

a) Local cryotherapy using liquid nitrogen vapours were conducted with application of Polish-made cryo-aplicator. The treatment was carried out in a temperature of -196°C from a distance of 10-15 cm at a covered knee joint. Amount of treatments in a series was 10; two series were conducted (totally 20 treatments); time of treatment was increased during series (maximally up to 3 minutes) [11].

b) System cryotherapy was conducted in a cryogenic chamber in a temperature of -110°C . Amount of treatments in a series was 20; they were conducted 5 times a week; treatment time was 3 minutes [11-13].

c) Rehabilitation program:

1. active exercises consisting in knee joint discharging (axial discharging in UGUL, time 10 minutes);
2. isometric exercises of quadriceps muscle of thigh, cramp time – 7 s, break time – 14 s, three series 20 cramps each, rest between series – 3 minutes;
3. shank waving in full scope of mobility sitting on a table at stabilised thigh, time – 5 minutes; active exercises with a resistance of knee joint extensors and flexors [14].

Amount of repetitions in a series was selected individually.

Results of researches

Frequently meet MET and A characteristic symptom of patella-thigh overload syndrome is pain occurring in the area of THE knee joint. At the beginning, the pain appeared after physical effort and then during rest. The anamnesis showed that patients suffered pain ailments when running as well as climbing up and coming down the stairs. Often some troubles with straightening knee joint occurred after a long-time bend. All of the patients suffered some former traumas. 89% of the patients had had analgesic therapy. Physiotherapy treatments (butapyrasole and lignocaine ionophoresis) were applied; the rest of patients ignored the traumas. Unsatisfactory effects made the patients search

better methods of treatment.

Measurements of lower limbs circumferences in case of patients taking part in system as well as local cryotherapy on levels I, II, III did not show differences. The measurements of circumferences on stage III showed that in case of system cryotherapy, the differences in circumferences occurred in 76.5% of patients and in case of local cryotherapy, the differences were observed a 100% of patients. After the treatment applying system cryotherapy the differences between circumferences equalized in case of 90% of patients while concerning local cryotherapy in case of 66% of patients. In both groups the difference on level III was at the average 0.5-1 cm. Range of knee joint mobility did not change distinctively before and after the therapy.

Measurements of knee joint extensors and flexors strength comprising examinations before and after the analysis and comparing with analogous parameters of healthy lower limb show that after a 3-4 week rehabilitation procedure, ratio between extensors and flexors is very close to one in a healthy limb. That means that muscle imbalance resulting from a patella-thigh conflict stabilizes due to rehabilitation process assisted by local and system cryotherapy.

Table 16.1. Diagnosis tests of patients taking part in local cryotherapy treatments

No.	Initials	Age	Sex	Diagnosis tests
	Before			After

In the group of patients taking part in local cryotherapy treatments prior to medication, average pain intensity was 7 points, and in case of system cryotherapy – 8 points in a VAS scale. After the treatment applying local as well as system cryotherapy 10% of patients noted pain close to 4 points in a VAS scale.

Results of diagnosis and functional tests

The results of diagnosis tests: I – static test (Clark symptom), II – Waldron dynamic test, III – percussion test (Frund symptom) for people taking part in a local cryotherapy treatments have been presented in the table 16.1. Before the treatment, in diagnosis tests I, II and III of patients taking part in a local cryotherapy treatments, test I was positive in case of 88% of patients, whereas tests II and III were positive in all cases. After the treatment, tests I and II were positive in case of 12% of patients. Test III was negative in case of 80% of patients and in case of 20% it remained at the same level.

Table 16.2. Results of tests of patients taking part in local cryotherapy treatments

No.	Initials	Age	Sex	Functional tests results Before	After
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trzaski – cracks

niewielki ból – mild pain

brak bólu – no pain

ograniczenie ruchomości rzepki – patella mobility constraint

obrzęk - edema

Legend (referring to tab. 16.2 and tab. 16.4): IV – results of patella mobility constraint test, V – results of Mc Connell test, VI – results of Zohlen symptom

Table 16.3. Diagnosis tests of patients taking part in system cryotherapy treatments

No.	Initials	Age	Sex	Diagnosis tests Before	After
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The results of functional tests (IV – results of patella mobility constraint test, V – results of Mc Connell test, VI – results of Zohlen symptom) of patients taking part in a local therapy treatments have been presented in the table 16.2. Before the treatment, in diagnosis tests IV was positive in case of 87% of patients whereas tests V and VI showed that pain occurred in case of 67% of patients. After the treatment, tests IV and V were positive in case of 33% of patients while test VI showed that in case of 73% of patients pain remained at the same level.

The results of diagnosis tests of patients taking part in a system cryotherapy treatments have been presented in the table 16.3. Before the treatment, in diagnosis tests I, II and III of patients taking part in a system cryotherapy treatments, test I and III were positive in all cases and test II was positive in case of 70% of patients. After the treatment, tests I, II and III were positive in case of 80% of patients. Pain remained at the same level in case of 12% of patients.

Table 16.4. Results of tests of patients taking part in system cryotherapy treatments

No.	Initials	Age	Sex	Functional tests results Before	After
				trzaski – cracks	
				znacznie mniejszy ból – considerably smaller pain	
				niewielki ból – mild pain	
				ból w stawie – pain in articulation	
				brak bólu – no pain	
				ograniczenie ruchomości rzepki – patella mobility constraint	
				obrzęk – edema	

The results of functional tests of patients taking part in a system

cryotherapy treatments have been presented in the table 16.4. Before the treatment, the diagnosis tests: IV, V and VI of patients taking part in a system cryotherapy treatments were positive in case of 88% of patients. After the treatment, tests IV, V and VI were negative in case of 55% of patients whereas pain remained at the same level in case of 45% of patients.

Conclusions

Cryorehabilitation contributed to decrease of pain ailments in examined group of patients in a way that is comparable in two groups.

Decline of pain ailments enabled exercises that are comparable in two groups.

Applied therapy contributed to improvement of knee joint functions that is confirmed by results of static and dynamic tests.

Suggested therapy seems to be effective against the disease, however, it requires further examinations based on a bigger group of patients.

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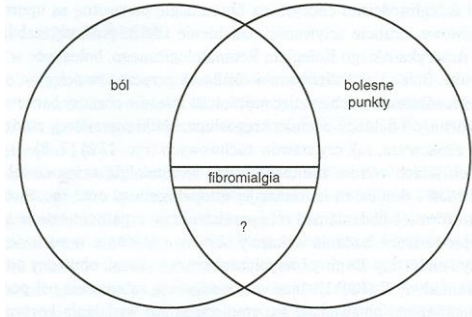
Chapter 17

Anna Skrzek, Helena Śmiechowicz, Zdzisław Zagrobelny

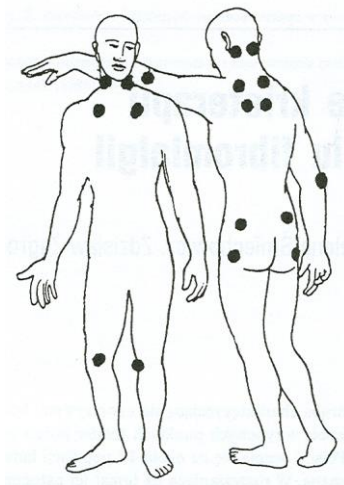
Application of cryotherapy in fibromialgia (FMS) treatment

Introduction

FMS is an disease characterized by persistent arthrodynia and myalgia and also tender points painfulness (Pic. 17.1). The frequency of prevalence in Poland is evaluated at 4% for adults. The etiology of disease is unknown. The genetic predispositions, dyssomnia, abnormal concentration of serotonin, somatomedin C, prostoglandine E₂ and disorder of hypothalamus-hypophysis-adrenal glands axis were considered in seeking of pathogenesis [1-6].



Pic. Relationship between pain and occurrence of tender points



Pic 17.2. The number of tender points in primary FMS according to American Rheumatologic Board

The main ailments of patients suffering from primary FMS are persistent arthrodynia and myalgia, sensation of rigidity muscular weakness, dyssomnia and according to American Rheumatologic Board, tenderness of 11 from 16 tender points. Pains are localized in muscle-tendon attachment region including mostly shoulder and pelvic girdle as well as upper and lower segment of spinal, chest, rarely elbow, tarsal, hands or mandible jonts (Pic 17.2) [7, 8].

In recent years the increase of FMS interest has contributed to researches and reports to the point of disease etiopathogenesis development. The researches of the role of FMS pathogenesis transmitters have been undertaken as well. Investigations that were carried out proved reduced concentration of

tryptophan, serotonin and endorphin in serum. The reduced level of somatomedin in serum C (IGF-1) was revealed by Bennet and co-workers. Other researches suggest disorders of hypothalamus-hypophysis-adrenal glands axis what leads to decrease of cortisol excretion in 24-hour urine [3, 4, 7]. Nevertheless, because of unclear causes and mechanisms of disease development, possibility of effective treatment of patients suffering from primary FMS are limited. It is recommend RECOMMENDED to apply painkillers, nonsteroid, anti-inflammatory drugs that relax muscles, simultaneously with physiotherapeutic procedures [7, 8]. The very good analgesic and relaxing effect that facilitates kinesitherapy is observed after systemic cryotherapy procedures.

The aim of the research

The preliminary examinations:

1. The usefulness of systemic cryotherapy in FMS treatment evaluation.
2. The demonstration of cryorehabilitation influence on course of a disease and evaluation if the method represents only symptomatic treatment or modifies the course of a disease.

Scheduled examinations:

1. ditto,
2. ditto.
3. The influence of cryostimulation on selected biochemical indexes of patients suffering from FMS examination, i. e. the level of serotonin, P-substance, beta-endorphin, somatomedin in serum C (IGF-1), concentration of calcitonin, cortisol, prolactin and estradiol in serum.
4. The role of biochemical selected parameters in hyperalgesia evaluation.

Material and methodology

The group of 15 women (10 have finished the test) at the age of 26-54, in case of

which, in accordance with criterions of the American Rheumatologic Board (ACR), the primary FMS was diagnosed were subjected to examination [7].

Patients were qualified for further researches by The Institute of Rheumatology of Medical Academy in Wrocław. The women were subjected to 2- and 3-minute procedures of cooling the organism in temperature from -110 to – 150 Celsius degree, at the physiotherapy faculty of Academy of Physical Education in Wrocław. The aim of the program, which lasted 4 weeks, amounted to 20 procedures of systemic cryotherapy, and one hour gymnastics, according to detailed planned patterns of loosen, calming and the whole organism efficiency improving exercises, after procedure.

The inquiry examination, that was performed, concerned:

- 1 the character, intensity of ailments and disease duration,
- 2 patients' physical efficiency,
- 3 course of a disease.

Cryotherapy efficacy, before, after 10 and 20 procedures, according to VASP, that is Visual Analogical Scale of Pain (0-lack of pain, 10-very intense pain) was evaluated by examinations of intensity and ailments localization.

After finishing the research program patients estimated their health state as:

- 1 high deterioration,
- 2 deterioration,
- 3 lack of meliorations,
- 4 change for the better,
- 5 significant betterment.

Results

Results of inquiry examination
percentage improvement of health (%)

myalgia	100
arthrodynia	100
body rigidity	60
oedemas	50
headaches	100
vertigos	40
diarrhoeas and constipations	10
cryaesthesia	40
tiredness sensation	100
sleep disorder	70
emotional lability	60
dissatisfaction with life	10
dyspasia (stairs)	80
difficulties with every days duties performing	30
lack of physical activity	60
painkillers administration	80

Pain intensity

The average intense of perceptible pain was evaluated according to analogical scale 0-10. It amounted to 4,6 before therapy, 5,2 after 10 and 3,1 after 20 procedures.

Pain localization

The number of tender points before procedure amounted to 12,4, 8,1 after 10 procedures and 5,9 after 20 procedures.

The subjective estimation of patient

All of patients affirmed their health state has improved after 20 procedures.

Discussion

The inquiry examination that were carried out proved the presence of characteristic of FMS symptoms such as persistent arthrodynia and myalgia, tender points painfulness, body rigidity, decrease of muscular strength what affect unfavourably general efficiency of organism, sleep disorder, emotional lability and others dysfunctions.

The initial observations of cryotherapy influence on patient suffering from FMS, showed significant alleviation of pain ailments from 6,4 to 3,1 according to the scale as well as improvement of clinical state. The Visual Analogical Scale of Pain was used which is somewhat simplified but fairly easy way of receiving experimental data. The number of painfulness tender points decreased significantly, from 12,4 to 5,9 points after 20 procedures, as well.

The mechanism of analgesia, under the influence of extremely low temperatures, relies probably on blocking the passage of pain impulse within spinal cord so as not to reach cerebral cortex. The endogenic opioid system is also mobilized that is inter-systemic beta endorphin production [9,10].

On the basis of preliminary observations on ONE may say that cryostimulation has significant impact on decreasing of pain and can be one of the most effective method of FMS treatment. The examination of 50 patients permit to develop additional, effective way of FMS treatment. The monitoring of some biochemical parameters concentration will contribute to:

1. explanation of observed symptoms pathogenesis,
2. determination of some factors in hyperanalgesia,
3. confirmation of treatment efficacy.

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Chapter 18

Sylwia Gachewicz, Anna Skrzek, Józef Przybylski

Effectiveness of local cryotherapy in treating knee joint degenerative

disease

Introduction

Knee joint degenerative disease is the most common disease of circumferential joints disease. In populations of well developed countries, it concerns 70% of people after 65yo. Because of its protracted, progressing and irreversible character, it bothers a NO A plenty of people [1-3].

In knee joint degenerative disease pain ailments occur in a joint as well as circumarticular. The dysfunction results from inflammable reaction of synovial membrane and structures stabilizing a joint. Clinically it manifests as joint pain, pain under pressure often intensified in the areas of muscle-tendon attachments, thickening of articulation contours, sometimes presence of excessive joint fluid and constraint of range of knee joint mobility [3-5].

Etiology of knee joint retrogressive changes (*gonarthrosis*) is not well known. Epidemiologic researches bring evidence confirming rightness of many theories considering participation of metabolic, environmental, mechanical and hereditary factors in etiopatogenesis of the disease.

The most important risk factors are: obesity, congenital and acquired joints defects, individual predisposition, peracute injuries and excessive load caused by either professional work or practicing sport [1,3].

Knee joint retrogressive changes occur as a result of imbalance between tissues biological immunity and their mechanical endurance. Consequences of the imbalance allow to indicate following groups of knee joint retrogressive changes:

- 1) idiopathic,
- 2) post-inflammable,
- 3) static,
- 4) posttraumatic,
- 5) rheumatic [3-5].

Selection of a proper method of treatment in case of knee joint

degenerative disease depends on type of changes, advancement of the pathological process and patient's age. Preservative behaviour can be basis of a treatment in its non-advanced stage [4, 10]. The objective of this research work is to attempt to determine efficiency of applied preservative treatment, depending on properly planned kinesitherapy preceded by local cryotherapy treatments of patients with knee joint degenerative disease.

Applying cryotherapy treatments is well-grounded because of advantageous operation of cold on human organism. Analgesic performance has been proved. Cold decreases velocity of nerve fibres conductivity hampers skin nociceptors, partially or entirely blocks fibres C and declines emission of pain mediators.

Cryotherapy hampers inflammable processes due to locally decreased metabolism activity of cells that are taken over by inflammation (moderation of enzymatic reactions i.e. inflammation mediators). Performance against bleeding, haematoma or posttraumatic and postinflammable edema is also beneficial.

Cooling treatments influence muscles tension. During the treatment in a temperature of -160 to -180°C that lasted over a minute, activity of muscle spindles or gamma motoneurons declines having an effect on decreasing muscle tension [8-12].

Method of treatment

All of examined patients directed to Pracownia Krioterapii na wydziale Fizjoterapii AWF we Wrocławiu (Laboratory of Cryotherapy at the Department of Physiotherapy at the Academy of Physical Education in Wrocław) were treated preservatively. The treatment comprised not only principal physiotherapeutic procedure but also reduction of articulation excessive load by decreasing (when overweight) body weight or relieving the joint using walking stick as well as avoiding long-time standing, kneeling or squatting. Physiotherapeutic procedure consisted in applying local cryotherapy and kinesitherapy.

In case of all patients, once a day, 10 treatments of local cryotherapy of pathological knee joints were performed using medical cryostimulator KT-100. Cooled limb was situated in “analgesic position” that means a knee joint angle of approximately 25°. Gas stream (solution of atomized liquid nitrogen and air) was pointed to knee joint by applicator that was distant from the cooled surface by approximately 10-20 cm. The treatment lasted about 3 minutes. Gas temperature was -190°C.

In the kinesitherapy, that was preceded by local cryotherapy, isometric exercises of quadriceps muscle and 20-minute exercises of unloaded knee joint and after them, active exercises of articulation extensors and flexors were applied.

Material and research method

Four 45-72 (at average 58) year old females were examined to find out the retrogressive changes of either a knee joint or both knees. In case of 14 patients, changes of courses of a rheumatoid joint inflammation were observed and in case of 10 patients, as a result of former traumas. In case of 10 patients they resulted from former traumas.

Ten females suffered from a characteristic varus deformity. In most cases some walk disturbances caused by pain alignments were observed resulting in “analgesic walk” with characteristic disturbance in a prop phase. 6 patients were walking on crutches, 14 were limping and 7 had swinging walk.

All of the patients took part in 10 local cryotherapy treatments that were followed by rehabilitation exercises. Knee joint retrogressive changes was cooled. In case of patients that suffered from the disease on both sides, joint with bigger pathological change was a subject of research. Planned tests were conducted twice: test I – before the therapy and test II – after a series of 10 treatments.

The tests consisted in: measuring thigh circumference and limb length, range of limb mobility, range of knee joint mobility, functional tests and

determining pain ailments according to scale.

Measurements of circumference were taken on three highs (over a knee joint, at a knee joint and under it) as well as measurements of relative and absolute limbs length were taken using measuring tape in cm. Ranges of active and passive knee joint mobility when bending and straightening were measured using goniometer.

Functional tests consisted in climbing up the stairs and coming down, kneeling down and knee bending (performed by patients themselves without any support). During the test, patients defined if they felt pain in examined articulation and how far (amount of steps or knee bends) they can go without feel of pain.

Evaluation of pain was done applying Laitinen scale, where: 1 – no pain, 2 – mild pain, 3 – strong pain, 4 – very strong pain, 5 – pain impossible to bear.

The results of circumferences measurements and ranges of mobility were a subject of statistic analysis applying t-Student test with a confidence level of $p < 0.001$, $p < 0.01$ or $p < 0.05$. At the same time, the results of functional tests were put down in numbers. All of the results were presented at 9 diagrams.

Results of researches

The results of “climbing-the-stairs test” defining an amount of steps taken up (fig. 18.4) and down (fig. 18.5) with no feel of pain was based on a following scale: A – pain from the beginning, B – less than 5 steps with no pain, C – 5-10 steps with no pain, D – 10-20 steps with no pain, E – more than 20 steps with no pain.

The result of “knee-bending test” determining an amount of knee bends with no feel of pain (fig. 18.7) was based on a following scale: A – feel of pain accompanies knee bending from the beginning; B – less than 5 knee bends with no pain.

Discussion

Obtained results show an improvement of functional state of knee joint with

retrogressive changes of patients who took part in local cryotherapy and kinesitherapy.

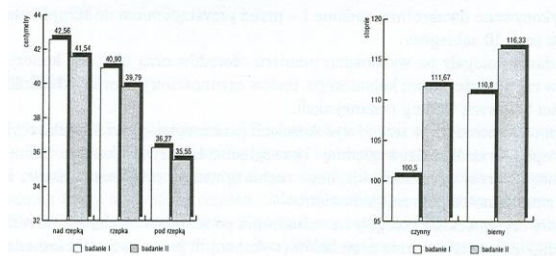


Fig. 18.1. Change of circumferences in the area of a diseased limb. Differences between them are statistically essential (confidence level $p < 0.001$)

Fig. 18.2. Ranges of knee joint bending mobility. There are observed essential differences between tests I and II for active as well and passive range ($p < 0.001$)

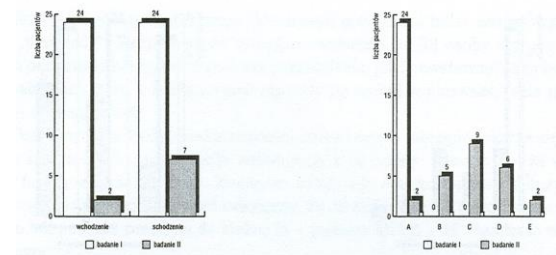


Fig.18.3 Subjective sense of pain in diseased joint during “walking the stairs test” (up/down the stairs)

Fig.18.4 “walking the stairs test” – number of steps overcome without pain (upstairs)

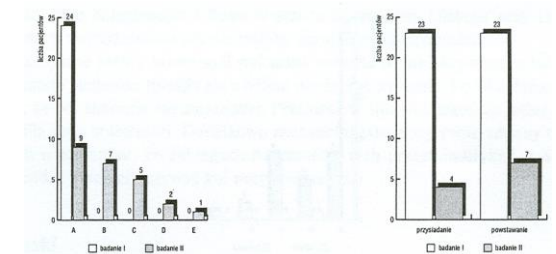


Fig. 18,5 “walking the stairs test” – number of steps overcome without pain (downstairs)

Fig. 18.5 “knee bending test” sense of pain in diseased joint (up/down)

The results of researches analysis prove that after 10 procedures, joints circumferences decreased in every level by about 10 cm. In the second examination, significant improvement of motion range of joint was noticed. The active range flexure increased by 11⁰ and passive by over 5⁰.

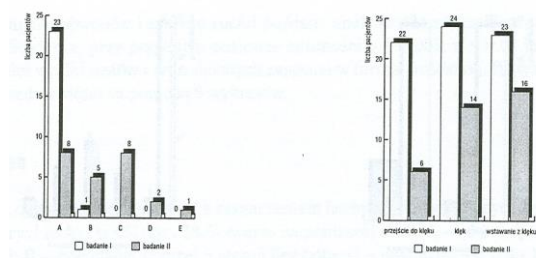


Fig. 18.7 “knee bending test”

Fig. 18.8 Sense of pain in diseased joint during functional “kneeling test” (kneel – erect knee – arising form kneeling)

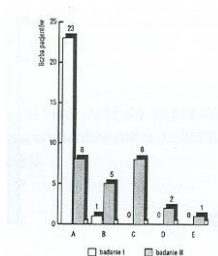


Fig. 18.9 Subjective sense of pain according to Laiten scale

Only 2 of 24 patients felt pain during “walking the stairs test” (upstairs). Seven of them complained about pain during walking downstairs. Before the procedures all of the patients complained about pain, performing the same activities. The test proved, walking downstairs is more painful activity than walking upstairs.

Profitable effects of applied cryotherapy is also confirmed by analysis of “knee bending test”. The research before the treatments showed that 23 out of 24 patients suffered pain during bending down as well as while standing upwards. After 10 treatments, only 4 patients continuously felt pain in the first phase of a bend and 7 in the second.

Kneeing test turned out to be very helpful in checking effectiveness of applied treatments, too. It was noticed that before the treatments, all phases (going down on knees, kneeling down and standing upwards) caused considerable pain in case of all patients. After 10 treatments, only 6 patients notified pain when going down on their knees, 14 – while kneeling and 16 – when standing upwards.

Observations of patients with *gonarthrosis* proved that they experienced difficulties during such simple actions as walking the stairs, bending knees or kneeling that are every-day activities. However, while performing them, pressure on pathologically changed articulation surfaces is considerable and moreover knee cap is strongly pressed against thigh bone. It causes big pain ailments in knee joint. Therefore, when retrogressive changes, these actions should be restricted.

Positive effects of cryotherapy were pointed out in subjective feel of pain. At the beginning, all of the volunteers reported pain impossible to bear. After 10 treatments they claimed that pain declined considerably. It was described as strong or mild. One patient declared no pain. Moreover, positive changes in a way of walking were observed. After the treatments, most of patients stopped limping and 4 out of 6 stopped using crutches.

Conclusions

Applied local cryotherapy of patients with retrogressive changes of knee joint, turned out to be helpful resulting in distinctive decrease of knee edema. Higher range of active and passive knee joint mobility was achieved.

After the therapy, subjectively perceived pain of pathologically changed

articulation declined. Applied treatments made it easier to walk the stairs, kneeling or knee bending.

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Chapter 19

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The systemic cryotherapy and a cytolytic reaction of a complement.

Introduction

Rheumatic arthritis' treatment through the cooling of the whole organism (whole body cryotherapy) was introduced and described for the first time in Japan in the mid-seventies [22]. The effects of the stimulating application of

extremely low temperatures (-110-180 degrees centigrade) vary a lot [15, 25]. People who were applied the cryotherapeutic treatments (locally or whole bodily) can have (clinically) [1, 2, 3]:

- 1 Subjective painlessness – local, zonal distant, whole body, connected with the turn off of the touch receptors through cold, slow down of the stimuli's conduction, the increase of endorphin's emission;
- 2 Congestion OR DECONGESTION? of the previously cooled places, healthy muscles' atony, the increase of strength and also the decrease in spasticity of muscles when it is present (attenuation of nerve conduction and nerve and muscles activation);
- 3 The increase of plasma concentration of important hormones; noradrenalin, ACTH, cortisone, testosterone in case of men and the increase of the metabolism' activity in case of women [18].

The majority of these changes was WERE confirmed directly after the treatment or short series of entering the cryochamber [6, 21]. Data concerning the effects of cryotreatments conducted in a longer time interval are rarely published.

The effect of the whole body cryogenic temperatures' application on the level and bactericidal activity of complement's proteins is not well known. The system of the complement (complement, C) is responsible for many important immunological response' mechanisms and owes its name to the ability of succoring or completing antibodies' activity in fighting infection [8, 11, 19]. It consists of, together with the regulation factors, the group of 30 serum proteins and tissue fluids. Complement's system is a cascade of proteins which behave like proenzymes (early-reacting proteins), where one activates another according to a particular order in chain reaction. Proteins C which are activated, are later broken into two subunits – a and b. The activation of late-reacting proteins C is not enzymatic; it is based on the creation of a membrane attack complex MAC on the surface of the main membrane [9, 10, 13, 16]. The complement system is continuously activated in vivo and potentially it could destroy its own cells [20]. Due to destructive abilities of a complement, almost half of the proteins of its

system have a regulative role [5, 14, 17, 26].

As a result of organism's exposition to extremely low temperatures the level and enzymatic activity of structural proteins can be modified, influencing indirectly the effectiveness of opsonization and phagocytosis' processes, wrong activation of C3 component, antibodies level (mainly IgM). In consequence it can change the degree of complement' system induction and the level of blood serum's bactericidal activity in case of people who were applied therapeutic treatments [7].

Material and methods

The group of 6 students (3 men and 3 women), who voluntarily agreed for examinations in cryochamber and blood sampling, took part in the research. Participants were healthy and had had some examinations previously done. The participants entered the cryochamber in three cycles. Each cycle consisted of 5 entrances – everyday from Monday to Friday – together 15 treatments. The blood was sampled on the first day of each cycle before entering the cryochamber and on the fifth day – after leaving the cryochamber. After 30 days from finishing the last cycle the blood samples of each student were taken one more time (49 days from the beginning of the treatment). During the whole period of examinations students did not take part in any physical education activities.

Determination of the level of C3 proteins and C4 complement in serums

The level of the constituents of the complement C3 and C4 in examined human serums (NSL) were determined by the Mancini method. In this method plates with agar gel including monospecific policlonic antibodies against a particular protein of MEGA-TRADING limited company (Gliwice) were used. The examinations were done according to producer's instructions by putting agar sumps of 5 µl of the examined serum and the plate's incubation for 48 hours in temperature of 20 degrees centigrade. The diameter of the precipitative ring was

measured with the help of nomogram MEGA. The concentration of a given protein was read in the concentration table enclosed by the producer [7].

Bactericidal activity of serum determination

To determine the bactericidal activity of serum, referential sensitivity of serum sensitive *Shigella flexneri* 1b and *Shigella flexneri* 3b strains was determined on the bactericidal activity of human serum (NSL) with the help of a modified method of Doroszkiewicz [4].

S. flexneri stereotype 1b' bars have, in a repetitive subunit of O-specific side chain LPS, in a derivative side chain, glucose joined 1,4 bond with N-acetylglucosamine and trisaccharide module including three molecules of rhamnose, where the third one is **zacylowana**. Antigenic mutant 3b is divested of this derivative glucose side chain. The feature of type antigen III and at the same time group-type 6 is given by a **zacylowana** rhamnose. The first of these features, type antigen III in stereotype 1b is masked by glucose of the derivative side chain responsible for type antigen I. These structural differences in the structure of O-specific side chain LPS are also visible in the sensitivity of bacteria on cytotoxic activity of complement's proteins, antigenic mutant *S. flexneri* 3b Lak⁺ is less sensitive than a strain *S. flexneri* 1b. The ability of lactose fermentation lets define the dynamic of quantity changes in a mixed population of these two strains, incubated with NSL and also lets determine the level of spontaneous bactericidal activity of serum's proteins.

In described method the cells of the strains *S. flexneri* 1b and its antigenic mutant *S. flexneri* 3b Lak⁺ were incubated in a common broth for 18 hours in 37 degrees centigrade. After the mixing of the culture in volume ratio 100:1, 50 µl of the mixture was transported to 3 ml of sterile broth with the temperature of 37 degrees centigrade and incubated for one hour. Next the culture was being whirled for 20 minutes with 2 thousand revolutions per minute and the supernatant was poured off. The whirled bacterial deposit was put in 5ml of 0,9% Na Cl with the experience of active adult serum (the concentration of about

1×10^6 was obtained).

In the research of cytolytic reaction of a complement in serum of adults who were applied cryotherapeutic treatment 0,5 ml of bacterial suspension was added to 0,5 ml of a properly diluted serum (ratio 1:1, final volume 1 ml).

The mixture of bacterial suspension and serum was incubated for 3 hours in 37 degrees centigrade, doing inoculation at the beginning, just after the stirring process, after 30 minutes and after 180 minutes of incubation. The sample of 100 μ l volume in dilution 10^{-4} and 10^{-2} was inoculated on a MacConkey base and incubated for 24 hours in 37 degrees centigrade. Comparing the number of bacteria cells able to create colonies inoculated on the plates directly after stirring (value 100%) with the number of the survived bacteria cells after 30 minutes and 180 minutes of incubation the cytolytic activity of complement proteins was determined in percentages.

Results

The average value of C3 protein concentration at OF people who start the series of the cryotherapeutic treatments was 132,4 mg/%. It has its place in a physiological norm. After 5 days of entering the cryochamber the decrease in C3 protein concentration was observed of AT about 12 % in relation to the initial value. After a second week further not so significant decrease of C3 protein concentration was observed. This time for another 1,5 %. After the third week of treatments the increase of C3 protein concentration was observed and got the values similar to those after the first cycle. The final value determined after 30 days from the end of the cycles (of entering to cryochamber) increased to 93,9% of the initial value.

Similar dependencies were observed while examining concentration of C4 protein. However, in this case the final value was about 9,3% higher than the initial concentration. Complete examinations' results are presented in table 19.1.

Table 19.1 The average concentration of C3 and C4 proteins in serum of people who were applied the whole body cryotherapy.

Protein concentration (mg/%)					
	Initial value	After the first cycle	After the second cycle	After the third cycle	Final value
C3	132,4	116,5	114,8	116,3	124,3
C4	33,4	31,5	33,2	32,5	36,5

The intervals of physiological concentrations for particular proteins include respectively: C3 – 50 -120 mg/%, C4 – 20 – 50 mg/%.

The received values show the decreasing tendency; in a longer time span the proteins' concentration levels grow.

Table 19.2 The average concentration of antibodies IgA, IgG in serums of people

who were applied the whole body cryotherapy.

Immunoglobulin concentration (mg/dcl)					
	Initial value	After the first cycle	After the second cycle	After the third cycle	Final value
IgA	364,3	346,2	344,2	386,8	387,3
IgG	1246,3	1109,9	1659,0	1432,4	1392,9
IgM	190,3	167,0	167,5	198,2	215,9

The intervals of physiological concentrations for particular proteins equal respectively: IgA – 90 -450 mg/dcl, IgG – 800 – 1800 mg/dcl, IgM – 60 – 280 mg/dcl.

The comparison of the obtained values of antibodies' levels IgA, IgG, IgM indicates their decreasing tendency after the first week of treatments, then the increase until a value, which is bigger than the initial concentration, is obtained.

Table 19.3 Average bactericidal activity of serum counted after 180 minutes of incubation.

Treatments' cycle	I		II		III		IV
Day of a treatment	1	5	1	5	1	5	1
% of the survived	0,43	0,09	0,21	0,14	0,43	0,10	0,12

bacteria	6	3	3	7	8	1	1
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The average values of bactericidal serum's activity, after an insignificant decrease, show a clear increasing tendency.

The analysis of the level of concentration of the examined classes of immunoglobulin (IgA, IgG, IgM) showed significant changes depending on the number of cryotherapeutic treatments. After the first and second cycle of entrances into cryochamber the immunoglobulin's concentration in blood serum at OF people who were applied the treatments decreased in comparison to the initial value. Only the average value of immunoglobulin's (IgG) concentration was increasing quicker and after the second cycle the level reached 133% of the initial value. After 30 days from the end of three series the levels of immunoglobulins reached respectively: IgA – 106,3%, IgG – 11,7%, IgM – 113,4 % of the initial value.

It was observed that during the whole period of examinations there was an increase of the bactericidal activity of the serum until it got the final value of 360% of the initial value. It was stated that a two-day break between the first and the second, and the second and the third cycle of treatments caused a relative decrease of bactericidal serum's activity. Each five-day cycle of treatments increased the level of bactericidal serum's activity above the initial value. After 30 days from finishing the cycles of the whole body cryotherapy treatments the serum's activity was 360% higher.

The above results have a particular dynamic, which proves the phasic rhythm of our organism. The initial decrease and then an increase of the examined parameters prove their periodicity, which is characteristic for adaptation of a human organism to some specific environment conditions, which he is in.

Too small group of people took part in the pilotage research to be able to do a proper statistical analysis. Due to this fact only average values were

presented.

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Chapter 20

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The influence of the systemic cryotherapy on the chosen inflammation's parameters in case of patients with stiffening arthritis of a vertebral column –preliminary report

Introduction

The notion of cryotherapy carries a meaning of a stimulating superficial application of cryogenic temperatures, under -100 degrees Celsius in time of 2 or 3 minutes to bring about and use some physiological reactions of an organism for cold [5, 6, 11, 12]. Cryotherapy can be applied locally and for the whole body in a cryochamber.

After each session kinesis therapy is chosen individually for each patient to increase and consolidate the beneficial effects of low temperatures' treatment [1, 6, 10, and 11].

The best known therapeutic effects of the whole body cryotherapy are:

- 1 Pain relief, lowering inflammation's activity
 - 2 Tension decrease of skeleton muscles and the increase of muscles' strength
 - 3 Edema reduction, better condition of joints' mobility
 - 4 Better injuries' healing
 - 5 Relaxation, mood improvement and the increase of tiredness' resistance
- [1, 5, 6, 10-12]

In everyday clinical practice the whole body cryotherapy is very often used in locomotive system's illnesses: stiffening arthritis of vertebra's joints, rheumatic arthritis, circuit and backbone joints' degeneracy, injuries, osteoporosis and fibromialgy. The whole body cryotherapy was proved to be effective also in neurological illnesses such as spastic paresis, sclerosis multiplex, radicular affections. Cryotherapy is often used as a form of biological renewal, for example in case of professional sportsmen [2, 5, 6, 10, 11, 12].

On the basis of literature data and some observations we can claim that the whole body cryotherapy treatment is well accepted by the sick. With good patients's verifications, perfect timing and well conducted intervention the complications appear very rarely. Sometimes some superficial frostbite was observed caused by the machine failure or polluted nitrogen. The most frequent subjective feelings of the sick who were applied a whole body cryotherapy are; the feeling of hot, relaxation, quieting down and slackening. A transitory intensification of pain can sometimes occur but it shouldn't be the reason to stop the treatment [1, 5, 6, 11].

Unconditional contraindication for the whole body cryotherapy is claustrophobia, Raynaud' disease, thyroid gland' hypofunction, strong affections of air passages, heart and vascular system's illnesses (unstable coronary illness, failures in valve apparatus – the narrowing of aortic semi-lunar valves or

narrowing of bifid valve, circulation's insufficiency, serious dysfunctions of heart rhythm [5, 6, 11].

The aim of the research

The aim of our research was to evaluate some biochemical parameters at OF patients with a stiffening inflammation of vertebra's joints under the influence of the whole body therapy.

The thesis is an introductory report of the clinical and experimental research conducted in Silesian Medical University which was to assess the influence of the whole body cryotherapy on a homeostasis of an organism. The research programme of a whole body cryotherapy was accepted by a Bioethics Commission of Silesian Medical University in June 2002.

Material and methodology

Patients with recognized stiffening vertebra arthritis were directed to The Chair and Clinical Department of Inner Diseases and Physical Medicine. Hospitalization aimed to qualify patients for the whole body cryotherapy. As a result of an interview, physical examination and some additional examinations for the whole body cryotherapy seven sick men were qualified. Each of them was informed about the type and aim of the research and therapy and agreed in a written way to administer them.

The average of age of the examined group was $45,2 \pm 5,4$ years, the average time of an illness from the time of recognition was $17,3 \pm 6$ years.

Biochemical research was done on the day before the whole body cryotherapy treatment cycle. The following factors were marked:

- 1 C-reactive protein (CRP) with a turbidimetric method
- 2 Seromukoid with a colorimetric method modified by Winzler
- 3 Fibrinogen with a turbidic method
- 4 Immunological panel (immunoglobulin IgG, IgA, IgM, complement

fractions C3 and C4) with a turbidimetric method

5 Proteinogram with a colorimetric burette method

Patients were applied later WITH a two-minute treatment of the whole body cryotherapy with the temperature of -130 centigrade for ten days with a two-day break after five treatments. Directly after each treatment session of cryotherapy there was a 60-minute kinesis therapy according to an individual rehabilitation scheme.

The treatments of the whole body cryotherapy and kinesis therapy were conducted in the Silesian Centre of Rehabilitation and Physical Medicine in Ruda Śląska. During the whole body cryotherapy patients were wearing shorts, thick socks, gloves, clogs for feet, ear-shield and double surgeon mask for face. Before entering the chamber patients dried their skin with a towel to get rid of an excess sweat. During the treatment in a cryochamber patients were controlled by a doctor and moved all the time. The whole body cryotherapy treatments were well tolerated by all sick people.

Before the therapy the sick were not applied any farmacological treatment, however, during the cryotherapy sessions the demand for analgesic and antiphlogistic medicines was smaller.

After the end of the whole cycle of cryotherapy patients had another biochemical examination done according to the same scheme.

The obtained results of the biochemical research are presented in a statistical analysis with the use of t-Student test.

Results

Obtained results of the research in average values \pm standard deviation with a statistical evaluation are presented in tables 20.1-20.3.

Table 20.1 The concentration of some parameters of inflammation (average value \pm standard deviation) in serum of the sick with a stiffening vertebra's arthritis before and after the cycle of the whole body cryotherapy with a statistical

assessment, (IS)- the difference statistically significant, (NS)- the difference statistically not significant.

Parameter	Number of the examined people	Before the cryotherapy cycle	After the cryotherapy cycle	Statistic significance
C-reactive protein (CRP) [ng/ml]	7	7,13±1,10	4,90±0,77	(IS) p=0,0003
Seromukoid [g/l]	7	1,07±0,12	0,94±0,17	(IS) p=0,0137
Fibrinogen [g/l]	7	4,03±0,79	3,91±0,59	(NS)

Table 20.2 The concentration of some constituents of a compliment and immunoglobulin (average value ± standard deviation) in the serum of the sick with a stiffening vertebra's arthritis before and after the cycle of the whole body cryotherapy with a statistical assessment, (IS)- the difference statistically significant, (NS)- the difference statistically not significant.

Parameter	Number of the examined people	Before the cryotherapy cycle	After the cryotherapy cycle	Statistic significance
The constituent C3 of a compliment [mg/dl]	7	108,15±12,42	104,23±9,44	(NS)
The constituent C4 of a compliment [mg/dl]	7	27,10±5,76	26,05±5,36	(NS)
IgA [mg/dl]	7	291,00±38,29	253,50±32,29	(IS) p=0,0006

IgG [mg/dl]	7	975,66±139,5	880,83±129,2	(IS) p=0,0010
		4	6	
IgM [mg/dl]	7	103,30±69,59	96,25±50,32	(NS)

Table 20.3 The concentration of a complete protein and the participation of particular protein fractions (average value ± standard deviation) in the serum of the sick with a stiffening vertebra's arthritis before and after the cycle of the whole body cryotherapy with a statistical assessment, (IS)- the difference statistically significant, (NS)- the difference statistically not significant.

Parameter	Number of the examined people	Before the cryotherapy cycle	After the cryotherapy cycle	Statistic significance
Complete protein concentration [g/l]	7	70,50±2,16	68,02±4,37	(NS)
Albumins {%}	7	57,96±4,55	52,30±8,48	(NS)
Alfa-1-globulin [%]	7	5,44±0,81	5,36±1,07	(NS)
Alfa-2-globulin [%]	7	11,26±2,33	12,38±1,62	(NS)
Beta-1-globulin [%]	7	6,78±1,35	8,26±1,65	(IS) p=0,0009
Beta-2-globulin [%]	7	5,40±1,75	6,16±2,29	(NS)
Gamma-globulin [%]	7	12,76±2,68	15,14±3,38	(NS)

Results' analysis and discussion

The conducted research showed significant changes in C-reactive protein (CRP) concentration, seromukoid, immunoglobulin and the participation of particular globulin fractions in electroforetic distribution at IN patients with some inflammation changes of a bone-joint system before and after the cycle of a whole body cryotherapy. The significant statistically decrease in C-reactive protein concentration (CRP), seromukoid and immunoglobulin IgA and IGG and increase of fraction beta-1-globulin concentration is worth emphasizing.

The observed decrease of immunoglobulin and sharp phase protein's concentration can be an indirect confirmation of a significant antiphlogistic role of the whole body crotherapy.

Immunoglobulins are the part of majority of globulin fractions of serum but in fractions beta-2 and gamma-globulin their participation is most visible. Lack of statistically significant changes of the majority of globulin fraction in electroforetic distribution of proteins from patients' (who were applied cryotherapy) serum is very surprising, especially in spite of a significant decrease in immunoglobulin' concentration. It seems that it can be caused by the increase of other proteins' concentration, which were part of these fraction, such as lipoproteins, which came into being as a result of the intensification of adipose processes of an organism under the influence of the whole body cryotherapy [7].

Literature data concerning the behavior of parameters of inflammation and protein fractions of serum are not unequivocal. The cause of this can be the application of different kinds of cryotherapy and the way of choosing the examined people. Jonderko and co writers [3] showed that three-week local cryotherapy does not work antiphlogistically at patients with rheumatic arthritis. In their research after the application of cryotherapy they did not observe significant differences in seromukoid and alfa-2-globulin concentration in comparison to indicators from before the cryotherapy. Sobiech and co writers [8] did not show the influence of cryotherapy on C-reactive protein, seromukoid and complete

protein concentration but the examined group of people was healthy. Wawrowska [11], however, got statistically significant decrease of seromukoid's concentration at patients with a rheumatic arthritis within a cycle of two-week whole body cryotherapy. In this group an increase of alfa-1-globulin was also observed.

The results of pilotage researches which have been conducted so far on not a very numerous group of the sick with a stiffening vertebra's arthritis are promising enough to continue them with a more numerous groups and the expansion of laboratory examinations, especially lipid parameters. The evaluation of protein and lipid fractions' behavior of serum in case of healthy volunteers applied the treatment of cryotherapy would also be an interesting research.

Conclusion

The obtained preliminary results confirm the antiphlogistic dimension of the whole body cryotherapy at IN the sick with a stiffening vertebra's arthritis.

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Chapter 21

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**The influence of the whole body cryotherapy on the psychical
condition of a human being.**

Introduction

The observation of people exposed to extremely low temperatures allowed
CONFIRMATION OF ITS...confirming its positive influence on a psychical

sphere. It was observed that after leaving a cryogenic chamber there was a change in patients' frame of mind, who report stress relief, deep relaxation and soothing effect. Their mood improves significantly. This state lasts a few hours or even longer. These observations haven't been confirmed by any scientific research so far. In some, not very numerous reports, which deal with the topic of the whole body cryotherapy the beneficial influence of low temperatures on psyche was emphasized.

Emotions which remain in a close relation with other psychical functions such as perceiving, thinking and acting are one of the aspects of psychical life. The notion "mood" in psychiatric terminology means an emotional state which lasts longer. The mood can be elevated or lowered, anxiety or disforic. A pathologically lowered frame of mind characterizes long term hopelessness, sadness, low spirits, malaise and lack of happiness. Depressive frame of mind is characterized by low self-esteem, evaluation of past, present and future with a feeling of being guilty and finally suicidal thoughts. Disfory is accompanied by the feeling of regret for fate and people, harm, exasperation, and even anger. The feeling of unjustified threat, strong jactitation and some behavioral symptoms (sleeping and attention dysfunctions, irritability, panic) and autonomous system problems (palpitation, sweats, hot flashes, dizziness, headaches, etc.) are typical for anxiety. Mood dysfunctions can appear once or repeatedly during the A life time. Social, professional and family functioning dysfunctions are the consequences of a depression episode. Depression, especially in a hard form and strong intensity can lead to disability. The suicide risk in affective disorders is 19 %.

Nowadays it is thought that the risk of depressive episode occurrence during a life time concerns only 15-20% of people in highly developed societies and twice as often the victims are women. The prevalence of depressive disorders is still increasing, not only in connection with better diagnostic and availability of specialists, but also due to the lengthening of human life, societies ageing, stressful environment factors' exposure and access to chemical products causing depression. Despite better and better psychopharmacological and

psychotherapeutic methods, still the measures helping in psychic dysfunctions therapy are being searched for. From non-pharmacological biological methods the most common are: phototherapy (exposition to light – radiant flux density 2500-10000 lux, effective in seasonal depression), sleep deprivation and electro-shock.

Whole body cryotherapy and depressive symptoms – pilotage research

The observations made during cryotherapeutic treatment need a scientific confirmation of its positive influence on mood. In Wroclaw Institute of Clinical Physiotherapy the research evaluating the influence of a whole body cryotherapy on humans' psyche was administered.

In the introductory pilotage research the changes of mood at OF people with depressive dysfunctions were analyzed after the application of the whole body cryotherapy cycle. It was assumed that the impact of extremely low temperatures on peoples' mood causes the increase of activity of serotonergic and noradrenergic of some parts of the brain and probably through this mechanism it leads to clinical depression symptoms' withdrawal.

Method

The research was administered among the group of 23 patients: 18 women and 5 men, aged 37-70, who agreed in a written way to participate in this project. They were patients of psychiatric day department or hospital dispensary, who were treated for depressive dysfunctions. These patients were under pharmacological treatment at the same time. Before the examinations patients were familiarized with the construction of the chamber and some safety measures. The sick had some general examinations done which was the condition to administer the treatment. Before each entrance to the chamber the sick had their blood pressure measured. Patients were wearing swimming suits inside the chamber but had their nose and mouth protected by a surgeon mask,

their ears by a woolen band and their feet by shoes with wooden soles.

Patients had ten cryotherapeutic treatments between the 14th of May and the 31st of July 2001. The cycle of treatments, which lasted two weeks for each patient, consisted of two series of five treatments carried out only on weekdays. Between the series there was a weekend break. Each time patient was in the chamber for 160s. The temperature applied in cryogenic chamber during the first treatment was -110 degrees Celsius and with the analysis of organism adaptation was gradually lowered to -150 centigrade in case of a last treatment.

THE Twenty one point Hamilton depression rating scale (HDRS, Hamilton 1967) was used to measure the level of depression intensity. This method is a popular and confirmed scientific tool used for depression diagnostic and rating of its intensity (with the 3-and 5-level scale of quantity rate).

The measurement was carried out in two time points, T0 – before cryotherapeutic intervention and T1 – after the cycle of 10 interventions. While analyzing the position from the scale where the pointing rate was zero during the first measurement was omitted, because this signified the absence of a given symptom at the examined person. In such cases in T1 for the same positions the pointing rate was also zero. As a result of such procedure the number of answers for particular questions was not identical. Additionally, due to the small number of answers for questions of position 16-B and 17 in Hamilton scale (only 1-5 patients from 23 gave the answer for question concerning the loss of weight in the past and for question about the insight into experienced depression symptoms), they were excluded from further analysis.

Results

For each of the depression symptoms assessed by a Hamilton scale the value of chi-square test was counted. Almost in all cases the value exceeded two- or three times the critical value (range between 9,2 – 15,1), for the critical level $\alpha = 0,001$. On these bases it can be stated that the attenuation of depressive symptoms intensity observed after the cycle of treatments is

statistically significantly connected with their application.

Table 21. The values of chi-square test and the Pearson's contingency C factors for each position of scale.

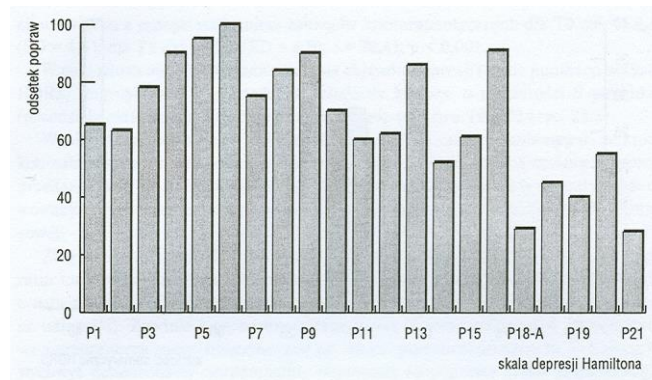
Hamilton depression rating scale positions	chi	Critical value (0,001)	C
P1 - depressive mood	38, 0	13,3	0,6 7
P2 - the feeling of guilt	42, 2	13,3	0,6 9
P3 - dispiritedness	46, 0	13,3	0,7 1
P4 - sleeping dysfunctions	46, 0	11,3	0,7 1
P5 – shallow, intermitted dream	40, 5	11,3	0,6 9
P6 – early waking up	44, 0	11,3	0,7 1
P7 – complex activity	33, 8	13,3	0,6 5

P8 – tardiness	33, 1	11,3	0,6 5
P9 – jactitation	36, 4	13,3	0,6 6
P10 – fear, depressive symptoms	39, 8	15,1	0,6 8
P11 – fear, somatic symptoms	38, 8	15,1	0,6 8
P12 – alimentary canal	17, 5	9,2	0,5 6
P13 – general somatic symptoms	30, 5	11,3	0,6 3
P14 – libido, month cycle	32, 8	11,3	0,6 5
P15 - hypochondria	39, 3	13,3	0,6 8
P16 – the loss of body mass	30, 3	11,3	0,6 8
P17 – presence of daily general feeling fluctuation	6,9	11,3	0,3 6
P18 – intensification of daily general feeling fluctuation	35, 4	11,3	0,6 6
P19 – depersonalization, derealization	21, 5	13,3	0,5 7
P20 – illusions	28, 0	13,3	0,6 2
P21 – obsessions, phobias	8,0	11,3	0,3 8

Only for position 'daily general feeling fluctuations' (position P18-A of the

scale) no significant dependence was confirmed, however, the position 'obsessions, phobias' (P21 Of the scale) is correlated on a critical level of $\alpha = 0,05$ (the critical value of chi-square test on this level equals 7,8).

Basing on assigned values of chi-square statistics, the following Pearson's contingency C factors were counted, which can be interpreted as a measure of the strength of the connection between the conducted cryotherapeutic treatments and their effectiveness in depressive dysfunctions. It should be emphasized that these are not strict counterparts of correlation ratio counted for continuous features (for example, the maximum value of contingency factor equals in this case 0,71). For most of the positions in Hamilton scale Pearson's contingency C factors were very high (between $C=0,56$ and $C=0,71$), with the exception of position P18-A and P21 mentioned earlier ($C=0,36$ and $C=0,38$, respectively). The above data was collected and summarized in table 21.



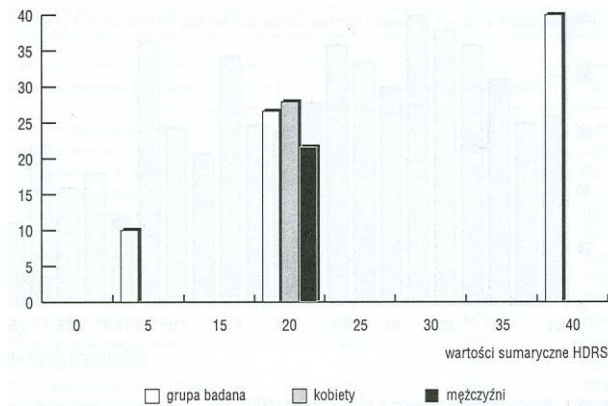
Pic. 21.1 intensity change of symptoms in HDRS after a cycle WBCT (%).

To compare the effectiveness of the conducted cryotherapeutic treatments in relation to particular depression symptoms, the change of each symptom's intensity in T1 was recounted as a percentage of intensity of measurement T0; the results are illustrated in picture 21.1

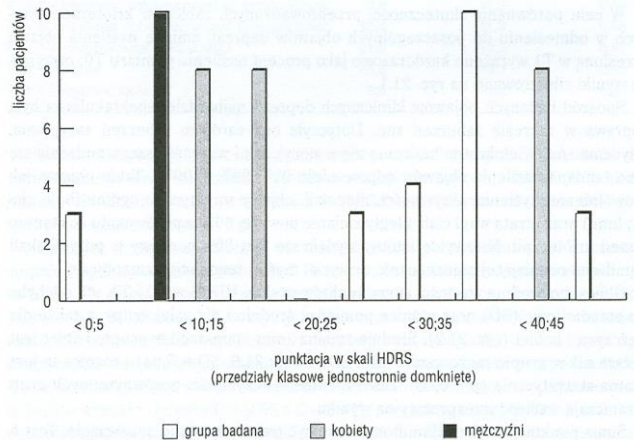
Among all the examined clinical depression symptoms the most spectacular was the improvement in sleep disorders. It concerned disorders of falling asleep, dream shallowing (numerous waking up during the night sleep), and early waking up in the morning (the change of intensity of symptoms equals 91%, 98%, 100%, respectively). Such symptoms as tardiness of thinking, activity,

jacitation, general somatic symptoms (headaches and others) and the loss of body mass were changed in over 80% in comparison to the state before cryotherapy. The fact of 80% improvement in position of Hamilton scale dealing with dispiritedness, suicidal thoughts and tendencies seems to be quite significant.

Average values of points sum in HDRS scale in T0 and T1 were counted, their standard deviation (SD) and differences between averages for the whole group, and also for men and women (pic.21.2). The average change of points sum in the group of women is higher than in the group of men (27,89, SD = 5,05; 21,6, SD = 5,94) and this difference is significant statistically ($p = 0,03$). Big differences in multiplicity of comparable groups limit the interpretational value of the result.



Pic. 21.2 The average value of overall point rate in HDRS scale for the whole group T0 and T1 and the differences of these averages for women and men.



Pic. 21.3 Distribution of points sum HDRS before and after the whole body cryotherapy.

The sum of points in Hamilton scale can be treated as quasi-continuous. Test *t*-Student for dependent samples confirms the statistically significant change of points sum in relation with conduction of cryotherapeutic treatments for T0 $\chi = 38,4$ (SD = 4,4); for T1 $\chi = 11,8$ (SD = 4,6); $t = 22,41$, $p < 0,001$.

To illustrate the distribution of depression symptoms intensity (pointing rate sum in HDRS scale) these values were grouped into sectional intervals with the span of 5 points (sectional intervals closed left-sided) for measurement T0 and T1 (pic. 21.3).

The results of the administered pilotage research let presume that short-term exposure for extremely low temperatures evokes numerous changes in neurotransmission o.u.n. They probably behave similarly to changes observed after application of anti-depression medicines or after electro-shock therapy.

The attenuation of depression symptoms which occurred under the influence of extremely low temperatures can be the result of, among others, level of catecholic amines' increase in the areas of the largest concentration of noradrenergic neurons (blue place, the side part of the cover). According to noradrenergic theory of depression, intensification of noradrenergic transmission observed after application of anti-depressive medicines, which inhibit the capture of noradrenalin to neurons, is responsible for the improvement of patients'

psychical state.

The results of Zagrobelny's research [8] prove the noradrenergic mechanism of anti-depressive effect of cryotherapy. It appears that the concentration of noradrenalin in serum of women and men after one cooling process of the whole body in cryogenic chamber are much higher than the concentration of this hormone before cooling (Zagrobelny, 1993) [8]. The mechanism of increasing the concentration of noradrenalin in serum is connected with a stressful reaction caused by a rapid coolness of the body. Undoubtedly the whole body cryotherapy treatment is a strong stressful stimulus. Surveys proved the start-up of different processes in an organism which is exposed to extremely low temperature, and activation of hypothalamus structures, the increase of endogenous catecholamines release, ACTH, cortisol and beta-endorphins [8]. The role of catecholic amines (noradrenalin, and dopamine) in regulating the mood has been proved. Steroid hormones, also ACTH, also influence emotions, as they usually improve the mood. If they are applied protractedly in too large doses, they can evoke some psychical aberration, such as manic states, more rarely depressive states, dysfory, emotional lability, or even consciousness disorders and schizophrenic psychosis.

Low temperature of the surrounding stimulates skin receptors of cold, warmth, nociceptors, and sensitive to warmth mechanoreceptors. The transmission of these impulses to o.u.n. by reflexive arcs, which are not very well known, causes the emission of corticotrophin releasing hormone – CRH in hypothalamus. CRH not only increases the emission of ACTH by a hypophysis but also activates the emission of beta-endorphins' precursor – proopiomelanocortin, and 13-endorphinum. 13-endorphins are probably also emitted from adrenal glands' nucleus (core). But endogenous catecholic amines also have their part in releasing 13-endorphins. At the end of 70s endogenous opioidic peptides were called endogenous neuroleptics. In the light of contemporary data the activation of central opioidic neurons influences inflectionally processes connected with learning, memory consolidation and recalling, acting directly through noradrenergic and serotonergic neurons. A lot

of data indicate that opiodic receptors are placed on the endings of presynaptic dopaminergic neurons. Endogenous opioids decrease the emission of dopamine by activating these receptors. This leads to compensatory intensification of dopaminergic transmission. Dopamine influences the prize system in brain. Its deficiency can cause the loss of joy of life and abilities to feel pleasures. Opioids decrease also the emission of noradrenalin in some brain structures, modulate the emission of acetylcholine and increase the emission and revolutions of serotonin. Their role in psychosis' pathogenesis and treatment is not known, however the discovery of endogenous opioid system gave new prospects in c.u.n. researches. First casuistic operations, which indicated anti-depressive influence of 13-endorphinum was published by Kline in 1979. The hypothesis, that depressive syndrome correlates with the decreased activity of opiodic systems, is also confirmed by the research of electro-shock mechanisms. This kind of treatment causes a significant increase of 13-endorphinic system's activity. In Zagrobelny's research it was shown that the concentration of 13-endorphinum in women and men's serum was after the cooling process in the chamber significantly larger than the concentration of this neurohormone before the treatment. It can be assumed that the series of ten treatments of the whole body cryotherapy caused bigger secretion of 13-endorphines in o.u.n. than the average.

Sleep dysfunctions which were reduced the most in this research are the indication of hypothalamus regulatory system and brain stem dysfunctions. Low temperatures can lead to normalization of functions of these brain structures and changes in serotonin system. This hypothesis can be proved also by the fact that clinical picture of sleep dysfunctions at IN people with depression is similar to sleep dysfunctions observed with the application of compounds which perturbs serotonin's synthesis. The increase in serotonin's synthesis by application of big doses of its precursor – L-tryptofan, makes the process of falling asleep quicker and decreases the number of waking ups during the night. Serotonin is transformed in pineal gland into melatonin which plays a big role in regulation of the cycle – dream-wakefulness. Clinic research indicates that the inhibition of

reflexive capture of serotonin in synapse correlates positively not only with anti-depressive effect but also anti-fear and calming down effect.

An interesting thing observed during the following research was the fact that after completing a series of treatments WBCT, there was a significant improvement in libido. The gathered data suggest, however, that the change in this parameter should concern mainly men. In this research the change covered both sexes equally. According to Zagrobelny, who measured the concentration of testosterone in serum before and after one treatment of cooling the body, these concentrations were almost similar as far as women are concerned but men had the concentration of testosterone significantly higher after the cooling [8].

Disorders in menstruation cycle during the depression were also normalized. It seems that this fact has to be explained by the rationalization of hypothalamus functions, as it was in the case of biological rhythms disorders. Other mechanisms, which have not been proved so far, can also have some influence on mood after the application of the whole body cryotherapy.

The permanency of cryotherapy effect on treating depression is not known. At the time of finishing the observations the sick who took part in the research still felt better psychically, similarly to the effects after the last of the series of treatments. It suggests the durability of the effects of the treatment and can be an additional argument to continue this research.

The above ideas and the results of the pilotage research let the authors assess the application of low cryogenic temperatures as an additional help in psychic dysfunctions' therapy.

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