World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

The therapeutic effects of Thermos-mineral water Ilidza-Sarajevo in osteoarthritis of the knee

Amira Skopljak *

Department of Family Medicine, Faculty of Medicine, University of Sarajevo, Sarajevo, Bosnia and Herzegovina.

World Journal of Advanced Research and Reviews, 2024, 24(02), 2265–2271

Publication history: Received on 15 October 2024; revised on 22 November 2024; accepted on 25 November 2024

Article DOI: https://doi.org/10.30574/wjarr.2024.24.2.3585

Abstract

The beneficial effect of thermomineral (sulfur) water in the treatment of degenerative rheumatic diseases of the peripheral joints is the result of the incorporation of sulfur in the form of sulfates and sulfides into the cartilaginous parts of the joints. The aim research is to examine the therapeutic effects of thermomineral-sulfur water from Ilidza-Sarajevo using the iontophoresis method in osteoarthritis of the knee and compare it with the effects of the classic galvanization method. The study was observational, prospective, included 100 participants with osteoartritis of the knee, 50 in the Iontophoresis group with sulfur water (ISW) and 50 in the group where the Classic galvanization method (CG) was applied, both genders, aged between 31 and 80. The research was conducted in two Centers for Physical medicine and rehabilitation in Sarajevo Canton. The research results show that there is a statistically significant difference in the reduction of pain in patients after 10 days of therapy, using the ISW method 33%, with the CG method it is 24% ($p< 0.05$). After 15 days of treatment using the ISW method 57%, according to the CG method 45% ($p<0.05$). The increase in the range of mobility of the knee joint with the ISW method after 10 days of treatment is 13%, and with CG 10% ($p=0.336$). Results after 15 days of therapy with the ISW method 22%, and with CG treatment 16% ($p=0.074$). The use of Ilidza sulfuric water using the iontophoresis method in osteoarthritis of the knee improves the establishment of the functional ability of the knee joint.

Keywords: Thermomineral water Ilidza; Osteoarthritis of the knee; Iontophoresis; Therapeutic effects

1. Introduction

Degenerative diseases of the joints are a socioeconomic problem today in both the underdeveloped and the developed world. The direct costs of diagnosing, treating and rehabilitating patients are extremely high. Restrictions on activities of daily life, loss of working days and inability to work, caused as a result of this disease, indirectly reflect on high costs, standard of patients and society as a whole.

Although degenerative joint diseases are a widespread disease, the etiology of the disease is unknown and insufficiently studied. A large number of authors believe that several factors are involved in the etiology of osteoarthritis. Some factors such as age, gender, hormonal status, obesity, genetic influences, physical activity, climatic conditions and diet have a certain, albeit unclear, role in the etiology of the disease. Some forms of osteoarthritis are the result of a mutation in one gene for collagen synthesis (1,2,3). Congenital or acquired static deformities (congenital hip dysplasia, flat feet) favor the development of degenerative rheumatism (4).

The clinical symptomatology of osteoarthritis, primary or secondary, is dominated by pain, dysfunction and deformation of the affected joint. Formation of osteophytes, loss of cartilage, spasm of surrounding muscles and

* Corresponding author: Amira Skopljak

involvement of peri-articular tissue cause limited mobility (5). Range of motion decreases and in many cases requires physical treatment (6).

Physical therapy includes the therapeutic effect of various physical agents, which are applied through certain physiological structures, primarily through the skin. The goal of physical therapy in the treatment of degenerative rheumatic diseases of the knee is reflected in the following: reduction or elimination of pain, improvement of local circulation, reduction of edema through resorption, increase of elasticity of connective tissue, increase of range of motion, improvement of joint function, improvement of general physical condition and postponement of disability. The beneficial effect of thermomineral (sulfur) water in the treatment of degenerative rheumatic diseases of the peripheral joints is the result of the incorporation of sulfur in the form of sulfates and sulfides into the cartilaginous parts of the joints. Arthritic cartilage has a reduced content of chondroitin-6-sulfate and keratan sulfate.

Sulfuric water with H_2S (hydrogen sulphide) passes through the skin relatively quickly. Sulphide resorption is proportional to the concentration of sulfur in the water and the duration of its effect on the skin, which depends on the pH of the skin and hair. Therapy with a warm bath of sulfur water with a sulfur concentration of 50 mg/l for 30 minutes brings about 1.5 mg of sulfur into the skin. A large amount of sulfide is deposited in the outer epidermal layer. Subsequent resorption will be completed within 24 hours. Likewise, sulfur in the form of H_2S is easily resorbed in the intestines (7).

In addition to the indicated indications, sulfur water has other effects and can be used in the treatment of diseases of the locomotor apparatus, catarrhal changes of the respiratory tract, gastrointestinal diseases, urolithiasis, in the treatment of gynecological diseases, peripheral circulation disorders, heavy metal poisoning, gout, hyperkeratolytic form of skin diseases (8,9,10).

Qualitative-quantitative indicators of the quality of the thermal mineral water of Ilidza were made in the laboratory of the Public Health Institute of Sarajevo Canton. According to the balneological classification, the sulfuric water of Ilidza is of the hydrocarbonate-sulfate-chloride-calcium-sodium type, mineralization 3,400 mg/l, carbonic acid hypertherm temperature 58 °C . It contains 573 mg/l sulfate and 10.6 mg/l sulfide. The radioactivity of the water is 0.3-0.9 Bq/l Ra and 0.3 μg/l U. The CO_2 content in the water is about 500 mg/l.

The physico-chemical analysis of the sulfuric water of Ilidza conducted by E. Ludvig in 1886, then the analyzes performed in 1986 (after 100 years), were almost identical, which indicates the stability of the quality of this sulfuric water. This is confirmed by a significantly expanded water analysis carried out in 2002. Spas that use thermal mineral water with a high sulfur content, among which is spa Ilidza near Sarajevo, are among the most valued spas in the world, because they have multiple applications in balneology and the treatment of many diseases (11).

It has been experimentally proven that in rabbits that drank sulfur water from Ilidza, ear cartilage has a much stronger and more stable structure compared to control animals that drank plain water (12). According to N. Zjuzin, the special effects of sulfur water can be achieved by applying sulfur water using different methods: drinking, hydrotherapy (baths, underwater massages, galvanic baths, showers, bathtubs, swimming pools), electrotherapy (classic galvanization, iontophoresis), inhalation (13).

Iontophoresis of drugs represents the transcutaneous introduction of medicinal substances into the body through intact skin. Earlier research indicates that the concentration of the medicinal substance introduced through the iontophoresis method is many times higher than in other ways of application. Prolonged release of the drug achieves the maintenance of an elevated concentration in the tissue (14). According to some studies, the presence of a medicinal substance after iontophoresis can be proven locally even up to 72 hours after its introduction. The concentration of the drug introduced in this way is many times higher than with parenteral or oral administration (15).

The aim of this research is to examine the therapeutic effects of thermomineral-sulfur water from Ilidza-Sarajevo using the iontophoresis method in osteoarthritis of the knee and compare it with the effects of the classic galvanization method.

2. Material and Methods

2.1. Study Design

The study was observational, prospective, the selection was made using the random sample method, included 100 participants with osteoartritis of the knee, both genders, aged between 31 and 80. The respondents were divided into two groups, 50 in the Iontophoresis group with sulfur water (ISW) and 50 in the group where the Classic galvanization method (CG) was applied. The research was conducted in two Centers for Physical medicine and rehabilitation in Sarajevo Canton**,** during the period of six months.

Inclusion criteria are patients over 30 years of age, both sexes, patients with clinical symptoms (pain, swelling, deformities, limited mobility of the knee joint).

Exclusion criteria are patients with epidermal lesions, metal in the field of electric current propagation, febrile conditions, bleeding and tendency to bleeding, severe decompensation of the heart, highly elevated blood pressure, malignant tumors.

Exclusion criteria are the occurrence of an acute infectious or other disease, the occurrence of an allergic reaction, the occurrence of other unwanted effects, non-adherence to the test program.

2.2. Reseach medhods

The research used a device for galvanic current therapy, electrodes 10x10 cm, transversely placed on the knee, pads (sponges) 1 cm thick, soaked in sulfur water under the cathode in the group with Iontophoresis sulfur water (ISW), and in the group Classic galvanization method (CG) soaked in physiological solution under the anode. Duration of therapy 15 days, daily, 30 minutes with re-soaking the pad for 15 minutes. Current strength 0.5 mA/cm^2 with control of the subject's sensitive feeling.

Research parameters - tests and measurements are joint circumference in centimeters, joint mobility range - goniometry, pain scale from 1 - 10, X-ray of the knee joint. Musculoskeletal status was evaluated at the beginning, after the 10th and after the 15th day of therapy.

Tests of physical and chemical parameters of the sulfur water of Ilidza, for the purposes of this work, were performed on samples taken from the most productive well of thermomineral waters, i.e. research well IB-2 Ilidza (Q = 100 l/s, Tv = 58 °C).

2.3. Statistical analisys

The data were processed statistically and presented tabularly and graphically. In the statistical processing of the results, standard methods of descriptive statistics were used. Student t-test, was used to test statistical significance between groups. Values of $p<0,05$ were taken as statistically significant.

3. Results and discussion

In the research participated 100 male and female respondents between the ages of 31 and 80. In the gender structure of the selected respondents, women are the most represented. In the group with the application of iontophoresis with the sulfur water of Ilidza, 76% are women in the age range of 40-80 years, and in the group with the application of galvanization, as many as 86% are women, of which 70% are aged 40-70. Men are less represented in the structure of the respondents, 24% in the group with the application of iontophoresis and 14% in the group with the application of classical galvanization.

When choosing the subjects, confirmation of the presence of the degenerative process of the knee was carried out by checking the X-ray findings, whereby it was determined whether the changes were initial or advanced.

Table 1 Comparative table of X-ray changes of the knee joint in the group with the application of galvanization and iontophoresis

N= 100	**X-ray CHANGES (%)**	
Subjects		
	Initial	**Advanced**
Cllasic galvanization	46	54
Iontoforesis sulfur water	24	76

Of the total number of subjects, in the group with the application of galvanization, 54% of patients had visible X-ray - advanced changes in the knee joint, and even 76% of subjects with X-ray - advanced changes in the group with the application of iontophoresis with sulfur water Ilidza.

The average body weight of the respondents shows that, of the total number of respondents, 42% have a body weight of 71-80 kg, 37% have a body weight of 81-100 kg. As many as 18% of subjects in the group with the application of iontophoresis have a body weight of over 100 kg, and only 4% of the subjects in the group with the application of classical galvanization.

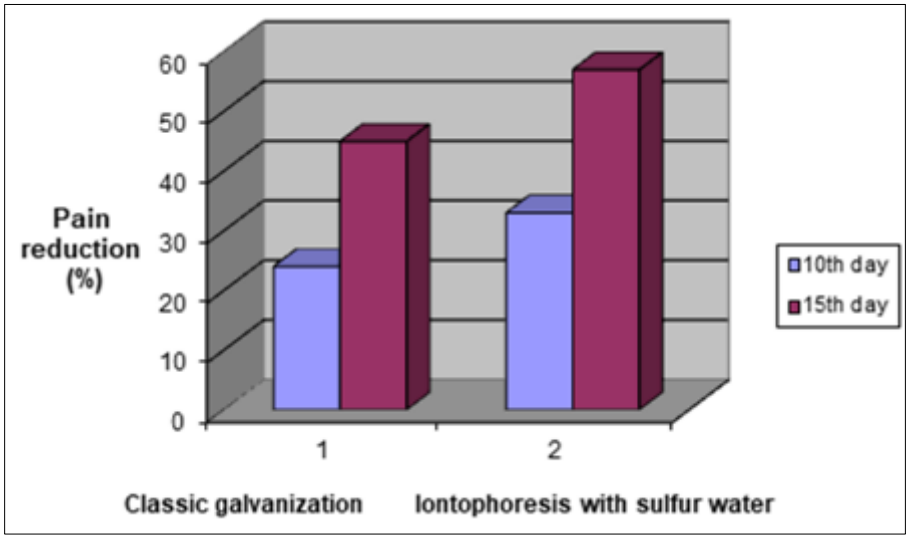

Figure 1 Reduction of pain in osteoarthritis of the knee after the 10th and 15th day of therapy with the use of classic galvanization and iontophoresis with sulfur water

From the presented comparative assessment of pain reduction, when applying classic galvanization and iontophoresis with sulfur water from Ilidza, it is noted that the pain reduction when applying galvanization is 24% after 10 days, or 45% after 15 days of therapy. On the other hand, with the application of iontophoresis of sulfuric water of Ilidza, the pain reduction after 10 days of therapy amounts to 33%, i.e. 57% after 15 days, which shows the importance of using this method in the treatment of degenerative knee processes.

Statistical data processing, using the method of iontophoresis in relation to galvanization, can conclude that after 10 days of therapy there is a significant difference in changes on the pain scale ($p=0.03$). After 15 days of therapy, there is an extremely significant difference on the pain scale ($p < 0.05$). The above points to the complete justification of the application of iontophoresis with the sulfur wat er of Ilidza in osteoarthritis of the knee.

Analyzing the results on the reduction of the knee joint volume when applying galvanization and iontophoresis with sulfuric water from Ilidza, it was determined that with the application of galvanization, after 10 days of therapy, the joint volume decreases by 1%, and with iontophoresis with sulfuric water by 2%. The reduction of the joint circumference increases by extending the therapy after the 15th day of galvanization, the knee circumference decreases by 2%, and in iontophoresis therapy with Ilidza sulfur water, it decreases by 3% compared to the initial changes. The

above clearly indicates the positive effects of applying iontophoresis with Ilidza sulfur water in the treatment of osteoarthritis of the knee.

Table 2 Comparison of changes on the pain scale in subjects with the use of CG and JSW

Number subjects		**Pain scale with the Galvanization method**			**Pain scale with the Iontophoresis method**		
Classic galvanization	**Ionotophoresis**	**CG**			**JSW**		
50	**50**	***day 0***	***10th day***	***15th day***	***day 0***	***10th day***	***15th day***
Mean		6.07	4.60	3.34	6.16	4.20	2.70
Standard deviation		1.85	1.64	1.65	1.57	1.97	1.98
Student t - test		2.13			2.63		
P =		0.036			0.010		

By statistical processing of the data, it can be concluded that after 10 days of therapy, there are no significant differences in the changes in the circumference of the knee joint. After 15 days of therapy, the differences are very close to the threshold of significance (p=0.09).

Analyzing the results of the increase in the range of mobility of the knee joint when using classic galvanization and iontophoresis with sulfuric water in Ilidza, it was determined that when applying galvanization, after the 10th day of therapy, the range of mobility of the joint increases by 10%, and with iontophoresis with sulfuric water by 13%, after the 15th day application of galvanization, the range of mobility of the knee increases by 16%, and in iontophoresis therapy with Ilidza sulfur water, it increases by 22%. The above clearly indicates the positive effects of applying iontophoresis with Ilidža sulfur water in the treatment of osteoarthritis of the knee.

A statistical analysis of the benefits of applying the iontophoresis method compared to classical galvanization in changes in the range of motion of the knee joint shows that after 10 days of therapy there are no significant differences (p=0.33). After 15 days of therapy, the differences are very close to the threshold of significance (p=0.07). It is evident that better results are achieved by prolonging the therapy.

Sulfur thermal waters are widely used in the treatment of rheumatism and osteoarthritis (16). In this study, based on the results of monitoring the effects of iontophoresis with sulfur water in relation to the application of classical galvanization on the scale of pain, joint circumference and knee joint mobility, it can be concluded that there is a complete justification for its use in physical therapy in patients with degenerative changes in the knee joint . The results of iontophoresis with Ilidza sulfur water in degenerative processes of the knee joint can certainly be improved by extending the therapy to 20 days and in combination with other methods of physical therapy.

The oldest material evidence of the use of sulfuric water in Ilidza comes from the time of the Romans (138 to 161 BC), who gave this place the name Aqua S, which most likely means sulfuric water. Later, archeological research proved that the Romans used this water as baths in balneotherapy. Ludvig E. in his work "Sulfur spa Ilidza near Sarajevo" compares Ilidza and the quality of its water with the world's most famous spa (17). In 1893, the spa doctor Grinfeld J. stated that the following diseases were treated in the Ilidza spa: chronic rheumatism in the muscles and joints, women's diseases, sciatica, writing spasm.

Significant balneological tests of the sulfur waters of Ilidza were carried out by Ciglar M. in 1966 and 1980 and indicated a wide therapeutic range in which sulfur plays a significant role in the treatment of inflammatory and degenerative rheumatism, diseases of the peripheral nervous system, chronic inflammatory gynecological diseases and skin diseases (12) .

Relatively similar results in the treatment of osteoarthritis of the knee were achieved by other researchers using the method of balneotherapy with thermal sulfur waters, physicochemically different from the sulfur water of Ilidza.

Kovacs I, Bender T. performed tests on the therapeutic effects of Cserkeszolo thermal water in Hungary in patients with knee osteoarthritis. In a double-blind controlled study, tests were conducted on 58 subjects with osteoarthritis of the knee using the balneotherapy method in thermal water (active treatment) and similarly colored water (placebo

treatment). Balneotherapy was applied for 15 days with treatment lasting 30 minutes a day. Musculoskeletal status was evaluated at the beginning and end of the balneotherapy course, and three months later. The study showed significant results in the examined parameters (pain reduction, range of motion, sensitivity to palpation, climbing stairs) in patients treated with Cserkeszolo thermal water (18).

In the research of Stefanovski M. et al. the results of the application of the balneophysical complex (interfering currents, ultrasound, paraffin therapy, kinesitherapy and balneotherapy with sulfate-sulfide water) in the rehabilitation of patients with osteoarthritis of the knee are stated. Tests were conducted on 54 patients for a duration of medical rehabilitation of 17.5 +/- 5.5 days. The test results showed an improvement in the range of motion, manual muscle test and walking length in patients, and the significance of the application of the mentioned rehabilitation methods (19).

Hydrotherapy and balneotherapy have long been used as complementary treatments for diseases of the musculoskeletal system (20,21).

The test results obtained by the above-mentioned researchers indicate that significant effects can be achieved in the treatment of osteoarthritis of the knee using thermal and mineral waters with a completely different composition than the thermal mineral-sulfur water of Ilidza. If it is taken into account that the thermal mineral waters of Ilidža, due to their quality, have comparative advantages compared to all the waters in the region, it can be quite justifiably concluded that they can be successfully applied by various methods in the therapy of degenerative processes of the knee joint, as well as other osteoarthrosis and diseases.

4. Conclusion

The use of the natural source of thermomineral (sulfur) water Ilidza using the Iontophoresis method in osteoarthritis of the knee leads to a faster reduction in pain, an increase in the range of joint mobility, a reduction in the range of the knee joint, and a faster establishment of functional capacity compared to the application of the classical electroplating method.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

Statement of ethical approval

The author declares that the research was done in accordance with ethical guidelines.

Statement of informed consent

Informed consent was obtained from all individual participants included in the stady.

References

[1] Bleasel JF, Holderbaum D, Haqqi TM, Moskowitz RW. Clinical correlation of osteoarthritis associated with single base mutations in the type II procolagen gene. J. Rheumatol. 1995; 43,34-6.

[2] Williams CJ, Jimenez SA. Heritable diseases of cartilage caused by mutations in collagen genes, J. Rheumatol. 1995; 43, 28-33.

[3] Maulenbelt I, Bijkerk C, de Wildt S.C.M. Investigation od the assotiation of the CTRM and TRLI genes with radiographically evident osteoarthritis in subject from the Rotterdam Study. Arthritis Rheum. 1997; 40, 1760-3.

[4] Lane N.E, Nevit M.C, Cooper C, Pressman A, Gare R, Hochberg M. Acetabular dysplazia and osteoarthritis of the hip in elderly white womwn. Ann. Rheum. Dis. 1997; 56, 627-30.

[5] Popovic M, Stevanovic D, Mitrovic D. Rheumatic and related diseases-diagnosis and therapy. Military Publishing House Beograd. 2000; 18, 21-25.

[6] Kottke F. J,Lehmann J.F,Krusen¨s Handbook of Physical Medicine and Rehabilitation,W.B.Saunders Company Philadelphia, 1990; 683-687.

[7] Amelung W, Hildebrand G Balneology and medical climatology, Springer-Verlag Berlin, Heidellberg, New York, Tokyo, 1985.

[8] Cristall G, Abramo A, Pollasatrini L. Treatment of chronic inflammation of the upper respiratory airways by inhalation thermal therapy with sulfur-sulfate-bicarbonate-alkaline earth mineral water: a study of nasal cytology, Acta Otorinolaryngol. Ital.1996; 16(6 suppl.55):91-94.

[9] Bortolotti M, Turba E, Mari C, et al. Changes caused by mineral water on gastrointestinal motility in patients with chronic idiopathic dyspepsia .Minerva Med.1999; 90(5-6):187-194.

[10] Grossi F, Fontana M, Conti R, et al. Motility of the gastric antrum and the gallbladder following oral administration of sulfate-bicarbonate, Instituto di Idrologia Medica, Universita degli, Studi di Roma, La Sapienza Clin-Ter,1996; 147(6): 321-326.

[11] Tisma R, Spa Ilidza - Condition and possibilities of using thermal mineral water., Sarajevo, 1989; 59-61.

[12] Ciglar M. Collection of papers on the possibilities of using thermomineral water Ilidza, Sarajevo, 1989; 95-97.

[13] Zjuzin N. Feasibility study of investments in research and use of geothermal water from the IB-10 Ilidza well - Balneology, Institute of Geology, Faculty of Civil Engineering in Sarajevo; 2003.

[14] Knor T. Iontophoresis in clinical medicine, Medical Journal 2001; 7(2):93–85.

[15] Zekovic P. Physical therapy with rehabilitation, Institute for textbooks, Beograd, 1996; 11-28.

[16] Branco M, Rego N.N, Silva P.H, Archanjo I.E, Ribeiro M.C, Trevisani V.F. Bath thermal waters in the treatment of knee osteoarthritis; a randomized controlled clinical trial. Eur. J. Phys. Rehabil. Med., 2016; 52(4):422-430.

[17] Ludvig E. Sulfur spa Ilidza near Sarajevo, Vienna., 1894; 1-12.

[18] Kovacs I, Bender T. The therapeutic effects of Cserkeszolo thermal water in osteoarthritis of the knee, Rheumatology, 2002; 21(6):218-221.

[19] Stefanovski M.et.al. Rehabilitation of patients with gonarthrosis using the balneophysical complex of the Mljecanica spa, Proceedings of the First Congress of Physicians for Physical Medicine and Rehabilitation of Bosnia and Herzegovina with International Participation, Tuzla, 2000; 115.

[20] Morer C, Roques C.F, Francon A, Forestier R, Maraver F. The role of mineral elements and other chemical compounds used in balneology; data from double blind randomized clinical trials. Int. J. Biometeorol., 2017; 61(12):pp.2159-2173.

[21] Karagulle M, Kardes S, Karagulle M.Z. Real-life effectiveness of spa therapy in rheumatic and musculoskeletal diseases: a retrospective study of 819 patients. . Int. J. Biometeorol., 2017; 61(11):pp.1945-1956.