościowy, metabolizm lipidów

## INTRODUCTION

Currently, there is a growing interest in biologically active food additives based on natural, environmentally friendly components. One of the most promising products in this area are biological additives created using the green freshwater alga *Chlorella* (*Chlorophyta*, *Trebouxiophyceae*) [1-5]. *Chlorella* contains protein, chlorophyll, dietary fiber, fatty acids, carotenoids, sulfated polysaccharides, glycoproteins, antioxidants, nucleic acids, trace elements, vitamins, etc., which explains its significant biological activity [6, 7]. As a result, the number of studies studying *Chlorella vulgaris* is growing not only as a source of useful substances for use in functional nutrition but also the possibility of its use for therapeutic and prophylactic purposes [8-12]. So, there is evidence of a positive effect of chlorella on the degree of cardiovascular risk [13], a pronounced hypotensive effect [14]. Studies have shown a decrease in blood glucose levels, an increase in the number of glutathione-positive cells in diabetes mellitus, and an increase in the percentage of insulin-producing beta cells and glucogone-producing cells [15, 16]. The effect of *Chlorella vulgaris* on the regulation of the level of lymphocytes, granulocytes, and other immunocompetent cells has also been proven [17]. There is evidence of positive changes in the level of bilirubin and enzymes of hepatic metabolism [18]. A fairly large number of works are devoted to the effect of chlorella intake on lipid metabolism [19, 20]. Many authors have obtained interesting data on the effect of *Chlorella* consumption under oxidative stress: the researchers found a significant increase in the oxidative activity of blood serum [21-23]. The special economic attractiveness of using chlorella is given by the simplicity of cultivation and low cost of this alga [24, 25]. However, the vast majority of these studies were performed on laboratory animals, which does not allow us to test the obtained data with sufficient accuracy for clinical purposes [26, 27]. An additional complication is a fact that chlorella in the vast majority of studies is used in the form of powders, tablets, suspensions, which does not allow us to accurately determine what type of algae and at what concentration was used. The stated facts served as the basis of the current study, the purpose of which was to study the effect of the course intake of an aqueous suspension of living *Chlorella* culture (*Chlorella vulgaris*) on the body of healthy people.

## MATERIAL AND METHODS

The study involved 30 clinically healthy people, aged 17 to 66 years, 10 men and 20 women. Written informed consent was obtained from all subjects for research. The subjects took an aqueous suspension of live chlorella of *Chlorella vulgaris* strain IGF No. C-111 at a concentration of 19-34 million cells/ml, manufactured by Algalife, Ukraine, in an amount of 500 ml per day, 250 ml in the morning and evening, for 20-30 minutes before meals. The course of administration was 28 days.

Before and after completion of the course, the following studies were carried out: anthropometry, a study of body composition, a study of physical performance (PWC<sub>170</sub> test), a general blood

test, and a biochemical blood test. To study the compositional components of the body, the Omron BF-512 monitor (Japan) was used, which allows one to determine the fat and muscle components, as well as the amount of visceral fat. The study of physical performance was carried out by testing the value of PWC<sub>170</sub> on a Torneo B-507M bicycle ergometer (Italy) with simultaneous recording of heart rate and blood pressure. In a general blood test, a detailed blood formula was studied. A blood biochemical analysis included the determination of the following indicators: total, direct and indirect bilirubin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), total cholesterol, triglycerides, low and high-density lipoproteins.

For a subjective assessment of the general condition of the subjects, the SAN questionnaire was used (well-being, activity, mood).

The reliability of changes in the indicators before and after the course was assessed based on the sign criterion (G-criterion) for related samples using the XLSTAT program.

## RESULTS AND DISCUSSION

At the end of the course, none of the subjects noted a deterioration in well-being, on the contrary, positive dynamics was observed in 84.3%, with 46.7% noted an increase in general tone, a decrease in the duration required to restore sleep, and 30% noted normalization of bowel function.

Anthropometric measurements showed that under the influence of the course of taking chlorella there was no significant change in the weight of the subjects ( $P > 0.05$ ), this is also indicated by the absence of a change in body mass index ( $P > 0.05$ ). At the same time, there was a significant proportional decrease in the waist and hips ( $P < 0.05$ ), as a result of which the index (waist-hips) remained unchanged ( $P > 0.05$ ).

When studying the composition of the body, an unreliable ( $P > 0.05$ ) decrease in the percentage of the fat component and an unreliable increase in the muscle component ( $P > 0.05$ ) were found. There was also no significant decrease in visceral fat content ( $P > 0.05$ ), however, there was a clear downward trend in this index by 12% in men and 8.7% in women, respectively.

The assessment of physical performance did not reveal significant changes in the values of PWC<sub>170</sub> and PWC<sub>170</sub>/kg ( $P > 0.05$ ). However, if we follow the dynamics of the indicator PWC<sub>170</sub>/kg of fat mass, then there is a significant increase in the value of physical performance: ( $5.8 \pm 3.95$ ) W/kg and ( $8.8 \pm 5.99$ ) W/kg,  $P < 0, 01$ . This observation allows us to conclude that the indicator PWC<sub>170</sub>/kg of fat mass is more sensitive to assess the dynamics of physical performance than the more used indicator PWC<sub>170</sub>/kg.

Of particular interest are the changes that have occurred in the values of hemodynamic parameters, both in a state of muscle rest and during the provision of physical activity (Table 1).

As can be seen from the table, a rather pronounced, although statistically unreliable ( $P > 0.05$ ) tendency to decrease in the initial value of the heart rate was recorded. At the same time, the observed decrease in the values of the initial systolic and diastolic pressure was significantly significant:

**Table 1.** The dynamics of hemodynamic parameters in a state of relative muscle rest under the influence of a course of chlorella,  $X \pm s$ 

Indicators	Before the course	After the course	Reliability, P
Heart rate, bpm	74,6±9,15	71,4±7,65	>0,05
Systolic pressure, mmHg	124,4±14,89	114,3±14,76	<0,001
Diastolic pressure, mmHg	79,1±11,79	75,2±11,74	<0,05

$P < 0.001$  and  $P < 0,05$ , respectively. This confirms the reports of other researchers about the pronounced antihypertensive effect of chlorella [28-30]. To assess the effectiveness of hemodynamics during exercise, we calculated the double product - the product of the heart rate and systolic pressure and the Robinson index - the quotient of dividing the double product by the load power. After the course, these values significantly decreased - ( $P < 0.01$ ) and ( $P < 0.01$ ), respectively, which indicates a significant increase in the effectiveness of hemodynamic support for physical exercise.

When analyzing changes in the elements of the blood formula, the following results were obtained (Table 2).

The total number of red blood cells did not significantly change, but the hemoglobin level increased significantly ( $P < 0.001$ ). As a result, at a high level of confidence, there was an increase in the color index ( $P < 0.001$ ), which indicates a significant improvement in the oxygen transport function of the blood. There was also a significant increase in the number of leukocytes and lymphocytes (within the standard parameters), which allows us to assume the stimulation of the immune

system of the blood. At the same time, significant changes in the number of other blood cells were not observed.

The analysis of the dynamics of biochemical parameters gave the following results (Table 3).

The most statistically significant changes were recorded in indicators reflecting the functional state of the liver. A significant decrease in the values of total and direct bilirubin ( $P < 0.001$  and  $P < 0.05$ , respectively) is observed, which indicates an improvement in its detoxification function. This is also evidenced by a significant decrease in ALT level ( $P < 0.05$ ) and, correspondingly, a decrease in the AST / ALT ratio ( $P < 0.05$ ). At the same time, we did not register significant changes in terms of lipid metabolism, which were reported by some authors. This can be explained by differences in the concentration and state of aggregation of the active substance used - a dry extract of chlorella or an aqueous suspension.

## CONCLUSION

The data obtained in this research allow us to draw the following conclusions. When using an aqueous suspension of

**Table 2.** Dynamics of indicators of the blood formula under the influence of the course of chlorella,  $X \pm s$ 

Indicators	Before the course	After the course	Reliability, P
Red blood cells, $10^{12}/l$	4,8 ± 0,47	4,7 ± 0,49	>0,05
Hemoglobin, g/l	138,08 ± 27,08	142,98 ± 16,4	<0,001
Color indicator, u	86,9 ± 4,19	91,1 ± 4,59	<0,001
White blood cells, $10^9/l$	5,7 ± 1,15	6,5 ± 1,68	<0,05
Lymphocytes, %	2,3 ± 0,39	2,5 ± 0,51	<0,05
Monocytes, %	3,2 ± 0,43	3,1 ± 0,37	>0,05
Eosinophils, %	2,8 ± 0,63	2,9 ± 0,57	>0,05
Basophils, %	0,8 ± 0,07	0,7 ± 0,09	>0,05
Granulocytes, %	3,3 ± 0,92	3,6 ± 0,88	>0,05

**Table 3.** Dynamics of biochemical parameters under the influence of the course of chlorella,  $X \pm s$ 

Indicators	Before the course	After the course	Reliability, P
Total bilirubin, $\mu M/L$	13,4 ± 5,26	11,2 ± 6,34	<0,001
Direct bilirubin, $\mu M/L$	2,5 ± 1,18	2,0 ± 1,15	>0,05
Indirect bilirubin, $\mu M/L$	10,9 ± 4,39	9,2 ± 5,41	<0,05
ALT, u/l	28,2 ± 12,51	25,7 ± 11,53	<0,05
AST, u/l	33,6 ± 8,18	35,6 ± 10,01	>0,05
AST/ALT, u	1,3 ± 0,47	1,5 ± 0,50	<0,05
GGT, u/l	24,6 ± 17,26	24,0 ± 17,45	>0,05
Total cholesterol, mm/l	5,5 ± 1,30	5,5 ± 1,27	>0,05
Triglycerides, mm/l	1,4 ± 0,65	1,2 ± 0,73	>0,05
High-density lipoproteins, mm/l	1,5 ± 0,41	1,6 ± 0,43	>0,05
Low-density lipoproteins, mm/l	3,4 ± 1,05	3,3 ± 0,95	>0,05

a live *Chlorella culture (Chlorella Vulgaris)* by healthy people during the 28-day course, a positive dynamics of subjective well-being is observed, due to an increase in general tone, a decrease in the duration required to restore sleep. When studying the dynamics of anthropometric indicators, no significant change in the weight of the subjects was found. Unreliable changes in the fat and muscle components and a tendency to a decrease in visceral fat are observed. The study of physical performance revealed a significant increase in PWC<sub>170</sub>/kg of fat mass. A significant increase in hemodynamic efficiency was recorded due to a decrease in systolic and diastolic pressure, which manifests itself both in a state of muscle rest and in ensuring the fulfillment of physical activity. The dynamics of the indicators of the blood system indicates an improvement in oxygen transport function due to an increase in the hemoglobin content, as well as stimulation of the immune system of the blood. Under the influence of the course intake of chlorella, the functional state of the liver, in particular, its detoxification function, improves.

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KONFERENCJE



**III Międzynarodowa Konferencja Naukowa  
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2. Fizjoterapia w diagnostyce i leczeniu zaburzeń postawy ciała.
3. Fizjoterapia specyficzna i jej skuteczność w leczeniu skolioz.
4. Varia.

**Warsztaty:**

1. Diagnostyka w metodzie FITS – klucz do zastosowania odpowiedniej terapii.
2. Metoda FITS (Funkcjonalna Indywidualna Terapia Skolioz) - metoda leczenia skolioz rekomendowana przez SOSORT. Prowadzącym będzie współtwórca metody, Andrzej M'hango.

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# Value of Lumbar Lordosis and Back Pain in the Female Population Over 50 Years of Age

## Wartość kąta lordozy lędźwiowej, a dolegliwości bólowe grzbietu w populacji kobiet po 50 roku życia

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### SUMMARY

**Introduction:** In highly developed societies, back pain is a fairly common phenomenon, and its causes are usually multifactorial. Backaches can be caused by improper body posture, anatomical conditions, overloads, inflammation and many other factors. Changes in the shape of the spine in the sagittal plane, such as shallowing or deepening physiological curves translate into a change in the distribution of forces acting on individual parts of the spine, overloading the axial organ of movement.

**Aim:** The aim of the study was to determine the relationship between the individual variants of lordosis (hypolordosis, hyperlordosis, norm) and pain experienced by women in the area of the lumbosacral spine (L/S).

**Material and Methods:** The study group was a population of women over 50 ( $n = 277$ ), divided into three subgroups, i.e. women with: normal, shallow and deepened lordosis, evaluated in the sagittal view in computed tomography imaging studies.

**Results:** Deepened lordosis is associated with the highest BMI = 27.30 but a rather low average pain value (VAS = 4.60), which approximately corresponded to the severity of the discomfort in the group of women with normal lumbar lordosis. Shallow lordosis correlates with a lower BMI = 26.60 and the highest level of pain (VAS = 6.67). When the lordosis angle was normal, the pain was the lowest.

**Conclusions:** The size of the lordosis angle may be a predictor of the occurrence of pain. A larger lumbar lordosis angle correlates with a higher body weight but pain in this group of women occurs with similar intensity as in the group of women with a normal lumbar lordosis angle. The research results indicate a strong correlation ( $p < 0.0229$ ) between shallow lordosis and the severity of pain experienced by the examined women, which should be taken into account when planning treatment.

**Key words:** lumbar lordosis, spinal deformity, pain

### STRESZCZENIE

**Wstęp:** W społeczeństwach wysoko rozwiniętych dolegliwości bólowe kręgosłupa są dość powszechnym zjawiskiem, a ich przyczyny zwykle mają charakter wieloczynnikowy. Bóle kręgosłupa mogą być wywołane niewłaściwą postawą ciała, uwarunkowaniami anatomicznymi, przeciążeniami, stanami zapalnymi i wieloma innymi czynnikami. Zmiany ukształtowania kręgosłupa w płaszczyźnie strzałkowej, takie jak spłyconie czy pogłębienie fizjologicznych krzywizn przekładają się na zmianę rozkładu sił działających na poszczególne części kręgosłupa, przeciążając osiowy narząd ruchu.

**Cel:** Celem badań było określenie związku pomiędzy poszczególnymi wariantami lordozy (hypolordoza, hiperlordoza, norma), a dolegliwościami bólowymi odczuwanymi przez kobiety w obszarze kręgosłupa lędźwiowo-krzyżowego (L/S).

**Materiał i metody:** Grupę badaną stanowiła populacja kobiet po 50 roku życia ( $n=277$ ), podzielona na trzy podgrupy, czyli kobiety z prawidłową, spłyconą i pogłębioną lordozą, które oceniano w rzucie strzałkowym w badaniach obrazowych z użyciem tomografii komputerowej.

**Wyniki:** Pogłębiona lordoza wiąże się z najwyższym wskaźnikiem BMI=27,30, lecz dość niską uśrednioną wartością dolegliwości bólowych (VAS=4,60), która w przybliżeniu odpowiadała nasileniu dolegliwości w grupie kobiet z prawidłową lordozą lędźwiową. Zaś spłycona lordoza koreluje z niższym wskaźnikiem BMI=26,60 i najwyższym poziomem dolegliwości bólowych (VAS=6,67). W przypadku prawidłowego kąta lordozy, występujące dolegliwości bólowe były najmniejsze.

**Wnioski:** Wielkość kąta lordozy może być predyktorem występowania bólu. Większy kąt lordozy lędźwiowej koreluje z większą masą ciała ale dolegliwości bólowe w tej grupie kobiet występują z podobnym nasileniem jak w grupie kobiet z prawidłowym kątem lordozy lędźwiowej. Wyniki badań wskazują na silną korelację ( $p < 0,0229$ ) między spłyconą lordozą a nasileniem odczuwanych przez badane kobiety dolegliwości bólowych, co powinno być brane pod uwagę przy planowaniu leczenia.

**Słowa kluczowe:** lordoza lędźwiowa, deformacja kręgosłupa, dolegliwości bólowe

## INTRODUCTION

Back pain is a very common phenomenon in highly developed countries, and its causes are usually multifactorial. The ailments can arise as a result of poor posture habits, resulting e.g.: from hours of forced and unnatural repetition of work hours every day (e.g. a dentist, doctor performing ultrasound examinations, etc.), sedentary lifestyle (e.g. office worker, driver, etc.) or even no regular physical activities (without overloading). Factors causing back pain also include: the incompetent lifting of objects from the floor by leaning, as well as the incorrect positioning of the body during sleep, in which the spine rotates along its long axis, lateral bends and the deepening or shallowing of physiological curves (kyphosis, lordosis). This nature of this pain can be called postural pain, which is the result of the overload of tissue and joint structures [1].

The pain in the lumbosacral spine and pelvis, which occur in almost half of pregnant women is a separate problem. During this period, the body posture changes as a result of the center of gravity shift and weight gain, in such a way that the pelvis is leaned forward and the spine in the lumbar spine acquires the characteristics of hyperlordosis [2].

Back pain can also be the result of an ongoing disease process involving the spine and adjacent tissues, such as: discopathy, fractures, ankylosing spondylitis, cancer and other [3].

In the differential diagnosis of back pain, attention is paid to the source of the back pain, and if it is of spinal origin, the pain tends to increase when moving or lifting heavy objects, and disappears when you rest or lack of physical activity. In turn, back pain of a non-vertebral origin does not appear or intensify with movements and can indicate serious diseases.

Changes in the shape of the column of the spine are responsible for the generation of pain and posture defects [4].

In newborns, the spine has the shape of one kyphosis running through the entire trunk, and the appearance of cervical and lumbar lordosis is a consequence of the gradual upright position. Already after about 1.5 years, when the child begins to walk, all the curves that occur in an adult are formed and four physiological bends of the spine are alternately arranged: cervical lordosis, thoracic kyphosis, lumbar lordosis and sacral kyphosis. This specific shape of the spine resembles a spring, which allows it to act as the main shock absorber for the skull and central nervous system [5].

At 20-30 years, the spine is of an optimal shape and reaches its greatest length. After 50 years of age, the physiological curvatures of the spine can increase due to the weakening of the elasticity of the soft tissues stabilizing it and the dehydration of the interbody discs [6, 7].

In order to deepen lumbar lordosis, anatomical features such as excessive body weight or weakened postural muscles, as well as the weakening of bone structure, compression and fractures can contribute.

In turn, the reduction of lumbar lordosis can be caused by spinal canal stenosis, which can be affected by: degenerative disc disease, osteophytosis of the posterior edges of the stems, calcification in the posterior longitudinal ligament, thickening of the yellow ligaments or spondylolisthesis.

The correct angle of lumbar lordosis in an adult healthy person should be between 30 and 50°. According to radiological criteria, the correct angle of lumbar lordosis is between 135 and 140° [8].

Any deviation from the values is associated with the formation of spinal deformities, which include the shallowing or deepening of physiological curvatures, but this is not only a cosmetic problem but also affects the function of internal organs and is undoubtedly associated with pain.

## AIM

The aim of the study was to determine the relationship between individual variants of lordosis (hypolordosis, hyperlordosis, norm) and pain experienced by women in the area of the lumbosacral spine (L/S).

## MATERIAL AND METHODS

The study was conducted on a population of women over 50 (n = 277). MSCT (Multi Slice Computed Tomography) was used, enabling the examination of patients in the supine position with the lower legs straightened, which is not a significant difference with respect to tests performed in a standing position [9-12].

On the lateral cross-sections of the spine in the L/S segment, the values dividing the studied group into three subgroups, i.e. women with normal, shallow and deepened lordosis, were determined according to radiological criteria of the lumbar lordosis bend angle. Angle values between 135 and 140° corresponded to normal lordosis; higher values indicated shallow lordosis (hypolordosis), and lower values of the angle indicated deepened lordosis (hyperlordosis) [8].

The study also used the VAS (Visual Analogue Scale) scale to measure pain sensations in the studied group of women.

The reason for exclusion was the lack of consent to participate in the study and: inflammatory diseases of the spine (osteomyelitis, discitis), oncological disease, vertebral fractures and previous surgical procedures in the examined area.

The statistical study was carried out using the Statistica 13 program.

## RESULTS

The subject examination included gathering information on the severity of pain in the lumbosacral region, which was evaluated using the VAS scale. Patients underwent measurements of body mass and length, the data was used to calculate the BMI (Body Mass Index). The data was combined with elements of the imaging study, according to which the examined women were assigned to three groups: with normal, excessive and shallow lumbar lordosis. This comparison indicates that the group of patients with excessive lordosis was characterized

by the largest body mass index, which in averaged values placed this group of patients in the upper overweight range. The average BMI values for the other two groups were also in the range reserved for overweight people and were similar for both groups – 26.6 for shallow lumbar lordosis and 26.5 for normal lordosis (Table 1).

**Table 1.** Sections of descriptive statistics for the BMI in individual variants of lordosis

	Lordosis	BMI Average	BMI Standard deviation
1	Shallow	26.601770	4.874386
2	Correct	26.562821	4.443151
3	Excessive	27.302326	4.949319
4	Total	26.808303	4.775326

In the Kruskal-Wallis test for multiple comparisons between individual variants of lumbar lordosis, no significant statistical results were obtained for the BMI ( $p = 0.5485$ ), which indicates that the variables are not closely related (Table 2).

**Table 2.** Multiple comparisons for BMI and individual variants of lumbar lordosis

Variable: BMI	P-value for multiple (two-sided) comparisons; BMI Independent (grouping) variable: Lordosis. Kruskal-Wallis test: $H(2, N=277) = 1.201541 p = .5484$		
	Shallow R:134,70	Correct R:136,69	Excessive R:146,75
Shallow		1.000000	0.879421
Correct	1.000000		1.000000
Excessive	0.879421	1.000000	

In the combination of individual variants of lumbar lordosis for the intensification of pain in the VAS scale, it can be observed that the lowest average pain values were presented in the group of patients with normal lumbar lordosis, while the highest values were recorded in the group of women with shallow lumbar lordosis (Table 3).

**Table 3.** Sections of descriptive statistics for the size of pain complaints expressed on the VAS scale for individual lordosis variants

Cross-sectional table of descriptive statistics N = 277 (Dependent variables do not contain BD)			
	Lordosis	VAS Average	VAS Standard deviation
1	Shallow	6.415929	2.099003
2	Correct	4.846154	1.414920
3	Excessive	5.174419	1.809724
4	Total	5.588448	1.960741

Table 4 below presents the analysis of relationships for pain complaints expressed in the VAS scale, and individual

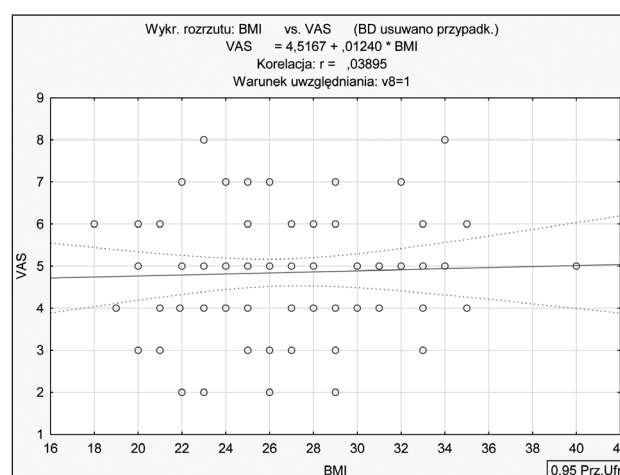
variants of lumbar lordosis, where for the average values of pain symptoms statistically significant relationships were obtained between the group of women examined with normal and shallow lumbar lordosis and excessive and shallow lumbar lordosis ( $p < 0.000053$ ). When comparing the group of women with normal and excessive lumbar lordosis, no statistically significant relationships were present.

**Table 4.** Analysis of the relationship between individual variants of lumbar lordosis

Variable: VAS	P-value for multiple (two-sided) comparisons; VAS Independent (grouping) variable: Lordosis Kruskal-Wallis test: $H(2, N=277) = 35.13724 p = .0000$	
	shallow R:172.31	correct R:108.26
Shallow		0.000000
Correct	0.000000	
Excessive	0.000053	0.706986

Table 5 presents the analyses of the relationships between the BMI index and pain values (VAS) presented in individual groups of examined women with a breakdown into normal, excessive and shallow lumbar lordosis. The existence of a correlation was demonstrated in each of the studied relationships: for normal ( $p < 0.038948$ ), excessive (0.057091) and shallow ( $p < 0.022936$ ).

The data with the lowest BMI (26.56) and the lowest average pain value (VAS = 4.51) concerned women with normal lordosis. The above data is presented graphically in



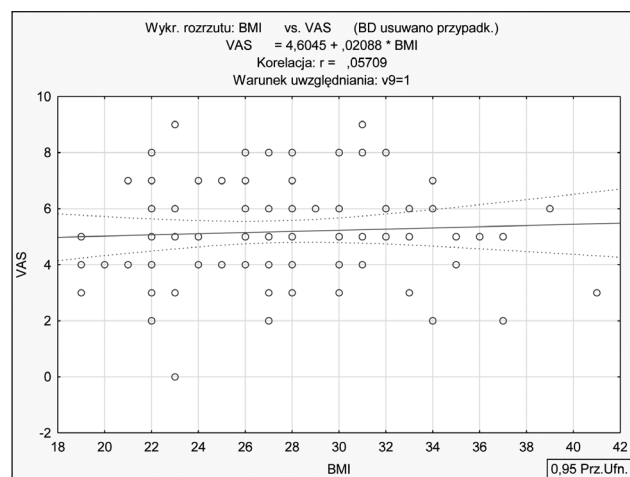
**Figure 1.** Graphical presentation of the spread between the pain degree (VAS scale) and the BMI for the examined women with the correct angle of lumbar lordosis

Women with excessive lordosis and the highest BMI = 27.30 showed a fairly low average pain value (VAS = 4.60), which approximately corresponded to the severity of the discomfort in the group of women with normal lumbar lordosis. The summary for the above data is presented in graphical form in Figure 2.

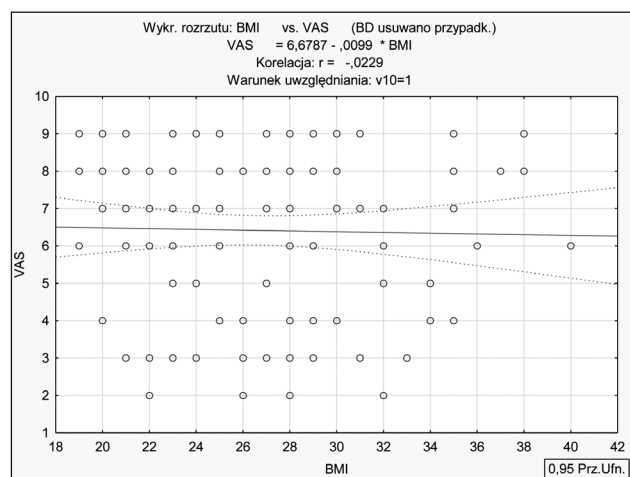


**Table 5.** Analysis of the relationship between the BMI and VAS variables in individual variants of lumbar lordosis. Correlations are significant with  $p < 0.05000$ 

Variable	Normal lordosis n = 78	Excessive lordosis n = 86	Shallow lordosis n = 113
	Condition for inclusion: v8=1	Condition for inclusion: v9=1	Condition for inclusion: v10=1
	VAS		
BMI	0.038948	0.057091	0.022936

**Figure 2.** Graphic presentation of the spread between the size of pain (VAS scale) and the BMI for the examined women with deepened lumbar lordosis

The examined women with shallow lordosis and BMI = 26.60 had the highest average pain value (VAS = 6.67). The summary for the above data is presented in graphical form in Figure 3.

**Figure 3.** Graphic presentation of the spread between the amount of pain (VAS scale) and the BMI index for the examined women with shallow lumbar lordosis

## DISCUSSION

Back pain is most often associated with degenerative changes, however, the changes do not explain the pathogenesis of pain sufficiently, because it is not proportional to it, and apart from that, it is also present in painless periods. Therefore, additional components of pathomechanism should be taken

into account, such as deepened or shallowed physiological curvatures of the spine in the sagittal plane [13].

The curvature of the spine increases its overall resistance to axial loads, which is why the efficiency is the highest in a properly shaped spine, and vice versa – if the spine loses any of the curvatures, then its comprehensive ability to carry loads decreases, and with increasing curvatures, the shear component increases on parts of the vertebrae [14, 15].

Pain is the main symptom of spinal insufficiency, and its assessment is quite difficult. An interview is the basis of the assessment, and the auxiliary tests are aimed at excluding or confirming the diseases that can be the cause of the pain, the presence of which requires treatment. The classic X-ray (X-ray) tests are most often used to diagnose lumbar-sacral spine problems, and in unclear cases the MSCT (Multi Slice Computed Tomography) and the MRI (Magnetic Resonance Imaging) tests.

The main method of measuring the spine used in the project was the MSCT study, in which patients were examined in a supine position with the lower legs straightened, and not in a standing position as suggested by some authors basing their opinion only on guesses. Their hypotheses have not been confirmed in any studies. This concept was based on the sum of gravity and weight, which is to have a stronger effect on the patient in a standing position. However, according to many comparative studies performed in standing and lying positions of the same patients, the authors of the reports came to the same conclusions that the upright standing and lying position are functionally convergent and do not differ from each other [9-12].

The image of the examination looks completely different in persons in whom the examination was performed in the supine position with the lower limbs bent, because then the pelvic bone tilts backward and the lumbar lordosis angle shallows.

Zwierzchowska and Tuz report that increasing the lumbar lordosis angle is closely related to the higher frequency of pain [16].

Oakley et al. noticed that most of the patients treated by them for lumbar pain have lumbar hyperlordosis. They described the case of a 46-year-old patient with radiologically diagnosed lumbar hyperlordosis and significant pain, which resolved after corrective exercises and the restoration of the correct lordosis angle [17].

Our own research shows something completely different, namely that the highest pain values are recorded in a group of women with shallow lumbar lordosis, which can be strongly associated with spinal stenosis and spinal straightening as

an effect of escape from pain and the effects of reducing the capacity of the spinal canal.

The therapy should take all possible components of pain in a given case into account, which can also be affected by changes in the lumbar lordosis angle.

## CONCLUSIONS

Deviations from the correct values of the lumbar lordosis angle result in a change in compressive and shear forces, which is associated with pain sensations in the studied population of women. This relationship can be a clue to differentiate the physiotherapy program of women reporting back pain – depending on the size of the lumbar lordosis angle.

The size of the lordosis angle can be a predictor of the occurrence of pain.

A larger lumbar lordosis angle correlates with a higher body weight but pain in this group of women occurs with similar intensity as in the group of women with a normal lumbar lordosis angle.

Research results indicate a strong correlation ( $p < 0.0229$ ) between shallow lordosis and the severity of pain experienced by the examined women, which should be taken into account when planning treatment.

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## Conflicts of interest:

The Authors declare no conflict of interest

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# Effect of Therapy Using Aquatic Treadmill on the Functional Status of Patients with Knee Arthrosis

## Wpływ terapii z wykorzystaniem bieżni wodnej na stan funkcjonalny osób z artrozą stawów kolanowych

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### SUMMARY

**Introduction:** Arthrosis is considered as a disease of the whole locomotor system, which may be prevented and treated at early stages. Gonarthrosis develops gradually within 10-15 years, interfering with daily activities and capability for work. Aquatic exercises are considered as a potentially effective therapeutic intervention in persons with knee arthrosis.

**Aim:** Assessment of the effectiveness of a 4-week aquatic treadmill exercise programme, with respect to the measurement of pain, balance, function, and mobility.

**Materials and Methods:** The study covered 15 patients with gonarthrosis, using a 4-week cycle of exercises. The results of measurements included a visual-analogue scale for assessing pain, Time Up and Go (TUG) for balance, 6-meter walk test for mobility and Lequesne index for function. The exercise protocol covered an aquatic treadmill using water jets to destabilize while standing, and achieve high ratings of perceived exertion during walking.

**Results:** The comparison of results obtained by the patients after 20 interventions, with those obtained before therapy allowing the presumption that on the level of significance  $\alpha = 0.05$  there occurred statistically significant differences in the results of the tests performed ( $p < 0.05$ ). This concerned both pain complaints (VAS scale, Lequesne index of severity for arthrosis of the knee), as well as functional tests TUG, and measurement of the range of motion ( $p = 0.041-0.001$ ).

**Conclusions:** Based on the results of the study a decrease was observed in pain complaints, improvement of the range of motion in the joints, balance and function, after participation in a 4-week aquatic treadmill exercise programme, which contained the components of balance and endurance training.

**Key words:** gonarthrosis, knee joint, aquatic therapy, aquatic treadmill, training, rehabilitation, proprioception

### STRESZCZENIE

**Wstęp:** Artroza stawów jest uważana za chorobę całego układu ruchu, której można zapobiegać i leczyć we wczesnych stadiach. Gonartroza (ang. *gonarthrosis*) rozwija się powoli w ciągu 10-15 lat, zakłócając codzienne czynności i zdolność do pracy. Ćwiczenia w wodzie są uważane za potencjalnie skuteczną interwencję terapeutyczną u osób z chorobą zwyrodnieniową stawów kolanowych.

**Cel:** Ocena skuteczności 4-tygodniowego programu ćwiczeń na bieżni wodnej w zakresie pomiaru bólu, równowagi, funkcji i mobilności.

**Materiał i metody:** Badaniem objęto 15 uczestników z gonartrozą, korzystających z 4-tygodniowego cyklu ćwiczeń. Pomiarów wyników obejmowały wizualno-analogową skalę bólu, test Time Up and Go – TUG dla równowagi, 6-metrowy test dla mobilności i indeks bólowo-czynnościowy, Lequesne'a dla funkcji. Protokół ćwiczeń obejmował trening równowagi w bieżni wodnej za pomocą dysz wodnych, aby destabilizować podczas stania i uzyskać wysokie oceny postrzeganego wysiłku podczas chodzenia.

**Wyniki:** Porównanie wyników uzyskiwanych przez pacjentów po 20 zabiegach z wynikami uzyskanymi przed terapią pozwala na stwierdzenie, że na poziomie istotności  $\alpha = 0,05$  występują statystycznie istotne ( $p < 0,05$ ) różnice w wynikach przeprowadzonych testów. Dotyczy to zarówno dolegliwości bólowych (skala VAS, wskaźnik zaawansowania choroby zwyrodnieniowej stawu kolanowego Lequesne), jak również testów funkcjonalnych TUG, pomiarów zakresu ruchomości ( $p = 0,041-0,001$ ).

**Wnioski:** Na podstawie przeprowadzonych badań stwierdzono zmniejszenie dolegliwości bólowych, poprawę zakresu ruchomości stawów, równowagi i funkcjonalności po wzięciu udziału w 4-tygodniowym programie ćwiczeń na bieżni wodnej, który zawierał komponent treningu równowagi i wytrzymałościowego.

**Słowa kluczowe:** gonartroza, staw kolanowy, terapia w wodzie, bieżnia wodna, trening, rehabilitacja, propriocepcja

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## INTRODUCTION

Arthrosis is the most frequent disease affecting the joints [1, 2]. The number of patients suffering from joint pain and deepening disability increases, especially in highly developed countries. According to the data by the World Health Organization, it is currently the fourth most common cause of mobility problem in females, and the eighth in males. This is also the main cause of pain and deterioration of the quality of life of the elderly [3]. Arthrosis causes for patients many problems of physical, psychological as well as social nature, especially for those at older age. The priority goal of treatment is the reduction of pain complaints, anxiety, improving joint function, and limitation of the risk of disability.

Arthrosis is a disease with complex etiology [4]. The risk factors of its development include constitutional factors, as well as the factors causing intra-articular mechanical changes, and external factors affecting the joint [3]. Gonarthrosis is the disease in which there occurs an imbalance between the processes of regeneration and degradation of the articular cartilage [5, 6]. The main symptoms include: pain, oedema, limitation of the function, and deformation of the joint. Osteoarthritis (OA) was considered as a cartilage disorder, which may be effectively treated surgically at advanced stages by arthroplasty. At present, OA is considered as a disease of the whole organ, which may be prevented and treated at early stages. Arthrosis of the knee joints develops slowly within 10-15 years, interfering with daily activities and ability to work [7]. One of the available, although new, forms of conservative treatment of gonarthrosis is *aquatic treadmill therapy*. There are no gold standards for exercises in the treatment of arthrosis, it is stated that patients with arthrosis who are not able to perform active free exercise due to pain caused by load, balance disorders, should start therapy in the water environment [8, 9]. Exercises in an aquatic treadmill are the only form of aquatic exercises which allow a high level of control over the intensity of training, where the depth of water, belt speed and the intensity of water flow may be regulated in order to create an equivalent energy demand between exercises on aquatic and land treadmills [10, 11, 12].

## AIM

Assessment of the effect of therapy using an *aquatic treadmill* on the functional status of persons with arthrosis.

## MATERIALS AND METHODS

The study included 15 patients with the symptoms of gonarthrosis (5 females and 10 males). The mean duration of

the occurrence of the symptoms of arthrosis was from 1-5 years. A pilot study was conducted at the Institute of Rural Health in Lublin. Patients participating in the study were treated in the Rehabilitation Centre at the Institute. The patients underwent specialist examination and were qualified for participation in the project. Before starting therapy and after its completion a subjective assessment of the effectiveness of interventions was performed using: an author-constructed questionnaire, VAS scale for the measurement of pain, and the Lequesne index of severity for arthrosis of the knee (*Lequesne Index 0-24*). An objective evaluation was carried out based on functional tests and measurements before and after interventions: 6-meter walk test on level ground, the test assessing the level of patient's mobility and the risk of falls 'Up and Go' (TUG), and measurement of the range of motion of the joint by means of a goniometer. The degree of severity of gonarthrosis was evaluated based on changes in the radiologic image according to the Kellgren-Lawrence Grading Scale. Fifteen patients diagnosed with gonarthrosis, based on X-ray, were underwent 20 therapeutic interventions on an aquatic treadmill (duration of intervention 20 min). All sessions of aquatic exercises were performed in the Rehabilitation Centre on an aquatic treadmill (FOCUS) in special footwear (Figure1), with the water level at the height of the xiphoid process. Water temperature was at 30°C, and air temperature - 24 °C. All treadmill adjustments during the protocol were performed by the same research assistant, who also provided oral encouragement during each training session. Observance of the exercise protocol was complete and none of the participants reported adverse effects, which suggests that



**Figure 1.** Aquatic treadmill therapy  
**Rycina 1.** Terapia w bieżni wodnej

exercises on an aquatic treadmill, including balance training, were well tolerated by patients with OA, and may be effective in the treatment of the symptoms of knee arthrosis.

The results obtained were statistically analyzed and graphically presented by means of Tables and Graphs. Analysis of the results was performed using the software package SSPS 19.0. In order to compare data obtained in tests prior to therapy with the results obtained after therapy, the Wilcoxon signed-ranks test and T-test were used.

## RESULTS

Fifteen patients with gonarthrosis (aged  $64.5 \pm 10.2$ ) completed a 4-week exercise cycle. The results of measurements included a visual-analogue scale for assessing pain, Time Up and Go (TUG) for balance, 6-meter walk test for mobility and Lequesne index for function. The exercise protocol included balance training on an aquatic treadmill using water jets to destabilize while standing, and achieved high ratings of perceived exertion during walking. The majority of patients participating in the study were urban inhabitants (60%), compared to rural inhabitants (40%). In 60% of the patients, obesity was observed based on the BMI value, in 6.7% – overweight, while the remainder had a normal body weight (Table 1). In 53.3% of patients, gonarthrosis occurred in both knee joints, in 40% – in the left knee joint, whereas in only one patient in the right joint (Table 2). The duration of knee joint osteoarthritis was: in 33.3% of patients  $\geq 5$  years, in 46.7% – 1-5 years, in 20% patients  $\leq 1$  year (Table 3). Based on the assessment of a radiogram the severity of the degenerative disease was evaluated according to Kellegren and Lawrence classification at II° in the right knee joint in 40% patients (Table 4), and in the left knee joint at III° in 33% of patients (Table 5).

Considering the fact that the applied Kolmogorov-Smirnov test showed discrepancies in the analyzed parameters from normal distribution, at the subsequent stages of analysis non-parametric tests were used. Changes in the results of tests which occurred

**Table 1.** BMI values in the examined group

**Tabela 1.** Wartości wskaźnika BMI w badanej grupie

	BMI	
	Frequency	Percentage
Slim build	1	6.7
Normal build	4	26.7
Overweight	1	6.7
Obesity	9	60.0
Total	15	100.0

**Table 2.** Site of arthrosis

**Tabela 2.** Umiejscowienie choroby zwyrodnieniowej

	Site of arthrosis	
	Frequency	Percentage
right knee	1	6.7
left knee	6	40.0
both knees	8	53.3
Total	15	100.0

**Table 3.** Duration of arthrosis

**Tabela 3.** Czas trwania choroby zwyrodnieniowej stawów

	Duration of arthrosis of knee joints	
	Frequency	Percentage
$\leq 1$ year	3	20.0
1 - 5 years	7	46.7
$\geq 5$ lat	5	33.3
Total	15	100.0

**Table 4.** Classification according to Kellegren-Lawrence scale – knee joint R (scale 0-4)

**Tabela 4.** Klasyfikacja wg skali Kellegrena Lawrence'a – staw kolanowy R (skala 0-4)

	Classification according to Kellegren-Lawrence scale – knee joint R (scale 0-4).	
	Frequency	Percentage
0	2	13.3
1	3	20.0
2	6	40.0
3	2	13.3
4	2	13.3
Total	15	100.0

**Table 5.** Classification according to Kellegren-Lawrence scale – knee joint L (scale 0-4)

**Tabela 5.** Klasyfikacja wg skali Kellegrena Lawrence'a – staw kolanowy L (skala 0-4)

	Classification according to Kellegren-Lawrence scale – knee joint L (scale 0-4)	
	Frequency	Percentage
0	1	6.7
1	3	20.0
2	4	26.7
3	5	33.3
4	2	13.3
Total	15	100.0

**Table 6.** Values of asymptotic significance (2-sided) obtained in T test for dependent samples on the level of significance  $\alpha = 0.05$  for the following tests: VAS, Lequesne, TUG, measurement of range of mobility

**Tabela 6.** Wartości istotności dwustronnej otrzymane w teście T dla prób zależnych na poziomie istotności  $\alpha = 0,05$  dla testów: VAS, Lequesne, TUG, pomiar zakresu ruchomości

T-Test	P
VAS change (in motion)	0.000
VAS change (at rest)	0.000
TUG change	0.000
Measurement of the range of mobility	0.041
Lequesne_before SUM - Lequesne_after SUM	0.00

after therapy were compared using the test for dependent samples. The test was carried out at the level of significance  $\alpha = 0.05$ . Table 6 presents the compilation of the results, statistically significant values were marked with red colour. The comparison of result

**Table 7.** Values of Z statistics and p-value obtained in Wilcoxon test for all variables in the examined group

**Tabela 7.** Wartości statystyki Z oraz p-value otrzymane w teście Wilcoxon dla wszystkich zmiennych w badanej grupie

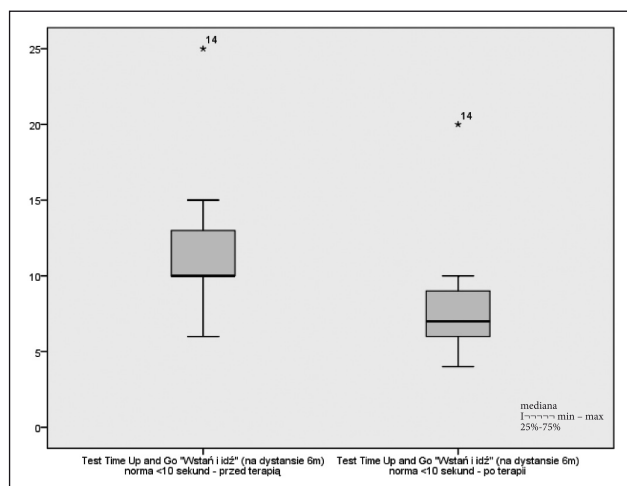
Wilcoxon matched pairs test	Range of R joint mobility after therapy flexion - Range of R joint mobility before therapy flexion -	Range of R joint mobility after therapy extension - Range of R joint mobility before therapy extension	Range of L joint mobility after therapy flexion - Range of L joint mobility before therapy flexion -	VAS scale (after) Assessment of intensity of pain complaints during movement 0 - lack of pain; 10- strongest pain VAS (before) Assessment of intensity of pain complaints during movement: 0 - lack of pain; 10 - strongest pain	0 - lack of pain; 10- strongest pain	Time Up and Go test (at a distance of 6m) normal <10 seconds - after therapy - Time Up and Go test (at distance of 6m) normal <10 seconds - before therapy	Lequesne_after_SUM Lequesne_before_SUM
Z	-3.208b	-2.000c	-3.247b	-3.352c	-2.388c	-3.453c	-3.356c
Asymptotic significance (2-sided)	0.001	0.046	0.001	0.001	0.017	0.001	0.001

obtained after 20 interventions with those obtained before the therapy, showed statistically significant differences ( $p < 0.05$ ) between the results of the tests performed. This concerned both pain complaints (VAS scale, Lequesne index of severity for arthrosis of the knee), as well as functional tests TUG, and measurement of the range of motion.

In turn, the Wilcoxon matched pair test was performed at the level of significance  $\alpha = 0.05$  (Table 7). While comparing p values in Wilcoxon test based on Z statistics with the level of significance  $\alpha = 0.05$ , statistically significant differences were observed between all the characteristics examined. It was found that pain intensity evaluated using the VAS scale decreased, the range of mobility in knee joints increased,

an improvement was also noted in function and mobility. Graphic interpretation of results obtained in Time Up and Go (TUG) and Lequesne index before and after therapy was presented using box plots (Figures 2, 3).

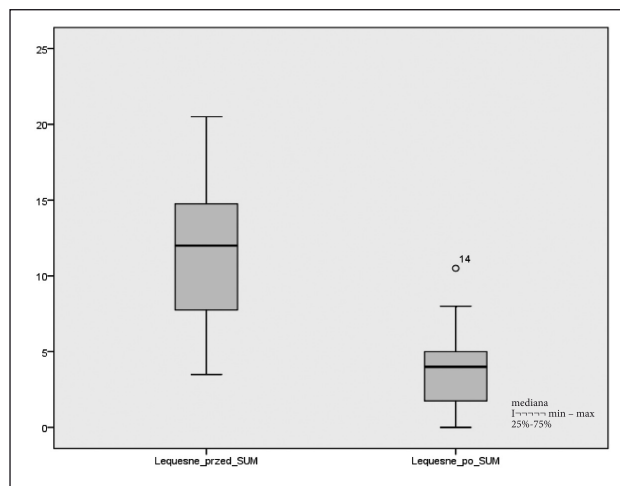
Therapy using an aquatic treadmill is a form of rehabilitation and performance training in patients with knee osteoarthritis. At present, the aquatic treadmill is one of the most modern devices designed for patient rehabilitation. It prevents injuries, decreases pain, restores or improves joint mobility. Water resistance improves the whole locomotor system, and decreases stiffness of the joints. It provides more benefits from exercises, lengthens the stride, simultaneously minimizes pain, and increases blood flow in patients.



median  
Time Up and Go test (at a distance of 6 m) normal < 10 seconds – before therapy.  
Time Up and Go test (at a distance of 6 m) normal < 10 seconds – after therapy.

**Figure 2.** Box plot (box and whisker plot) comparison of TUG test before and after therapy

**Rycina 2.** Wykres skrzynkowy (ramka-wąsy) porównanie testu TUG przed terapią i po terapii



median  
Lequesne before SUM  
Lequesne after SUM

**Figure 3.** Box plot (box and whisker plot) Lequesne's pain functional index before and after therapy

**Rycina 3.** Wykres skrzynkowy (ramka-wąsy) indeks bólowo-czynnościowy Lequesne'a przed terapią i po terapii

## DISCUSSION

In the study, the effectiveness of a 4-week exercise programme on an aquatic treadmill was evaluated in patients with knee osteoarthritis. An improvement of the majority of measurements was observed after the 4-week training period, which confirmed the research hypothesis. Therapy in water cannot replace land therapy, but offers its supplementation or even acceleration. The correct usage of the properties of the water environment offers many benefits in the rehabilitation process at its individual phases. Water is an excellent environment for performing exercises improving the range of motion in the joints, proprioception and muscle strength in the lower extremity. Through the degree of immersion, exercises in deep or shallow water, using an additional resistance or turbulence, it is possible to adjust the degree of difficulty of exercises to the goals the patient wishes to achieve. Nevertheless, it should be remembered that the progression of exercises, similar to land therapy, depends mainly on the degree of functional fitness of a patient [13, 14]. Denning et al. [11] compared the effectiveness of an aquatic and land treadmill in patients with knee arthrosis. The key observation in their study was that after just three 20-minute exercises of a moderate intensity, the participants showed a considerable reduction of pain complaints ( $p = 0.01$ ) to the benefit of training in the water environment [ES] = 0.49 and 1.12, respectively. Therapy in water, in some aspects, helps to optimize the rehabilitation process [15]. Additionally, it allows prevention of the hazardous effect of immobilization – muscle atrophy, limited mobility, increase in pain [14]. This is confirmed by own study. According to Hassan et al. [16, 17], while designing the training on an aquatic treadmill for patients with gonarthrosis, it is important to incorporate balance training component, because many patients with OA showed balance deficits, compared to older persons from the control group. Balance disorders and older age of patients increase the risk of falls [8, 18]. Water properties play a crucial role in the rehabilitation of patients with knee arthrosis. Depending on the level of immersion in water, rehabilitation may take place at various levels of loading. This is especially beneficial when a patient does not tolerate a full load, or has a doctor's orders to avoid it. In their study, Krekora et al. [19] observed that together with an increase in BMI there also occurs an increase in pain complaints and an advancement in the limitation of the knee joint function. In such cases, the alternative form of therapy are exercises on an aquatic treadmill. The viscosity of water, on the one hand, allows resistance to movement, and on the other hand, unloads the joints and reduces the risk of fall. A lower water temperature decreases oedema, while a higher temperature shows anti-pain and relaxation effects [14]. The water environment, due to its properties, provides a patient with support, reduction of anxiety of a fall in water, as well as difficulties during performing exercises through turbulences.

Maki et al. [20], while investigating the optimum training techniques in order to improve balance in the elderly, state that sensory training and resistance exercises are necessary [18].

A basis for these recommendations is facilitating balance reactions and an increase in muscle strength. From this point of view, it is justifiable to consider the destabilizing agent and strength training in patients with gonarthrosis on an aquatic treadmill. The use of a water jet (counter-current) while standing serves as a training technique in the therapy of coordination and balance disorders in the water environment. The application of a stream of water while standing may also serve as an effective method for increasing the intensity of exercises and muscle strength [10]. The latest evidence confirms the use of short-lasting high-intensity interval training (HIT) as the method for improving physical fitness and proprioceptive neuromuscular facilitation [21, 22, 23]. High-intensity interval training may be especially beneficial for patients with OA, because it not only increases muscle strength, but may also be completed in a relatively short time which may mobilize the patient to actively participate in therapy [8, 24, 25].

## CONCLUSIONS

1. In the study, after a 4-week aquatic treadmill exercise programme containing a component of balance and endurance training, the following were observed: reduction in pain complaints, improvement of the range of joint mobility, balance and function.
2. Aquatic therapy may be an effective form of supplementation of therapy in patients with gonarthrosis. The progression of aquatic exercises can slightly precede the progression on land, which may contribute to the acceleration of the effects of rehabilitation.
3. Water buoyancy reduces relative body weight, which reduces joint load. Exercises on an aquatic treadmill may be used by older persons who suffer from osteoarthritis, as well as by younger persons, in the course of development where other types of therapy are not yet indicated.

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The Authors declare no conflict of interest

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# Effect of Immobilization on Changes in Blood Glucose and Cholesterol Concentration in the Examined Mice – Preliminary Studies

## Wpływ immobilizacji na zmiany koncentracji glukozy i cholesterolu we krwi badanych myszy – badania wstępne

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### SUMMARY

**Introduction:** Immobilization in animals may be an analogue of strong neurogenic stress in humans, in which an adaptive reaction aimed at energy mobilization of the system seems seemingly insignificant. The animal does not move, so it does not lose energy. However, there is an energy mobilization of the organism in which most regulatory organs and systems participate.

**Aim:** To assess the extent of possible changes in glucose and plasma cholesterol concentration in mice subjected to immobilization.

**Material and Methods:** The study was conducted on 40 female Swiss mice at the age of 12 weeks unselected and selected for a high rate of weight gain. Plasma concentrations of glucose and total cholesterol were determined.

**Results:** Immobilization caused a significant reduction in glucose concentration (83%) and a significant increase in cholesterol (121%) in the plasma of mice selected in comparison to the control group. [From the analysis of multidirectional variance the significance of statistically confirmed differences induced by selection was revealed in relation to glucose [F = 21.81] and plasma cholesterol [F = 45.63].

**Conclusions:** The selection for high body weight had a significant effect on the level of the examined indicators. This may indicate that selected mice obtained greater protein gain in the form of larger body increases, with lower glucose levels, were forced to work more economically at the cellular level, managing their structural and energetic metabolites more carefully.

**Key words:** stress, immobilization, glucose, cholesterol

### STRESZCZENIE

**Wstęp:** Unieruchomienie u zwierząt może być analogiem silnego stresu neurogenego u ludzi, w którym reakcja adaptacyjna mająca na celu mobilizację energetyczną ustroju wydaje się pozornie bez znaczenia. Zwierzę nie porusza się, więc nie traci energii. Dochodzi jednak do mobilizacji energetycznej organizmu, w której bierze udział większość organów i układów regulacyjnych.

**Cel:** Ocena zakresu ewentualnych zmian koncentracji glukozy i cholesterolu w osoczu i w wątrobie myszy poddanych immobilizacji.

**Materiał i metody:** Badania przeprowadzono na 40 samicach myszy linii Swiss w wieku 12 tygodni nieselekcjonowanych i selekcjonowanych na wysokie tempo przyrostu masy ciała. W osoczu oznaczono koncentrację glukozy i cholesterolu całkowitego.

**Wyniki:** Immobilizacja spowodowała istotne obniżenie koncentracji glukozy (83%) zaś znamienny wzrost cholesterolu (121%) w osoczu myszy selekcjonowanych w porównaniu z grupą kontrolną. Z analizy wariancji wielokierunkowej istotność różnic potwierdzonych statystycznie wywołanych selekcją ujawniła się w odniesieniu do glukozy [F=21.81] i cholesterolu w osoczu [F=45.63].

**Wnioski:** Selekcja na wysoką masę ciała miała znamienny wpływ na poziom badanych wskaźników. Świadczyć to może, że myszy selekcjonowane uzyskując większy przyrost białka w postaci większych przyrostów ciała, przy niższym poziomie glukozy, już na poziomie komórkowym były zmuszone pracować bardziej ekonomicznie, ostrożniej gospodarując swoimi metabolitami strukturalnymi i energetycznymi.

**Słowa kluczowe:** stres, immobilizacja, glukoza, cholesterol

## INTRODUCTION

Stress is caused by sudden, strong IT and energy stimulation [1-4]. The response to this stimulation is generated at the molecular and cellular level, which is also confirmed by numerous earlier analyzes of this phenomenon [5-9]. Immobilization causes a metabolic imbalance of both humans and animals [10]. During immobilization, under conditions of reduced muscle activity, which seems paradoxical, the metabolic rate and energy intensify. Hypermetabolism associated with immobilization can be attempted to explain both by the accelerated reactions of the central nervous system and its effect on metabolism, mainly of skeletal muscles. It is also known that the longer staying of muscle fibers in a state of contraction and thus in a state of increased tension causes intensification of metabolic changes in them. Here come a suggestion that stress analysis should be devoted to further experiments on changes under the influence of immobilization as an example of a stress factor.

## AIM

The aim of the study is to assess the extent of possible changes in glucose and cholesterol concentration in plasma and liver of unselected and selected mice undergoing immobilization.

## MATERIAL AND METHODS

The study was carried out on 20 female 12-week-old Swiss mice with an average body weight of 30-35 grams, selected for 24 generations avoiding kinship at a high rate of weight gain and 20 unselected (control), with an average body weight of 18-20 grams whose parents were randomly associated.

Animals of both groups were randomly selected from the entire population from the breeding of the Institute of Genetics and Animal Breeding of the Polish Academy of Sciences in Jastrzębiec. All individuals were kept in standard farm conditions in a room with a temperature of 22 degrees Celsius and natural photoperiodism, on average 12 hours of light and 12 hours of darkness. The animals were fed a homogeneous "Murigran" industrial mix (16% protein) produced at the Feed and Mixture Factory in Motycz near Lublin. They were provided with constant access to water in the form of automatic teats and bottles mounted in the mesh of the cage cover.

Selection was carried out when the mice were 42 days old.

All mice were divided into groups of 10 according to the following scheme:

- Control group – unselected mice.
- Group – unselected mice undergoing 48 hours immobilization.
- Control group – selected mice.
- Group – selected mice undergoing 48 hours immobilization.

Control mice groups (I and III) were not disturbed throughout the experiment. Group II and IV were subjected to 48 hour immobilization, enabling them to eat food and providing them with constant access to water.

After sufficient time, mice were decapitated and blood was drawn into heparinized tubes, centrifuged in an MPW 211 centrifuge for 10 minutes at 3.5 thousand rotations/minute. Liver sections were also collected and perfused with chilled air to + 4 degrees Celsius with 0.9% sodium chloride, ground and suspended in 0.1 M phosphate buffer pH 7.4 with 10mM EDTA, followed by homogenization at 12.000 rotations/minute in a Janetzky K24 centrifuge.

In the obtained liver supernatants and in blood plasma, the concentration of glucose and total cholesterol was determined based on enzymatic methods using Bio-Lachema-Test diagnostic tests. The concentration of these indicators in the liver was expressed in  $\mu\text{moles/gram}$  of fresh tissue in blood plasma in  $\text{mmol/liter}$  of plasma.

The data results were statistically analyzed using the Harvey statistical program. Medium values  $\bar{x}$  and standard deviations  $S_d$  of indices in plasma and liver were calculated in control and experimental groups of selected and unselected mice as well as statistical significance according to the Student's "t" test.

## RESULTS

As can be seen in Table 1, the stress of immobilization caused a significant reduction in plasma and liver glucose concentration of the mice selected to 83% and 84% compared to the values in the control mice group. Unselected mice showed no statistically confirmed differences (Table 2).

As it results from multidirectional variance analysis Tables 3-6, the significance of statistically confirmed differences induced by selection was revealed in relation to liver glucose

**Table 1.** Glucose concentration in plasma and liver in unselected and selected mice in control and experimental groups; n = 10; control activity = 100% [own study]

**Tabela 1.** Koncentracja glukozy w osoczu i wątrobie myszy niselekcjonowanych i selekcjonowanych w grupach kontrolnych i eksperymentalnych; n=10; aktywność kontroli=100% [opracowanie własne]

Tissue/organ	Mice group	Control		Immobilization	
		$\bar{x}+S_d$	$\bar{x}+S_d$	$\bar{x}+S_d$	%
Plasma mmol/l	Unselected	106.9+58.5	95.1+39.5		89
	Selected	121.4+59.7	100.8+28.5*		83
Liver $\mu\text{mol/gram}$	Unselected	0.063+0.03	0.057+0.01		90
	Selected	0.096+0.07	0.081+0.02*		84

\*p<0.05; \*\*p<0.01; \*\*\*p<0.001 – statistically confirmed result

**Table 2.** Cholesterol concentration in plasma and liver of unselected and selected mice in control and experimental groups; n = 10; control activity = 100% [own study]**Tabela 2.** Koncentracja cholesterolu w osoczu i wątrobie myszy nieselekcjonowanych i selekcjonowanych w grupach kontrolnych i eksperymentalnych; n=10; aktywność kontroli=100% [opracowanie własne]

Tissue/organ	Mice group	Control	Immobilization	%
		$\bar{x}+S_d$	$\bar{x}+S_d$	
Plasma mmol/l	Unselected	111.8+53.2	123+39.0	110
	Selected	57.0+27.9	69.0+15.5*	121
Liver $\mu$ mol/gram	Unselected	0.042+0.03	0.044+0.01	104
	Selected	0.036+0.01	0.040+0.02	112

\*p&lt;0.05; \*\*p&lt;0.01; \*\*\*p&lt;0.001 – statistically confirmed result

Table 2 shows that the immobilization stress caused a significant increase in cholesterol concentration up to 121% in the plasma of the selected mice.

**Table 3.** Analysis of variance for plasma glucose [own study]**Tabela 3.** Analiza wariancji dla glukozy w osoczu [opracowanie własne]

Variation source	DF	Sum of squares	Medium square	F	F <sub>tab</sub>
Selection	1	0.002101	0.002101	0.048	0.8271
Group	3	0.063937	0.012787	0.292	0.9164
Selection x group	3	0.014603	0.002921	0.067	0.9954
Residue	132	5.788810	0.043855		

Medium=1.97849; Error=0.2094; CV=10.58; R squared= 0.014; R=0.117;

**Table 4.** Analysis of variance for liver glucose [own study]**Tabela 4.** Analiza wariancji dla glukozy w wątrobie [opracowanie własne]

Variation source	DF	Sum of squares	Medium square	F	F <sub>tab</sub>
Selection	1	0.033245	0.033245	21.805*	0.010
Group	3	0.002757	0.000551	0.362	0.8745
Selection x group	3	0.001431	0.000286	0.188	0.9648
Residue	132	0.201255	0.001525		

Medium=0.07497; Error=0.03905; CV=52.08; R squared= 0.157; R=0.396;

**Table 5.** Analysis of variance for cholesterol in plasma [own study]**Tabela 5.** Analiza wariancji dla cholesterolu w osoczu [opracowanie własne]

Variation source	DF	Sum of squares	Medium square	F	F <sub>tab</sub>
Selection	1	10.270423	10.270423	45.633*	0.010
Group	3	0.664747	0.132949	0.591	0.7095
Selection x group	3	0.027841	0.005568	0.025	0.9002
Residue	132	29.708558	0.225065		

Medium=0.83280; Error=0.47441; CV=56.97; R squared= 0.270; R=0.519;

**Table 6.** Analysis of variance for cholesterol in the liver [own study]**Tabela 6.** Analiza wariancji dla cholesterolu w wątrobie [opracowanie własne]

Variation source	DF	Sum of squares	Medium square	F	F <sub>tab</sub>
Selection	1	0.000900	0.000900	1.579	0.2111
Group	3	0.004884	0.000977	1.714	0.1347
Selection x group	3	0.000312	0.000062	0.109	0.9880
Residue	132	0.075246	0.000570		

Medium=0.04200; Error=0.02388; CV=56.85; R squared= 0.075; R=0.274

( $F = 21.805$ ) and plasma cholesterol ( $F = 45.633$ ). The interaction between the selection and the group of animals subjected to immobilization was not significant with respect to any of the parameters tested.

## DISCUSSION

The mechanism of adaptive changes in which the hypothalamic-pituitary-adrenal axis plays fundamental role, has a complex course and although it allows “survival” in a particular stressful situation, it can cause a set of harmful reactions leading to disease disorders. Changes in the body’s adaptive fitness can occur under the influence of various factors, i.e. changes in environmental conditions or lifestyle.

The impact of negative environmental factors on animal performance has long been known. Animal adaptation is a reaction to specific and not always favorable environmental conditions. Therefore, for economic reasons it is desirable to increase the adaptability of animals by carrying out the selection for a specific characteristic. The importance of stress as a phenomenon adversely affecting life processes and the productivity of farm animals has already been described [11]. On the other hand, for economic reasons, it is desirable to increase the adaptability of animals by carrying out the selection so that it does not contribute to reducing their resistance to stressors.

## IMMOBILIZATION

Immobilization is considered an example of typical not only physical but also neurogenic stress [1, 5]. Under conditions of complete or partial limitation of the ability to perform movements, the load on the motor apparatus changes and hemodynamic changes in the body are revealed. Lack of motor activity or its long-term reduction lead to many undesirable symptoms [12]. At the end of the first week in bed, human disturbances in the water and electrolyte balance are revealed. Increased urinary excretion of electrolytes and nitrogen can also be seen, as well as increased blood clotting. Protein catabolism has also been found to increase, resulting in a decrease in blood glucose, inhibition of somatotropin secretion, and gastric acid secretion disorders most likely associated with an increase in metabolic rate and an energy deficit. An increase in corticoid blood in mice, as well as adrenaline and corticosterone concentration was also visible [13]. Because immobilization stress is a neurogenic-physical stimulation, it seems to be particularly difficult to interpret at the molecular level.

## GLUCOSE

Glucose is practically the only source of energy used by the brain in physiological conditions. It consumes about 75% of all blood-borne glucose. The remaining 25% use other tissues, mainly muscles and erythrocytes. Still other tissues may use, for example, free fatty acids provided by the blood as energy material. They can also synthesize, such as liver glucose, from non-carbohydrate precursors during gluconeogenesis. However, with limited physical exertion, e.g. muscles do not show increased demand for their own glycogen and glucose supplied to them from the liver [14-19].

48-hour immobilization, on the other hand, significantly reduced glucose in the liver and selected mice (up to 84%) and in their plasma (up to 83%).

## CHOLESTEROL

Disruption of homeostasis by environmental thrusters is manifested not only in hormonal mobilization adequate to the thrust, but also in biochemical changes occurring in cells and tissues [21].

Cholesterol is sometimes interpreted as one of the lipid physiological indicators that cannot be omitted in the interpretation of stress reactivity. As is known, its concentration in the blood is often associated with fat and protein content in the diet [21-23].

The 48 hour immobilization resulted in a significant increase in plasma cholesterol glucose concentration in 121% of selected mice. The observed increase in cholesterol concentration may indicate the metabolic plasticity of animals exposed to immobilization.

## SELECTION

Selection of laboratory animals is widely used in animal husbandry to obtain highly efficient individuals. It gives a selective advantage to individuals with higher parameters of some phenotypic features considered as economically important. However, it is known that animals selected for high productivity are more susceptible to harmful environmental conditions and less resistant to diseases.

Selection of animals for a specific useful characteristic leads to very efficient individuals due to a specific breeding purpose, but these animals require maintaining comfortable breeding conditions. Even the most favorable genotypes in the face of changes in the environment are not able to reveal their potential possibilities. Hence, intensive and long-term selection for selected features can be “overly effective”, that is, there may be unwanted changes in other characteristics that lead to the population losing its plasticity or ability to respond to the effects of a changing environment.

It is known, for example, that the selection of laboratory animals for low body weight results in reduced fertility and higher mortality of offspring. Similar results were obtained in some cases of selection for high body weight, or high weight gain. It has also been shown that long-term selection of mice for high weight gain increases negatively not only reproduction, but also life expectancy [11].

Therefore, selection is also a means of causing genetic progress of production traits in animals, but also of the loss of certain genetic resources conditioning resistance to the effects of e.g. mutagenic or stress factors, and thus the loss of broadly understood adaptation.

## CONCLUSIONS

Based on the results obtained, the following conclusions can be made:

Analysis of multifactorial variance revealed the statistical significance of differences induced by selection in terms of liver glucose and plasma cholesterol.

In mice selected under the effect of 48 hours immobilization, plasma cholesterol concentration increased and plasma and liver glucose levels decreased.

Selection for high body weight had a significant impact on the level of the indicators studied. This may indicate that selected mice obtaining a greater increase in protein in the form of greater body growth, with lower glucose levels, were already forced to work more economically at the cellular level, more carefully managing their structural and energy metabolites.

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The Authors declare no conflict of interest

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A – Research concept and design, B – Collection and/or assembly of data, C – Data analysis and interpretation, D – Writing the article, E – Critical revision of the article, F – Final approval of article

# Zagrożenie depresją u adolescentów z chorobami reumatycznymi

## Risk of Depression in Adolescents and Young Adults with Rheumatic Diseases

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### STRESZCZENIE

**Wstęp:** Badanie miało na celu zwrócenie uwagi środowiska medycznego na aspekty zdrowia psychicznego młodych pacjentów jako czynnika, który znacząco wpływa na skuteczność leczenia chorób reumatycznych.

**Cel:** Sprawdzenie występowania ryzyka depresji wśród młodzieży i młodych dorosłych z chorobami reumatycznymi.

**Materiał i metody:** Badanie zostało przeprowadzone w grupie 68 osób młodzieży i młodych dorosłych (18-22 lata) z chorobami reumatycznymi. Grupa kontrolna składała się ze 102 młodych dorosłych (18-22 lata) bez zdiagnozowanej choroby przewlekłej. Ryzyko depresji mierzone za pomocą narzędzia przesiewowego – Kutcher Adolescent Depression Scale (KADS).

**Wyniki:** Analiza wykazała, że prawdopodobieństwo wystąpienia depresji w badanej grupie wyniosło 35,3%. W grupie kontrolnej wskaźnik ten wynosił 19,6%. Wyniki były istotne statystycznie ( $p = 0,028$ ).

**Wnioski:** Wyniki badania dowodzą, że ryzyko depresji wśród nastolatków i młodych dorosłych z chorobami reumatycznymi jest znacznie wyższe, niż u zdrowych młodych ludzi. Najwyższe ryzyko depresji wiąże się ze zmęczeniem, niskim poziomem energii i brakiem motywacji, a także z poczuciem zmartwienia, nerwowości, paniki, napięcia i lęku.

**Słowa kluczowe:** depresja, choroby reumatyczne, adolescenti

### SUMMARY

**Introduction:** The study is aimed at drawing the attention of the medical environment to the mental health aspects of young patients as a factor that significantly influences the efficiency of their rheumatic disease treatment.

**Aim:** This paper is to check the risk of depression among a group of adolescents and young adults with rheumatic diseases.

**Material and Methods:** The study was conducted among a group of 68 late adolescents and young adults (18-22 years old) with rheumatic diseases. The control group consisted of 102 young people (18-22 years old) without a diagnosed chronic disease. Risk of depression was measured using a screening tool – the Kutcher Adolescent Depression Scale (KADS).

**Results:** The analysis showed that the probability of depression in the study group was 35.3%. In the control group, this rate was 19.6%. The results were statistical significance ( $p=0.028$ ).

**Conclusions:** The results of this study prove that the risk of depression among adolescents and young adults with rheumatic diseases is significantly higher than in healthy young people. The highest risk of depression is related to feeling tired, fatigue, low energy levels and lack of motivation as well as feeling worried, nervous, panicky, tense, keyed-up and anxious.

**Key words:** depression, rheumatic disease, adolescents

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### WSTĘP

Choroby reumatyczne, powszechnie uznawane za rzadkie, dotyczą wg szacunków 1 na 4 dorosłych Amerykanów (są to stany zapalne stawów lub inne reumatyczne dolegliwości). Amerykańskie CDC (ang. *Centers for Disease Control and Prevention*), przewiduje że liczba ta będzie wzrastać, a w roku

2040 stany zapalne stawów będą dotyczyć 26% populacji dorosłej [1]. Spośród najczęściej stawianych diagnoz możemy wyróżnić przede wszystkim chorobę zwyrodnieniową stawów, reumatoidalne zapalenie stawów, dnę moczanową, toczeń rumieniowaty układowy, fibromialgię [2]. Choroby autoimmunologiczne (jak reumatoidalne zapalenie stawów

czy toczeń układowy) występują rzadziej, ale nadal dotykają znaczną część populacji [2]. Jest jednak wiele chorób reumatologicznych, które dotyczą również młodych ludzi; 7% dorosłych Amerykanów w wieku 18-44 lata miało zdiagnozowane reumatoidalne zapalenie stawów [3] (rzs może dotknąć 0,2% osób w wieku 20 lat [2]).

W zakresie opieki nad młodymi osobami z chorobami reumatycznymi coraz częściej podkreśla się istotność świadomego włączania pacjenta w proces leczenia. Edukacja pacjentów w zakresie ich choroby, a co za tym idzie, aktywne ich zaangażowanie prowadzi do istotnej poprawy wyników klinicznych. Nie bez znaczenia pozostaje też fakt zmniejszenia dzięki temu kosztów opieki zdrowotnej [4]. Wymaga to jednak poznania grupy społecznej jaką są osoby chorujące na schorzenia reumatyczne. Celem więc staje się zrozumienie potrzeb, priorytetów młodych chorych ludzi [3].

Z badań wynika, że głównym problemem młodych z chorobami reumatologicznymi jest obawa, że nie zostaną zaakceptowani jako pełnosprawni członkowie społeczeństwa [3]. Uczucie to wynika ze strachu przed niepełną kontrolą nad swoim życiem ze względu na nieprzewidywalny przebieg choroby. Codziennymi doświadczeniami tych pacjentów są zwykle ból i zmęczenie, a to nierzadko ogranicza zdolność do pracy, czy też zdolność do uczestnictwa w społecznych aktywnościach [2]. Ponadto, chorym reumatologicznym towarzyszy często ból przewlekły. U osób z bólem przewlekłym występuje większe ryzyko samobójstw. Jest to szczególnie związane z rodzajem bólu, jego intensywnością i czasem trwania oraz bezsennością, która mu towarzyszy. Depresja dotyka chorych reumatycznych dwa razy częściej w porównaniu z populacją. Współistnienie tych dwóch chorób wpływa na zwiększenie kosztów służby zdrowia, większą ilość zwolnień z pracy oraz utraty pracy [2].

Ważnym tematem okazuje się być także przejście z opieki medycznej pediatrycznej a tej skierowanej do osób dorosłych. Związane jest to z procesem transformacji tożsamości społecznej [5]. Zamiast skoordynowanego, zaplanowanego działania, obecnie jedna na dwie młode osoby nie doświadczają skutecznego przeniesienia do reumatologii dorosłych [6, 7]. Mają poczucie przejścia do nowego nieznanego środowiska bez przygotowania ich rodziny [8]. Często towarzyszy im uczucie przebywania w zawieszaniu, co generuje dodatkowy niepokój. Uznaje się, że proces wzmocnienia pacjenta w fazie przejściowej powinien rozpocząć się jak najwcześniej, aby upewnić się, że młodzi ludzie są gotowi na przejście do opieki dla dorosłych [8].

Istotnym wydaje się tu być także temat wpływu przebiegu choroby na życie seksualne. Opisuje się, że 70-80% badanych ma problemy w tym zakresie funkcjonowania. Odczuwają oni dyskomfort, brak zainteresowania seksualnego, czy też postrzeganie swojego ciała jako mało atrakcyjnego [3] – w przeciwieństwie do dorosłych reumatycznych, u których to współwystępowanie zaburzeń zdrowia psychicznego indukuje powstanie zaburzeń seksualnych, nie sama choroba reumatyczna (a te czynniki, które w ogólnej populacji wpływają na seksualność jak otyłość, palenie tytoniu, zaburzenia sercowo-naczyniowe nie mają wśród pacjentów reumatycznych większego znaczenia [3]).

Wartym zaznaczenia jest także temat obawy młodych kobiet z chorobami reumatycznymi o możliwość, zarówno zajścia w ciążę,

ale też wejścia w rolę dobrej matki, tj. pogodzenia macierzyństwa ze swoimi codziennymi dolegliwościami wynikającymi z przebiegu choroby [9]. Dużą rolę w tym zakresie odegrało powstanie zaleceń dotyczących planowania reprodukcji u kobiet z toczeniem układowym i zespołem antyfosfolipidowym [10].

W raporcie PARE Youth europejskiej organizacji zrzeszającej osoby z chorobami reumatycznymi (PARE), podkreślono istotę zdrowia psychicznego na przebieg choroby. Ponad 90% młodych chorych podkreśla znaczenie i występowanie tych zaburzeń (jednakże z pomocy psychologicznej korzysta jedynie 17%). Tymczasem w grupie dorosłych reumatycznych odsetek ten utrzymuje się na poziomie 30%-60% [1,11]. Jednoznacznie wskazuje to na konieczność zwrócenia uwagi na stan psychiczny młodych osób z chorobami reumatologicznymi, a tym samym konieczność wprowadzenia szybkiej interwencji psychologicznej. Prowadzenie działań edukacyjnych podnoszących ich wiedzę na temat krótko- i długoterminowych skutków leczenia [12], czy też skutków przyjęcia lub zaniechania leczenia powinno istotnie wpłynąć na zmniejszenie poziomu niepokoju [5].

## CEL

Celem pracy jest sprawdzenie ryzyka wystąpienia depresji w grupie adolescentów z chorobami reumatycznymi. Podjęte badanie ma zwrócić uwagę środowiska medycznego na aspekt kondycji zdrowia psychicznego młodych chorych, jako czynnika istotnie wpływającego na skuteczność podstawowego leczenia choroby reumatycznej.

## MATERIAŁ I METODY

Badaniu poddano 68 osób z chorobami reumatycznymi w okresie adolescencji późnej w wieku 18-22 lata. W grupie badanej najliczniejszą grupę stanowiły osoby z rozpoznaniem MIZS (młodzieńcze idiopatyczne zapalenie stawów) – 20 osób, RZS (reumatoidalne zapalenie stawów) – 15 osób, TRU (toczeń rumieniowaty układowy) – 11 osób, spondyloartrypatie, niezróżnicowane zapalenie stawów – 8 osób oraz ŁZS (łuszcycowe zapalenie stawów), ZZSK (zesztywniające zapalenie stawów kręgosłupa) – 3 osoby. Kryterium włączenia stanowiło zdiagnozowanie choroby reumatycznej oraz wiek mieszczący się w adolescencji późnej. Grupę kontrolną stanowiły 102 osoby w stadium adolescencji późnej w wieku 18-22 lata, jednak bez rozpoznania choroby przewlekłej.

Do określenia prawdopodobieństwa wystąpienia depresji zastosowano przesiewowe narzędzie (Skala Depresji Adolescentów według Kutchera) – KADS (ang. *Kutcher Adolescent Depression Scale*). KADS został opracowany w celu pomocy w zakresie zdrowia publicznego i klinicznej identyfikacji zagrożenia depresją u młodych ludzi. Został stworzony przez klinicystów z doświadczeniem w dziedzinie oceny depresji młodzieży przy rozwoju i zastosowaniu różnych skal i narzędzi w klinicznych badaniach i formalnym otoczeniu. Prace nad KADS zostały przeprowadzone na grupach uczniów szkół średnich, w warunkach klinicznych oraz w zakresie projektów badawczych. Narzędzie jest skalą samoopisową dla osób w wieku od 12 do 22 lat. Zalecono je do wykorzystania w wielu raportach eksperckich, w tym w Krajowym Instytucie Oceny Klinicznej (UK) i wytycznych GLAD-PC

(USA i Kanada) [13]. KADS został przetłumaczony na wiele różnych języków i jest używany globalnie. W 2013 roku dokonano polskiej adaptacji KADS [14].

## WYNIKI

Na zbiorze danych wykonano analizy częstości, testy „t” równości średnich dla grup niezależnych wraz z obliczeniem istotności statystycznej uzyskanych różnic oraz analizy tabel kontyngencji wraz z obliczeniem współczynnika kontyngencji (korelacji). Przyjęto poziom istotności statystycznej 0,05. Wszystkie analizy przeprowadzone zostały w oparciu o program statystyczny SPSS w wersji 4.0.

Badania wykazały, że prawdopodobieństwo wystąpienia depresji w grupie chorych na choroby reumatyczne wynosi 35,3% (taki odsetek badanych z grupy chorych uzyskał wynik KADS informujący o możliwości wystąpienia depresji). W grupie kontrolnej (zdrowych) odsetek ten wynosi 19,6%. Aby sprawdzić, czy średnia wyników KADS w grupach zdrowych i chorych różni się w sposób istotny statystycznie, wykona-

no „test t” równości średnich w grupach niezależnych. Test ten wskazuje na dwustronną istotność statystyczną:  $p=0,028$ . A zatem wyniki KADS różnią się w analizowanych grupach w sposób istotny statystycznie (tabela 1-3).

Współczynnik kontyngencji wynosi 0,173, co jest wartością umiarkowaną. Istotność statystyczna  $p=0,22$ .

Najwyższe wyniki w kwestionariuszu KADS w grupie osób chorych uzyskano w pytaniu 3 (uczucie wyczerpania fizycznego, zmęczenie, braku energii, braku motywacji, nie-radzenia sobie ze sprawami, które uprzednio nie sprawiały kłopotów) – średnia wyników 1,31 oraz 5 (uczucie zmartwienia, zdenerwowania, paniki, napięcia, poirytowania, niepokoju) – średnia wyników 1,16. Najniższe wyniki uzyskano w pytaniu 6 kwestionariusza (myśli, plany albo czyny samobójcze czy samoszkodzące) – średnia wyników 0,15 (tab. 4).

Dokonano również analizy zależności prawdopodobieństwa wystąpienia depresji w zależności od płci badanych. Stwierdzono, że większe prawdopodobieństwo występowania depresji dotyczy grupy kobiet. Różnica ta (między grupą mężczyzn a kobiet)

**Tabela 1.** Prawdopodobieństwo depresji w grupie chorych

	KADS	Częstość	Procent	Procent ważnych	Procent skumulowany
Ważne	Możliwa depresja	24	35,3	35,3	35,3
	Prawdopodobnie brak depresji	44	64,7	64,7	100,0
	Ogółem	68	100,0	100,0	

Źródło: opracowanie własne

**Tabela 2.** Prawdopodobieństwo depresji w grupie kontrolnej

	KADS	Częstość	Procent	Procent ważnych	Procent skumulowany
Ważne	Możliwa depresja	20	19,6	19,6	19,6
	Prawdopodobnie brak depresji	82	80,4	80,4	100,0
	Ogółem	102	100,0	100,0	

Źródło: opracowanie własne

**Tabela 3.** Prawdopodobieństwo depresji w grupie badanej i grupie kontrolnej – tabela krzyżowa

		Grupa		Ogółem
		Zdrowi	Chorzy	
KADS	Możliwa depresja	19,6%	35,3%	25,9%
	Prawdopodobnie brak depresji	80,4%	64,7%	74,1%
	Ogółem	100,0%	100,0%	100,0%

Źródło: opracowanie własne

**Tabela 4.** Wyniki w grupie chorych w poszczególnych pytaniach w kwestionariuszu KADS

	N	Minimum	Maksimum	Średnia	Odchylenie standardowe
KADS-1	68	0	3	0,76	0,883
KADS-2	68	0	3	0,65	0,806
KADS-3	68	0	3	1,31	0,885
KADS-4	68	0	3	0,81	0,918
KADS-5	68	0	3	1,16	0,987
KADS-6	68	0	2	0,15	0,466
N Ważnych (wyłączenie obserwacji)	68				

Źródło: opracowanie własne



nie jest jednak istotna statystycznie, na co wskazuje wartosc istotnosci wspolczynnika kontyngencji  $p=0,088$  (tab. 5).

**Tabela 5.** Prawdopodobienstwo depresji w zaleznosci od plci badanych

		PŁEĆ		
		Męczyzna	Kobieta	Ogółem
KADS	Mozliwa depresja	20,0%	41,7%	35,3%
	Prawdopodobnie brak depresji	80,0%	58,3%	64,7%
	Ogółem	100,0%	100,0%	100,0%

Źródło: opracowanie własne

Dokonano również analizy zaleznosci prawdopodobienstwa wystapienia depresji w zaleznosci od wieku badanych – zastosowano podzial na dwie kategorie: do 19 lat oraz 20 i więcej lat. Stwierdzono, że większe prawdopodobienstwo wystepowania depresji dotyczy badanych do 19 lat. Różnica ta nie jest jednak istotna statystycznie, na co wskazuje wartosc istotnosci wspolczynnika kontyngencji  $p=0,140$  (tab. 6).

**Tabela 6.** Prawdopodobienstwo depresji w zaleznosci od wieku badanych

		WIEK GRUPY		
		do 19 lat	20 i więcej lat	Ogółem
KADS	Mozliwa depresja	46,2%	28,6%	35,3%
	Prawdopodobnie brak depresji	53,8%	71,4%	64,7%
	Ogółem	100,0%	100,0%	100,0%

Źródło: opracowanie własne

## DYSKUSJA

Przewlekłe zapalne choroby reumatyczne, takie jak reumatoidalne zapalenie stawów, ma bardzo duży wpływ na wynik oceny jakosci zycia tych pacjentów [15]. Ich choroby zaburzają codzienne funkcjonowanie, takie jak podjecie pracy zawodowej, zycie rodzinne, podejmowanie aktywnosci rekreacyjnych. Te aspekty ludzkiego funkcjonowania zwykle są niedoceniane przez lekarza prowadzacego, przyjaciół pacjenta czy nawet rodzinę. Ponadto, bardzo ważnym aspektem jest mozliwosc wystepowania zaburzeń psychicznych z chorobami reumatycznymi [16, 17].

Przewlekły charakter opisywanych chorób, charakteryzujacych się stałym lub okresowym doświadczaniem bólu, wpływa na stan psychiczny pacjentów. Wykazują oni silne obawy dotyczace wpływu postepujacej choroby na ich codzienną aktywnosc, a co za tym idzie, na obciażenie opieką nad nimi innych osób [18]. W związku z tym miewają myśli samobójcze, czy też próby samobójcze, które mogą prowadzić do samobójstw dokonanych [19]. Wśród dolegliwosci towarzyszacych chorobom reumatycznym są także zaburzenia snu, czy objawy, takie jak stres, lęk i depresja [20]. Tymczasem współwystepowanie depresji wraz z zaburzeniami snu silnie wiąże się z ryzykiem samobójstwa. Ryzyko samobójstwa jest bardziej prawdopodobne u plci żeńskiej [21]. Biorąc pod uwagę to, że w wielu przypadkach u chorego reumatologicznego

wystepuje wiele czynników ryzyka, należy zwrócić szczególną uwagę na to aby kompleksowe leczenie tej grupy chorych, wykraczalo poza leczenie jednostki podstawowej [4].

Ponadto, choroby reumatyczne nie tylko powodują ograniczenie sprawnosci ale również prowadzą do uposledzenia zdrowia psychicznego, a przez to pogarszają jakośc zycia [22].

Należy również zwrócić uwagę na problem postawienia diagnozy depresji u chorych reumatologicznych. Ma to miejsce np. u pacjentów z RZS, u których objawy choroby oraz depresji, takie jak zmęczenie, utrata masy ciała, bezsenność, brak apetytu nakładają się na siebie i depresja często jest nierozpoznawana [23]. Dlatego użycie skali KADS jak w przedstawionym badaniu może być narzędziem bardzo pomocnym w tej grupie chorych. Zdiagnozowanie chorób współistniejacych, w tym depresji, może zwiększyć efektywnosc prowadzonej terapii [14].

Stan psychiczny chorego reumatologicznego koreluje z aktywnością choroby oraz stopniem nasilenia objawów, które będą wzrastać wraz ze zwiększeniem poziomu stresu u chorego [24].

Przed wszystkim ból w powiazaniu ze stanami obnizonego nastroju stanowią czynniki ryzyka zachowań samobójczych tych pacjentów. Stwierdzono, że zarówno myśli samobójcze, jak i skuteczne działania samobójcze wystepują częściej u pacjentów z toczniem układowym, fibromialgią i zapaleniem stawów [25]. Głównymi wyznacznikami były współwystepowanie depresji w fibromialgii [26] i zapaleniu stawów oraz choroba neuropsychiatryczna w toczniu układowym [25]. W oparciu o te wyniki należałoby wprowadzić system badań przesiewowych, które w szybki i skuteczny sposób zapobiegłyby zjawiskom samobójstw w grupach chorych na choroby reumatyczne [25]. Okazuje się bowiem, że ryzyko samobójstw rośnie w przypadku pacjentów z współistniejącymi chorobami psychicznymi (przede wszystkim depresją), a znacznie maleje w przypadku wystepowania jedynie rozpoznania choroby reumatologicznej. W jednym z badań stwierdzono, że pacjenci z fibromialgią, którzy wcześniej próbowali popełnić samobójstwo, mieli wyniki badań oceny ryzyka depresji znacznie wyższe, od tych którzy nigdy nie próbowali popełnić samobójstwa [19].

Badania potwierdzają, że wystapienie depresji jest bardziej prawdopodobne u osób z bólem dolnego odcinka kręgosłupa [27]. Zauważono w tej grupie, że współwystepowanie migren oraz psychogenicpain wiąże się z większym ryzykiem zgonu z powodu samobójstw [28].

## WNIOSKI

Prawdopodobienstwo wystapienia depresji u adolescentow z chorobami reumatycznymi jest znacząco wyższe niż w grupie zdrowych młodych osób.

Najwyższe wyniki prawdopodobienstwa depresji wiążą się z uczuciem wyczerpania fizycznego, zmęczeniem, brakiem energii, brakiem motywacji oraz z uczuciem zmartwienia, zdernerowania, paniki, napięcia, poirytowania, niepokoju.

Większe prawdopodobienstwo wystapienia depresji dotyczy kobiet, jednak różnica nie jest statystycznie istotna.

Większe prawdopodobienstwo wystapienia depresji dotyczy osób młodszych wśród późnych adolescentow, jednak różnica nie jest statystycznie istotna.

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# Assessment of Usability of Thermal Bicarbonate Mineral Water from the “Odra-5/I” Intake in Grabin Opole Silesia (SW Poland) for Therapeutic and Prophylactic Purposes

## Ocena możliwości wykorzystania zasobów szczaw termalnych z odwiertu „Odra-5/I” w Grabinie na Śląsku Opolskim do celów leczniczych i profilaktycznych

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### SUMMARY

Thermal bicarbonate mineral water belong to sought-after balneological resources. This kind of water are a balneological product and valuable raw material used in health resorts for the wider health strategy - prophylaxis and recreation. The discovery of thermal bicarbonate mineral water in Grabin near Opole in 1983 was purely incidental when a intake was made for the recognition of the geological structure of the crystalline basement of Mesozoic and Cenozoic sediments. Thermal bicarbonate mineral water existing in Grabin can be found in the Fore-Sudetic block and is a unique phenomenon. Its chemical composition, and especially high total mineral salt content of the waters from Grabin, indicate a type of mineral water unparalleled in Poland. The content of solids is much higher than in all other waters existing in e.g. Lower Silesian health resorts. Its special feature is also the source performance, which is 150-200m<sup>3</sup>/h and is unprecedented when compared to other sources in the region. The discovery of thermal bicarbonate mineral water in Grabin also puts a new light on the presence of perspective areas for drawing waters useful in medical care and prevention.

**Key words:** thermal bicarbonate mineral water, balneotherapy, crenotherapy, Grabin, Opole Silesia, SW Poland

### STRESZCZENIE

Szczawy termalne należą do poszukiwanych surowców balneologicznych. Ten rodzaj wód jest cennym tworzywem wykorzystywanym w uzdrowiskach w szeroko rozumianej strategii zdrowotnej - profilaktyce i rekreacji. Odkrycie w 1983 r. szczawy termalnej w Grabinie koło Opola nastąpiło przypadkiem przy okazji wykonania odwiertu do rozpoznania budowy geologicznej krystalicznego podłoża osadów mezozoicznych i kenozoicznych. Występujące w Grabinie szczawy termalne są na obszarze bloku przedsudeckiego zjawiskiem unikalnym. Skład chemiczny, a zwłaszcza duża sumaryczna zawartość soli mineralnych wód z Grabina, wskazuje na niespotykany w skali kraju typ wody mineralnej. Zawartość składników stałych jest w niej znacznie większa niż we wszystkich innych wodach występujących np. w uzdrowiskach Dolnego Śląska. Cechą szczególną jest również wydajność źródła, która wynosi 150-200 m<sup>3</sup>/h i jest nieporównywalna z innymi źródłami w regionie. Odkrycie szczawy termalnej w Grabinie rzuca także nowe światło na występowanie obszarów perspektywicznych dla ujmowania wód przydatnych w lecznictwie i profilaktyce.

**Słowa kluczowe:** szczawy termalne, balneoterapia, krenoterapia, Grabin, Śląsk Opolski

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### INTRODUCTION AND PURPOSE OF THE STUDY

The purpose of the study was to evaluate the physiochemical properties of the unique thermal bicarbonate mineral water from Grabin in the context of its use in prevention and balneotherapy.

Grabin is a village in Opole Silesia, located at approx. 210 m asl, within the Niemodlin Bank raising to approx. 50 m above the valley of Nysa Kłodzka. In terms of physico-geographical regionalisation of Poland it is located in the Niemodlin Plain [1], and tectonically it belongs to the frontier zone of the Fore-

Sudetic Monocline and the Lower Silesia block [2]. No presence of any Permo-Triassic sediments typical for the monocline has been found in the deep intake in Grabin. At the Precambrian structures of the Lower Silesia block there are Cretaceous sediments of the Opole Silesia depression. Until the half of the 19th century there was a local health resort in the town, which was also the first spa in Opole Silesia [3]. The health resort was mainly focused on peloid therapy and mineralised water from shallow intakes [4]. It can be assumed that they were not bicarbonate mineral water or thermal springs, but no closer data is available to "Odra-5/I" intake drilled in 1983. Thermal bicarbonate mineral water existing in Grabin can be found in the Fore-Sudetic block and is a unique phenomenon [5]. These are known only in further surroundings, in the area of the Czech Sudety Mountains in the region of Bruntal or Opawa Valley, and – what we only know from the chronicles – in Trzebina near Prudnik [6]. Low emission of CO<sub>2</sub> was also recorded to the west of Grabin near Henryków [7]. The presence of bicarbonate mineral water on a wider scale is however probable in this area, if we take into account the presence young-tertiary volcanic rocks which are hidden or semi-hidden along the eastern belt from the west to the surroundings of Opole. This belt in the region of Brzeg-Grodkowo-Niemodlin intersects with a large, however discontinuous, dislocation zone running to the south, defined fragmentarily by tectonic studies and satellite images as "Koszalin-Nysa lineament" [6]. The currently documented deposits of healing waters Grabin 5/1 (Odra) has a surface area of 161.3 km<sup>2</sup> within the resource area. The final boundaries of the deposits have not yet been recognized.

### **GEOLOGICAL PROFILE OF THE AREA WITH WATER-BEARING BALNEOTHERAPEUTIC POTENTIAL**

In terms of the healing water-bearing potential, Grabin is the easternmost point of the Sudety province. The region of the Fore-Sudetic block belongs to the least studied regions of Poland. Under the Upper Cretaceous layers from the depth of 485m tectonic disturbances of the precambrian paragneiss [8]. Thanks to the intake of 1983 at the area of the Brzeg-Nysa zone with the depth of 545 m [9] the thermal bicarbonate mineral water self-outflow was discovered with the temperature of 31.4 °C and mineralisation of 10g/dm<sup>3</sup>. The performance of the source was estimated as above 150 m<sup>3</sup>/h [10]. The borehole is situated near the Opole- Nysa route, approximately 30 km from Opole and 25 km from Nysa, in the southern part of Grabin developed areas. The borehole profile hole includes the quaternary, tertiary, upper Cretaceous and proterozoic layers [11]. This profile in the upper part is as follows: from 0.0 m asl to 17.0 m asl – Quaternary, and between 17.0-246.0 m asl – Tertiary [6]. In the structure of tertiary deposits at the depth of 17.0m asl to approximately 79.0m asl slightly sandy, olive-beige, poorly calcareous clays were found. At the depth of 79.0m asl to 130.0m asl there are grey clay sands with clay interbeddings, constituting tertiary water-bearing complex. At the depth of 130.0m asl to 145.0m asl the following was found: sludge, clay and fine

sands with the impressions of leaves, pieces of charred wood and thin pieces of lignite carbon, which were categorised as sarmatian on the basis of palynological analyses. The next tertiary layers are as follows: 145.0-173.6m asl – spotted clays with interbeddings of clay sands, 173.6-187.7 m asl – white and creamy limestones, often porous, with clay and marl sludge lamins, with a very rich fauna of the lower Miocene, 187.7-246.0m asl. – spotted clays and clay sands, grey sludge on the bottom, slightly calcareous. Below, between 246.0-485.0m asl there are upper Cretaceous sediments of the Silesia Opole depression. No Cenomanian or Coniacian layers typical for bottom depressions were found here. The whole upper Cretaceous profile from the intake in Grabin was classified as Turonian. On the basis of the lithological characteristics of the sediments, the section from 246.0m asl to 465.0m asl was classified as upper Turonian. It is built mostly with sandy marls, finely laminated, with two inserts. The section from 416.4m asl to 423.0m asl and the section from 448.7m asl to 465.0m asl shows the composition including the water-bearing, fragile, very porous lime-sandstone. The lower Turonian 465.0-485.0m asl includes very solid silica marls interbedded with knobby limestones with glauconite characterised by wavy-lenticular lamination typical for the busy environment of the sedimentation [6].

At the depth of 485.0-545.0m asl there are Proterozoic layers with the following profile:

- 485.0-529.0 m asl – gray mica paragneiss with pseudomorphs from andalusite, with veins, aplitoid lenses and quartz-feldspar nests and in the section 485.0-502.0m asl weathered, especially on the roof,
- 529.0-538.0 m asl – gneiss breccias stuck together with calcite,
- 538.0-545.0 m asl – a breccia consisting of porous and cavernous calcite with carbonated pieces of gneiss mylonites (filling of the stepped gap) [6].

### **THE RESULTS OF THE PHYSIO-CHEMICAL COMPOSITION TESTS OF THERMAL BICARBONATE MINERAL WATER IN GRABIN**

Water samples collected during the self-outflow, as well as after the stabilisation of the waters in the hole, were tested in 1983 and in 1990 in "Balneoprojekt" laboratory in Szczawno-Zdrój and in the Geological Institute in Wrocław (Table 1, 2, 3) [6, 12]. The results of the analysis demonstrate the stability of its physio-chemical composition. Based on the analysis, the water from Grabin can be defined as mineral (0.9-1.0%) thermal bicarbonate mineral water – bicarbonate-sodium-magnesium-calcium-silica water. This water has a slightly pungent, lye taste, its pH is 6.7-6.8 [6]. On the basis of geological measurement at the depth of 539m asl., the thermal bicarbonate mineral water temperature was 35.6°C. At the outflow from the Cretaceous-gneiss levels the temperature was unchanged and was 31.4°C. At the outflow from the Cretaceous level the recorded temperature was 23.6°C. In biological terms the water is satisfactory, as geological conditions preclude any contamination of this type.

**Table 1.** Results of the analysis of the chemical composition of water "Odra 5/1" intake in Grabin (in 1dm<sup>3</sup>), 1990 r.**Tabela. 1.** Wyniki analizy składu chemicznego wody z odwiertu „Odra 5/1” w Grabinie w 1dm<sup>3</sup> in 1990.

Cations		Milligrams	millivals	% millivals
Sodium	Na <sup>+</sup>	1600	69.59	60.34
Potassium	K <sup>+</sup>	145	3.71	3.22
Lithium	Li <sup>+</sup>	3.2	0.46	0.40
Ammonium	NH <sub>4</sub> <sup>+</sup>	2.0	0.11	0.09
Calcium	(Ca <sup>2+</sup> )	333.3	16.63	14.42
Magnesium	(Mg <sup>2+</sup> )	289.0	23.77	20.61
Strontium	(Sr <sup>2+</sup> )		not determined	
Ferrous	(Fe <sup>2+</sup> )	29.0	1.04	0.90
Manganous	(Mn <sup>2+</sup> )	0.45	0.02	0.02
Sum		2401.95	115.33	100.00

Anions		Milligrams	millivals	% millivals
Fluoride	(F)	0.5	0.3	0.03
Chloride	(Cl)	516.6	15.57	12.59
Bromide	(Br)	3.0	0.04	0.03
Iodide	(I)	0.5	0.00	0.00
Sulphate	(SO <sub>4</sub> <sup>2-</sup> )	9.0	0.19	0.16
Hydrogen carbonate	(HCO <sub>3</sub> <sup>-</sup> )	6159	100.94	87.19
Carbonate	(CO <sub>3</sub> <sup>2-</sup> )		Not found	
Hydrogen arsenic	(HAsO <sub>4</sub> <sup>2-</sup> )		Not found	
Nitrite	(NO <sub>2</sub> <sup>-</sup> )		Not found	
Nitrate	(NO <sub>3</sub> <sup>-</sup> )	0.2	0.00	0.00
Sum		6688.8	115.77	100.00

**Table 2.** Undissociated components of the thermal bicarbonate mineral water from Grabin**Tabela. 2.** Składniki niezdysojowane szczawy termalnej z Grabina

Metasilicic acid H <sub>2</sub> SiO <sub>3</sub>	104
Metaboronic acid HBO <sub>2</sub>	0.7
The sum of the dissolved solid components:	9195.45

**Table 3.** Gas components of the thermal bicarbonate mineral water from Grabin**Tabela. 3.** Składniki gazowe szczawy termalnej z Grabina

Free carbon dioxide CO <sub>2</sub>	1524
Hydrogen sulphide H <sub>2</sub> S	Not determined
Radon Ra	nCi
	Not found

### THE PERSPECTIVE OF THE USE OF THERMAL BICARBONATE MINERAL WATER FROM GRABIN FOR THERAPEUTIC AND PREVENTIVE PURPOSES

The general concentration of the dissolved salts and the temperature of water at the outflow of the discussed thermal bicarbonate mineral water source are factors predisposing to its use in prophylaxis, balneotherapy and drinking therapy. These waters may be used in the following procedures: general and local, at medical individual baths (total baths, halfbaths, 3/4 baths, sitting baths). The application of the partial bath

allows to limit the hydrostatic operation of the water and thus reduces the burden of cardiovascular system [13]. The therapeutic results and physiological procedures in thermal bicarbonate mineral water are decided by the type and concentration of the main cations and accompanying ions, water temperature, frequency of treatments and their duration and individual qualification for the absorption of carbon dioxide by skin [14]. Physiological results of the hydrogen carbonate baths are stronger when the treated skin area is larger. Their results tend to increase the vascularisation of skeletal muscles and heart muscle, release the tissue hormones within the skin, increase the number of active capillaries in the skin, reduce the blood pressure, facilitate the arterial oxygen release by the blood or to intensify the metabolism [15]. Treatment with this balneological resource also indicate the antiseptic properties, contribute to an increase in the brain vascularisation and the oxygen exchange in the lungs. Therefore, such treatment is recommended for the mild hypertension, narrowing inflammation of the arteries, partial disorders of arterial circulation or capillary circulation disorders. Other recommendations also include: some heart diseases e.g. athletic heart syndrome, neurovegetative and psychosomatic disorders, psychovegetative disorder or polyneuropathy. The transcutaneous application of carbon dioxide also includes the following diseases: Raynaud's syndrome, chronic venous insufficiency, obstructive arterial disease [16]. The waters also have an impact on the improvement of non-specific resistance, stimulate autonomous thermoregulatory mechanisms and

improve resistance to diseases, which is an essential effect of any physio-preventive activities. After dilution the water may also be used in crenotherapy and for the production of bottled water. In the drinking treatment the recommendations are as follows: diseases requiring the increase in diuresis, kidney stones, chronic diseases of the urinary tract, liver diseases, poisoning with heavy metals where it is required to reduce the level of bilirubin in the blood. Bicarbonate mineral water used in the drinking treatment also influence the concentration of certain blood components. In the treatment of anemia, e.g. an increase in the level of hemoglobin and erythrocytes is achieved. This type of water also has an important effect on the treatment of diabetes in an initial stage by reducing the blood sugar level and stimulating the insulin [17].

## DISCUSSION

Opole Silesia has a long tradition of spa treatment and is one of the prospective areas in the context of the development of balneotherapy and balneological preventive therapy. The region is well known for highly mineralized thermal mineral waters in Grabina near Niemodlin and mineral waters of karstic springs in Odrowąż, Gąsiorowice, Roźniątów and Błotnica Strzelecka and thermal brines from Wołczyn [18]. The region of the Fore-Sudetic block in frontier zones of the Lower Silesia monocline, where the sources of thermal bicarbonate mineral water can be found, belongs to the least studied regions of Poland. The tests have shown that the main resource of healing water in this place are cracked and weathered Proterozoic paragneiss and ground breccias. The existence of unique thermal bicarbonate mineral water in this area led to isolate a small area around Grabin in the Niemodlin area and gave a base for its classification as prospective areas for healing waters. Because of the concentration of dissolved salts and the temperature at the outflow, thermal bicarbonate mineral water from Grabin should be managed for the use in disease prevention, crenotherapy, balneotherapy. The source can also significantly affect development on rehabilitation tourism in a region [19]. It is also necessary to carry out geochemical research and further recognize the range of the healing water deposits and its possible variability within the zone of existence like in another part of Poland [20, 21].

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The Authors declare no conflict of interest

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# Comparison of Results of Local Cryotherapy Obtained with the use of Medical Devices and with the use of Ice in Patients After Reconstruction of the Anterior Cruciate Ligament in the Context of Guaranteed Healthcare Services

## Porównanie wyników krioterapii miejscowej uzyskiwanych przy użyciu urządzeń medycznych i z użyciem lodu u pacjentów po rekonstrukcji więzadła krzyżowego przedniego w kontekście świadczeń gwarantowanych

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### SUMMARY

**Introduction:** The development of innovative medical technologies is associated with the need to evaluate the procedures included in the guaranteed service basket, with particular emphasis on assessing currently available medical procedures in terms of their clinical effectiveness. The paper constitutes a critical review of literature by comparing the results of studies found as a result of a search in four online databases.

**Aim:** The main purpose of this paper is to compare the clinical effectiveness of two cryotherapy methods: medical devices and ice treatments in patients after anterior cruciate ligament reconstruction.

**Material and Methods:** The scientific reports were reviewed through the Medline, Embase, Cochrane Library and PEDro databases, in accordance with the designed search strategy using the following keywords: Anterior Cruciate Ligament Reconstruction, Cryostimulation, Cryotherapy, Cold Therapy, Cold Stimulation.

**Results:** As a result of the search, a total of 170 publications were found, of which 4 studies were included in the analysis. Statistically significant therapy outcomes in the context of analgesia with a predominance of medical devices were obtained in two of four studies. However, in the context of anti-edema action only in one of the two studies, the statistically significant result was higher in the group of patients who used the medical device with simultaneous compression.

**Conclusions:** 1. The results of the trials suggest that devices utilizing cryocompression have the highest efficiency in the case of analgesic and anti-edema action after arthroscopic reconstruction of ACL and are positively received by patients who use this form therapy. However, the results of randomized trials are not sufficient to draw definitive conclusions about the effectiveness of this form of therapy. 2. The need to amend the provisions of the relevant legal acts regulating the conditions for the provision of services and determining the criteria for the selection of offers in the procedure regarding the conclusion of contracts for the provision of medical services. 3. The need to using a uniform terminology regarding the name of the treatments utilizing low temperatures. 4. The need to conduct large multicentre randomized clinical trials with standardized intervention.

**Key words:** cryostimulation, cryotherapy, reconstruction of the anterior cruciate ligament, treatment outcome, guaranteed health benefits basket

### STRESZCZENIE

**Wstęp:** Rozwój innowacyjnych technologii medycznych wiąże się z potrzebą ewaluacji procedur zawartych w koszyku świadczeń gwarantowanych, ze szczególnym uwzględnieniem oceny aktualnie dostępnych procedur medycznych pod kątem ich skuteczności klinicznej. W pracy dokonano krytycznego przeglądu literatury poprzez porównanie wyników badań odnalezionych w wyniku przeszukiwania czterech internetowych baz danych.

**Cel:** Głównym celem niniejszej pracy jest porównanie skuteczności klinicznej dwóch metod terapii zimnem: zabiegów wykonywanych urządzeniami do krioterapii oraz zabiegów z użyciem lodu u pacjentów po rekonstrukcji więzadła krzyżowego przedniego.

**Materiał i metody:** Dokonano przeglądu doniesień naukowych poprzez bazy Medline, Embase, Cochrane Library oraz PEDro, zgodnie z zaprojektowaną strategią wyszukiwania używając następujących słów kluczowych: Anterior Cruciate Ligament Reconstruction, Cryostimulation, Cryotherapy, Cold Therapy, Cold Stimulation.

**Wyniki:** W wyniku wyszukiwania odnaleziono łącznie 170 publikacji z czego do analizy włączono 4 badania. Istotne statystycznie wyniki terapii w kontekście działania przeciwbólowego z przewagą dla urządzeń do krioterapii uzyskano w dwóch z czterech badań. Natomiast w kontekście działania przeciwobrzękowego tylko w jednym z dwóch badań wynik istotny statystycznie był wyższy w grupie pacjentów, u których stosowano urządzenie do krioterapii z jednoczesną kompresją.

**Wnioski:** 1. Wyniki badań sugerują, że urządzenia wykorzystujące kriokompresję mają najwyższą skuteczność w przypadku działania przeciwbólowego i przeciwobrzękowego po artroskopowej rekonstrukcji WKP oraz są pozytywnie odbierane przez pacjentów, u których stosowano taką formę terapii. Wyniki badań z randomizacją nie są jednak wystarczające, aby wyciągnąć ostateczne wnioski dotyczące skuteczności takiej formy terapii. 2. Konieczność zmian zapisów stosownych aktów prawnych regulujących warunki realizacji świadczeń oraz określających kryteria dotyczące wyboru ofert w postępowaniu w sprawie zawarcia umów o udzielanie świadczeń opieki zdrowotnej. 3. Konieczność stosowania jednolitej prawidłowej terminologii dotyczącej nazwy zabiegów z użyciem niskich temperatur. 4. Konieczność przeprowadzenia dużych wieloośrodkowych randomizowanych badań klinicznych z wystandaryzowaną interwencją.

**Słowa kluczowe:** kriostymulacja, krioterapia, rekonstrukcja więzadła krzyżowego przedniego, efekty leczenia, koszyk świadczeń gwarantowanych

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## INTRODUCTION

In accordance with the provisions of the currently applicable Regulation of the Minister of Health on guaranteed services in the field of therapeutic rehabilitation set out in Appendix No. 1 – *The list and conditions for the implementation of guaranteed services (...)*, in the field of outpatient physiotherapy, systemic rehabilitation carried out in the conditions of the day-care centre or unit, or in stationary conditions, the nitrogen vapour cryostimulation kit is a required equipment when a given procedure (cryotherapy/cryostimulation) is provided at the place where the services are performed. However, it is unclear in what medical factors and clinical conditions as well as in what form the above procedure should be performed. In addition, in the current Regulation of the Minister of Health on detailed criteria for the selection of offers (...) in competitive process regarding the conclusion of contracts of the medical rehabilitation type, in the category of medical equipment and apparatus or rooms, one of the additional scoring criteria is to have a set for cryostimulation with nitrogen vapours in the place where the services are provided (in the case of outpatient physiotherapy – weight of 3 points, in the case of systemic rehabilitation carried out in day or day ward conditions, or in stationary conditions – weight of 1 point) [1, 2]. While in the foregoing operates the term “cryostimulation” is used, in the case of medical procedures in accordance with dictionary ICD-9 version 5.46 published by the National Healthcare Fund (NFZ) we can find entries regarding, for example, local cryotherapy with liquid nitrogen (93.3951), local cryotherapy CO<sub>2</sub> (93.3952) – not included in the list of guaranteed services, cryotherapy with electrically cooled air (93.3998). This term is also used for surgical procedures e.g. cryotherapy of superficial lesions (00.9601) [3].

According to the definition, cryotherapy in physiotherapy and therapeutic rehabilitation is cold therapy. The word is

derived from Greek and consists of two individual words: *kryos* - cold and *therapeia* – therapy. Although once the concept included simple treatments utilizing low temperatures, now the concept of cryotherapy is very broad in meaning and includes methods of treatment via low temperatures, as well as the application of low temperatures in the wellness and training preparation of athletes. The exact explanation of what is meant by the term cryotherapy is, however, very complex. Well, in Anglo-Saxon and Scandinavian countries, cryotherapy is considered to be therapeutic treatments utilizing cold temperature of 0°C and lower. From an etymological point of view, this seems to be correct. According to this definition, cryotherapy includes such treatments as ice compress, cold water baths, which in Poland are referred to as zabiegi z zakresu zimnocznictwa (cryotherapeutic treatments). Specialists from Germany and Japan understand the concept of cryotherapy as based on stimuli, stimulating the action of extremely low temperatures on the outer shell of the body (below -100°C) for a period of no more than 3 minutes to induce physiological reactions of the body to cold and use them to support basic treatment and kinesiotherapy. Also, in Poland, the definition is not coherent and many authors understand cryotherapy differently. The situation is also complicated by the fact that the term cryotherapy is sometimes used interchangeably with the word cryosurgery, which in many cases hinders the selection and interpretation of publications [4-14].

In the light of the information presented above, it seems reasonable to use the term cryotherapy to refer to all non-invasive (non-destructive) cold treatments, which are performed locally and stimulating the external surface of the body in order to induce and use physiological systemic and organ reactions to cold, including cold compresses utilizing ice, snow, cooling gels, or devices utilizing liquid nitrogen vapours, carbon dioxide or



chilled atmospheric air. Thus, it is proposed that destructive (damaging) treatments utilizing cold be called cryosurgery. Therefore, the following definition of cryostimulation is proposed in this paper to unify the terminology related to the therapeutic use of cold: "Cryostimulation is a short-term, stimulus based, stimulating application of low or very low temperatures to the external surface of the body to induce and use physiological systemic and organ reactions to cold." Therefore, in this study, all cryotherapeutic treatments, e.g. crushed ice compresses, cold baths and showers as well as therapies related to the use of liquid nitrogen or carbon dioxide, will be treated as cryotherapy.

A field that successfully uses the therapeutic effects of cold is physiotherapy. Local cryostimulation due to its analgesic, anti-inflammatory and anti-edema character is one of the physiotherapeutic procedures which is particularly applicable in the case of injuries, e.g. related to damage to ligament structures [15–22].

The purpose of this paper is to compare the results obtained with the use of medical equipment and with ice therapy in patients after anterior cruciate ligament reconstruction in the context of the conditions for the implementation of guaranteed services in the field of therapeutic rehabilitation.

## MATERIAL AND METHODS

In order to compare local cryotherapy forms in terms of analgesic and anti-edema effects on patients after anterior cruciate ligament reconstruction, scientific reports were reviewed through the Medline (via Pubmed), Embase (via Ovid), Cochrane Library and PEDro databases, according to the designed search strategy.

The search strategy was developed on 24 January 2020 and was based on keywords related to a population – patients after anterior cruciate ligament reconstruction and intervention – local cryotherapy (Table 1).

**Table 1.** Key words used in the search strategy

**Tabela 1.** Słowa kluczowe użyte w strategii wyszukiwania

Population/Populacja
Anterior Cruciate Ligament Reconstruction
Intervention/Interwencja
Cryostimulation Cryotherapy Cold Therapy Cold Stimulation
Source/Źródło: Own study/Opracowanie własne

The scientific reports were found by means of selection conducted in three stages.

- Exclusion of duplicates.
- Selection on the basis of titles and abstracts.
- Analysis of full texts.

For the purposes of this analysis, in order to identify studies on the use of local cryotherapy in patients after anterior cruciate ligament reconstruction, the following criteria for inclusion of studies in the analysis were adopted.

- Population: patients after anterior cruciate ligament reconstruction.
- Intervention: cryotherapy treatment using medical devices (including liquid nitrogen vapour, carbon dioxide, chilled atmospheric air, apparatus utilizing chilled water, other electrical devices generating a constant temperature for cooling, enabling tissue cooling).
- Comparator: treatment using ice (including crushed ice, snow, ice bags).
- Endpoints: assessment of analgesic effect, assessment of anti-edema effect.
- Type of trial: RCT - a two-sided trial in which one side was a group of patients who underwent surgery using a medical device, and the other was a group of patients who underwent surgery using ice.

The study was selected by one person and was carried out on the basis of the above-mentioned inclusion criteria adopted before the search. The process leading to the final selection of scientific reports is presented in the form of a diagram in accordance with the recommendations of PRISMA (Figure 1). In order to find additional studies, the references of reviews identified during the analytical work in connection with the study were also searched.

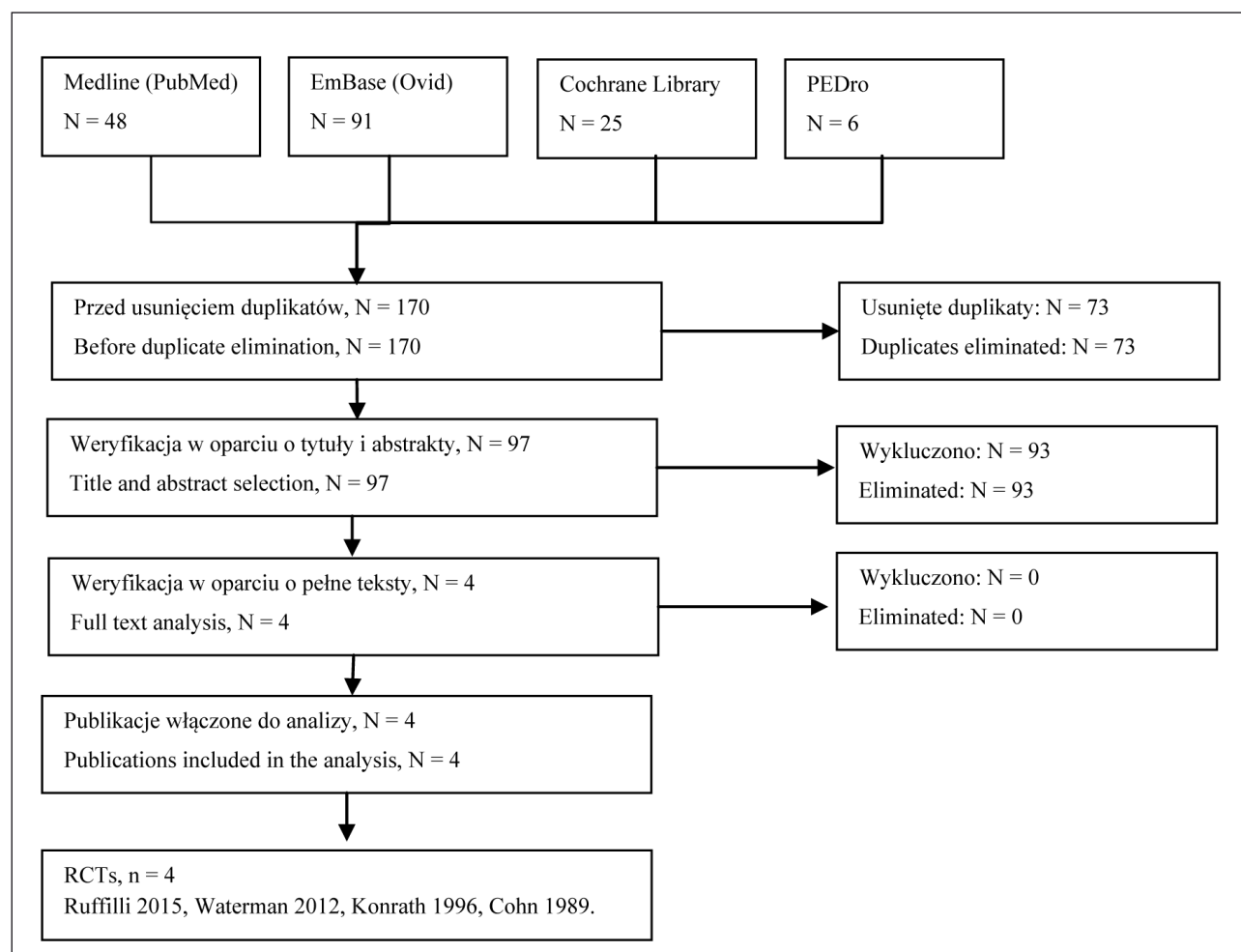
## RESULTS

As a result of the search, a total of 170 publications were found, respectively MEDLINE 48 results, EMBASE 91 results, Cochrane Library 25 results and PEDro 6 results. After excluding duplicates by verifying them on the basis of their titles and abstracts, 103 publications were obtained. As a result of the selection of studies, four RCTs were included in the analysis. The detailed characteristics of the studies are presented in the table below (Table 2).

No studies were found in which an intervention involved a therapy with the use of liquid nitrogen vapours, carbon dioxide or chilled atmospheric air was. In the found studies, the cooling inserts (temperature range from +26,5°C to +4,5°C), ice packs and cryocompression devices using chilled water were used in the cryotherapy.

Due to the high heterogeneity of the population under study, treatment (including cryostimulation), transplants, endpoints used and measurement methods, no meta-analysis of the study results was performed.

The endpoint related to the analgesic effect of therapy was identified in all studies included in the analysis. The measurement method involved the use of pain scales: VAS (Waterman 2012) or NRS (Ruffilli 2015), or levels of doses of medicaments (Konrath 1996, Cohn 1989). In the case of analgesic cryostimulation measured via a pain scale, a statistically significant result was obtained in two studies (Ruffilli 2015, Waterman 2012). However, in the case of assessment via the drugs taken, a statistically significant outcome was obtained in one study (Cohn 1989). Statistically significant therapy outcomes with a predominance of cryostimulation devices were obtained in two of four studies (Ruffilli 2015, Waterman 2012). It is worth noting, however, that in both studies these devices combined compression



**Figure 1.** Research selection scheme

*Rycina 1.* Schemat selekcji badań

with the simultaneous effect of cold [23–26]. The outcomes are presented in Table 3.

The endpoint related to the anti-edema effect of cryotherapy was identified in two studies included in the analysis (Ruffilli 2015, Waterman 2012). In both studies, assessment was made via postoperative knee circumference measurement and postoperative knee circumference increase. Only in one study a statistically significant result was more favourable in the group of the patients who used the cryostimulation device – with simultaneous compression (Ruffilli 2015) [23, 24]. The outcomes are presented in Table 4.

Only in two studies the analysis of patients' subjective assessment was performed. In the Ruffilli's 2015 study, the subjective assessment of the device was positive. Nine patients (39%) rated the device as very comfortable, 13 (57%) rated the device as comfortable, and only one (4%) reported lack of comfort. Five patients (22%) said the device was very useful, in 13 cases (57%) the opinion was positive, three (13%) patients were very dissatisfied, and two (9%) patients were completely dissatisfied. In the Waterman's 2012 study, no statistically significant differences were found between the two groups [23, 24].

## ANALYSIS LIMITATIONS

This study identifies the following limitations that hinder comparison and an objective assessment of the interventions used:

- high heterogeneity of the groups treated: diversity in terms of age, sex;
- lack of complete information on the level of physical activity and clinical condition of patients undergoing treatment;
- lack of detailed information on the frequency of the treatment and time of the treatment;
- no standardization of temperatures used;
- no standardization of measurement of clinical effects;
- variety of medicaments;
- low quality studies;
- low number of studies;
- no possibility to analyse clinical effects in subgroups.

## DISCUSSION

Cryotherapeutic treatments are a common choice among treatment options in the case of musculoskeletal injuries and in the case of postoperative treatment of orthopedic patients [7, 27].

**Table 2.** Characteristics of the studies included in the analysis**Tabela 2.** Charakterystyka badań włączonych do analizy

Study	Characteristics
Ruffilli 2015 [23] 4/10 according to the PEDro scale	Population: N = 47  Transplant used: Semitendinosus tendon (ST) and gracilis muscle (GR) transplantation  Groups: A: cryotherapy device (HiloTherm) n = 23 (14 M / 9 W) age on average: 32  B: ice bag n = 24 (15 M / 9 W) age on average: 31
Waterman 2012 [24] 4/10 according to the PEDro scale	Population: N = 36  Transplant used: autogenous transplant (n = 18), allogeneic transplant (n = 18).  Groups: A: cryostimulation device (Game Ready®, CoolSystems) n = 18 (15 M / 3 W) age on average: 28  B: ice bag n = 18 (15 M / 3 W) age on average: 30
Konrath 1996 [25] 4/10 according to the PEDro scale	Population: N = 100  Transplant used: BPTB  Groups: A: cooling insert 4,44–10°C (40–50°F) n = 27 (21 M / 6 W) age on average: 27  B: cooling insert 21,11–26,67°C (70–80°F) n = 23 (13 M / 10 W) age on average: 25  C: ice pack n = 23 (17 M / 6 W) age on average: 26  D: no cryotherapy n = 27 (16 M / 11 W) age on average: 26
Cohn 1989 [26] 4/10 according to the PEDro scale	Population: N = 54  Transplant used: BPTB  Groups: A: Thermal blanket providing a constant temperature of 10°C n = 26 (17 M / 9 W) age on average: 22  B: ice pack n = 28 (15 M / 13 W) age on average: 25
BPTB – (bone-patellar tendon-bone) transplant 1/3 of the patella ligament; M – men; W – women. Source: Own study	

**Table 3.** Statement results for the endpoint related to the analgesic effect of cryotherapy**Tabela 3.** Zestawienie wyników dla punktu końcowego odnoszącego się do działania przeciwbólowego krioterapii

Study/ Badanie	Group/ Grupa	n	Intervention/ Interwencja	Pain rating scale/ Skala oceny bólu	Medications/ Zażywane leki		
Ruffili [23]	A	23	CD	0,9 ± 0,8	A < B (p < 0,0001)	b. d.	NS
	B	24	Lód/ Ice	2,4 ± 1,7			
Waterman [24]	A	18	CD	-4,11	A < B (p = 0,002)	-	-
	B	18	Lód/ Ice	15,67			
Konrath [25]	A	27	CD 4–10°C	-	-	Hyd., Morf., Mep. 3,96	NS
	B	23	CD 21–27°C	-			
	C	23	Lód/ Ice	-			
	D	27	Brak/ Absence	-			
Cohn [26]	A	26	CD 10°C	-	-	Mep. 5,25 Hydr. 1,41	A < B (p < 0,01)
	B	28	Lód/ Ice	-			

b. d. – no data/brak danych; CD – cryo devices/urządzenie do krioterapii, Dikl. – Diclofenac/Diklofenak; Hydr. – Hydrocodon/Hydrokodon;  
Hydr. – Hydroxyzine/Hydroksyzyna; Kode. – Codeine/Kodeina; Mep. – Meperidine/Meperydyna; Morf. – Morphine/Morfina;  
NS – no significant difference/różnica nieistotna statystycznie.

Source/Źródło: Own study/Opracowanie własne

**Table 4.** Results for the endpoint related to the anti-edema effect of cryotherapy**Tabela 4.** Zestawienie wyników dla punktu końcowego odnoszącego się do działania przeciwobrzękowego krioterapii

Study/ Badanie	Group/ Grupa	n	Intervention/ Interwencja	Postoperative knee circumference/ Pooperacyjny obwód kolana	Postoperative increase of knee circumference/ Pooperacyjny przyrost obwodu kolana		
Ruffili [23]	A	23	CD	b. d.	NS	b. d.	A < B (p = 0,001)
	B	24	Lód/ Ice	b. d.			
Waterman [24]	A	18	CD	41,39	NS	2,2	NS
	B	18	Lód/ Ice	41,89			

b. d. – no data/brak danych; CCD – cold compression device/urządzenie do kriokompresji.

Source/Źródło: Own study/Opracowanie własne

Several clinical studies have shown improvements in objective and subjective results when using cryotherapy after ACL reconstruction [28–35]. Also, the Raynor's 2005 meta-analysis indicates that patients who underwent cryotherapy experienced significantly less pain, although no significant differences in terms of exudation or range of motion were indicated [36].

In addition, in the literature we may find the advantages of combining cryotherapy with simultaneous compression. The use of compression seems to contribute to additional benefits in the case of traumatic soft tissue injuries and in patients after surgery, including ACL reconstruction [7, 37–40]. Compression results in local reduction of blood flow, smaller edema and gives increased benefits than just raising the treated limb [41]. In addition, the meta-analysis performed in the systematic review of Martimbianco 2014 suggests that cryotherapy with simultaneous compression compared to the lack of cryotherapy leads to a significant reduction in knee pain assessed 48 hours after arthroscopic reconstruction of ACL (p < 0,00001) [42].

Therefore, while the selection of cryostimulation as one of the therapeutic options used in the patient rehabilitation programme seems to be undeniable, the method of applying cold is disputed. Even though the studies compared different forms of application (ice, devices using chilled water with simultaneous compression) and covered different temperature ranges, they do not allow to draw undeniable and unambiguous conclusions about the best possible form of cold application. The results of the studies are ambiguous, and the quality of the trials raises doubts about the results obtained due to among others on the way of application and administered drugs. Nevertheless, it is worth considering the provisions of relevant legal acts regulating the conditions for the provision of services and determining the criteria for the selection of offers in the procedure regarding the conclusion of contracts for the provision of medical services. In the light of the principles of evidence-based medicine, it seems unreasonable to determine only one of many forms of cold therapy. Due to the fact that many interventions are used simultaneously in

the therapeutic programme, and the nature of the treatments is often adapted to the current clinical needs of the patient, it seems unreasonable to limit the therapeutic possibilities to only one form of therapy. It is also worth considering the costs associated with equipping the centres with a “nitrogen vapour cryostimulation kit”, which is one of the most expensive of the available cryotherapy forms, the more so, as there are no studies providing convincing evidence for the efficacy of such a form of therapy compared to cheaper forms, e.g. therapy using cooled compressed air or the very cheap option of crushed ice [43, 44].

## RESULTS

The high heterogeneity of the groups subjected to the treatments varied in terms of age, sex, as well as the lack of detailed information on the frequency and duration of the treatment, or the lack of complete information on the level of physical activity and clinical condition of patients undergoing treatment make it impossible to draw unambiguous conclusions regarding the selection of the most effective form of treatment used in in the case of patients after ACL reconstruction. Based on the low quality of evidence, it also seems impossible to draw conclusions about the sub-group most sensitive to cold. The currently limited evidence from studies with randomisation only suggests that the effects of cold may have immediate short-term benefit by reducing pain and swelling during the inflammatory response after ACL reconstruction. Studies suggests that cryotherapy may have significant benefits in controlling postoperative pain, while no significant improvement in anti-oedema effects is found. Thus, the results of the studies provide suggestive evidence that cryotherapy can effectively serve as a complementary treatment in the management of pain in the early phase after arthroscopic ACL reconstruction. In the light of the available study, considering the ease of application, low costs in the case of ice, it seems that cryotherapy is justified as a physiotherapeutic procedure in the rehabilitation program after ACL reconstruction. To draw clear conclusions about the best possible form of therapy, large multicenter randomized clinical trials are necessary. However, these trials should be based on standardised procedures and apply clearly defined criteria. Thus, in the absence of sufficient scientific evidence, consideration should be given to amending the entries in the relevant regulatory documents determining only one form of cold therapy.

## CONCLUSIONS

The results of the trials suggest that devices utilizing cryocompression have the highest efficiency in the case of analgesic and anti-edema action after arthroscopic reconstruction of ACL and are positively received by patients who use this form of therapy. However, the results of randomized trials are not sufficient to draw definitive conclusions about the effectiveness of this form of therapy.

The need to amend the provisions of the relevant legal acts regulating the conditions for the provision of services and determining the criteria for the selection of offers in

the procedure regarding the conclusion of contracts for the provision of medical services.

The need to harmonize the terminology regarding the name of the treatment utilizing cold.

The need to conduct large multicentre randomized clinical trials with standardized intervention.

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# Adult Acquired Flatfoot

## Płaskostopie nabyte dorosłych

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### SUMMARY

Acquired adult flatfoot is a three-dimensional deformation, which consists of hindfoot valgus, collapse of the longitudinal arch of the foot and adduction of the forefoot.

The aim of the work is to present problems related to etiology, biomechanics, clinical diagnostics and treatment principles of acquired flatfoot.

The most common cause in adults is the dysfunction of the tibialis posterior muscle, leading to the lack of blocking of the transverse tarsal joint during heel elevation. Loading the unblocked joints consequently leads to ligament failure. The clinical image is dominated by pain in the foot and tibiotarsal joint.

The physical examination of the flat feet consists of: inspection, palpation, motion range assessment and dynamic force assessment. The comparable attention should be paid to the height of the foot arch, the occurrence of "too many toes" sign, evaluate the heel-rise test and correction of the flatfoot, exclude Achilles tendon contracture. The diagnosis also uses imaging tests.

In elastic deformations with symptoms of posterior tibial tendonitis, non-steroidal anti-inflammatory drugs, short-term immobilization, orthotics stabilizing the medial arch of the foot are used. In rehabilitation, active exercises of the shin muscles and the feet, especially the eccentric exercises of the posterior tibial muscle, are intentional.

The physiotherapy and balneotherapy treatments, in particular hydrotherapy, electrotherapy and laser therapy, are used as a support. In advanced lesions, surgical treatment may be necessary, including plastic surgery of soft tissues, tendons, as well as osteotomy procedures.

**Key words:** acquired flat feet, posterior tibial muscle, rehabilitation

### STRESZCZENIE

Nabyte płaskostopie dorosłych jest trójpłaszczyznową deformacją, na którą składa się koślawość tyłostopia, zapadnięcie podłużnego łuku stopy oraz odwiedzenie przodostopia.

Celem pracy jest przedstawienie problematyki związanej z etiologią, biomechaniką, diagnostyką kliniczną oraz zasadami leczenia nabytego płaskostopia.

Najczęstszą jego przyczyną u dorosłych jest dysfunkcja mięśnia piszczelowego tylnego, prowadząca do braku zablokowania stawu poprzecznego stępu podczas uniesienia pięty. Obciążanie niezablokowanych stawów w konsekwencji doprowadza do niewydolności więzadłowej. W obrazie klinicznym dominują dolegliwości bólowe w obrębie stopy, stawu skokowo-goleniowego.

Na badanie fizykalne stopy płaskiej składa się: oglądanie, badanie palpacyjne, ocena zakresu ruchomości oraz kontrola siły dynamicznej. Należy zwrócić uwagę porównawczą na wysokość sklepienia, występowanie objawów „zbyt wielu palców”, ocenić test uniesienia pięty i korektywność płaskostopia, wykluczyć przykurcz ścięgna Achillesa. W diagnostyce wykorzystuje się także badania obrazowe.

W deformacjach elastycznych z objawami zapalenia ścięgna m. piszczelowego tylnego stosuje się niesterydowe leki przeciwzapalne, krótkotrwałe unieruchomienie, ortezy stabilizujące przysiódkowy łuk stopy. W rehabilitacji celowe są ćwiczenia czynne mięśni łydki i stopy, a szczególnie ćwiczenia ekscentryczne m. piszczelowego tylnego.

Wspomagająco wykorzystuje się zabiegi z zakresu fizykoterapii i balneoterapii, szczególnie wodolecznictwa, elektroterapii i laseroterapii. W zmianach zaawansowanych konieczne może być leczenie operacyjne obejmujące plastykę tkanek miękkich, ścięgien, a także zabiegi osteotomii.

**Słowa kluczowe:** płaskostopie nabyte, mięsień piszczelowy tylny, rehabilitacja

## INTRODUCTION

The height of the foot arch varies within the population. There is a wide variety, and the so-called low arch is not a pathology. The term of flat foot should refer to the pathological lowering of the longitudinal arch with associated pain symptoms. It describes the final phase of the arch collapsing along with hindfoot and forefoot deformities. The acquired adult flatfoot is a three-dimensional deformation consisting of the hindfoot valgus, collapse of the longitudinal arch of the foot, and adduction of the forefoot. Flatfoot caused by posterior tibial tendon dysfunction is relatively common and causes fatigue and pain in the feet in adults [1, 2].

## EPIDEMIOLOGY

Despite the lack of reports regarding the occurrence of flatfoot in adults, it can be safely stated that this is a common disease process and it concerns a significant part of the population. It is more common in women between 45 and 65 years of age, the incidence is higher in obese people and diabetics, about 50% of patients associate the onset of the injury with this area. Degeneration of the posterior tibial muscle is a progressive process [3].

## SELECTED BIOMECHANICAL ELEMENTS OF ANKLE JOINTS

The posterior tibial muscle attaches proximal in the shin area and peripherally on the navicular tuberosity. This muscle stabilizes the tarsocalcaneal joint from the medial side. The posterior tibial tendon is a strong plantar supinator and flexor of the foot. It blocks the transverse (inter)tarsal joints (talonavicular joint and calcaneocuboid joint), maintains the longitudinal arch of the foot [1]. Biomechanical and electromyographic studies suggest that the posterior tibial muscle tendon acts as a stabilizer during the gait and putting the weight on the limb [4].

During gait, when the posterior tibial tendon tightens just before the heel elevation phase, the axes of the talonavicular and calcaneocuboid joints are divergent, blocking the transverse (inter)tarsal joints. This stiffens the medial column of the foot and gives rise to a long level arm for strong rebound when walking. Hindfoot movements block and unblock the transverse (inter)tarsal joints [4]. The transverse tarsal joint is formed by the talus, calcaneus, navicular and cuboid bones, which form the peak of longitudinal arches of the foot [5].

## ETIOLOGY

Causes of flat feet in adults:

- Posterior tibial muscle dysfunction – the most common cause
- Contracture of gastrocnemius muscle or the Achilles tendon contributes to secondary dysfunction of the posterior tibial muscle.
- Neurogenic deformities.
- Arthritis – resulting in subluxation of hindfoot joints and posterior tibial tendonitis.

- Primary degenerative changes of the metatarsal joints or their abnormal adhesion.
- Abnormal adhesion after a calcaneus or cuboid bone fracture.
- Peroneal muscle spasticity in neuromuscular disorders.
- Disturbances in the axis of the knee joint, tibia or ankle joint in the frontal plane lead to the valgus feet- resulting foot deformity is the secondary.

## PATHOPHYSIOLOGY

In the disease process, the talus is positioned in the plantar flexion, the calcaneus in pronation, and the navicular and cuboid bones in partial pronation. As the hindfoot valgus builds up, compensatory supination of the forefoot occurs. As the deformation progresses, the lateral column of the foot is effectively shortened. If the posterior tibial tendon is not able to supinate the hindfoot before the heel is elevated, the Achilles tendon calcaneal attachment remains lateral to the axis of the talocalcaneal joint. Achilles tendon contraction then causes hindfoot pronation. In this situation, transverse tarsal joints remain unblocked and the arch of the foot may bend. At the tendon course, at a distance of 40 mm proximal to the navicular protuberance, there is a zone of reduced vascularization, which extends proximally especially over a length of 14 mm, because in this place the tendon does not have a mesentery, and the surrounding synovial sheath is also moderately vascularized. This is a place of increased susceptibility to mechanical wear. It is possible that transient ischemia creates a risk of tendon failure and initiates a cascade of dynamic instability. In this situation, the tendon has a relatively high concentration of collagen 3 (it is the collagen present in the early phase of the tendon healing process). As a consequence, this reduces the stretching capacity, which in continuous act leads to tendon failure and dysfunction. If there is a loss of stiffness of the talocalcaneonavicular complex, the posterior attachments of the posterior tibial tendon are in the valgus position. Tendon elongation by 1 cm significantly reduces its effectiveness as a primary dynamic arch stabilizer [2, 3, 6].

## CLINIC AND DIAGNOSIS OF THE ACQUIRED ADULT FLATFOOT

Clinical symptoms are strictly localized initially in the course of the posterior tibial muscle tendon, the patient reports pain, in the period of advanced changes a progressive deformities of the foot are gradually observed. The following prove helpful in the diagnostics: “too many toes” sign, heel- rise test and diagnostic imaging. Palpation of the posterior tibial muscle tendon may show soreness and swelling of soft tissues. The “too many toes” sign in the foot is associated with increased adduction of the forefoot, which is the result of posterior tibial muscle tendon failure. Raising the foot and placing it on the toes requires proper tibial posterior muscle tendon function. When the tendon is efficient, the calcaneus bone supinates and fix in the valgus position. Posterior tibial tendon insufficiency prevents full heel elevation or valgus positioning when standing on one leg. The patient



is only able to partially lift the heel, which remains fixed in valgus position.

The lateral radiogram of the foot makes it possible to assess the angle between the talus bone and the first metatarsal bone. A value greater than 4 degrees means a flat foot. The angle of inclination of the lower surface of the calcaneus should also be determined. Its correct value is 17-32 degrees. On the basis of the decrease in the angle value, the reduction of the arch height can be noted. A decrease in the distance of the middle cuneiform bone from the ground indicates an arch collapse [7, 8].

### THE TREATMENT PROCESS

Treatment of acquired adult flatfoot is difficult, depending on the stage of the disease. An important role here is played by properly commissioned and selected orthopaedic equipment, the implemented rehabilitation process and the correct qualification for surgical treatment and the type of surgery performed (Table 1).

*Margaret Lobo, Justin Greisberg "Foot & ankle. Core knowledge in orthopaedics" 2010*

In cases of rigid flatfoot, the purpose of using the orthoses is to stabilize the foot in the existing position, which allows pain relief and possible partial correction within the remaining flexibility of the foot. The use of an orthosis requires the use of accommodative orthoses individually shaped on a deformed foot of the patient. [3,10].

An individually made functional orthosis used in acquired adult flatfoot (Figure 1) allows to improve stability control through: deep heel depression, high medial and lateral margin, medial wedge under the heel and depression in the place of elevation of the talonavicular joint [10].

With significant weakening of ligament stabilization, orthoses including the tibiotarsal joint should be used – AFO orthoses. Figure 2 shows the AFO orthosis of the Arizona type with a rigid shell and leather trim. At present, functional orthoses for tibiotarsal joint with individual plantar insert are used. In this type of AFO orthosis, a semi-rigid design of the shin part was used to control the internal rotation of the tibia and a functional plantar insert to control the talocalcaneal joint and the Chopart joint.



*Own material*

**Figure 1.** An orthosis used in posterior tibial tendon dysfunction



*Own material*

**Figure 2.** Ankle-shin and foot orthosis (AFO) of the Arizona type

The use of this orthosis is recommended for corrective flatfoot when it is desirable to maintain full mobility in the joint.

The rehabilitation process uses phenomenon of the body's reactivity to kinetic, thermal, light, mechanical, electrical and chemical stimuli. It is based mainly on movement

**Table 1.** Treatment of acquired adult flatfoot depending on the stage of the disease

Stage	Symptoms	Treatment
1	pain, swelling no deformation	plaster cast, plantar arch stabilizing insert debridement of the posterior tibial muscle tendon
2	elastic deformation "too many toes" sign	stabilization of the foot arch, AFO orthosis, UCBL orthosis, posterior tibial tendon surgery, medial/lateral foot column osteotomy and fixation
3	rigid deformation	AFO orthosis, UCBL orthosis fixation (selective or triple)
4	rigid deformation degenerative changes of the talocalcaneal joint	rigid AFO orthosis extensive fixation (peri-tibial or tibiocalcaneal)

AFO – ankle-foot orthosis; UCBL – orthosis of the Biomechanics Laboratory of the University of California.



*Own material*

**Figure 3.** Richie type orthosis. Functional articulated functional orthosis with semi-rigid shin supports, designed to control deformation in the transverse and frontal planes

therapy, supportive physical procedures, massage and balneotherapy. Short, 5-7 minute, daily, systematic active exercises for the shins and feet are important. Eccentric exercises of the posterior tibial muscle are important, usually bilateral, consisting of gradual positioning of the feet, on their lateral edge (pronation, supination) in a standing position and gradual active return to full plantar load of the feet. One can use supportive treatments like thermotherapy, phototherapy, electrotherapy, high and low frequency magnetic fields, and ultrasounds.

The goal of the physical medicine in this case is to relieve pain and inflammation by improving blood supply to the skin and subcutaneous tissue affecting thermoregulation, metabolism, removing unnecessary metabolic products, and improving the functional capacity of the autonomic nervous system. Therefore, in the field of balneotherapy, treatments with the use of hydrogen sulphide baths and beneficial effects of sulphur in diseases of the osteoarticular system, carbonic acid baths used to support obesity and overweight, peloids – especially mud. Its components, i.e. oestrogens, steroids, humic acids, can penetrate the skin and cause reactions from the autonomic nervous system, smooth muscles or mucous membranes (improving the quantity and quality of synovial fluid). Mud causes the formation of active congestion which is associated with improved tissue nutrition and stimulation of repair processes [9].

Collagen is also used locally for periarticular and intramuscular injections.

Unfortunately, actively progressing pathologies of the posterior tibial tendon and Achilles tendon with the correct

height of the arch should be treated with repair surgery or tendon surgery. Bone correction and soft tissue surgery on the medial side of the foot is an effective solution for a flexible (corrective) flatfoot. Bone tissue procedures include medializing calcaneal osteotomy, lateral column lengthening and/or medial column stabilization [11]. Triple arthrodesis should be performed in the case of hindfoot stiffness or degenerative changes that cannot be treated with hindfoot-saving treatments [12,13]. Total ankle arthroplasty potentially gives the chance of maintaining some mobility, but carries a relatively high risk of complications, especially in the case of feet with pre-existing serious deformities [14-21].

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### KONFERENCJE

## III Spotkanie Ekspertów – Poznań

To już po raz trzeci na Uniwersytet Medyczny w Poznaniu przybyli eksperci nie tylko z Polski, ale i innych części świata.

Za nami III Spotkanie Ekspertów FOIZJOTERAPIA-ORTOPEDIA-REUMATOLOGIA, które prezentuje Uniwersytet Medyczny jako jednostkę naukową dążącą do wytyczania spójnych, jednolitych, opartych na badaniach naukowych, ale i doświadczeniu, metod multidyscyplinarnego postępowania z pacjentami.

III Spotkanie Ekspertów odbyło się w Sali Senatu Uczelni, zachowując charakter spotkania zamkniętego, z wybranymi i zaproszonymi uczestnikami. Inicjatorem oraz przewodniczącym komitetu organizacyjnego był

dr Mateusz W. Romanowski. Komitetowi Naukowemu przewodniczył prof. dr hab. Włodzimierz Samborski.

Spotkania Ekspertów, które z tak dużym sukcesem rokrocznie organizujemy są niepowtarzalnymi na terenie Polski wydarzeniami edukacyjnymi. Każdy z zaproszonych uczestników ma możliwość zabrania głosu, skonfrontowania swoich doświadczeń z rozwiązanymi stosowanymi w innych ośrodkach specjalistycznych. Spotkaniu, w którym uczestniczy zawsze kilkudziesięciu wybranych ekspertów towarzyszy życzliwa dyskusja specjalistów różnych dziedzin.

W tym roku tematem pierwszej sesji było leczenie dysfunkcji kończyny górnej.

Przedstawione prace były podsumowaniem najnowszej dostępnej literatury wzbogaconej o doświadczenia własne prelegentów. Drugim bardzo ciekawym modułem tematycznym były kliniczne aspekty leczenia skoordynowanego, ukierunkowane głównie na bezpośredni dostęp do fizjoterapeuty (direct acces to physiotherapy). Tę sesję prowadzili prelegenci z różnych stron świata. Porównanie polskiego myślenia oraz organizacji warunków pracy z pacjentem ze standardami międzynarodowymi było tematem żywej dyskusji.

Podsumowaniem III Spotkania Ekspertów, będzie napisanie wytycznych leczenia choroby zwyrodnieniowej stawu kolanowego i biodrowego oraz bólu okolicy kompleksu barkowego.

Podobne opracowania powstały po realizacji poprzednich spotkań. Prelekcje z tegorocznego spotkania, jak i poprzednich, można obejrzeć na kanale YouTube „Spotkanie Ekspertów”.

Już teraz trwają prace organizacyjne nad IV Spotkaniem Ekspertów, które odbędzie się 11 grudnia 2020 roku w Poznaniu - więcej informacji będzie można uzyskać na <http://SpotkanieEkspertow.pl/>



# Traumatic Injury of Medial Meniscotibial Ligament – Diagnostics and Conservative Treatment

## Uszkodzenie urazowe więzadła łąkotkowo-piszczelowego przyśrodkowego – rozpoznanie i leczenie zachowawcze

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### SUMMARY

The paper aims to present diagnostic methods and options of conservative treatment of traumatic injuries of medial meniscotibial ligament (MTL). Ca. 75% of all sport-related injuries pertains to the lower extremity; among those, knee damage the second most frequent, after ankle damage. The anteromedial part is where knee pain occurs most frequently.

Knee injuries often lead to damage to ligament structures, including medial meniscotibial ligament, which is rarely reported in the literature. Those ligaments may be damaged when the knee is subject to forces leading to valgity and rotation of the femur, internally, and of the tibia, externally. Damage may be caused in an isolated manner, through overloads and combined microdamage.

Medial meniscotibial ligaments are formed by a fibrous layer of the articular capsule and are a part of the deep medial collateral ligament. They run from the medial meniscus to the proximal part of the tibia.

An MTL examination consists of three parts: medical interview, physical examination and additional examinations. Due to the structure of MTL, its diagnostics must be expanded by an examination of the anterior cruciate ligament (ACL), medial collateral ligament (MCL) and the medial meniscus.

Treatment in the acute condition is carried out according to the PRICE (Protection, Rest, Ice, Compression, Elevation) rules. In the subacute and chronic condition, therapy may be expanded for instance by manual therapy methods, functional training, physical therapy and kinesiology taping.

**Key words:** medial meniscotibial ligament, knee, diagnosis, therapeutics

### STRESZCZENIE

Celem pracy jest przedstawienie metod diagnostycznych oraz propozycji leczenia zachowawczego uszkodzeń więzadła łąkotkowo-piszczelowego przyśrodkowego.

Okolo 75% wszystkich urazów sportowych dotyczy kończyny dolnej, a wśród nich uszkodzenia stawu kolanowego znajdują się na drugim miejscu po stawie skokowym. Część przednio-przyśrodkowa to najczęstsza lokalizacja objawów bólowych stawu kolanowego.

Urazy tego stawu często prowadzą do uszkodzenia struktur więzadłowych, w tym rzadko opisywanego w literaturze uszkodzenia więzadła łąkotkowo-piszczelowego (MTL) przyśrodkowego. Więzadła te mogą zostać uszkodzone podczas działania na staw kolanowy sił koślawiających i rotujących kość udową wewnątrz i kość piszczelową zewnątrz. Do urazów może dochodzić w sposób izolowany wskutek przeciążeń i sumujących się mikrourazów.

Więzadła łąkotkowo-piszczelowe przyśrodkowe utworzone są przez warstwę włóknistą torebki stawowej oraz są częścią głębokiego więzadła pobocznego przyśrodkowego. Przebiegają od łąkotki przyśrodkowej do części bliższej kości piszczelowej.

Badanie MTL składa się z trzech części: badania podmiotowego, przedmiotowego oraz badań dodatkowych. Ze względu na swoją budowę diagnostyka MTL musi być poszerzona o badanie więzadła krzyżowego przedniego (ACL), więzadła pobocznego przyśrodkowego (MCL) oraz łąkotki przyśrodkowej.

Leczenie w ostrej fazie odbywa się zgodnie z zasadami PRICE. W stanie podostrym i przewlekłym terapia może być poszerzona m.in. o techniki terapii manualnej, trening funkcjonalny, fizykoterapię oraz plastry dynamiczne.

**Słowa kluczowe:** więzadło łąkotkowo-piszczelowe, kolano, rozpoznanie, leczenie

## INTRODUCTION

The anteromedial part is where knee pain occurs most frequently (75%). There are many causes of pain in that region – damage to the tibial collateral ligament (MCL), the medial meniscus (MM), the attachment of the muscles forming the “goose’s foot” and the bursa found underneath [1-3].

Ca. 75% of all sport-related injuries pertains to the lower extremity; among those, knee damage the second most frequent (13,4%), after ankle damage (38.7%) [4-6]. Knee damage most often lead to damage to ligament structures (40%), among which the anterior cruciate ligament (ACL) and medial collateral ligament (MCL) are damaged most often (46% and 29% of cases, respectively) and the lateral collateral ligament (LCL) is damaged the least frequently (2) [3]. The cause that is rarely reported in the literature is damage to medial meniscotibial ligament (MTL), also referred to as the medial coronary ligament (lig. coronariummediale) [7].

The paper aims to present diagnostic methods and options of conservative treatment of traumatic injuries of medial meniscotibial ligament.

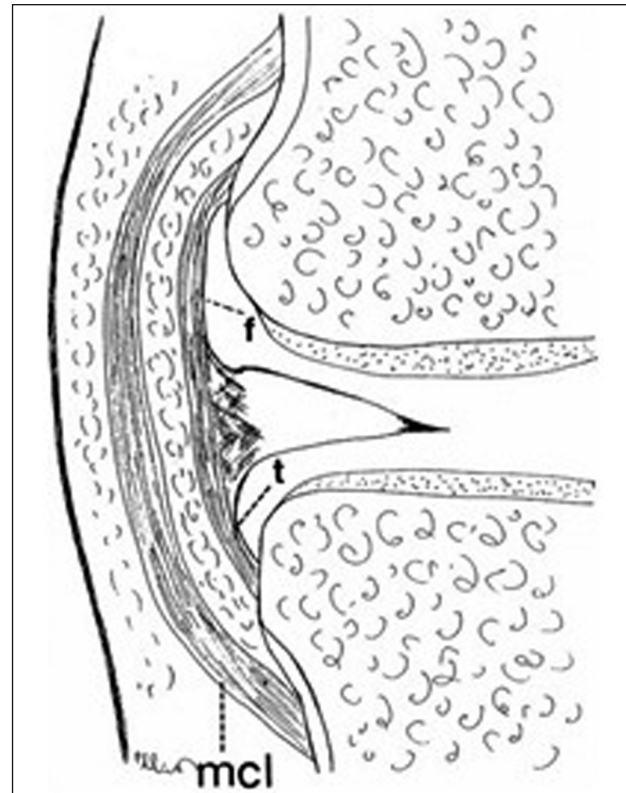
## ANATOMY

The knee is the largest joint in the human body, being a synovial connection of hinge (modified) type. It is formed by the femur, the tibia and the patella. The knee consists of three compartments – two femorotibial joints (medial and lateral) and the patellofemoral joint. In the collateral compartments, there are menisci, which divide the knee into two levels: the upper one – meniscofemoral – and the lower one – meniscotibial. The medial meniscus is longer and wider than the lateral meniscus as the medial (femorotibial) compartment takes more area [8-10].

The knee capsule is composed of the external layer – fibrous one – and the internal synovial one, which covers all surfaces of the articular chamber that do not have articular cartilage. The fibrous layer surrounds the condyles of the femur and the intercondylar fossa from the top and from the bottom it attaches to the edge of the articular surface of the tibia. An exception is the site where the tendon of the popliteus muscle passes through the articular capsule. The fibrous layers contains several thicker parts forming articular ligaments, including meniscotibial ligaments [8, 10-12].

Medially, the meniscotibial ligaments form a stabilisation system over the entire circumference of the medial meniscus. Therefore, it is worth looking at the biomechanics of the lower level – the meniscotibial – where rotation occurs. The longitudinal axis of movement moves through the condyle of the femur medially. Rotations occur most often when the knee is bent or towards the final phase of extension [10]. During those movements, the menisci move in the same direction as the condyles of the femur and in the opposite direction than the condyles of the tibia [8, 9].

Meniscotibial ligaments also form the deep medial collateral ligament (dMCL) (Figure 1). MCL counteracts forces causing valgity at 20° flexion and excessive external rotation at 90° flexion. MCL is a structure strengthening



**Figure 1.** Medial collateral ligament (MCL) along with marked meniscofemoral ligament (MFL) (f) and the meniscotibial ligament (MTL) (t) [13]

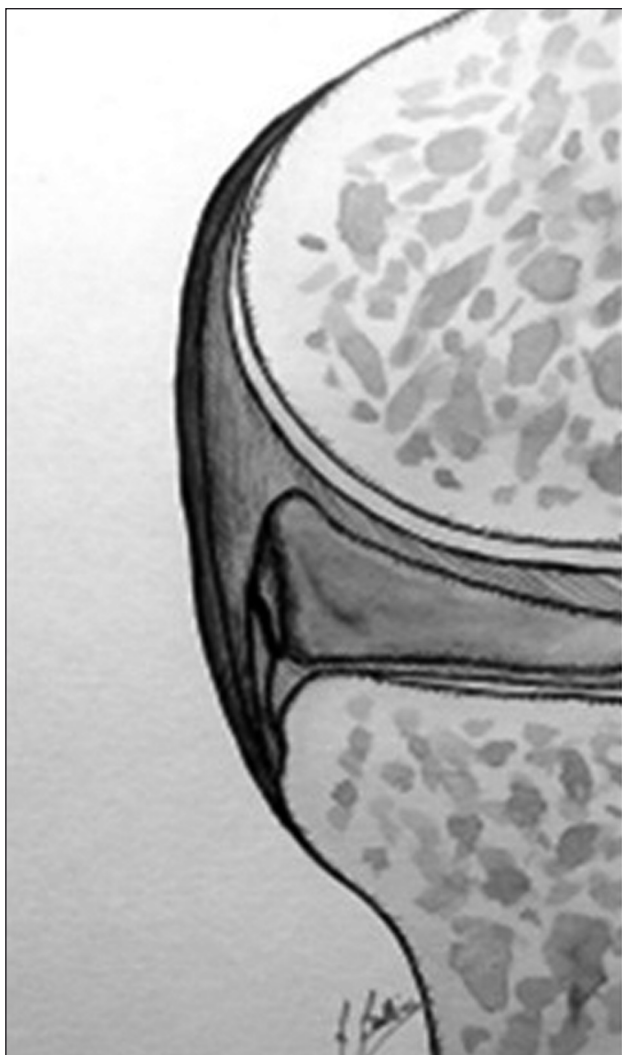
**Rycina 1.** MCL (mcl) wraz z zaznaczonym więzadłem łąkotkowo-udowym (f) oraz więzadłem łąkotkowo-piszczelowym (t) [13]

the knee medially and creating a fibrous band running towards the front and back off the lateral line of the joint. An important fixed structure are fibres of the medial collateral ligament, the posterior oblique ligament and the deep capsular ligaments. On the other hand, the movable structures strengthening the medial collateral ligament are the semimembranosus tendon complex and the medial vastus medialis complex [8, 9].

As there is a strong connection between MCL and the medial meniscus, the latter is less movable than the lateral meniscus. Due to the function of the medial meniscotibial ligament, i.e. control of external rotation of the tibia, its damage may lead to lack of control over that movement and instability in the lower knee compartment. This may lead to damage to the marginal portion of the medial meniscus [8, 13-17].

## ETIOPATHOLOGY

The meniscotibial ligaments are most often be damaged when the knee is subject to forces leading to valgity and rotation of the femur, internally, and of the tibia, externally. Damage may be caused in an isolated manner, through overloads and combined microdamage, and it may accompany such damage as damage to tibial collateral ligament (MCL) or full tear of the anterior cruciate ligament (ACL) [18]. Despite the fact that the meniscotibial ligaments are not structured as classic ligaments, the classic classification of mechanical damage can be applied to them. There are three degrees of damage:



**Figure 2.** Damage to the medial meniscotibial ligament [18]  
**Rycina 2.** Uszkodzenie więzadła łokotokowo-piszczelowego przyśrodkowego [18]

I – mild – slight damage to the ligament involving a full tear of several of its fibres, which does not distort the stabilisation function.

II – moderate – considerable damage to the structure of the ligament with its partial tear and maintained system of fibres, which causes the ligament to extend and distorts the stabilisation function (Figure 2), but which does not cause abnormal laxity of the joint.

III – severe – full tear of the ligament with instability of the joint [19].

Damage to MTL may lead to the full tear of the medial meniscus, which results in progressing instability and increased pressure in the medial compartment, and subsequently – damage to the articular cartilage [18-21].

### DIAGNOSTICS OF DAMAGE TO MEDIAL MENISCOTIBIAL LIGAMENTS

A knee examination is to begin with the inspection of the joint in standing and lying position. As the coronary ligaments are a part of the articular capsule and MCL, there is a possibility of post-traumatic inflammation [22].

In the medical interview, the healthcare professional should pay attention to information correlated with MTL damage. The pathology pertains first and foremost to individuals doing sports. Patients often do not remember the exact moment of damage and the problem develops slowly. What is significant is the occurrence of stinging pain in the medial region of the knee without the sensation of joint blocking. If there is no direct injury, when the cause of damage to the medial meniscotibial ligaments are instances of microdamage accumulating over a long period of time, there will be no inflammation [22, 23].

On physical examination, it is necessary to assess passive flexion, extension and external and internal rotation of the knee when the patient is lying on their back. The examination should be performed on both knees to compare the pathological joint with the healthy one.

Directly after injury, diagnostics may be considerably hindered by pain, reflexive muscle tension and a haematoma. Therefore, in many cases another clinical examination is required after several days. The persistent inflammation may result in an articular pattern. According to J. Cyriax, an articular pattern is a list of percent-based limitation of individual motions in a given joint. Movements are written down from the most to the least limited. The examination is carried out in the form of passive movements performed by the therapist. What is assessed are the range of motion and the examiner's subjective sensation accompanying the final range of motion, i.e. end feel or end resistance. In the case of knee inflammation, the end feel is referred to as "springy". An articular pattern of the knee means considerable limitation of flexion and slight limitation of extension. Rotations in both directions remain unrestricted [22, 23].

Due to the anatomic structure of the medial meniscotibial ligament, the following diagnostic tools also include tests than can confirm damage to the anterior cruciate ligament (ACL), the medial collateral ligament (MCL) and the medial meniscus. As there is a possibility of combined injuries which may affect several structures, it seems significant to perform all of the following tests:

**Test in passive external rotation** – the test is performed with the patient lying on their back with their knee bent at 110°. The therapist grabs the knee from the top with one hand, placing their fingers on the joint groove to palpate the occurring motion. With their other hand, they grab the patient's foot and introduces maximum ankle dorsiflexion. Subsequently, the therapist introduces the maximum external rotation in the knee, provoking symptoms in the region of MTL [10, 20]. Please note that the test in question may provoke symptoms in the tibial collateral ligament (MCL) and the medial meniscus. To exclude or confirm those structures in the diagnostic process, the knee valgity test and the palpating meniscus test are to be performed [18, 20, 24].

**Knee valgity test** – it is performed with the patient lying on their back. At the first stage of examination, the therapist introduces passive adduction of the lower leg at 20° in the knee. What is assessed is the range of motion, the opening degree of the articular space and end feel. Subsequently, the

test is repeated in full extension of the knee. At the second stage of the examination, there should be stronger rigidity and narrower range of motion due to the tension of the cruciate ligaments. The test aims to assess the pain symptoms in and the stability of the tibial collateral ligament (MCL) [9,14, 22, 25].

**Palpation meniscus test** – patient lying on their back with the knee bent at 90-110°. The therapist palpates the entire length of the knee space with the edge of their thumb. The positive test symptom is intense stinging pain [26].

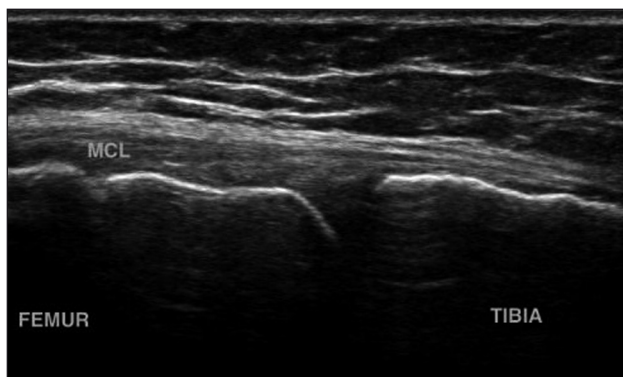
**Palpation of medial meniscotibial ligament** – the test is performed with the patient lying on their back. Firstly, the therapist assessed the temperature of the fully extended joint with the back of their hand. Subsequently, the patient's knee is bent to 90°. The therapist examines the anteromedial space of the knee with the edge of their thumb, pressing the meniscotibial ligament towards the articular surface of the tibia [22].

**Anterior drawer chest** – the test is performed with the patient lying on their back with their knee bent at 90°. The therapist grabs the tibia and pulls it anteriorly. To make the test more sensitive, they add external rotation of the lower leg. Even though the anterior drawer test is first of all intended to diagnose damage to the anterior cruciate ligament according to Hugston et al., the test can also show damage to meniscotibial ligaments. Such damage is indicated by moderately positive result combined with stinging pain in the anteromedial region of the knee [9, 25, 27].

#### IMAGING EXAMINATIONS

To confirm the diagnosis, imaging examinations are used – ultrasound (USG) or magnetic resonance imaging (MRI). In the classic ultrasound, hypogenic areas of the ligaments connected with collagen fibre degeneration can be exposed (Figure 3.) [28, 29].

The MRI image shows increased intra-ligament intensity of the signal or blurred margins of the ligament (Figure 4). Knee ligaments can be damaged typically in three places:



**Figure 3.** An ultrasound image with a fully torn MCL in the bone portion of the tibia, pulled and retracted towards the head (the femur)

**Rycina 3.** Obraz USG z rozerwanym więzadłem MCL w części kostnej piszczeli i pociągnięciem i wycofaniem go w kierunku dogłowym (kość udowa)

Źródło: [https://cdn-eu-ec-1.yottaa.net/50e5c1b84707e60c8000021f/www.sonosite.com/v~4b.82/sites/default/files/styles/media\\_gallery\\_large/public/2014\\_IMAGE\\_X-PORTE\\_KNEE\\_2.1.jpg?yocs=c\\_&yoloc=eu](https://cdn-eu-ec-1.yottaa.net/50e5c1b84707e60c8000021f/www.sonosite.com/v~4b.82/sites/default/files/styles/media_gallery_large/public/2014_IMAGE_X-PORTE_KNEE_2.1.jpg?yocs=c_&yoloc=eu)



**Figure 4.** MRI image – damage to the meniscofemoral ligament (A) and the meniscotibial ligament (B) [1]

**Rycina 4.** Obraz RM – uszkodzenie więzadła łokotkowo-udowego (A) oraz łokotkowo-piszczelowego (B) [1]

attachment to the femur or the tibia or the tendinous portion. Ligament damage is frequently accompanied by damage to articular capsule, usually its synovial portion, which leads to an intra-articular haematoma [1, 28, 30, 31].

#### TREATMENT

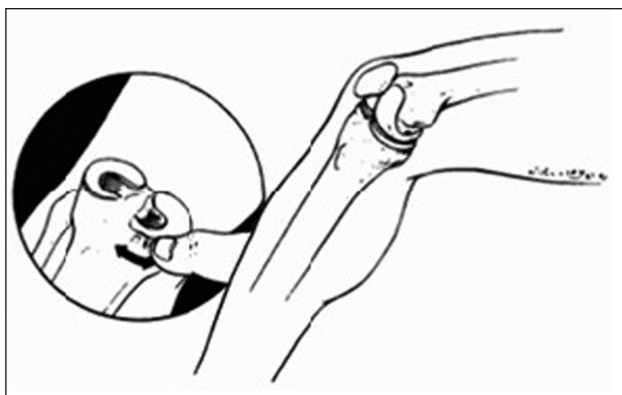
As the medial meniscotibial ligaments are a part of the articular capsule, if they are damaged, articular capsule inflammation, mentioned above, can occur. Its characteristic symptoms are increased temperature in the joint, congestion, swelling and pain [32, 33]. Acute phase treatment should aim to minimise the inflammatory response. What may help in that case is the PRICE rule (Protection, Rest, Ice, Compression, Elevation) and immobilisation with an orthosis [34].

Below, selected forms of physical therapy treatments for damage to medial meniscotibial ligaments are presented:

#### DEEP TRANSVERSE FRICTION MASSAGE (DTFM)

One of the suggested treatments of MTL damage is deep transverse friction massage (DTFM). The procedure may be started on day 4 after knee injury. It is recommended to apply DTFM twice a week. The first session of the procedure takes 2 minutes and the duration should be gradually extended over the next sessions to 15 minutes.

DTFM of MTL is performed in the position of bending the patient's knee to 90° and the external rotation of the shin. The therapist places his second finger with the third finger placed on it on the medial part of the knee gap. The therapist's forearm positioned in pronation ensures contact of the second finger with MTL on the surface of the tibial plate. The massage is performed in a transverse direction to the course of MTL fibers (Figure 5). This MTL treatment takes 2-3 weeks [22, 35].



**Figure 5.** Deep transverse friction massage of the medial meniscotibial ligament [35]  
**Rycina 5.** Głęboki masaż poprzeczny więzadła łąkotkowo-piszczelowego przyśrodkowego [35]

## FUNCTIONAL TRAINING

Due to the most frequent damage mechanism, that is forces leading to valgity of the knee and rotating the femur internally and the tibia externally, the rehabilitation process should include training of abductors and external rotators of the hip and the vastus medialis oblique muscle – VMO). What is significant are concentric and eccentric exercises in closed and open muscle chains and proprioceptive training [36, 37].

## PHYSICAL THERAPY

In the case of MTL damage, Hudes recommends low-energy muscle treatment [15]. Referring to papers concerning treatment of other knee ligaments, it is worth introducing physical therapy procedures such as ultrasounds (UD), shockwave, topical cryotherapy (in acute condition) and warm compresses and peloids (in chronic condition) [38-40].

## KINESIOLOGY TAPES

What may facilitate the healing of coronary ligaments are kinesiology tapes. A combination may be used of application on the quadriceps muscle and application on a ligament covering the area of Hoffa's disease and MCL with tension of 50-70% [41, 42].

## ORTHOPAEDIC EQUIPMENT

Orthopaedic equipment in the form of orthoses may be taken into consideration in the case of damage to meniscotibial ligaments combined with damage to the medial collateral ligament (MCL) [34, 37]. Immobilisation is recommended for 1-2 weeks at -20° extension and 70-90° flexion. In the next weeks, the range is increased until full range of motion is obtained. MCL heals from 4 to 6 weeks [43].

## CONCLUSIONS

One of the causes of pain in the anteromedial region of the knee is damage to the medial meniscotibial ligaments. The consequence of that injury might be increased the load on the neighbouring structures, e.g. the medial meniscus [16, 44]. The diagnostics and treatment of the medial meniscotibial ligaments is still a challenge due to the insufficient number of publications about that topic. Another problem is the

possibility of combined damage, where structures such as the tibial collateral ligament, the anterior cruciate ligament and the medial meniscus may be involved. Therefore, the diagnostics should be expanded by the examination of those structures. The methods for examination and treatment of MTL damage presented in this paper do not exhaust all options, so there is a strong need for further studies concerning this topic.

**Conflict of interest:** The authors report no conflict of interest.

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## POLA NADZIEI

**Z Jarosławem Osiakiem, wiceprezesem firmy Med & Life, producentem wyrobów medycznych Viofor JPS System, rozmawia Barbara Ignatowska**

**W tym roku obchodźcie Państwo 25 rocznicę powstania firmy. Co było inspiracją do podjęcia decyzji o wejściu na rynek urządzeń medycznych?**

Zwykły przypadek i moje problemy ze zdrowiem. Miałem przy tym szczęście zetknąć się z fantastycznymi lekarzami i naukowcami Prof. Tadeuszem Miką, Doc. Szymonem Kubiakiem, Doc. Stanisławem Grabcem, Prof. Aleksandrem Sieroniem. To pod ich wpływem zainteresowałem się możliwościami jakie daje medycyna fizykalna i w 1995 roku powstała firma Med & Life.

**Jak z perspektywy czasu ocenia Pan swoją decyzję?**

Mam satysfakcję, że wskoczyłem do tego pociągu. Zrozumiałem, że trudno wyobrazić sobie rozwój współczesnej medycyny bez wykorzystania zjawisk fizycznych w diagnostyce i terapii. Od tamtego czasu wszystko w życiu moim i mojej żony Ireny, która jest Prezesem Med & Life, zmieniło się całkowicie. Nasze cele biznesowe i czas dzielimy między rodzinę i działania związane z rozwojem wyrobów Viofor JPS. Wszystko to realizujemy w warunkach konkurencji, która nie zawsze gra fair.

**Jak scharakteryzowałby Pan wyroby Viofor?**

Generowane przez Viofor JPS parametry pola elektromagnetycznego, kształt, częstotliwość i indukcja są tak dobrane, aby wywołać w organizmie korzystne efekty biologiczne wspierające homeostazę, czyli równowagę biologiczną mającą decydujący wpływ na nasze zdrowie, wydolność organizmu i dobre samopoczucie. Nowa generacja wyrobów przeznaczana jest do wspomagania procesu leczenia, rehabilitacji, odnowy biologicznej i prewencji chorób. Wykorzystywanym w wyrobie czynnikiem terapeutycznym jest impulsowe pole magnetyczne w systemie JPS i energia światła. W naszej ofercie posiadamy ok. 60 pozycji katalogowych, w tym wyroby przeznaczone do użytku profesjonalnego i medycyny środowiskowej (leczenie w domu pacjenta).

**Proszę rozszyfrować skrót JPS?**

Skrót pochodzi od pierwszych liter twórców metody, profesorów: biofizyka Feliksa Jaroszyka, fizjologa Janusza Paluszaka oraz klinicysty i specjalisty medycyny fizykalnej Aleksandra Sieronina.

**W „Acta Balneologica” publikowanych było wiele prac opisujących terapię z użyciem państwa wyrobów. W jakich ośrodkach naukowych prowadzone były badania?**

Badania medyczne i obserwacje kliniczne prowadzone były w większości polskich ośrodków naukowych i akademiach np. Śląskim Uniwersytecie Medycznym, Poznańskim Uniwersytecie Medycznym, Wrocławskim Uniwersytecie Medycznym, Łódzkim Uniwersytecie Medycznym, Pomorskim Uniwersytecie Medycznym i w wielu innych placówkach w kraju i za granicą. Całość badań sfinansowana była z funduszy UE, projektów celowych i grantów naukowych. W pracę nad rozwojem wyrobu zaangażowana była Wojskowa Akademia Techniczna, Instytut Tele i Radiotechniczny oraz oczywiście zespół Med & Life.

**Często zarzuca się firmom medycznym, w szczególności farmaceutycznym, manipulacje w przedstawianiu wyników badań i fałszowanie statystyk. Czy spotkał się Pan z takimi zarzutami?**

Ależ oczywiście bywają takie sytuacje, w czasach wszechobecnego hejtu i nieuczciwych praktyk rynkowych, trudno się dziwić przejawom nieufności. Zdobyliśmy zaufanie dziesiątek tysięcy klientów, nie znany jest mi z nazwy żaden wyrób medyczny o tak udokumentowanym działaniu.

Badania są prowadzone cały czas, obecnie to ponad trzysta publikacji, trzydzieści pięć rozpraw doktorskich i habilitacyjnych potwierdzających skuteczność i bezpieczeństwo wyrobu.

**Widzę w biurze Med & Life ogromną ilość nagród i dyplomów, może Pan coś powiedzieć na ten temat?**

Tak jesteśmy oceniani przez ekspertów w Polsce i za granicą, wynikiem tego są dziesiątki nagród i wyróżnień w konkursach innowacyjnych technologii, na targach i konferencjach naukowych. Proszę popatrzeć, mamy tu zgromadzone złote medale z Paryża, Norymbergi, Genewy, Brukseli, Budapesztu i szereg innych prestiżowych nagród.

**Widzę, że w 2019 roku przyznano Med & Life tytuł Lidera Zmian na Mazowszu w kategorii biznes medyczny i po raz trzeci wyrób został wyróżniony przez Polską Agencję Rozwoju Przedsiębiorczości w konkursie Polski Produkt Przyszłości. Czy pomaga to firmie w budowaniu wizerunku nowoczesnej firmy?**

Na pewno tak, wysoka ocena niezależnych ekspertów i Agencji Państwowych wizerunkowo dla firmy ma wartość większą niż inne formy promocji. W styczniu tego roku z rekomendacji Polskiej Agencji Rozwoju Przedsiębiorczości znaleźliśmy się w gronie 70 najbardziej innowacyjnych polskich firm, które uczestniczyły w Wystawie zorganizowanej przez Kancelarię Prezydenta RP na 100 lecie niepodległości. W Polskiej Wystawie Gospodarczej „Od COP do GOSPODARKI 4.0”, branżę medyczną reprezentowały 4 firmy.

**Czy może mi Pan zdradzić jak pozyskaliście tak duże środki z Funduszy UE na rozwój firmy i wyrobów?**

Odpowiedź jest prosta, trzeba przygotować projekt innowacyjny i spełnić wymogi formalne. W większości projektów trzeba pozyskać partnera albo konsorcjanta np.: instytut naukowy. Pomaga w tym wizerunek firmy innowacyjnej i pozytywna ocena ekspertów oraz zdobyte nagrody i wyróżnienia.

**Gdzie można skorzystać z zabiegów Viofor JPS?**

Nasze wyroby dostępne są zarówno w publicznej jak i niepublicznej opiece zdrowotnej. Zapraszam na naszą stronę [www.medandlife.com](http://www.medandlife.com), gdzie znajdziecie Państwo naszych użytkowników: kliniki, szpitale, sanatoria, domy opieki, POZ i prywatne gabinety. Zapraszam również lekarzy i fizykoterapeutów do korzystania z bazy wiedzy, gdzie udostępnionych jest szereg publikacji i badań z wykorzystaniem Viofor.

**Na koniec mam pytanie na czasie. Czy Viofor JPS może być stosowany w okresie kiedy wszyscy jesteśmy zagrożeni infekcjami?**

Jak najbardziej. Wyroby spełniają kryteria medycyny opartej na dowodach naukowych EBM. Celem twórców było stworzenie nowej generacji wyrobów o wyższej skuteczności klinicznej z naciskiem na wsparcie mechanizmów regeneracyjnych, układu immunologicznego, układu krążenia i ośrodkowego układu nerwowego. Wyroby zaprojektowane do wykorzystania w warunkach domowych skutecznie wspierają homeostazę organizmu.

**Czy według Pana Viofor spełnił oczekiwania twórców i pacjentów?**

Tak, potwierdzają to zebrane w okresie 25 lat wyniki badań i obserwacji klinicznych oraz opinie profesjonalistów i użytkowników indywidualnych.

**Jesteśmy teraz w okresie pandemii koronawirusa, czy według Pana zastosowanie Viofor ma uzasadnienie?**

Musimy włączyć myślenie, nie jestem lekarzem, ale wszyscy immunolodzy i pulmonolodzy, którym zadałem to pytanie twierdzą, że kluczem w walce z patogenem w chorobach infekcyjnych jest prawidłowo funkcjonujący system odpornościowy. Badania wykazały, że jesteśmy w stanie dzięki immunotropowemu oddziaływaniu Viofor odbudować populację regulacyjnych limfocytów T i poprawę ich aktywności. U chorych zauważono jednocześnie redukcję aktywności cytokin prozapalnych i zwiększenie aktywności cytokin przeciwzapalnych. W badaniach klinicznych z użyciem Viofor stwierdzono u wszystkich dzieci leczonych z powodu nawracających infekcji dróg oddechowych – poprawę odpowiedzi immunologicznej. System odpornościowy wrócił do normy fizjologicznej. W grupie dzieci leczonych farmakologicznie bez zabiegów Viofor, żadne dziecko nie uzyskało poprawy. Identyczne wyniki uzyskano u osób z poparzeniami 20%-50% ciała. Również u tych pacjentów uzyskano pozytywną odpowiedź systemu immunologicznego, przyspieszenie procesu gojenia i poprawę stanu klinicznego. Obserwacje w okresie 6 miesięcy po zakończeniu badania wykazały zmniejszenie liczby incydentów o 90% , skrócenie czasu ich trwania o 80% i znaczącą redukcję leków z grupy NLPZ. W obu badaniach efekt pozytywny potwierdzono *in vivo* i *in vitro*. Warte uwagi są dobrze udokumentowane procesy ochrony komórki przed stresem oksydacyjnym oraz korzystne antystresowe i relaksacyjne oddziaływanie na ośrodkowy układ nerwowy. Niestety, w krótkim wywiadzie nie da się przedstawić 25 lat doświadczeń. Sądzę że oddziaływanie Viofor idealnie wpisuje się w holistyczne podejście do pacjentów w szeroko pojmowanej medycynie fizykalnej. Może być alternatywą dla leków z grupy NLPZ stosowanych w przewlekłym bólu i stanach zapalnych, jak również w schorzeniach wymagających poprawy krążenia i mikrokrążenia. Zapraszam wszystkich do korzystania z naszych doświadczeń dla dobra pacjentów i nas samych, albowiem „*Głupiec myśli, że dość rozumu; mędrzec wie, jak wiele mu brakuje*” (William Shakespeare).

[www.medandlife.com/publikacje-medyczne](http://www.medandlife.com/publikacje-medyczne)

## PROF. KRZYSZTOF MARCZEWSKI



**31 grudnia 2019 roku odszedł od nas wielki, dobry Człowiek, lekarz humanista Prof. dr hab. med. Krzysztof Marczewski. Z jego stratą nie możemy się pogodzić, przecież tyle jeszcze by mógłby zrobić dla nas wszystkich. Był specjalistą wielu dziedzin, dla nas najważniejsze, że był balneologiem.**

Krzysztof urodził się w Opolu Lubelskim 11 stycznia 1957 roku.

Studia medyczne ukończył z wyróżnieniem w 1981 roku w Akademii Medycznej w Lublinie. Jako pierwszy kierunek specjalizowania się wybrał nefrologię rozpoczynając pracę w Klinice Nefrologii kierowanej wówczas przez Prof. Zbysłuta Twardowskiego. Później zdobywał kolejne specjalizacje, ostatnią była balneologia i medycyna fizykalna. Pracował w Akademii Medycznej w Lublinie, Instytucie Medycyny Wsi w Lublinie, Wojewódzkim Szpitalu im. Jana Pawła II w Zamościu. Pracował naukowo zdobywając kolejne stopnie naukowe, dydaktycznie – **ucząc studentów. Pracował intensywnie do końca swojego życia.** Jeszcze 20 grudnia, 10 dni przed śmiercią recenzował pracę doktorską. Był recenzentem wielu prac doktorskich i magisterskich. Jest autorem wielu prac naukowych publikowanych w kraju i za granicą. Napisał kilka książek i rozdziałów w książkach. Dla nas opracował niezwykle cenny rozdział dotyczący endokrynologii i nefrologii w Wielkiej Księdze Balneologii, Medycyny Fizykalnej i Uzdrawiskowej, wydanej w 2018 r. Uczestniczył aktyw-

nie w wielu konferencjach naukowych w kraju i za granicą. Pracował również przez kilka lat w Europejskiej Grupie ds. Etyki w Nauce i Nowych Technologiach (EGL) w Brukseli. Posługiwał się biegle kilkoma językami. Ale był przede wszystkim lekarzem niezwykle cenionym przez pacjentów. Miał cierpliwość z każdym chorym porozmawiać i udzielić porady. Pacjenci Go kochali i On kochał tę pracę.

Był nagradzany wieloma prestiżowymi nagrodami jak Eiffel Gut Schwietzere, był stypendystą Deutche Akademische Austausch Dinst, Honorowym Członkiem Polskiego Towarzystwa Nefrologii. Poza tym otrzymał wiele odznaczeń państwowych m.in. Srebrny Krzyż Zasługi. Uczestniczył w pracach Zarządu Głównego Polskiego Towarzystwa Balneologii i Medycyny Fizykalnej.

Poza wybitnymi osiągnięciami naukowymi, dydaktycznymi i lekarskimi był wspaniałym mężem swej ukochanej Basi oraz Ojcem syna Tadeusza. Dla nas był kolegą niezwykłym, nigdy nie odmówił prośby o pomoc. Jego wielką zaletą charakteru była uczciwość, sumiennosc we współpracy ze środowiskiem lekarskim. Podziwiałam Jego dystygowane zachowanie w wielu trudnych sytuacjach, co budziło szacunek i respekt. Nie pił nawet kropli alkoholu, był absolutnym abstynentem. Zazdrościłam Jego szczerzej pobożności, której nigdy nie ukrywał.

Odszedł od nas Człowiek niezwykle, uczciwy o wielkim sercu. Nawet w cierpieniu umiał zachować godność. Przez prawie 2 lata żył z wyrokiem rozpoznania guza mózgu (glejaka). Pokornie znosił swoją chorobę, mając przecież świadomość tak okrutnej diagnozy. Trzymała Go praca, pacjenci i rodzina oraz przyjaciele. Wszyscy pragnęliśmy cudu, ale ten się nie pojawił, odszedł cicho, spokojnie bez bólu cielesnego.

Nie odszedł jednak od nas całkowicie. Zostawił wiele dobra na tej Ziemi, wielki dorobek naukowy, wielu uczniów i uratowanych od choroby pacjentów.

*Żegnaj Krzysiu  
Prof. Irena Ponikowska*

## DR KRZYSZTOF SPAŁEK

Krzysztofa Spałka wspomina Teresa Kudyba

Dr Krzysztof Spałek, naukowiec Uniwersytetu Opolskiego, zmarł po długiej i wyczerpującej chorobie 10 grudnia 2019 roku, nie doczekawszy swojej „pięćdziesiątki” ani wymarzonej habilitacji. Już w roku 1987 jako licealista dokonał osiągnięcia przełomowego dla polskiej nauki: odkrył stanowisko paleontologiczne w swojej rodzinnej wiosce – Krasiejowie, dzięki czemu Polska zaistniała na paleontologicznej mapie świata. Dziś krasiejowskie pradinozaury i zbudowany wokół nich Jurapark to międzynarodowe miejsce badań naukowych oraz jedna z największych atrakcji edukacyjnych i turystycznych w Polsce i Europie.

Krzysztof to był człowiek ponadprzeciętny. W mojej pamięci zapisał się jako wybitny botanik, wszechstronny i niezastąpiony badacz, popularyzator przyrody mojej ziemi rodzinnej, Śląska Opolskiego. Genialny zmysł obserwacyjny, ogromna wiedza, a przy tym skromność, pokora i charakterystyczne dla Górnoślązaka – pracowitość i rzetelność to cechy, które wyniosły go na panteon opolskich nauczycieli akademickich, przyrodników, krajoznawców, ale jednocześnie spowodowały jego ogromne osamotnienie w starciu z niszczącą takie cenne osobowości technokratyczną „punktozą”, jaka zapanowała w ostatnich latach na polskich uczelniach wyższych.

Doktor Spałek pozostanie nieśmiertelny w moich filmach edukacyjnych: „Dinozaury z Krasiejowa”, „Opolskie białe złoto”, „Z tarniną w herbie”. Bardzo ważny jest pierwszy z tych filmów. Udało mi się dotrzeć z kamerą do zakurzonych pudeł z kośćmi pradinozaurów, które 16-letni wówczas Krzysiek zawiózł na Uniwersytet Wrocławski i nikt z naukowców się nimi nie zainteresował. Wspólnie napisaliśmy przewodnik „Opolskie wędrówki krajoznawcze”, wzbogacony o unikatowe fotografie rzadkich roślin. Nie tylko potrafił je odnaleźć w terenie, wszystkie bezbłędnie nazwać i opisać, ale też odtworzyć lub wymyślić dla nich pożyteczne zastosowanie. Ostatnie z jego zdjęć – ciechocińskie słonorośla uwieczniłam w jubileuszowym albumie o Ciechocinku (2016).

Pozostanie nieśmiertelny wśród ziół... Sebastianum Silesiacum w Kamieniu Śląskim zawdzięcza mu znakomity ogród, zaprojektowany i założony w roku 2004, a stanowiący podstawową bazę terapii ziołowej, jednej z pięciu filarów profilaktyczno-leczniczej metody ks. Sebastiana Kneippa. W pobliżu pałacu rodu Strachwitz, miejscu urodzenia św. Jacka, dr Spałek zaprojektował rabaty, na których pojawiły się subtelnie pachnące zioła: hyzop, melisa, mięta, rozmaryn, szaflwia, lebiodka pospolita oraz sektory roślinności ozdobnej, krajobrazowo-florystyczny, owocowo-sadowniczy.

W ostatnich latach dr Spałek poświęcił się badaniom nad wykorzystaniem w terapii uzdrowiskowej roślin leczniczych, w tym wodnych i siennych (fenum). Rozpoczął intensywne badania łąk, skupiając się najpierw na Równinie Opolskiej, a od 2016 roku w okolicach Ciechocinka i Słońska, o co go poprosiłam. Osobiste poznanie wybitnej balneolog prof. Ireny Ponikowskiej, mieszkającej i leczącej w Ciechocinku, udział w roli panelisty na konferencji polskich balneologów, podjęcie ścisłej współpracy ze Stowarzyszeniem Komisja Zdrojowa miały zaowocować nie tylko międzynarodowymi publikacjami, ale stworzeniem w Ciechocinku centrum leczenia metodą Kneippa. Te znakomite plany przerwała choroba Krzysztofa. Słonorośla zaobserwowane w Ciechocinku w roku 2016 zainspirowały dr. Spałka do zaprojektowania parku roślin słonolubnych i tężni solankowej w Wołczynie na Śląsku Opolskim, gdzie podobnie jak w Ciechocinku występują źródła termalnej solanki, odkryte w latach 80-tych.

Krzysztof miał wielkie plany. Nie zdążył. Pozostawił wiele niedokończonych działań i opracowań, które kontynuować będą jego najbliżsi przyjaciele. Wkrótce powstanie drukiem książka, w której spisuję wspomnienia osób, którym dane było prywatnie lub zawodowo znaleźć się na Jego osobistej orbicie.

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Krzysztof Spałek – pracownik naukowo-dydaktyczny w Katedrze Biosystematyki Uniwersytetu Opolskiego: badacz geografii roślin, geobotaniki, fitosocjologii, fitoterapii i lecznictwa uzdrowiskowego. Współredaktor pierwszej w Polsce regionalnej „Czerwonej księgi roślin województwa opolskiego”. Odkrywca nowych dla Polski zbiorowisk roślinnych. Autor kilkuset publikacji popularnonaukowych, dziesiątek folderów, albumów, książek. Stały współpracownik czasopism: Sudety, Przyroda Górnego Śląska, Panacea, Spotkania z Zabytkami, Acta Balneologica. Fotograf przyrody, publicysta, regionalista, odkrywca światowej rangi stanowiska paleontologicznego w Krasiejowie. Laureat Nagrody im. Karola Miarki (2006) oraz nagród Rektora Uniwersytetu Opolskiego. Unijny ekspert do spraw obszarów Natura 2000. Biegły z listy Wojewody Opolskiego w zakresie ochrony przyrody.



fol. Mariusz Przygoda

**Ciechocinek 2019 r.**

**Szanowni Państwo**

W 2021 roku we wrześniu planujemy zorganizowanie kolejnego Kongresu Balneologicznego Polskiego Towarzystwa Balneologii i Medycyny Fizykalnej.

W związku z tym, uprzejmie zapraszamy Zakłady Lecznictwa Uzdrowiskowego do zgłaszania ofert na zorganizowanie Zjazdu.

Oferta powinna zawierać następujące dane:

- 1) dysponowanie trzema salami, w tym jedna na 300 miejsc, dwie na 100-150
- 2) miejsca (hall) wystawowe
- 3) możliwość zakwaterowania w pokojach 1- i 2-osobowych dla około 300 uczestników oraz apartament i wysokiej klasy pokoje dla gości zagranicznych i Vipów krajowych (łącznie 50 osób, razem około 350 osób)
- 4) zapewnienie wyżywienia dla około 350 osób
- 5) zapewnienie oryginalnego i ciekawego programu socjalnego i turystycznego dla gości zagranicznych
- 6) zaproponowanie stawki za osobodzień dla uczestników i gości, która będzie obejmować: wyżywienie, zakwaterowanie, bankiet, imprezę integracyjną

Po otrzymaniu od Państwa wstępnej oferty, Zarząd Główny PTBiMF przeanalizuje warunki wszystkich zgłoszonych ofert i wybierze jedno miejsce na zorganizowanie Kongresu Balneologicznego PTBiMF.

Oferty prosimy kierować na adres:

Polskie Towarzystwo Balneologii

i Medycyny Fizykalnej

ul. Leśna 3

87-720 Ciechocinek

e-mail: karolina.makowska@vp.pl

Z poważaniem:

dr n. med. Jacek Chojnowski

Przewodniczący ZG PTBiMF

# Wyciąg z Regulaminu publikowania prac w czasopiśmie Acta Balneologica

**Acta Balneologica** jest naukowym czasopismem Polskiego Towarzystwa Balneologii i Medycyny Fizykalnej. **Ukazuje się od 1905 roku.** Na łamach kwartalnika publikowane są recenzowane prace oryginalne, poglądowe, kazuistyczne z zakresu medycyny uzdrowiskowej – balneologii, bioklimatologii, balneochemii, dermatologii – choroby skóry, kosmetologii – dermokosmetyków, balneokosmetyków, hydrogeologii i medycyny fizykalnej – fizjoterapii, krioterapii, kinezyterapii, presoterapii a także rehabilitacji.

Adresatami czasopisma są lekarze, rehabilitanci, fizjoterapeuci wykorzystujący w pracy zawodowej wiedzę z zakresu balneologii i medycyny fizykalnej, ordynatorzy, dyrektorzy szpitali, menadżerowie uzdrowisk, sanatoriów, publicznych i prywatnych szpitali, zakładów opieki zdrowotnej, ośrodków SPA i odnowy biologicznej a także specjaliści innych dyscyplin medycyny.

Czasopismo jest indeksowane w **Web of Science ESCI (Emerging Sources Citation Index)**, **MNiSW – 20 pkt.**, oraz w Polskiej Bibliografii Lekarskiej, Bibliografii Geografii Polskiej. Posiada stały patronat Komitetu Rehabilitacji Kultury Fizycznej i Integracji Społecznej **Polskiej Akademii Nauk**. Redakcja wdraża procedurę zabezpieczającą oryginalność publikacji naukowych oraz przestrzega zasad recenzowania prac nadsyłanych do redakcji zgodnie z wytycznymi Ministerstwa Nauki i Szkolnictwa Wyszczególnego.

Redakcja przestrzega zasad zawartych w Deklaracji Helsińskiej, a także w Interdisciplinary Principles and Guidelines for the Use of Animals in Research, Testing and Education, wydanych przez New York Academy of Sciences' Adhoc Committee on Animal Research. Wszystkie prace odnoszące się do ludzi lub zwierząt muszą być przygotowane zgodnie z zasadami etyki.

**Zasady recenzowania prac.** Nadesłane prace są oceniane m.in. pod względem nowatorskiego przedstawienia tematu, znaczenia dla dalszego rozwoju badań naukowych oraz dla postępowania klinicznego. Wstępnej oceny tych tekstów dokonuje Redakcja. Prace niespełniające podstawowych warunków publikacji są odrzucane. Manuskrypty niekompletne lub przygotowane w stylu niezgodnym z zasadami podanymi poniżej odsyłane są autorom bez oceny merytorycznej. Pozostałe artykuły zostają zarejestrowane, a następnie są przekazywane do oceny niezależnych recenzentów. Prace zostają zakwalifikowane do druku po pozytywnej opinii wydanej przez recenzentów.

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## Przygotowanie manuskryptu

Regulamin zgłaszania artykułów do druku opracowano na podstawie „Uniform Requirements for Manuscripts Submitted to Biomedical Journals” *N.Engl. J.Med.* 1997;336:309-315.

## Prace oryginalne powinny mieć następującą strukturę:

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