Evaluation of the Effect of Hévíz Mud in Patients with Hand Osteoarthritis: A Randomized, Controlled, Single-Blind Follow-Up Study

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ABSTRACT: **Background:** Heat therapy is one of the most popular non-pharmacological treatments for osteoarthritis of the hand.

Objectives: To investigate the therapeutic and chemical effects of Hévíz mud on patients with hand osteoarthritis.

Methods: We randomly assigned 47 patients with mild-to-moderate hand osteoarthritis to two groups. Patients in group 1 (n=23) received Hévíz mud applied directly to both hands, whereas patients in group 2 (n=24) also received mud to both hands, but nylon gloves separated the skin from the mud. Patients in both groups underwent five 20 minute treatment sessions per week for 3 weeks. The temperature of the mud was 42ºC. Outcome measures were Visual Analogue Scale (VAS) scores, hand grip strength, the number of swollen and tender joints of the hand, the duration of morning joint stiffness, Health Assessment Questionnaire score, and EuroQoL Group 5-Dimension Self-Report Questionnaire score. The study parameters were evaluated at baseline, immediately after treatment, and after 16 weeks.

Results: Both groups showed improvement in nearly all assessed parameters at the end of treatment and at 16 weeks from the start of treatment. At the week 16 follow-up visit, the patient group directly treated with mud showed significantly better improvement in VAS for II and IV parameters and in swollen joint count in both hands compared to the nylon glove-mud group.

Conclusions: Hévíz mud therapy significantly improved objective and subjective parameters in patients with hand osteoarthritis and had a beneficial effect on the patients' quality of life. Further studies are required to evaluate the chemical effects of the mud.

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KEY WORDS: Hévíz mud, hand osteoarthritis, heat therapy, non-pharmacological treatment, impermeable nylon layer

The incidence of osteoarthritis (OA) of the hand in women and men is 15.9% and 8.2%, respectively [1]. The disease mainly presents with pain, loss of function and decreased hand grip strength, and predominantly affects the distal and proximal interphalangeal and first carpometacarpal joints. Hand osteoarthritis is often part of generalized osteoarthritis. The currently available treatments are mostly symptomatic [2]. The treatment guidelines issued in the last few years have included non-pharmacological treatment modalities such as exercise therapy, orthoses and heat therapies [3]. More and more studies are addressing the administration of balneotherapy and mud therapy [4,5]. Mud therapy is an effective part of the complex physiotherapy treatment in countries with natural therapeutic sources. Mud-like substances used for medical purposes are collectively called peloids. These substances are produced by geological processes in nature and are used in medical practice as fine suspensions mixed with water for bathing or wrapping. Muds are applied mainly in the form of packs and can be applied to certain body parts or to the whole body. In Hungary, if we treat only the hands or legs, we apply the so-called mud-bucket treatment. This procedure includes filling a 10 L bucket with mud prepared for the treatment. The patients place their hands or legs in the bucket.

The effect of heat, which is physical, is a well-recognized result of mud therapy. Heat absorbed by the mud is stored for a long time and is released slowly, thereby providing a prolonged heat effect. Odabasi et al. [6] showed that the direct application of a mud pack on knee osteoarthritis was more effective than its application through a nylon layer. Therefore, the aim of our study was to determine whether the results are the same with hand osteoarthritis. Our primary objective was to evaluate the pain intensity felt during rest and during exertion. Our secondary objective was to investigate the effect of the therapy on hand function and evaluate the quality of life in both groups.

PATIENTS AND METHODS

We conducted a randomized, control-group, single-blind follow-up study approved by the Regional Research Ethics Committee, Hungary (approval number 18/2012); the study was conducted in accordance with the Declaration of Helsinki. Before enrollment, study participants were informed verbally and in writing about the purpose of the study and the study procedures. Prior to enrollment, patients read the patient information sheet and signed the informed consent form.

Participants were 45–70 years of age, with documented mild-to-moderate hand osteoarthritis meeting the ACR (American College of Rheumatology) classification criteria for hand osteoarthritis [7], and hand pain characteristic of osteoarthritis present for at least 3 months.

Individuals were not included if they exhibited contraindications for mud therapy; had received intra-articular corticosteroid injections in the month before the study; had intra-articular hyaluronic acid injections, hand surgery, hand injury or hand fracture within the 6 months preceding the study; took symptomatic slow-acting drugs for osteoarthritis or had physiotherapy within the 3 months preceding the study; were diagnosed with inflammatory rheumatic disease, radiculopathy or carpal tunnel syndrome; or exhibited an inadequate mental state.

The study was conducted at the Covered Bath of Hévíz Thermal Lake and St. Andrew Hospital for Rheumatic Diseases (H-8380 Hévíz, Dr. Schulhof Vilmos Sétány 1, Hungary) between 4 April and 30 July 2013. The board-certified rheumatologists at Hospital Keszthely and at St. Andrew Hospital for Rheumatic Diseases invited the participants to join the study.

Patients were randomized into two groups. Patients in group 1 (direct, n=23) received mud (in a bucket) applied directly to both hands, while patients in group 2 (separation, n=24) received mud (also in a bucket) to both hands but nylon gloves separated the skin from the mud. Both groups underwent five treatment sessions each week for 3 weeks. The temperature of the mud was 42°C, and each treatment session lasted for 20 minutes. The examiners were blind to the therapy administered and patients were instructed not to inform the examiners to which group they had been assigned. Each patient was allocated to one of four rheumatologists and one of two physical therapists. Thus, the assessment of any individual patient was conducted by the same rheumatologist and physical therapist on each occasion. Patients were considered as having completed the study if they participated in more than 80% of the treatment sessions. Patients were asked not to begin new oral or intra-articular treatment during the study period and did not receive any additional physiotherapy.

The Lake of Hévíz is one of the largest natural thermal lakes in the world. The thermal mineral water of Hévíz combines the favorable characteristics of carbonate, sulfur, calcium, magnesium, hydrogen carbonate and very light radon-containing waters. The study was performed with Pannon standard medical mud. The mud contains a high percentage of Hévíz thermal water, 72–82%, as well as 7.7–4.5% minerals and 14.3–13.5% combustible organic compounds (2.4% sulfur, 5% humic acid).

The primary outcome measures were Visual Analog Scale (VAS) scores, hand grip strength, swollen and tender joint count, duration of morning joint stiffness, Health Assessment Questionnaire Disability Index [8], and EuroQol-5D-3L health questionnaire [9]. Participants were evaluated just before treatment (week 0), at the end of treatment (week 3), and at the follow-up visit (week 16). VAS scores were used to record the pain. VAS I and VAS II were recorded on a 0–100 mm scale, where 0 indicated no pain and 100 indicated intractable pain. VAS III and VAS IV were recorded on a 0–100 mm scale, where 0 was the best and 100 the worst condition of the hand:

- VAS I – hand pain at rest, as rated by the patient
- VAS II – hand pain on exertion, as rated by the patient
- VAS III – patient global assessment of OA of hands
- VAS IV – physician global assessment of OA of hands

The hand grip strength was measured by an independent physical therapist using a Baseline® hydraulic hand dynamometer (Fabrication Enterprises, New York, USA). Three tests were done with both the right and left hand. We used the mean of the three tests for the evaluation of both sides. The number of swollen and tender joints and the duration of morning stiffness in the small joints of the hand were recorded. The Health Assessment Questionnaire Disability Index [8] was used to assess hand function, and the EuroQol-5D-3L [9], a self-report questionnaire, was used for measuring quality of life.

Patients were randomly assigned to one of two groups following simple randomization with a computer-generated sequence. The randomizer was not involved in conducting the study but received the information about the patients via email. The person performing the statistical analysis did not participate in the randomization process. After randomization, an independent researcher assigned the participants to the appropriate group.

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM SPSS 20 software. Analysis was performed with the intention to treat. Sample size estimation was calculated after the assessment of the first 10 subjects. According to VAS data with 0.80 power, 14–46 patients in both groups would be the appropriate sample size. The data were expressed as means and standard deviations. The changes in assessments within groups were calculated using paired samples *t*-test and a Wilcoxon Signed-Ranks test. Significance value was corrected by the Bonferroni method because of multiple comparison ($P = 0.025$). Effect sizes were calculated for differences of group pre- and post-assessments according to the Klauer method. A *P* value was calculated using the independent samples *t*-test and the Mann-Whitney test for comparison of

changes in pre- and post-measurements. *P* values < 0.05 were considered statistically significant.

RESULTS

We screened 70 patients of whom 47 met the inclusion criteria, and they were randomized into two groups. All 47 patients completed more than 80% of the treatment sessions. All patients returned for the follow-up assessments. Flow charts of the patients with hand osteoarthritis included in the study are shown in Figure 1. The two groups were similar regarding baseline characteristics, except for the swollen joint count on the left side [Table 1]. In the patient group treated with mud directly applied to the skin, a durable and significant improvement was observed in the subjective parameters measured on the VAS scale and in the number of swollen and tender joints on both sides based on the changes from baseline to post-treatment and even at the follow-up assessments. In the nylon glove-mud group, a durable and significant improvement was observed post-treatment. At the time of the follow-up assessments using the VAS I, VAS III and VAS IV scores, the number of swollen and tender joints on both sides as well as the EQ-5D VAS and HAQ parameters were improved compared to baseline values. At the week 16 follow-up visit, the patient group directly treated with mud showed significant improvement in the VAS II and VAS IV parameters and swollen joint count for both the right and left sides compared to the nylon glove-mud group [Tables 2 and 3]. The improvement of the VAS IV score (the physician's assessment of the status of the hand) is also remarkable because in this single-blind examination the physicians did not know which patient belonged to which group, so their assessment of the hand was unprejudiced. The improvement in the nylon glove-mud group, though noticeable, was not significant. During the examination of hand grip strength of the right hand, the changes within the nylon glove-mud group were significantly better at the long-term follow-up examinations, but in the comparison of the two groups the difference was not significant. No adverse effects were observed during the study.

DISCUSSION

Kulisch et al. [10] confirmed the efficacy of the mineral thermal water of Lake Hévíz on pain, function, and quality of life in patients with knee osteoarthritis. Odabasi and colleagues [6] used mud therapy in patients with knee osteoarthritis. In their study, mud was directly applied to one knee of the patient (direct mud effect), whereas the other knee served as a control and was treated with a nylon-covered mud pack (heat effect only). During the 6 month follow-up period, the study parameters showed a better long-term improvement in the directly treated group compared to the control group treated with heat only. In our study, statistical analysis showed a significant and durable improvement in the evaluated parameters both in the group treated with mud applied directly to the skin and in the nylon glove-mud group. This can be attributed to the

Figure 1. Flow chart of patients with hand osteoarthritis

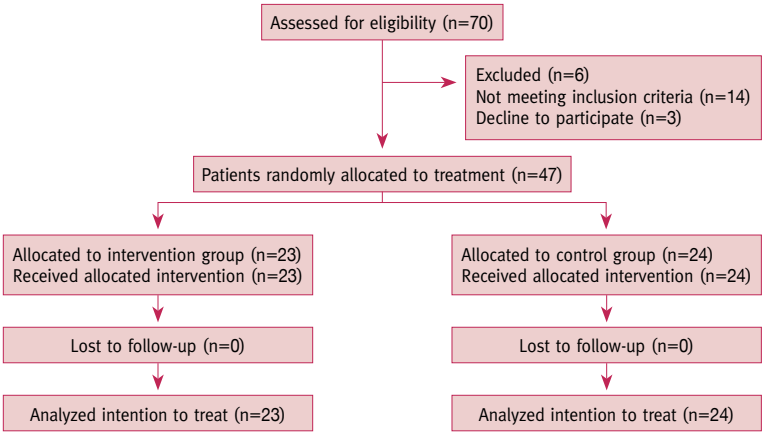

Table 1. Demographic data and other baseline clinical characteristics of the patients, by treatment group

		Patient group directly treated with mud (n=23)	Control group (n=24)
Male/female		1/22	1/23
Mean age, yr		64.9 (4.4)	64.0 (4.7)
VAS I – at rest		36.3 (22.8)	43.4 (21.9)
VAS II – on exertion		61.3 (17.7)	55.4 (19.9)
VAS III – patient's assessment		53.1 (19.0)	56.4 (17.2)
VAS IV – physician's assessment		55.4 (17.5)	57.0 (17.3)
Hand grip strength, right side	1	19.8 (7.3)	16.2 (6.6)
	2	18.4 (7.4)	15.6 (6.7)
	3	19.4 (7.5)	15.9 (7.1)
	Mean of 1–3	19.2 (7.3)	15.9 (6.5)
Hand grip strength, left side	1	19.2 (7.8)	16.1 (5.5)
	2	19.8 (7.6)	16.9 (6.0)
	3	20.3 (7.4)	17.0 (6.5)
	Mean of 1–3	19.8 (7.5)	16.7 (5.7)
	1	19.2 (7.8)	16.1 (5.5)
Swollen joint count, right side		3.7 (2.5)	2.6 (1.6)
Tender joint count, right side		2.9 (2.6)	2.9 (2.5)
Morning joint stiffness, right side		11.7 (9.3)	15.2 (7.3)
Swollen joint count, left side		3.3 (2.2)	1.8 (1.3)
Tender joint count, left side		2.6 (2.3)	2.4 (3.1)
Morning joint stiffness, left side		11.7 (9.3)	16.0 (23.3)
EQ-5D		0.6925 (0.2012)	0.6645 (0.2346)
EQ-5D VAS		54.8 (23.4)	44.3 (19.1)
HAQ		0.489 (0.543)	0.740 (0.610)

VAS = Visual Analogue Scale, HAQ = Health Assessment Questionnaire

Table 2. Tabulated summary of assessment measures: VAS I–IV, hand grip strength, number of swollen and tender joints, morning joint stiffness, EQ-5D, EQ5D VAS, and HAQ

		1st assessment pre-treatment		2nd assessment after treatment at week 3		3rd assessment at week 16	
		Group 1 (n=23)	**Group 2 (n=24)**	**Group 1 (n=23)**	**Group 2 (n=24)**	**Group 1 (n=23)**	**Group 2 (n=24)**
VAS I		36.35 ± 22.77	43.38 ± 21.92	20.78 ± 15.92 (*P* = 0.006)	25.33 ± 20.91 (*P* = 0.002)	19.09 ± 17.11 (*P* = 0.001)	29.63 ± 20.18 (*P* = 0.013)
VAS II		61.26 ± 17.70	55.42 ± 19.89	42.74 ± 20.64 (*P* = 0.001)	44.75 ± 24.65	35.13 ± 20.11 (*P* < 0.001)	43.79 ± 21.05 (*P* = 0.021)
VAS III		53.09 ± 18.97	56.42 ± 17.17	38.57 ± 16.90 (*P* = 0.013)	41.88 ± 22.11 (*P* = 0.006)	35.17 ± 17.52 (*P* < 0.001)	40.92 ± 21.57 (*P* < 0.001)
VAS IV		55.39 ± 17.49	57.00 ± 17.33	36.74 ± 12.49 (*P* < 0.001)	44.29 ± 17.17 (*P* = 0.001)	31.17 ± 13.70 (*P* < 0.001)	43.79 ± 16.18 (*P* < 0.001)
Hand grip strength, right side	1	19.78 ± 7.30	16.21 ± 6.56	20.22 ± 7.53	17.17 ± 7.01	19.96 ± 8.14	18.58 ± 5.33
	2	18.43 ± 7.41	15.58 ± 6.68	19.35 ± 7.80	16.88 ± 5.96	18.57 ± 8.05	17.83 ± 6.44
	3	19.43 ± 7.51	15.88 ± 7.06	19.74 ± 7.34	17.42 ± 5.56	19.30 ± 7.65	17.88 ± 5.72 (*P* = 0.025)
	mean	19.22 ± 7.26	15.89 ± 6.51	19.77 ± 7.47	17.15 ± 6.04	19.28 ± 7.81	18.10 ± 5.70 (*P* = 0.022)
Hand grip strength, left side	1	19.17 ± 7.82	16.08 ± 5.46	20.83 ± 7.06 (*P* = 0.025)	17.21 ± 5.52	19.26 ± 7.26	17.13 ± 5.66
	2	19.83 ± 7.62	16.88 ± 5.97	20.39 ± 7.00	17.96 ± 5.32	19.74 ± 7.89	18.00 ± 5.58
	3	20.35 ± 7.36	17.04 ± 6.52	21.13 ± 6.00	18.33 ± 5.77	20.52 ± 6.64	17.58 ± 4.96
	mean	19.78 ± 7.48	16.67 ± 5.66	20.78 ± 6.55	17.83 ± 5.33	19.84 ± 7.13	17.57 ± 5.26
Swollen joint count, right side		3.70 ± 2.53	2.63 ± 1.64	1.96 ± 1.52 (*P* = 0.001)	1.17 ± 1.27 (*P* < 0.001)	1.26 ± 1.21 (*P* < 0.001)	1.88 ± 1.70 (*P* = 0.021)
Tender joint count, right side		2.91 ± 2.61	2.88 ± 2.51	0.83 ± 1.47 (*P* < 0.001)	1.17 ± 1.34 (*P* < 0.001)	0.48 ± 0.95 (*P* < 0.001)	1.38 ± 2.16 (*P* = 0.002)
Morning joint stiffness, right side		11.65 ± 9.32	15.17 ± 23.54	9.39 ± 17.33	8.21 ± 9.42	3.83 ± 6.67 (*P* < 0.001)	5.58 ± 7.49
Swollen joint count, left side		3.26 ± 2.24	1.79 ± 1.28	1.43 ± 1.38 (*P* < 0.001)	0.67 ± 0.96 (*P* < 0.001)	1.04 ± 1.33 (*P* < 0.001)	1.08 ± 1.25 (*P* = 0.004)
Tender joint count, left side		2.57 ± 2.31	2.38 ± 3.08	0.61 ± 1.12 (*P* = 0.003)	1.08 ± 1.74 (*P* = 0.020)	0.43 ± 0.84 (*P* < 0.001)	0.96 ± 1.43 (*P* = 0.009)
Morning joint stiffness, left side		11.65 ± 9.32	16.00 ± 23.33	9.39 ± 17.33	8.21 ± 9.42	3.83 ± 6.67 (*P* < 0.001)	5.58 ± 7.49
EQ-5D		0.687 ± 0.150	0.665 ± 0.154	0.722 ± 0.150	0.709 ± 0.135	0.722 ± 0.198	0.716 ± 0.136
EQ-5D VAS		54.78 ± 23.39	44.29 ± 19.07	58.13 ± 16.33	58.96 ± 21.01 (*P* = 0.002)	62.96 ± 18.19	57.79 ± 21.96 (*P* = 0.021)
HAQ		0.489 ± 0.543	0.740 ± 0.610	0.440 ± 0.484	0.542 ± 0.467 (*P* = 0.003)	0.391 ± 0.509	0.542 ± 0.461 (*P* = 0.015)

P value were calculated using paired samples *t*-test and Wilcoxon test within groups. Significance value is 0.025 corrected by Bonferroni correction.
Numbers in bold indicate significance
VAS = Visual Analogue Scale, HAQ = Health Assessment Questionnaire

warm therapy effect. The biological response to heat (analgesic effect, hyperemia, decreased muscle tone, fibrinolytic and anti-inflammatory effect) is essential in the treatment of osteoarthritis. Beta-endorphin may also play a role in the analgesic effect [11]. In vitro studies have shown that the chemical components of mud pass through the skin [12].

However, when considering the differences between the two groups, three parameters showed a better long-term improvement in the group with direct mud therapy compared to the nylon glove-mud group, suggesting that in addition to its physical effect the mud also exerts a chemical effect (nevertheless, the difference between the two groups was very small). The possible reason for the less than expected difference between the two groups is that with knee packs the mud-covered surface is larger than with hand packs. Fioravanti et al. [13] randomized 60 patients with hand osteoarthritis into two groups. In addition to mud packs, one group received thermal water baths for 12 days while the other group received care (exercise therapy, medications) in an outpatient setting. In the group treated with balneotherapy, a significant improvement was seen in

Table 3. Mean differences of groups

		Mean differencies between 2nd and 1st assessment				Mean differencies between 3rd and 1st assessment			
		Group 1 (n=23)	**Group 2 (n=24)**	**Effect size**	***P***	**Group 1 (n=23)**	**Group 2 (n=24)**	**Effect size**	***P***
VAS I		15.56 ± 24.82	18.04 ± 25.86	0.017	0.739	17.26 ± 20.93	13.75 ± 24.99	0.228	0.605
VAS II		18.52 ± 23.22	10.67 ± 22.25	-0.398	0.243	26.13 ± 22.66	11.63 ± 23.08	-0.730	0.035
VAS III		14.52 ± 25.92	14.54 ± 23.67	0.017	0.998	17.91 ± 18.45	15.50 ± 16.99	-0.112	0.643
VAS IV		18.65 ± 19.96	12.71 ± 15.94	-0.409	0.264	24.22 ± 16.25	13.21 ± 12.69	-0.748	0.013
Hand grip strength, right side	1	-0.435 ± 3.641	-0.958 ± 6.011	-0.095	0.721	-0.174 ± 4.428	-0.38 ± 5.56	-0.314	0.141
	2	-0.913 ± 3.515	-1.29 ± 4.66	-0.048	0.755	-0.130 ± 3.60	-2.25 ± 4.74	-0.303	0.092
	3	-0.304 ± 4.405	-0.54 ± 5.15	-0.130	0.630	0.130 ± 3.109	-2.00 ± 4.10	-0.277	0.051
	mean	-0.551 ± 3.34	-1.26 ± 4.70	-0.097	0.553	-0.058 ± 3.408	-2.21 ± 4.39	-0.310	0.068
Hand grip strength, left side	1	-1.65 ± 3.30	-1.12 ± 3.74	0.013	0.612	-0.087 ± 3.741	-1.04 ± 3.78	-0.132	0.389
	2	-0.565 ± 3.95	-1.08 ± 5.17	-0.040	0.702	0.087 ± 2.661	-1.12 ± 5.38	-0.177	0.336
	3	-0.783 ± 4.33	-1.29 ± 4.97	-0.001	0.710	-0.174 ± 3.312	-0.542 ± 4.403	0.027	0.749
	mean	-0.00 ± 3.60	-1.17 ± 4.16	0.025	0.884	-0,058 ± 2.774	-0.903 ± 3.725	-0.107	0.384
Swollen joint count, right side		1.74 ± 2.16	1.46 ± 1.50	0.061	0.606	2.44 ± 2.39	0.750 ± 1.482	-0.923	0.006
Tender joint count, right side		2.09 ± 2.35	1.71 ± 1.85	-0.254	0.542	2.44 ± 2.57	1.50 ± 2.04	-0.547	0.174
Morning joint stiffness, right side		2.26 ± 14.89	6.96 ± 19.07	0.280	0.353	7.83 ± 8.37	9.58 ± 23.33	-0.051	0.735
Swollen joint count, left side		1.83 ± 1.85	1.12 ± 1.04	–0.169	0.114	2.22 ± 2.07	0.708 ± 1.083	-0.841	0.004
Tender joint count, left side		1.74 ± 2.47	0.917 ± 1.792	–0.389	0.107	2.13 ± 2.28	1.12 ± 1.92	-0.519	0.108
Morning joint stiffness, left side		2.26 ± 14.89	7.79 ± 18.96	0.328	0.273	7.83 ± 8.37	10.42 ± 23.33	-0.004	0.618
EQ-5D		-0.035 ± 0.141	-0.044 ± 0.117	-0.053	0.800	-0.035 ± 0.164	-0.050 ± 0.136	-0.109	0.469
EQ-5D VAS		-3.35 ± 20.12	-14.67 ± 20.19	-0.537	0.061	-8.17 ± 23.17	-13.50 ± 26.62	-0.237	0.469
HAQ		0.049 ± 0.281	0.198 ± 0.290	0.220	0.081	0.98 ± 0.359	0.198 ± 0.386	0.123	0.351

Independent samples *t*-test and Mann-Whitney test.
Effect size for mean differences of groups within pre-post assessments (Klauer, 2001)
Numbers in bold indicate significance
VAS = Visual Analogue Scale, HAQ = Health Assessment Questionnaire

all parameters for at least 3 months. A significant difference was observed between the two groups immediately after the treatment and for an additional 3 months (in some parameters even for 6 months). A favorable effect of hand mud therapy was observed by Codish and co-authors [14] in patients with rheumatoid arthritis. Reviewing the literature on mud therapy, we concluded that in most cases treatment was applied to the knee joint. Tefner and colleagues [15] compared mud with a glycerol-containing colored cream warmed to the same temperature administered to patients with knee osteoarthritis and objectively proved that mud therapy is more beneficial. Flusser et al. [16] treated 58 patients with knee osteoarthritis on 15 occasions for 3 weeks at home. One group received mud and the other group received mineral-depleted mud. At the end of treatment and during the follow-up period, only the mud-treated group showed a significant decrease in pain.

In a double-blind study, Abu-Shakra and colleagues [17] evaluated the efficacy of a real mud pack applied to the backs of patients with chronic lower back pain and compared the treatment with a mineral-depleted mud pack. They observed a significant decrease in intensity of pain only in the group treated with real mud, and the improvement persisted for 1 month.

Heat alone helps reduce muscle stiffness and increases the extensibility of tissues rich in collagen (e.g., tendons, fascia, joint capsules). Stimulation of heat receptors exerts its effect via the cutaneous visceral reflex pathway. Application of hot mud packs decreases the level of circulating prostaglandin E2, leukotriene B4, interleukin-1-beta, and tumor necrosis factor-alpha [18]. The anti-inflammatory and chondroprotective effects of mud were studied in rats with zymosan-induced arthritis. After 20 days, hyperplasia, cell infiltration and vascularization decreased while chondrocyte density, collagen and proteoglycan content increased in the mud-treated animals [19]. In a study by Güngen et al. [20] comparing mud therapy with heat packs, YKL-40 levels indicating cartilage degradation increased only in the heat pack-treated group along with clinical improvement 3 months after treatment. In another mud study, only the mud-treated group showed a significant and long-term decrease in interleukin-6 (IL-6) and insulin-like growth factor (IGF) levels in addition to the reduction of

pain and improvement in physical function, and these changes were significantly greater than in the control group [21]. After application of the mud pack, increased blood circulation was observed with a laser Doppler flowmeter, which lasted longer than the temperature increase [22]. A few publications have addressed the absorption of substances in the mud. An in vitro study confirmed that fulvic acid, ulmic acid and humic acid (water-soluble mud components) pass through the skin and enhance smooth muscle contractility via alpha-2 adrenergic and D2 dopamine receptors [23]. Reviewing 20 publications, Espejo and colleagues [24] found that mud therapy reduced pain in 17 cases and improved physical function and quality of life in 12 and 5 cases, respectively; however, due to methodological errors, further studies are required. Based on the most recent Osteoarthritis Research Society International (OARSI) guidelines, balneotherapy (including mud therapy) is a recommended treatment for knee osteoarthritis with co-morbidities at the same evidence level as biomechanical interventions, intra-articular corticosteroids, oral cyclooxygenase-2 (COX-2) inhibitors, selective non-steroidal anti-inflammatory drugs (NSAIDs), and duloxetine [25].

LIMITATION OF THE STUDY

An increase in the number of cases may have resulted in more significant differences between the two groups. The patients' knowledge of the effects of heat therapy could have added to the observed improvement in both groups. At the time of our examination, hand function tests such as the Functional Index for Hand Osteoarthritis (FIHOA) index or the Australian Canadian Osteoarthritis Hand Index (AUSCAN) index translated into Hungarian were not available in Hungary, which is why we applied the Health Assessment Questionnaire (HAQ). The examined patients were mostly women (95.7%). The absence of serious hand osteoarthritis cases was a further limitation. Additional studies involving more patients are required for the evaluation of the chemical effect of the mud.

CONCLUSION

In our human study, heat mud therapy significantly improved the subjective and objective parameters mainly in female patients with mild-to-moderate hand osteoarthritis and had a beneficial effect on the patients' quality of life.

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References

1. Haugen IK, Englund M, Aliabadi P, et al. Prevalence, incidence and progression of hand osteoarthritis in the general population: the Framingham Osteoarthritis Study. *Ann Rheum Dis* 2011; 70 (9): 1581-6.
2. Mahendira D, Towheed TE. Systematic review of non-surgical therapies for osteoarthritis of the hand: an update. *Osteoarthritis Cartilage* 2009; 17 (10): 1263-8.
3. Valdes K, Marik T. A systematic review of conservative interventions for osteoarthritis of the hand. *J Hand Ther* 2010; 23 (4): 334-50.
4. Kovács C, Pecze M, Tihanyi Á, et al. The effect of sulphurous water in patients with osteoarthritis of hand. Double-blind, randomized, controlled follow-up study. *Clin Rheumatol* 2012; 31 (10): 1437-42.
5. Horváth K, Kulisch Á, Németh A, et al. Evaluation of the effect of balneotherapy in patients with osteoarthritis of the hands: a randomized controlled single-blind follow-up study. *Clin Rehabil* 2012; 26 (5): 431-41.
6. Odabasi E, Turan M, Erdem H, et al. Does mud pack treatment have any chemical effect? A randomized controlled clinical study. *J Altern Complement Med* 2008; 14 (5): 559-65.
7. Altman R, Alarcón G, Appelrough D, et al. The American College of Rheumatology criteria for the classification and reporting of osteoarthritis of the hand. *Arthritis Rheum* 1990; 33 (11): 1601-10.
8. Rojkovich B, Poór Gy, Korda J. Multicenter study of the possible reproduction of EULAR joint index in rheumatoid arthritis. *Hungarian Rheumatology* 1997; 38: 206-12.
9. Baji P, Brodszky V, Rencz F, et al. Health state of the Hungarian population between 2000-2010. *Orv Hetil* 2015; 156: 2035-44.
10. Kulisch A, Benkő A, Bergmann A, et al. Evaluation of the effect of Lake Hévíz thermal mineral water in patients with osteoarthritis of the knee: a randomized, controlled, single-blind, follow-up study. *Eur J Phys Rehabil Med* 2014; 50 (4): 373-81.
11. Cozzi F, Lazzarin I, Todesco S, et al. Hypothalamic pituary-adrenal axis dysregulation in healthy subjects undergoing mud-bath-applications. *Arthritis Rheum* 1995; 38 (5): 724-6.
12. Tateo F, Ravaglioli A, Andreoli C, et al. The in-vitro percutaneous migration of chemical elements from a thermal mud for healing use. *Appl Clay Sci* 2009; 44 (1-2): 83-94.
13. Fioravanti A, Tenti S, Giannitti C, et al. Short- and long-term effects of mud-bath treatment on hand osteoarthritis: a randomized clinical trial. *Int J Biometeorol* 2014; 58 (1): 79-86.
14. Codish S, Abu-Shakra M, Flusser D, et al. Mud compress therapy for the hands of patients with rheumatoid arthritis. *Rheumatol Int* 2005; 25 (1): 49-54.
15. Tefner IK, Gaál R, Koroknai A, et al. The effect of Neydharting mud-pack therapy on knee osteoarthritis: a randomized, controlled, double-blind follow-up pilot study. *Rheumatol Int* 2013; 33 (10): 2569-76.
16. Flusser D, Abu-Shakra M, Friger M, et al. Therapy with mud compresses for knee osteoarthritis: comparison of natural mud preparations with mineral-depleted mud. *J Clin Rheumatol* 2002; 8 (4): 197-203.
17. Abu-Shakra M, Mayer A, Friger M, et al. Dead Sea mud packs for chronic low back pain. *IMAJ* 2014; 16 (9): 574-7.
18. Bellometti S, Galzigna L. Serum levels of a prostaglandin and a leukotriene after thermal mud pack therapy. *J Investig Med* 1998; 46 (4): 140-5.
19. Britschka ZM, Teodor WR, Velosa AP, et al. The efficacy of Brazilian black mud treatment in chronic experimental arthritis. *Rheumatol Int* 2007; 28 (1): 39-45.
20. Güngen G, Ardic F, Fındıkoğlu G, et al. The effect of mud pack therapy on serum YKL-40 and hsCRP levels in patients with knee osteoarthritis. *Rheumatol Int* 2012; 32 (5): 1235-44.
21. Sarsan A, Akkaya N, Ozgen M, et al. Comparing the efficacy of mature mud pack and hot pack treatments for knee osteoarthritis. *J Back Musculoskelet Rehabil* 2012; 25 (3): 193-9.
22. Poensin D, Carpentier PH, Féchoz C, et al. Effects of mud pack treatment on skin microcirculation. *Joint Bone Spine* 2003; 70 (5): 367-70.
23. Beer AM, Junginger HE, Lukanov J, et al. Evaluation of the permeation of peat substances through human skin in vitro. *Int J Pharm* 2003; 6;253 (1-2): 169-75.
24. Espejo-Antúnez L, Cardero-Durán MA, Garrido-Ardila EM, et al. Clinical effectiveness of mud pack therapy in knee osteoarthritis. *Rheumatology (Oxf)* 2013; 52 (4): 659-68.
25. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. *Osteoarthr Cartilage* 2014; 22 (3): 363-88.