Comparison of the effectiveness of peloid and paraffin treatment for symptomatic hand osteoarthritis in women: a single-blind randomized controlled study

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Abstract

Although peloid and paraffin treatments may have a positive effect in the short term on pain, functional status, hand grip strength, and quality of life in patients with hand osteoarthritis (HOA), there are no comprehensive and comparative studies of these therapies for HOA. The aim of our study was to evaluate the short-term effects of peloid and paraffin treatments in symptomatic HOA patients. Eighty female patients diagnosed with HOA were randomly divided into two equal groups: peloid group (peloid therapy and home exercise) and paraffin group (paraffin therapy and home exercise). Peloid and paraffin applications were performed over 3 weeks for a total of 15 sessions. Patients were evaluated with visual analog scale (VAS)-rest, -activity, and -handgrip for pain, Jamar hand dynamometer for grip strength, Australian/Canadian (AUSCAN) Osteoarthritis Hand Index for function, health assessment questionnaire (HAQ) for physical activity, Beck depression inventory (BDI) for depression, and short form-36 (SF-36) for quality of life. Evaluations were performed before treatment, in the 3rd week, and 1 month after treatment. For all parameters except SF-36, statistically significant improvements were observed in short-term evaluations compared to the baseline in both groups (p = .000). Reductions in HAQ scores in the 3rd week and 1st month (p = .001 and p = .003), and the decrease in BDI scores in the 3rd week (p = .005) was statistically significantly higher in the peloid group. Improvements in some subparameters of the SF-36 were statistically significant in favor of the peloid group. In female patients with HOA, both groups experienced similar positive effects on pain, functional status, and hand grip strength for up to one month, but the peloid group was found to be superior in the short term in terms of physical activity and some quality of life parameters. Peloid therapy can be preferred as a natural and reliable method for symptomatic HOA.

Keywords Exercise therapy · Hand osteoarthritis · Mud therapy · Pain · Paraffin therapy

Introduction

Hand osteoarthritis (HOA) is a very common situation progressing with pain in the hand joints, stiffness, reduced grip and squeeze strength, functional limitations, and reduced quality of life. It is frequently observed in middle-aged women, with a peak incidence in 50-year-old women. The etiology is multifactorial. The etiology includes abnormal mechanical loading and genetic factors and the place of inflammation in the pathogenesis is debatable. It may be classified radiographically and symptomatically (Marshall et al. 2018). Symptomatic HOA frequently involves more than one joint. The most commonly affected joints are the distal interphalangeal joints (DIP) and first carpometacarpal joint (CMC), respectively (Ouellette and Makowski 2006).

HOA treatment using pharmacological and non-pharmacological approaches was shown to reduce pain, increase...
grip and squeeze strength, and improve functional status and quality of life (Kolasinski et al. 2020). The 2018 European League Against Rheumatism (EULAR) HOA treatment guide stated that topical treatments are recommended as priority for systemic pharmacological treatments because of safety reasons (Kloppenburg et al. 2019). Topical NSAIDs were recommended as first-choice pharmacological topical therapy. It was emphasized that NSAIDs, due to their possible side effects especially, should be used carefully in a limited time to relieve symptoms. While positive effects of chondroitin sulfate were reported for pain reduction and functional improvement, there is no evidence yet for the efficacy of other symptomatic slow-acting drugs for osteoarthritis (SYSADOA) including avocado/soybean unsaponifiables, diacerein, and intra-articular hyaluronic acid (Kloppenburg et al. 2019; Kroon et al. 2018). Intra-articular steroid injection may be considered for painful interphalangeal joints with signs of inflammation. Patient education, joint protection methods, and exercise can be recommended by evaluating each patient. In addition, the use of thumb base orthosis is recommended, and long-term (>3 months) use should be advocated (Kloppenburg et al. 2019). Additionally, therapeutic heat applications, cognitive behavioral therapy, acupuncture, kinesiotaping, and paraffin applications are conditionally recommended as non-pharmacological modalities included in the 2019 HOA treatment management guidelines from the American College of Rheumatology (ACR) (Kolasinski et al. 2020). In a recent systematic review, besides the EULAR and ACR recommendations, the positive symptomatic effects of manual therapy, balneotherapy (mud therapy or thermomineral bath), low-intensity laser therapy, and magnetotherapy were also mentioned (Kroon et al. 2018).

A Cochrane review assessing the effect of exercise on HOA stated that stretching, strengthening exercises, isometric, and isotonic resistance exercises reduced pain and joint stiffness and provided improvements in function and quality of life (Østerås et al. 2017).

Paraffin therapy is one of the local thermal applications. In vivo studies showed that paraffin applications ensured a 7.5 °C increase in temperature in the joint capsule and 4.5 °C increase in muscle. Hyperemia resulting from relaxation of arteriolar smooth muscle fibers and vasodilatation of peripheral veins with paraffin application causes increases in tissue fluid transudation, increased lymph flow, and absorption of exudates. These mechanisms were correlated with reduced pain, increased hand grip strength, and improved functionality and quality of life in the short term for HOA patients (Dilek et al. 2013; Kasapoğlu Aksoy and Altan 2018; Öncel et al. 2021). Peloid treatment was shown to have similar positive effects in the short term for HOA patients (Kasapoğlu Aksoy et al. 2017; Tenti et al. 2020; Fioravanti et al. 2014). A current systematic review assessing the efficacy of conservative therapeutic approaches to HOA stated that thermal applications with paraffin and medicinal peloids ensured a reduction in joint pain and sensitivity and increased hand grip strength (Beasley et al. 2019). Another review stated that surface thermal applications with paraffin or hot packs applied before exercise reduced HOA symptoms (Kuran 2014). Peloid application for HOA treatment is a natural, cheap, and easily applied method, and includes advantages like the high heat-holding capacity of peloids. In this study, we aimed to determine if there was superiority in terms of short-term efficacy between paraffin and peloid treatments, with proven beneficial effects for HOA treatment.

**Material-method**

**Study design**

A prospective, single-blind, randomized controlled study.

**Participants**

Our study received permission from Necmettin Erbakan University Meram Faculty of Medicine, Non-Drug, and Medical Device Research Ethics Committee dated 09 February 2018 and numbered 2018/1192. The study included 80 female patients attending Konya Education and Research Hospital Physical Medicine and Rehabilitation clinic with complaints of pain in the hand joints, with at least 48 h of pain in at least two joints with palpation or at rest, with VAS-pain score ≥ 4, symptomatic idiopathic (primary) HOA diagnosis according to ACR diagnostic criteria, and aged over 35 years. Patients with communication problems, uncontrolled systemic disease (cardiovascular, pulmonary, hepatic,
renal, hematological, endocrine), OA developing secondary to diseases like rheumatoid arthritis, chondrocalcinosis, and psoriatic arthritis, history of hand surgery, carpal tunnel syndrome, tenosynovitis, De Quervain tenosynovitis, Dupuytren contracture, OA developing linked to previous fracture, open wound or scar in the hand-wrist region, collagen tissue disease, peripheral vascular disease, peripheral neuropathy history, sensory defects in the hand, cognitive inadequacy to a degree preventing adherence to the treatment program to be applied with advanced age, pregnancy, malignant disease, history of interventional intraarticular injection treatment to hand joints within the last 6 months, physiotherapy, paraffin or peloid therapy within the last 6 months, allergy to peloidotherapy, noncompliance to home exercise program, and major psychiatric disease were excluded from the study. All patients were informed about the study, and informed volunteer consent forms were obtained from patients.

**Randomization**

Patients were randomized based on simple randomization using the coin flip method into 2 equal groups. The 1st group underwent peloid therapy and an exercise program, while the 2nd group underwent paraffin therapy and an exercise program. Patients had hand grip strength measured with a Jamar hand dynamometer, pain severity measured with VAS at rest, during activity and when squeezing the hand, functional assessment with AUSCAN, mood assessed with BDI, physical activity assessed with HAQ, and quality of life assessed with SF-36 before treatment, in the 3rd week at the end of treatment and 1 month after treatment ended. As the patients could not be blinded due to the nature of the study, assessments were performed by a physician (BA) blind to the study groups to avoid potential bias. The other physician (HY) determined the treatment groups and observed possible side effects like skin irritation, itching, and heat intolerance during the treatment process.

**Intervention**

The first group \((n = 40)\) was given peloid therapy and a home exercise program. Peloid therapy was applied with 47 °C temperature, 1–2-cm thickness on the dorsal and palmar faces of both hands on 5 days per week for 3 weeks, a total of 15 sessions, with 20 min/day duration. Stretch film and then a towel were used to wrap the hands during the sessions. At the end of treatment, the peloid was cleaned by scraping off, and then the hands were washed and dried. The medical peloid was obtained from Köyceğiz in Muğla province and is rich in humic acid, organic, and inorganic material (Karaarslan et al. 2021).

The second group \((n = 40)\) was given paraffin therapy and the same home exercise program. Paraffin therapy was applied with the same number and duration of sessions at the same temperature as peloid therapy. The patient’s hands were dipped in paraffin 10 times with fingers extended and wrists in a neutral position. The hands were then wrapped in a nylon bag followed by a towel and left for 20 min. Then, the paraffin was stripped from the hands and removed.

The exercise program given to both groups included 2 sessions per day with 10 repeats of finger stretching, finger spreading, extending fingers and moving from right to left, making big fists and small fists, stretching and relaxing all fingers in extension while fingers are open on a table, and making the ok sign. These exercises were shown practically by the physician (BA) before the treatment and a printed paper describing the exercises visually was given to all patients. General recommendations were made about protecting the joints.

The patients were instructed not to take analgesics or other treatment apart from the recommended exercises and the treatment given. Also, particular attention was paid to the fact that they were not to take any analgesics for 24–48 h before the evaluations.

**Assessment parameters**

**Hand grip strength** For assessment of hand grip strength, a Jamar dynamometer (Jamar® Plus+Digital Hand Dynamometer from Patterson Medical by Sammons Preston) was used (Schmidt and Toews 1970). This measurement was evaluated to have high validity and reliability for assessing grip strength (Mathiowetz et al. 1984). Measurements were taken in sitting position, with shoulders in adduction, elbows at 90° flexion, and forearm in a position between supination and pronation with the handle position at 2nd and 3rd level. Patients were told using similar words and tone to grip the dynamometer with all their fingers in extension while fingers are open on a table, and the same home exercise program. Paraffin therapy was applied with the same number and duration of sessions at the same temperature as peloid therapy. The patient’s hands were dipped in paraffin 10 times with fingers extended and wrists in a neutral position. The hands were then wrapped in a nylon bag followed by a towel and left for 20 min. Then, the paraffin was stripped from the hands and removed.

The exercise program given to both groups included 2 sessions per day with 10 repeats of finger stretching, finger spreading, extending fingers and moving from right to left, making big fists and small fists, stretching and relaxing all fingers in extension while fingers are open on a table, and making the ok sign. These exercises were shown practically by the physician (BA) before the treatment and a printed paper describing the exercises visually was given to all patients. General recommendations were made about protecting the joints.

The patients were instructed not to take analgesics or other treatment apart from the recommended exercises and the treatment given. Also, particular attention was paid to the fact that they were not to take any analgesics for 24–48 h before the evaluations.

**Visual analog scale** Pain levels of patients were assessed with a horizontal 10 cm line with marks at 1 cm intervals. Pain levels were 0 = no pain to 10 = most severe pain, with values expressed numerically (Price et al. 1983).

**Australian/Canadian Osteoarthritis Hand Index** This scale assesses the functional status of HOA. This was assessed under 3 headings of pain (5 items), stiffness (1 item), and difficulties when performing daily living activities (9 items). Patients are asked to choose one of 5 responses (none, mild, moderate severity, severe, very severe (0–4)) for 15 items comprising assessments of pain, stiffness, and movement difficulties felt within the last 48 h. The reliability and validity studies of the AUSCAN index were performed (Allen et al. 2007).
Health Assessment Questionnaire This is an effective, sensitive, and valuable measurement tool to assess physical activity. It is used especially for adult arthritis patients. It comprises 20 questions related to a total of 8 activities. These activities include dressing, rising, eating, walking, hygiene, reach, grip, and activities of daily living. Each activity has points from 0–3. The survey questions the last 1 week. Total points are calculated as the mean points in 8 categories from 0 to 3 points (Bruce and Fries 2003; Kasapoğlu Aksoy et al 2017).

Beck Depression Inventory This scale assesses the presence and severity of depression. The scale comprises 21 items with points from 0 to 3 for each item. High points indicate more severe depression. The validity and reliability of BDI in the Turkish population were demonstrated by Hisli (1988).

Short Form-36 This scale assesses quality of life. It comprises 36 questions in eight subscales of physical function, physical role restriction, emotional role restriction, body pain, social function, mental health, vitality, and general health. Points are from 0 (worst health status) to 100 (best health status). It assesses the last 4 weeks (Ware and Sherbourne 1992). Turkish validity and reliability studies were performed (Koçyiğit et al. 1999).

Statistical analysis
Statistical analyses were performed within the scope of this study using the IBM SPSS 25 program (Armonk, NY, USA). The fit of variables to normal distribution was investigated using analytical methods (Kolmogorov Smirnov and Shapiro Wilk). Results showed that normal distribution assumptions were not met; for this reason, in-group analyses used the Wilcoxon test, while inter-group analyses used the Mann–Whitney U test. With the aim of identifying the degree of efficacy of each treatment application, Cohen’s effect size was calculated and reported. Additionally, variation indexes were calculated with the aim of identifying which treatment application was more effective. Statistical significance was accepted with a p value less than 0.05.

Results
A total of 118 consecutive HOA patients were assessed for participation in the study. As 38 patients did not abide by the inclusion/exclusion criteria or rejected participation, the study included a total of 80 female patients from 28th January 2019 to 29th December 2020. In our study, all patients in the peloid therapy group completed the study. In the paraffin group, 2 patients left the study due to COVID-19 infection and 4 patients left treatment unfinished due to fear of COVID-19 transmission, so the study was completed with 34 patients. These treatment applications were compared between themselves (Fig. 1).

There were no statistically significant differences between the patients receiving paraffin and peloid therapy in terms of age, body mass index, educational status, marital status, family type, employment status, and smoking (p < 0.05) (Table 1).

In-group comparisons of the VAS-rest, VAS-activity, VAS-hand grip, right-hand grip strength, left-hand grip strength, AUSCAN-pain, AUSCAN-stiffness, AUSCAN-function, HAQ, and BDI assessments observed statistically significant improvements compared to baseline in both the peloid and paraffin group at the end of the 3rd week of treatment and during 1st month assessment (p = 0.000) (Table 2). Comparisons between groups observed the reductions in the HAQ scores in the 3rd week and 1st month assessments were statistically significantly higher in the peloid group (p = 0.001 and p = 0.003). Comparisons between groups found that the reduction in BDI scores in the 3rd week was statistically significantly higher in the peloid group (p = 0.005). For all other assessments, comparisons between groups in the 3rd week and 1st month were not statistically significant (p > 0.05) (Table 2).

The quality of life assessment with the SF-36 scale in the peloid group observed statistically significant improvements in all subparameters in the 3rd week compared to baseline (p < 0.05). On 1st month assessment compared to baseline, for all subparameters apart from SF36-VE and SF36-SF, there were statistically significant improvements observed (p < 0.05). In the paraffin group, 3rd week and 1st month assessments observed statistically significant improvements for all subparameters compared to baseline, apart from SF36-PR, SF36-GH, and SF36-ER (p < 0.05). Comparisons between the groups found statistically significantly higher improvements for all subparameters apart from SF36-GH, and SF36-MH in the peloid group during the 3rd week assessment (p < 0.05). Comparison between the groups for the 1st month assessment found statistically significantly higher improvement in the peloid group compared to the paraffin group only for the SF36-PF subparameter (p = 0.009) (Table 3).

No side effects developed during treatment applications in both groups.

Discussion
In this single-blind controlled study, we aimed to assess the short-term effects of both peloid and paraffin treatments performed along with home exercises on pain, hand grip strength, function, quality of life, physical activity, and depression. In our study, positive effects were observed until the 1st month for pain, hand grip strength, function, and joint stiffness in both the peloid
and paraffin groups. However, statistically significantly better results were obtained for improvements in the peloid group compared to the paraffin group on assessments with HAQ and SF36-PF until the 1st month and for the BDI, SF36-PR, SF36-BP, SF36-VE, SF36-SF, and SF36-ER parameters until the 3rd week ($p < 0.05$).

Home exercise was shown to have positive effects on symptomatic improvement in HOA patients. A randomized controlled study assessing the effect of home exercise on female patients with HOA divided 80 women into two randomized equal groups. One group was given patient education, while the other group was given patient education along with a home exercise program. Patients were assessed before treatment and 3 months after starting exercise. The exercise group was found to be statistically significantly superior for activity performance, increase in hand grip strength, and decrease in pain (Hennig et al. 2015). In another 3-month follow-up study comparing patient education along with joint protection and home exercise with patient education alone, all follow-ups were completed by a single ergotherapist blind to the groups. Exercises were performed daily with each exercise repeated ten times. Assessments were performed with the HAQ, VAS-pain, global function assessment, and grip strength assessment. In the exercise group, 3rd month assessment observed increases in grip strength and improvements in global hand function (Stamm et al. 2002). In our study, both groups were given home exercises and the grip strength increase, pain reduction, and functional

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**Fig. 1** Flow diagram of the study population

| Enrollment | Assessed for eligibility (n=118) |
|------------|----------------------------------|
|            | Excluded (n=38)                  |
|            | - Did not meet inclusion criteria (n=22) |
|            | - Declined to participate (n=9) |
|            | - Other reasons (n=7) |
|            | Randomized (n=80)                |

| Allocation | Peloid therapy + Home exercise (Peloid group) (n=40) |
|------------|------------------------------------------------------|
|            | Paraffin therapy + Home exercise (Paraffin group) (n=40) |

| Follow-Up | Lost to follow-up (n=0) |
|-----------|-------------------------|
|           | - Could not continue study due to COVID-19 infection (n=2) |
|           | - Could not continue the study of fear of COVID-19 infection (n=4) |

| Analysis | Analyzed (n=40) |
|----------|----------------|
|          | Analyzed (n=34) |
Improvements in both groups were similar to the results of previous studies.

Thermal applications were shown to reduce pain and stiffness and increase joint mobility in patients with osteoarthritis. These effects were shown to be provided by increasing circulation in the affected region and by relaxation of muscles with the heat applied (Brosseau et al. 2003). A current review stated the positive impacts of heat applications in paraffin wax, balneotherapy, or peloid therapy for conservative treatment of HOA (Poletto et al. 2021).

There are studies showing that local heat application with paraffin wax provided reductions in pain and increases in muscle strength during HOA treatment. A single-blind randomized controlled study including 56 patients with HOA diagnosis who met the study criteria applied paraffin wax treatment to one group (n = 29) with the other group (n = 27) comprising the control group. Both groups were told to take paracetamol as necessary during the study duration. Paraffin application was performed in a similar way to our study. Differently, in each session, wax was left for 15 min. The results of 12-week follow-up observed analgesic effect, reduced joint sensitivity, and increased muscle strength (Dilek et al. 2013). Another single-blind randomized controlled study divided 61 HOA patients into two groups. One group was given paraffin therapy along with home exercise (n = 31), while the other group was only given home exercise (n = 30). The study duration ended after 6 weeks. Home exercise along with paraffin application was found to be statistically significantly superior for pain reduction and improvements in hand grip strength, finger pinch strength, functional status, and quality of life in the short term (Kasapoglu Aksoy and Altan 2018). A current randomized controlled study compared the efficacy of paraffin and fluidotherapy treatments for HOA patients. They observed reductions in pain, increases in hand muscle strength, and improvements in functionality and quality of life in both groups lasting up to three months. There was no superiority identified between the groups (Oncel et al. 2021). A current review stated that paraffin wax therapy applied with interventions like hand exercises, home exercises, or patient education provided statistically significant reductions in pain and functional improvements (Poletto et al. 2021). In our study, paraffin wax along with home exercise reduced pain, increased hand grip strength, improved functional status, and increased quality of life, which is compatible with the results of similar studies and statements in current reviews.

There are studies showing the positive effects of balneotherapy and thermotherapy on pain, function, and quality of life in HOA patients. In the study by Horváth et al., a thermomineral water bath applied at 38 °C provided improvements

| Table 1 Baseline characteristics of the study population |
|------------------------------------------------------|
|                                                       |
| Data are presented as mean ± standard deviation, or n (%) | Mann–Whitney U test and Wilcoxon test were used |
|                                                       |
|                                                       |
| Age, years, years | Peloid group (n = 40) | Paraffin group (n = 34) | p value |
| 57.72 ± 7.03 | 55.15 ± 8.31 | .153 |
| BMI, kg/m² | 30.88 ± 4.96 | 30.54 ± 5.62 | .784 |
| Primary school | 34 (85.0%) | 28 (82.3%) | .807 |
| Junior high school | 3 (7.5%) | 2 (5.9%) | .807 |
| High school | 2 (5.0%) | 3 (8.9%) | .784 |
| University | 1 (2.5%) | 1 (2.9%) | .784 |
| Marital status |                               |
| Married | 32 (80.0%) | 31 (91.2%) | .218 |
| Single | 3 (7.5%) | 0 (0.0%) | .218 |
| Other | 5 (12.5%) | 3 (8.8%) | .218 |
| Family type |                               |
| Nuclear family | 32 (80.0%) | 28 (82.4%) | .807 |
| Extended family | 8 (20.0%) | 6 (17.6%) | .784 |
| Employment status |                               |
| Employed | 2 (5.6%) | 3 (8.8%) | .514 |
| Housewife | 38 (95.0%) | 31 (91.2%) | .807 |
| Smoking status |                               |
| Current smoker | 1 (2.5%) | 2 (5.9%) | .499 |
| Non-smoker | 34 (85.0%) | 30 (88.2%) | .499 |
| Ex-smoker | 5 (12.5%) | 2 (5.9%) | .499 |

BMI: body mass index, n: number of participants
Table 2  Outcome measures for peloid and paraffin groups
d
| Outcome measures | Groups | Baseline | 3 weeks | 1st month | Within-group comparisons | Between-group comparisons |
|------------------|--------|----------|---------|-----------|--------------------------|--------------------------|
|                  |        |          |         |           | Baseline—3 weeks | Baseline—1st month |         |            | Baseline | 3 weeks | 1st month |
|                  |        |          |         |           | z   | p*   | r   | z   | p*   | r   | z   | p** | z   | p** | z   | p** |
| VAS-rest         | Peloid | 7.30±1.38 | 2.08±2.03 | 2.68±2.02 | −5.46 | .000 | .61 | −5.53 | .000 | .62 | −1.06 | .289 | −1.32 | .188 | −.198 | .843 |
|                  | Paraffin | 7.68±1.63 | 2.71±2.17 | 3.21±3.07 | −5.08 | .000 | .62 | −4.86 | .000 | .59 | −1.21 | .226 | −.983 | .326 | −.302 | .762 |
| activity         | Peloid | 7.92±1.33 | 2.58±2.10 | 3.15±2.08 | −5.53 | .000 | .62 | −5.53 | .000 | .62 | −1.02 | .310 | −.868 | .385 | −.253 | .800 |
|                  | Paraffin | 8.21±1.67 | 3.09±2.22 | 3.68±2.88 | −5.09 | .000 | .62 | −4.85 | .000 | .59 | −.374 | .708 | −.358 | .720 | −.423 | .672 |
| VAS-hand         | Peloid | 7.98±1.35 | 2.63±2.10 | 3.20±2.10 | −5.53 | .000 | .62 | −5.54 | .000 | .62 | −.959 | .337 | −.071 | .944 | −.654 | .513 |
|                  | Paraffin | 8.21±1.67 | 3.09±2.22 | 3.68±2.88 | −5.09 | .000 | .62 | −4.85 | .000 | .59 | −.326 | .814 | −.322 | .748 | −.152 | .129 |
| Right grip       | Peloid | 17.14±5.76 | 21.19±5.75 | 20.17±5.62 | −4.85 | .000 | .54 | −4.46 | .000 | .50 | −3.74 | .708 | −.358 | .720 | −.423 | .672 |
| strength         | Paraffin | 17.13±4.87 | 23.62±5.19 | 20.47±5.01 | −4.60 | .000 | .56 | −4.70 | .000 | .57 | −1.23 | .220 | −.374 | .708 | −.456 | .649 |
| Left grip        | Peloid | 15.34±6.10 | 20.27±6.07 | 19.88±6.09 | −5.15 | .000 | .58 | −5.08 | .000 | .57 | −1.23 | .220 | −.374 | .708 | −.456 | .649 |
| strength         | Paraffin | 16.03±4.12 | 19.58±4.94 | 20.04±4.96 | −4.75 | .000 | .58 | −4.58 | .000 | .55 | −.959 | .337 | −.071 | .944 | −.654 | .513 |
| AUSCAN-Peloid    | 16.65±2.62 | 6.67±4.39 | 8.37±4.15 | −5.52 | .000 | .62 | −5.39 | .000 | .60 | −.326 | .814 | −.322 | .748 | −.152 | .129 |
| pain             | Paraffin | 15.94±3.13 | 6.62±4.55 | 7.65±5.13 | −5.02 | .000 | .61 | −4.89 | .000 | .59 | −.959 | .337 | −.071 | .944 | −.654 | .513 |
| AUSCAN-Peloid    | 2.10±0.50 | .70±0.56 | .80±0.56 | −5.45 | .000 | .61 | −5.31 | .000 | .59 | −.236 | .814 | −.322 | .748 | −.152 | .129 |
| stiffness        | Paraffin | 2.00±0.98 | .73±0.86 | 1.12±0.91 | −4.27 | .000 | .52 | −3.95 | .000 | .48 | −.757 | .080 | −.544 | .586 | −.402 | .688 |
| AUSCAN-Peloid    | 22.52±5.09 | 8.70±5.91 | 10.20±5.03 | −5.45 | .000 | .61 | −5.37 | .000 | .60 | −.682 | .495 | −.344 | .003 | −.300 | .003 |
| function         | Paraffin | 20.29±7.49 | 9.70±6.07 | 11.56±8.62 | −4.54 | .000 | .55 | −4.22 | .000 | .51 | −.682 | .495 | −.344 | .003 | −.300 | .003 |
| HAQ              | Peloid | 95.4±10.75 | 33.2±12.9 | 35.5±11.2 | −5.46 | .000 | .61 | −5.35 | .000 | .59 | −.682 | .495 | −.344 | .003 | −.300 | .003 |
| Paraffin | 1.03±1.45 | .61±1.38 | .60±1.40 | −4.20 | .000 | .51 | −4.37 | .000 | .53 | −.682 | .495 | −.344 | .003 | −.300 | .003 |
| BDI              | Peloid | 8.28±5.25 | 4.80±4.51 | 4.87±4.19 | −3.90 | .000 | .44 | −3.49 | .000 | .39 | 2.84 | .004 | 2.78 | .005 | 1.63 | .102 |
| Paraffin | 11.91±6.58 | 8.29±6.73 | 6.88±5.73 | −2.81 | .000 | .34 | −3.62 | .000 | .44 | 2.84 | .004 | 2.78 | .005 | 1.63 | .102 |

r Cohen effect size, p significance value (< .05 statistically significant), p* p values for within-group comparisons were calculated using Wilcoxon test, p ** p values for between-group comparisons were calculated using Mann–Whitney U test, VAS visual analog scale-pain, AUSCAN Australian/Canadian Osteoarthritis Hand Index, HAQ Health Assessment Questionnaire, BDI Beck Depression Inventory

1 All values are presented mean ± standard deviation.
Table 3  Quality of life outcome measures for peloid and paraffin groups†

| Outcome measures | Groups     | Baseline | 3 weeks | 1st month |
|------------------|------------|----------|---------|-----------|
|                  | Baseline—3 weeks | z | p* | r | Baseline—1st month | z | p* | r |
| SF36-PF          | Peloid     | 48.37±18.82 | 75.00±14.79 | 73.12±4.15 | −5.34 | .000 | .56 | −5.02 | .000 | .56 |
|                  | Paraffin   | 43.82±19.15 | 55.29±24.58 | 60.15±22.70 | −2.73 | .006 | .33 | −4.27 | .000 | .52 |
| SF36-PR          | Peloid     | 10.62±26.49 | 72.50±31.42 | 61.87±38.81 | −5.02 | .000 | .56 | −4.70 | .000 | .53 |
|                  | Paraffin   | 22.79±33.35 | 33.09±44.26 | 39.07±43.94 | −1.17 | .240 | .14 | −1.72 | .085 | .21 |
| SF36-BP          | Peloid     | 42.25±16.92 | 70.87±12.20 | 61.44±14.15 | −5.05 | .000 | .56 | −4.53 | .000 | .51 |
|                  | Paraffin   | 32.28±15.12 | 54.78±20.86 | 60.88±21.16 | −3.91 | .000 | .47 | −4.60 | .000 | .56 |
| SF36-GH          | Peloid     | 42.62±12.76 | 47.37±13.15 | 46.00±9.69  | −2.55 | .011 | .28 | −1.97 | .048 | .22 |
|                  | Paraffin   | 45.29±14.46 | 45.44±17.64 | 46.32±16.89 | −0.12 | .990 | .01 | −2.28 | .819 | .03 |
| SF36-VE          | Peloid     | 51.25±20.44 | 65.75±17.78 | 56.12±18.31 | −3.52 | .000 | .39 | −1.13 | .260 | .13 |
|                  | Paraffin   | 44.85±22.03 | 54.56±21.72 | 56.03±17.91 | −2.44 | .015 | .30 | −2.43 | .015 | .29 |
| SF36-SF          | Peloid     | 64.37±24.60 | 84.06±13.57 | 69.69±16.72 | −3.80 | .000 | .42 | −1.34 | .180 | .15 |
|                  | Paraffin   | 54.78±27.53 | 66.91±23.41 | 70.59±24.98 | −2.05 | .040 | .25 | −2.54 | .011 | .31 |
| SF36-ER          | Peloid     | 25.00±40.47 | 78.33±32.51 | 75.00±32.69 | −4.33 | .000 | .48 | −4.22 | .000 | .47 |
|                  | Paraffin   | 38.23±41.95 | 50.98±46.59 | 51.99±47.29 | −1.81 | .070 | .22 | −1.53 | .126 | .18 |
| SF36-MH          | Peloid     | 62.70±19.81 | 73.70±12.76 | 73.10±12.32 | −3.69 | .000 | .41 | −2.85 | .004 | .32 |
|                  | Paraffin   | 57.65±21.01 | 69.76±20.33 | 69.18±14.98 | −3.16 | .002 | .38 | −2.45 | .014 | .30 |

Cohen effect size, p significance value (< .05 statistically significant), p* p values for within-group comparisons were calculated using Wilcoxon test, p ** p values for between-group comparisons were calculated using Mann–Whitney U test, SF36 short form 36, PF physical functioning, PR physical role, BP bodily pain, GH general health, VE vitality/energy, SF social functioning, ER emotional role, MH mental health.

†All values are presented mean ± standard deviation
in pain, function, and quality of life for up to 13 weeks (Horváth et al. 2012). In HOA patients, sulfuric thermal water treatment was shown to have positive effects on pain and functional status for up to 6 months (Kovács et al. 2012).

There are studies showing that local peloid therapy application provides a reduction in pain and improvements in functional status for HOA treatment. A current retrospective study assessing 212 patients treated for HOA diagnosis at the Levico Terme Spa Center applied a total of 12 sessions with 15 min/day 46 °C temperature local peloid packs and 30 min/day Levico’s water diluted with distilled water during a 2-week duration. Assessment of patients at the end of treatment observed reduced pain and morning stiffness duration, functional improvement, and increased hand grip strength compared to before treatment. These positive effects were stated to be possibly related to the physical and chemical content of the peloid and/or mineral water used. The symptomatic easing observed in the results of the study was considered to be related to reduced pain and muscle tone and increased cortisol and beta-endorphin release with the effect of heat. The contribution of the organic content of the peloid to these positive effects was stated. Local peloid therapy was recommended as a complementary non-pharmacological treatment method for HOA management (Tenti et al. 2020). In a randomized controlled single-blind trial, 47 patients with mild to moderate HOA were randomly divided into two groups. Hévíz mud was applied directly to the first group and mud was applied to the second group avoiding contact with a nylon glove, at 42 °C for 20 min/day in 15 sessions for 3 weeks. Although there were positive effects on pain, function, and quality of life for up to 16 weeks in both groups, positive effects on the number of swollen joints and pain were found to be superior in the group with direct administration (Gyarmati et al. 2017). A pilot study including 63 patients with HOA diagnosis abiding by the study criteria divided patients into two groups. The peloid group (n = 33) received 10 sessions of 47 °C temperature 30 min/day local peloid pack along with home exercises for 2-week duration. The control group (n = 30) was only given home exercise. The exercise program included hand grip strengthening, isometric exercises, and active resistance training. Patients were assessed before treatment, in the 2nd week, and in the 6th week. Patients in the peloid group were found to have statistically significant superior reductions in pain, and improvements in hand grip strength, functional status, and quality of life until the 6th week. In this study, the good heat-holding capacity of peloids and increases in noradrenaline, cortisol, and growth hormone levels with the effect of heat were associated with the positive symptomatic effects in the study findings. Additionally, the role of the increase in beta-endorphin levels in the analgesic effect was mentioned (Kasapoğlu Aksoy et al. 2017). Another randomized controlled study divided 60 patients with HOA into two randomized and equal groups. The spa therapy group (n = 30) received a total of 12 sessions of 20 min/day 43 °C temperature local peloid packs and sulfate–calcium-magnesium-fluoride water with 38 °C temperature for 15 min/day over 2 weeks. The control group continued with routine daily life. Both groups were requested to record daily consumption amounts of NSAIDS or paracetamol during the study. Participants were assessed with the VAS, HAQ, FIHOA, SF-36 scales, for morning stiffness, and symptomatic drug consumption before treatment, at the end of treatment, and in the 3rd, 6th, 9th, and 12th months. On all assessments, the spa therapy group was statistically significantly superior until the 3rd month. Symptomatic drug consumption was lower in the spa therapy group (Fioravanti et al. 2014). In our study, the pain reduction, functional improvement, increase in quality of life, increase in hand grip strength, and improvement in physical activity observed in our findings in the short term for the peloid group are consistent with the findings of similar studies. The effect mechanisms explained in similar studies may be associated with the positive outcomes of our study.

The role of mechanical, thermal, and chemical effects in the positive impact of balneotherapy and mud pack treatments on OA was stated (Fortunati et al. 2016). The positive effects of thermal mud applications were associated with the effects of suppressing inflammation and slowing down cartilage damage due to the decrease in the levels of prostaglandin E2, leukotriene B4, interleukin (IL)-1β, tumor necrosis factor-α, IL-6, IL-8, matrix metalloproteinases-3, leptin, and adiponectin, which are important mediators of circulation associated with cartilage damage and inflammation in OA. Local peloid packets and spa therapy were recommended for use in treatment in terms of positive effects on pain reduction and functional capacity for the conventional treatment of HOA (Fioravanti et al. 2014; Fortunati et al. 2016; Cheleschi et al. 2022).

**Limitations**

It is necessary to state some limitations of our study. First, the study only included participants of the female gender. For this reason, our study results represent the female gender and the lack of general results may be accepted as a limitation. During the study, the paracetamol consumption amounts among participants were not questioned, which is an important limitation. The lack of only home exercise group and the short follow-up duration are other important limitations.

**Conclusion**

In conclusion, thermal peloid and paraffin treatments applied with home exercises for women with HOA diagnosis were shown to provide similar improvements for pain assessed with VAS, functional improvement assessed with AUSCAN, reduced joint stiffness, and increased hand grip strength assessed with Jamar in the short term. Assessments...
of physical activity with HAQ, quality of life with SF36, and depression with BDI, found improvements were superior in the peloid group. Both peloid and paraffin therapies may be used along with home exercise in terms of beneficial effects on HOA symptoms. Peloid therapy may be recommended for priority use compared to paraffin therapy due to being a cheap, easy to apply, safe, and natural treatment, while also having more positive effects on quality of life, physical activity, and depression in the short term. It is necessary to support our study results with larger sample size randomized controlled studies providing long-term outcomes.

Declarations

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee (ethics committee decision number: 2018/1192) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent to participate Informed consent was obtained from all individual participants included in the study.

Conflict of interest The authors declare no competing interests.

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