

The effect of thermotherapy treatments on the degree of calcification of bone tissue

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Aneta Bac¹, Daniel Zarzycki², Dorota Czechowska¹, Maciej Górkiewicz³, Renata Woźniacka⁴, Paweł Sosin⁴, Elżbieta Szczygiet⁵, Edward Golec¹

¹ Orthopaedic Rehabilitation Department, Chair of Clinical Rehabilitation, Faculty of Motor Rehabilitation, The Bronisław Czech University School of Physical Education, Krakow, Poland, Manager: prof. dr hab. Anna Marchewka

² Chair and Orthopaedic Department, Medical Faculty, Jagiellonian University, Medical College, Krakow, Poland, Manager: prof. dr hab. Daniel Zarzycki

³ Epidemiology and Population Research, Institute of Public Health, Faculty of Health Sciences, Jagiellonian University, Medical College, Krakow, Poland, Manager: prof. dr hab. Andrzej Pająk

⁴ Department of Anatomy, Chair of Physical Therapy, Faculty of Motor Rehabilitation, The Bronisław Czech University School of Physical Education, Krakow, Poland, Manager: prof. dr hab. Marek Pieniążek

⁵ Traumatologic Rehabilitation Department, Chair of Clinical Rehabilitation, Faculty of Motor Rehabilitation, The Bronisław Czech University School of Physical Education, Krakow, Poland, Manager: prof. dr hab. Anna Marchewka

⁶ Physical Therapy Department, Institute of Physical Therapy, Faculty of Health Science, Jagiellonian University, Medical College, Krakow, Poland, Manager: dr hab. Jan Bilski

Address for correspondence/

Adres do korespondencji:

Dr Aneta Bac

Zakład Rehabilitacji w Ortopedii

Katedra Rehabilitacji Klinicznej

AWF im. B. Czecha,

al. Jana Pawła II 78

31-571 Krakow, Poland

tel. (12) 683 10 72

e-mail: anetabac@interia.pl

Summary

Introduction. One of the most serious problem of contemporary orthopedics is the treatment of changes of bone tissue density. This problem affected significant part of population especially women after the menopause. Bone structure disorders can cause a lot of local and general complications such as osteoporotical fractures. It is of great clinic importance to try to prevent such changes.

Objective. This work is aimed at attempting to determine the effect of paraffin treatments on the degree of calcification of the bone tissue in healthy people and in people with postmenopausal osteoporosis.

Material. In 2004, a series of pilot studies were carried out at the Physiotherapy Unit of the Academy of Physical Education in Krakow, in which two groups of subjects were employed in order to obtain an answer to the proposed hypotheses. Group one consisted of 44 healthy people, including 38 females, aged 21 – 34 (the average age 23 years), and 6 males, aged 22 – 28 (the average age 25 years). Group two was made up of 17 females with confirmed osteoporosis, aged 54 – 73 (the average age 67 years).

Method. The method of the study included history taking by means of a specially prepared survey form, the filling in of which expressed willingness to participate in the research programme. Each subject, no matter which group they belonged to, had a four time bone mineral density measure, made by non-invasive quantitative ultrasonography within the area of the calcaneal tubers of both limbs, first carried out before the series of the treatments and once again after 10, 20 and 30 treatments.

Each subject also took part in a series of paraffin treatments carried out according to the recommendations of the specialist literature, concerning the methods of application, as well as indications and contraindications for such treatments. The statistical analysis working out the parameters achieved during the research ended the research programme. The statistical analysis included descriptive statistics (the arithmetic mean and the percentage change), the ANOVA analysis, a t-student test for paired data and the correlation coefficient.

Results. Despite the considerable intensity of treatments, the statistical analysis of the parameters under the research did not reveal significant differences in the calcification of the calcaneal bone in the limb undergoing the treatment and the control limb. Such results were observed in both groups under the research.

Conclusions. The paraffin treatments do not cause the decrease of the mineral density of the bone, both in healthy people and in people with osteoporosis.

Key words: paraffin, thermotherapy, bones, osteoporosis, calcification

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INTRODUCTION

The subject of this research was undertaken as an attempt at verifying opinions on the harmfulness of deeply overheating treatments, with a special consideration of paraffin poultices, to the degree of bone calcification which extremely frequently appear especially in the Polish literature on the subject. Those opinions concern both the effect of paraffin on both healthy and weakened bone tissue including osteoporotic bone.

Majority of specialist reports do not confirm scientifically and exhaustively the theses presented by them. However, the majority of scientific reports concerning the issue offer no comprehensive explanation of the proposed thesis. Despite this, prevailing common conviction of negative effects of paraffin therapy on mineralization changes resulted in the fact that they were completely excluded from clinical practice. It can be expected that, among other reasons, such opinions are caused by the result of X-ray examination which was also commonly used in an evaluation of bone mass density. Its reliability in comparison with modern methods of assessment of the degree of mineralization and bone density seems to be unconvincing. Doubtless, deep-heat paraffin treatment is remarkably beneficial and its curative properties help to deal with a great deal of therapeutic problems. The application of paraffin alleviates pain in the afflicted areas, it relieves muscle tightness, it increases activity of auto-regulatory defence mechanisms which is manifested by the acceleration of the regeneration of damaged tissue and its metabolism. Therefore, it is crucial to determine the actual influence and efficacy of paraffin therapy on bone mass density, including osteoporotic one.

MATERIAL

Two groups of subjects took part in the pilot study. Group one consisted of 44 young and healthy volunteers, students of Physiotherapy at the Academy of Physical Education in Krakow, including 38 females, aged 21 – 34 (the average age 23 years) presenting 86% of this group and 62% of all examined people, and 6 males, aged 22 – 28 (the average age 25 years) presenting 14% of this group and 10% of all examined people.

Group two was made up of 17 females with diagnosed osteoporosis, aged from 54 to 73 (the average age 67 years) presenting 100% of this group and 28% of all examined people. A small number of this group resulted from the lack of data concerning the actual effect of paraffin on BMD, and at the same time on the existence of the potential risk of decalcification occurring after the series of paraffin treatments.

The research was based on a personal survey, elaborated according to our own pattern, a print-out of the densitometry documenting advanced osteoporosis in females from group two and the written consent of each of the subjects under the research to the paraffin treatment and bone density measurements.

METHOD

The method of the research work included a survey, BMD, a series of paraffin treatments and a statistical analysis of the parameters achieved during the research.

A specially prepared personal survey form, which at the same time constituted the subject's application and consent for the tests, was the basis for carrying out the survey.

Survey

Part one of the survey included questions about personal data, foot and joint ache complaints, with a special consideration of the ankle joints, and the history of possible injuries to the bones and joints of the foot which could affect the present calcification of bones or its changes.

Part two of the survey was made up of questions about the patient's possibly taking medicine affecting the calcification of bones and the coexisting diseases which can be the cause of bone mineralization disorders.

The third part of the survey concerned only female subjects and included questions about the regular occurrence of menses, the use of oral contraceptives and the possible gynaecological surgery procedures.

BMD

Each of the subjects (independent of their research group membership) had a four time BMD carried out by means of non-invasive USG, the first time before the commencement of the series of treatments and once again after 10, 20 and 30 treatments.

The measurements were made on the heels of both feet of each of the subjects and were carried out by means of special equipment (AOS 100), manufactured by Aloka, which determined the current density of bones in individual patients by calculating and analysing 3 parameters.

- The speed of sound (SOS) of the ultrasound impulses going through the heel bone was the first of the above parameters.
- The second one was the transmission index (TI) of the ultrasound impulses through the heel bone.
- The third parameter was the index of the sonographic assessment of osteoporosis (OSI), which was calculated from the speed of sound (SOS) and the transmission index (TI). The result was obtained from the following formula: $OSI = TI \times SOS^2$.

Series of paraffin treatments

In the case of each subject the paraffin treatments consisted of 30 paraffin poultices placed on the foot within the area of the right calcaneal tuber, once a day for 6 consecutive weeks. The left foot was treated as the control group and did not undergo any paraffin treatments. The paraffin treatment itself was carried out according to the principles mentioned in textbooks on systematics, the ways of recommendation of such treatments, as well as indications and contraindications to such treatments.

Statistical analysis

By means of statistical analysis there was calculated the achieved increase in OSI parameter, described as P12, P23, P34, L12, L23, L34, where

- P – the measurement result for the right foot
- L – the measurement result for the left foot;
- Index $j, j+1$ – increase in OSI value within the period of time from the measurement j to the measurement number $j+1$

RESULTS OF THE RESEARCH

Descriptive statistics.

- *Arithmetic average.* Arithmetic average of OSI in the right foot before the treatment equalled 2,943, after initial 10 applications of paraffin it dropped slightly to the level of 2,931, and afterwards it increased faintly to 2,945 (after 30 applications, that is, after 4 weeks) and finally it reached the level of 2,937 after the completion of treatment.

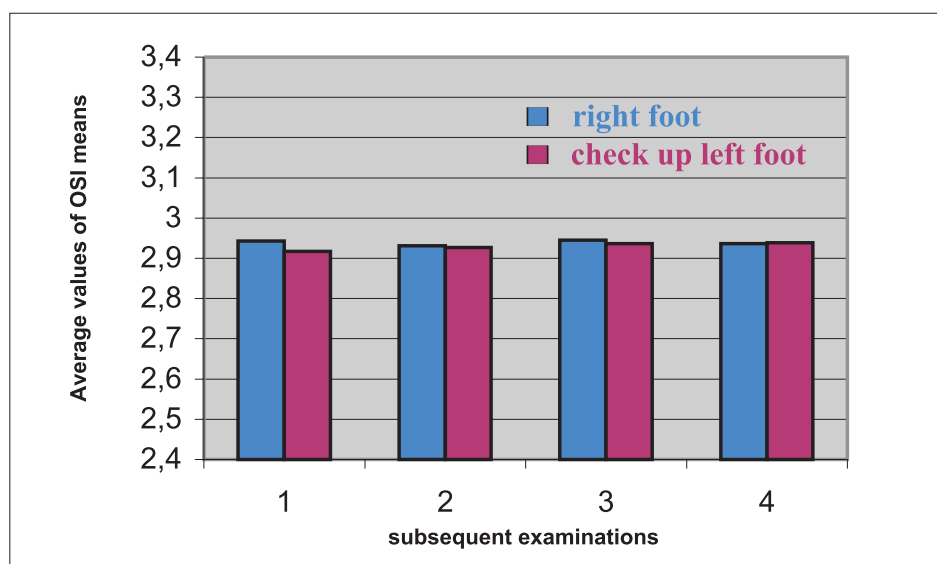
In the case of the left foot, the values were slightly lower. Prior to the beginning of the treatment, OSI equ-

alled 2,917, after 2 weeks it increased to 2,927, after 4 weeks it increased even more to 2,936 and after 6 weeks, the values reached 2,939. (see Tab. 1.)

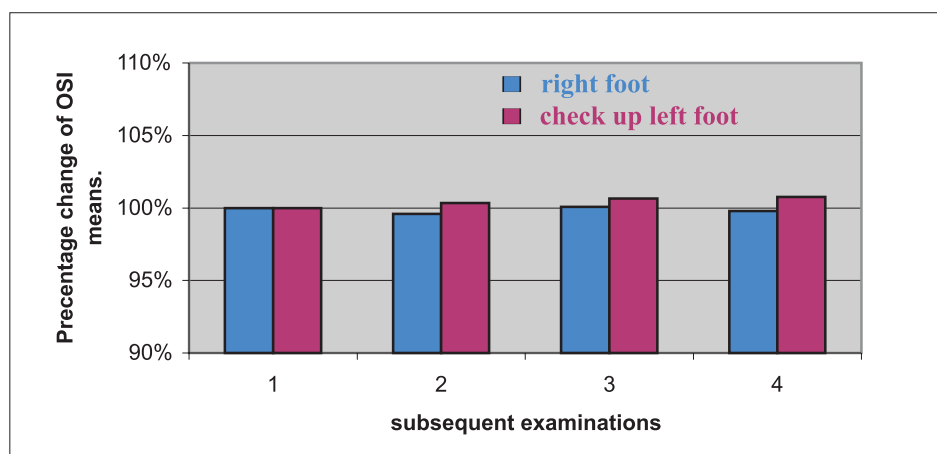
· *Percentage change.* Initial value of the percentage change of average OSI for the right foot before the treatment equalled 100%. After the initial application of 10 paraffin plasters (2 weeks) the value decreased slightly to 99,59%. After 10 consecutive treatments (4 weeks) it increased to 100,07%, and after the completion of treatment (6 weeks, 30 applications) it decreased again to 99,8%.

In the case of the left foot, the same initial value of the percentage change of average OSI varied in the following way: after 2 weeks it reached 100,34%, after another 2 weeks it increased slightly to 100,65% and upon completion it equalled 100,75%. (see Tab. 2.) Average value of another results of BMD examination for right and left foot and with relation to average of first examination presenting table 3 (for group – Healthy) and table 4 (four group – Osteoporosis). Common analysis of OSI value changes shows that after 6 weeks there was no changes for right feet with

Tab. 1. Average values of OSI in both feet in subsequent examinations



Tab. 2. Percentage change of OSI means in both feet in subsequent examinations



paraffin procedures, for left check-up feet there was minimal increase. (see Tab. 5.)

Statistical analysis

Six increase values calculated as a difference between the OSI values in the same subject and on the same foot in two consecutive measurements were analyzed statistically. The remaining parameters achieved during the research are in mathematical relation.

Three statistical methods were employed in this part of the analysis, namely: ANOVA, t-Student test for paired data and the correlation coefficient. (1, 2, 3)

In the case of both groups identical results were achieved in terms of quality and that is why the below described conclusions refer to both of them.

ANOVA

The checking of the assumption about the variance homogeneity resulted from the χ^2 and Bartlett tests.

The zero hypothesis:

- the average values of all the six OSI increase values do not differ substantially (see Tab. 6. and Tab. 7.)

Conclusion for both groups:

There are no grounds to reject the zero hypothesis, so we assume that the average values of all the increase values examined do not differ.

The t-student test for paired data

The admissibility of using the t-student test was checked while testing the assumptions for ANOVA.

- for the average values of the two paired trials used in successive OSI increases in the same person

For the zero hypothesis:

- the successive increase values in the same person do not differ significantly.

The following conclusion was drawn for both groups under the research:

- there are no grounds to reject the zero hypothesis for each pair of the successive OSI increase values in the same person on the same foot.

- for the average value from one trial used in 6 trials of individual increases

For the zero hypothesis:

- the average values of individual increases do not differ significantly from 0.

The following conclusion was drawn for both groups under the research:

- there are no grounds to reject the zero hypothesis for each of the OSI increase values under the research.

Pearson's linear correlation

Moreover, there was calculated the correlation coefficient between the increases of the OSI parameter for the right and left foot in the case of successive measurements made during the research work.

The testing of the correlation gravity is understood as the testing of the zero hypothesis:

- within the whole population under the research there is no correlation between the features tested, the correlation coefficient $R = 0$ despite the fact that the R correlation coefficient from the trial is different from zero.

On the basis of Pearson's linear correlation it was stated that between successive increases for the same foot

Tab. 3. Average value of results in group – Healthy

Healthy	P1	P2	P3	P4	L1	L2	L3	L4
mean	2,94	2,93	2,95	2,94	2,92	2,93	2,94	2,94
SD	0,22	0,24	0,25	0,22	0,23	0,20	0,26	0,23
% P1 (% L1)	–	99,6%	100,1%	99,8%	–	100,4%	100,7%	100,8%

Tab. 4. Average value of results in group – Osteoporosis

Osteoporosis	P1	P2	P3	P4	L1	L2	L3	L4
mean	2,24	2,23	2,22	2,24	2,22	2,22	2,20	2,22
SD	0,19	0,18	0,19	0,19	0,20	0,19	0,20	0,21
% P1 (% L1)	–	99,5%	99,3%	100,0%	–	100,2%	99,5%	100,4%

Tab. 5. Results breakdown of the first and last examination of OSI parameter for both feet in healthy people.

OSI – healthy people				
right foot			left foot	
with procedure			check-up	
	before procedures	after 30 procedures	before examinations	after 6 weeks
Arithmetical mean	2,943	2,937	2,917	2,939
Percentage change	100%	99,80%	100%	100,75%

there existed significant ($P < 0,05$) negative correlations, i.e. the earlier small increase is compensated for the next small increase and vice versa, and that there do not occur significant correlations between the increases on the right and left foot in the same person in both groups under the research.

DISCUSSION

In the Polish accessible periodical press there are only a few publications in which appeared attempts at achieving a reliable answer to the question whether the paraffin treatments really affect the mineral density of the bone tissue (BMD). Also among accessible articles in English we did not find any mentions of the relation between the paraffin poultices and the mineral density of the bone tissue.

In 1955 Turek - Wandzilak [4] discussed an issue of therapeutic value of heat in polio disease. However, she concluded that after a series of treatments applied to children, including paraffin therapy, no bone fractures nor demineralisation of bone tissue were diagnosed. Data presented can hardly be considered reliable because no method for delivering medical examination was presented and it was not stated what kind of diagnostic investigation served as a reference point for their results.

In 1971, Konieczna [5] carried out experimental research on guinea pigs and applied paraffin treatment. After completing the treatment she diagnosed changes in bone tissue by means of an X-ray method, as well as a post mortem and histopathology examination. A significant change in bone mass density was observed within a group of animals, which led to the conclusion that similar changes are expected to be found in human beings.

In 2001, Romanowski et al. [6] presented research which was carried out on a group of 18 women with primary osteoarthritis of the hands who received glove paraffin treatment. After completing a cycle of paraffin therapy, bone density was determined by means of a densitometric method used directly after the paraffin treatment and after 3 months since the beginning of the

therapy. The results observed by the authors show that there is no relation between the heat generated by the paraffin plaster and the degree of bone calcification. According to Tylman [7], a small number of paraffin applications does not have a detrimental effect on bone mass density. He suggests that such changes occur only after a cycle consisting of more than 20 applications. Many research reports on the subject show that there is a definite connection between a heating effect of paraffin therapy and decalcification in healthy bones [8,9,10,11]. The process increases significantly, particularly in the case of osteoporosis-affected bones [12,13,14,15,16,18,19,20]. Questions that arise in the process of verification of scientific hypotheses concentrate on an evaluation of two sample groups: one comprising healthy people and the other comprising those affected by osteoporosis. A small number of patients in the second group resulted from ethical reasons, because a lack of certainty concerning an actual effect of paraffin treatment on bone tissue required extra caution in its application. Additional problem in conducting the examination concerned obtaining permission from women with documented osteoporosis. Common conviction that warm paraffin therapy has a negative effect on bone mineral density causes refusal among many patients. In spite of a limited number of patients participating in the examination, it is believed that the results are reliable and can serve as a basis for further clinical research. It can be observed that the results show that in the sample groups no relation between deep-penetrating heat induced by paraffin therapy and the degree of bone calcification.

In spite of a high intensity of treatment (20 minutes daily), high frequency (6 consecutive weeks) and easy access to the bone (calcaneal bone practically free from muscle tissue), no fluctuation or change in the value of analysed parameters, that might be indicative of a decrease in the calcification of examined bones, occurred during a follow-up examination. Therefore, we hope that it is worthwhile to continue the research initiated by us in order to confirm definitely a lack of harmful effects of paraffin on the skeletal system.

Tab. 6. Variance analysis for healthy people

Variance source	SS	df	MS	F	p value	Test F
Between groups	0,02	5	0,005	0,25	0,94	2,25
Within groups	5,10	258	0,020			
Total	5,12	263				

Tab. 7. Variance analysis for people with osteoporosis

Variance source	SS	df	MS	F	p value	Test F
Between groups	0,02	5	0,003	0,73	0,60	2,31
Within groups	0,45	96	0,005			
Total	0,46	101				

CONCLUSIONS

1. The thermotherapy treatments in the form of paraffin poultices did not cause decalcification of the healthy bone tissue in the group of patients under the research.
2. The thermotherapy treatments in the form of paraffin poultices did not intensify decalcifications in the group of female patients with postmenopausal osteoporosis.

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