International Journal of Biometeorology (2021) 65:1391–1398
https://doi.org/10.1007/s00484-021-02111-2

ORIGINAL PAPER

Paraffin bath therapy in De Quervain's tenosynovitis: a single-blind randomized controlled trial

İlknur Aykurt Karlıbel[1] · Meliha Kasapoğlu Aksoy[1] · Ayşe Alkan[1]

Received: 21 January 2021 / Revised: 26 February 2021 / Accepted: 1 March 2021 / Published online: 6 March 2021

Abstract

Data on the efficacy of treatment modalities in De Quervain's tenosynovitis (DQT) is limited. Paraffin therapy is routinely used in treating hand osteoarthritis and neuropathies. However, there are not enough studies investigating paraffin effectiveness. This study evaluates the effectiveness of paraffin bath therapy on pain, functional status, muscle strength, and quality of life in patients with DQT. This prospective, single-blind, randomized, controlled study enrolled 51 DQT patients. Group 1 (n = 26) received paraffin bath + splint + exercise; Group 2 (n = 25) received splint + exercise therapy. Pain, handgrip strength, thumb palmar pinch strength, functional status, and quality of life were evaluated. Both treatment combinations improved pain, grip strength, palmar pinch strength of the thumb, functional status, and quality of life. The paraffin group provided more effective pain control than the paraffin-free group and was more effective in improving functional status, handgrip strength, and quality of life ($p < 0.05$). Apparently, adding paraffin therapy to the combination of the splint and therapeutic exercise positively affects the patient's treatment outcomes. For this reason, paraffin therapy should be included in the conservative treatment combinations in DQT.

Keywords De Quervain's tenosynovitis · Paraffin bath · Splint therapy · Therapeutic exercise

Introduction

De Quervain's tenosynovitis (DQT) is the compression of the abductor pollicis longus (APL) and the extensor pollicis brevis (EPB) tendons in the first dorsal compartment of the wrist due to the thickening of their surrounding sheaths. These muscles are responsible for the abduction and extension of the thumb (Nemati et al. 2017). DQT causes pain in the radial styloid region and dysfunction in the affected hand. This pain is aggravated by movement and activity that requires a first and ulnar deviation with thumb metacarpophalangeal (MP) joint flexion (Morgan et al. 2020). In a study, its prevalence was reported as 0.5% in men and 1.3% in women, and the age of occurrence was 30–55 years old (Papa 2012). Although the exact cause of De Quervain's tenosynovitis is unclear, blunt trauma, biomechanical compression, extreme fatigue, repetitive work-related activities, anatomical variations, genetic predisposition, cold temperatures, and rarely pathogens have been blamed for the etiology. Although it is called tenosynovitis, De Quervain's disease has not been generally associated with synovial sheath inflammation. An intrinsic mechanism is thought to play a role in the pathogenesis. The histopathological examination includes degenerative changes such as myxoid degeneration, fibrocartilage metaplasia, and mucopolysaccharide deposition rather than acute inflammation of the synovial sheath (Clarke et al. 1998; Batteson et al. 2008; Ferrara et al. 2020). Diagnosis is based on history and physical examination.

Recommended treatments for DQT are rest, physical therapy modalities, analgesics, thumb spica splint, corticosteroid injection, and surgery (Huisstede et al. 2018). However, data on the effectiveness of these treatments are limited. Active treatment options include an active painless range of motion exercises, strengthening exercises, tendon gliding exercises, self-applied eccentric exercises, and friction massage. The purpose of therapeutic exercises is to increase the APL and

✉ İlknur Aykurt Karlıbel
karlibeli@hotmail.com

Meliha Kasapoğlu Aksoy
melihakasapoglu@hotmail.com

Ayşe Alkan
aysealkan91@gmail.com

[1] Department of Physical Medicine and Rehabilitation, University of Health Sciences Bursa Yuksek İhtisas Training and Research Hospital, 16800 Yildirim, Bursa, Turkey

EPB tendons' slippage in the first dorsal compartment (Goel and Abzug 2015; Hadianfard et al. 2014).

The use of the thumb spica splint has been shown to aid in pain management by immobilizing the thumb and wrist joints, thus preventing thumb MP joint flexion and wrist ulnar deviation (Fedorczyk 2012). Although the splint in the treatment of DQT is controversial, its use is recommended, especially in painful patients (Ilyas 2009).

Paraffin bath is widely used to treat hand-related diseases such as osteoarthritis, rheumatoid arthritis, scleroderma, and carpal tunnel syndrome (Dilek et al. 2013; Ordahan and Karahan 2017; Sandqvist et al. 2004; Ayling and Marks 2000). In vivo studies have shown that paraffin bath treatment causes temperature increases of 7.5 °C in the joint capsule and 4.5 °C in the muscle (Kasapoğlu Aksoy and Altan 2017). Paraffin bath therapies have a local effect of relaxing smooth muscle fibers in the arterioles, causing vasodilation of the peripheral blood vessels so effective to improve circulation and promote relaxation. This hyperemia provides increased tissue fluid transduction, increased lymph flow, and absorption of exudates (Bender et al. 2005).

To our knowledge, despite the widespread use of paraffin baths in clinical practice, no randomized controlled trial has been reported in the literature on the efficacy of paraffin bath therapy in DQT treatment. This study aims to evaluate the effectiveness of paraffin bath combined with splint and exercise therapies versus splint and exercise therapy on pain, functional status, muscle strength, and quality of life in patients with DQT.

Methods

This single-blind randomized controlled clinical study was conducted in the physical medicine and rehabilitation clinics of Bursa Yuksek İhtisas Training and Research Hospital. The study was planned under the Helsinki Declaration rules, and local ethics committee approval was received (2011-KAEK-25 2019 / 11-13). All participants were informed about the study and signed a written consent form.

Study population

Patients between the ages of 18 and 65 who had pain (VAS (10 cm visual analog scale) ≥ 4 cases, pain duration ≥ 4 weeks), swelling, and tenderness around the radial styloid and diagnosed with DQT with a positive Finkelstein test were included in the study. Those who met the following criteria were excluded from the study: those using NSAIDs for the past 6 months; those with a history of direct trauma, fracture, injection, or surgery to the hand and wrist; those with additional diseases such as diabetes mellitus, goiter, coagulopathy, liver–kidney failure, COPD, cardiac, neurological and psychiatric diseases, acute–chronic infection, and malignancy; those with inflammatory systemic rheumatic diseases such as rheumatoid arthritis; those with abnormal findings on blood tests or wrist radiography; those with hand sensation disorders and skin lesions; and pregnant or nursing mothers.

The demographic data (age, gender, body mass index (BMI kg/m2)) of the patients were recorded.

Intervention

Sixty patients fulfilling the inclusion and exclusion criteria were randomized to two groups in a computer environment using a random number table (http://www.random.org/). Paraffin bath + splint + home-based exercise program was applied to Group 1 (n = 30), and splint + home-based exercise program was applied to Group 2 (n = 30). The patients continued their normal daily life activities during the treatment.

Paraffin bath A total of 10 sessions, 5 days a week for 2 weeks, were applied to the hand containing DQT. In paraffin bath, mineral oil and paraffin were mixed in a ratio of 1:6 (Homayouni et al. 2013). The paraffin temperature was adjusted to 52 °C using a thermometer. The patient was instructed to dip and remove in paraffin bath ten times, with the wrist in the neutral position and the fingers open. Subsequently, the hand was wrapped in a towel and left for 20 minutes to maintain heat (Kasapoğlu Aksoy and Altan 2017).

Thumb spica splint Splint features are as follows: it includes the wrist. It extends along the 2/3 radial part of the forearm and to the interphalangeal joint of the thumb. It positions the wrist in a 20° extension, the first carpometacarpal (CMC) joint at 40° abduction, and the first MP joint in extension. It allows movements of 2, 3, 4, and 5 fingers. It is a single piece and fabricated (Lee et al. 2002). The thumb spica splint was used for 4 weeks for both groups of patients. Splint removal was allowed at night and during exercise three times a day.

Home-based exercise programs The exercise program in the first week consisted of active and passive range of motion and stretching exercises performed at the pain margin in line with the extension, abduction, and position movements of the wrist and thumb. Besides, stretching exercises were applied for the forearm extensors and flexors. In the second week, tendon sliding exercises, eccentric exercises, and strengthening exercises (using a half-pound cylindrical can and rubber band) were applied (Lee and Zelouf 2011; Sanders 2004). The exercises were applied three times a day, removing the splint and repeating each movement ten times for 8 weeks.

Nonsteroidal–steroidal anti-inflammatory drugs were banned in both groups. They were allowed to take 500 mg of paracetamol, provided that they apply if needed.

Measures

Pain Based on pain during daily life activities, it was evaluated on a 10-cm visual analog scale (VAS) (0, no pain; 10, severe pain). Those with VAS ≥ 4 were included in the study.

Pain pressure threshold (PPT) It was evaluated with a pressure algometer (Baseline® Dolorimeters, NY, USA, 2015). The same researcher carried out the test under the same conditions for room temperature and test equipment. Measurements were made on the radial side of the wrist. The power unit of the device is calibrated to Newton/cm^2. With the device's probe, pressure increases at a rate of 1 N/s were carried out until pain was detected. The test was stopped with the subject "stop" command, and the value on the screen was recorded. Each measurement was performed three times and by taking the average of three measurements.

Handgrip strength (HGS) It was measured with a standard hand dynamometer (Jamar® Plus+ Digital Hand Dynamometer from Patterson Medical, Sammons Preston, Bolingbrook, USA). The Jamar dynamometer is the gold standard for evaluating grip strength (Shechtman et al. 2005). Each measurement was performed three times and by taking the average of three measurements. It was measured in kilogram-force.

Finger pinch strength (FPS) The patients' pinch strength was tested with a good and reliable pinch gauge (Jamar® Pinch Gauge, USA). The measurement was made by compressing the instrument between the thumb and the other finger. The test was performed three times, and the arithmetic mean value was taken as kilograms.

Quick arm–shoulder–hand (QDASH) score This questionnaire consists of 11 items, and each item is scored from 1 to 5. It is used to evaluate the function in upper extremity diseases. The 27.7-point change in the QDASH score is within the 95% confidence interval and is considered statistically significant. The total score is between 0 and 100. A high score indicates an impaired function (Beaton et al. 2005).

Short form-12 This questionnaire was abbreviated from the SF-36 Health Survey. The questionnaire, which consists of 12 questions, which aims to measure the quality of life, is calculated in two stages as physical component score and mental component score (Ware Jr et al. 1996).

Diagnostic evaluation and control visits were made by the same physical medicine and rehabilitation specialist. The researchers who evaluated the patient and planned the treatment were different. Both groups of patients were evaluated before treatment, at 2 weeks, and 8 weeks after treatment.

Statistical analysis

IBM SPSS 23.0 statistical software was used to analyze the data. Chi-square (c2) test was used to compare categorical data. The suitability of the data for normal distribution was evaluated with the Shapiro–Wilk test. In cases where the data showed normal distribution, Student's *t*-test was used. In cases where the data did not show normal distribution, the Wilcoxon signed-rank test was used for intragroup comparisons, and the Mann–Whitney *U* test was used to compare groups. Values with probability $p \leq 0.05$ were considered significant, and "there is a difference between the groups."

Results

The study was completed with 51 patients (Group 1, $n = 26$; Group 2, $n = 25$), as four patients in Group 1 did not complete their treatment (due to social reasons), and five patients in Group 2 did not attend the control visits (Fig. 1).

There was no statistically significant difference between the two groups in terms of pre-treatment, demographic data, and evaluation parameters ($p > 0.05$) (Table 1).

Intragroup comparison of the second (post-treatment) and eighth week values: When compared with pre-treatment, a statistically significant improvement was observed in the second and eighth weeks in all parameters except the SF-12 mental parameter in both groups ($p < 0.05$). The improvement in pain level increased in both groups from the second week to the eighth week ($p < 0.05$) (Table 2).

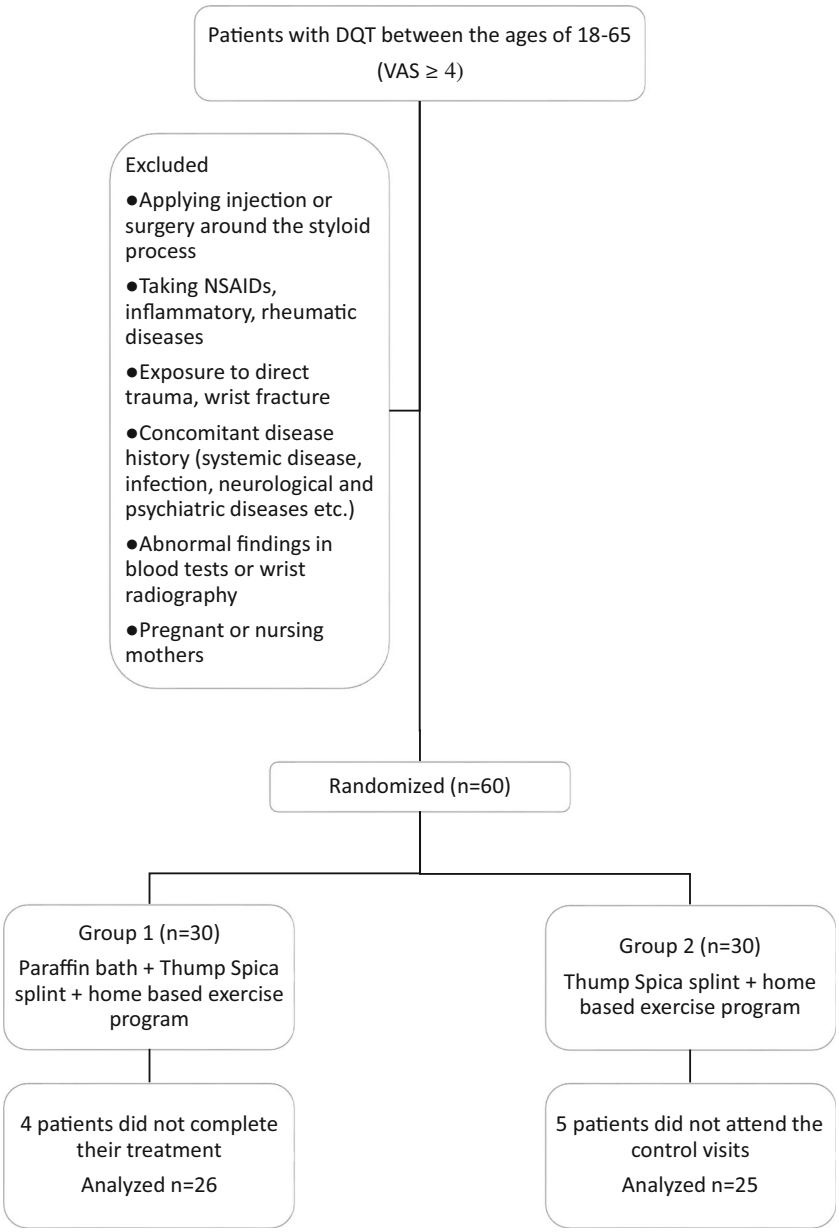
Comparison of difference scores between groups: The levels of improvement in pain, QDASH, HGS, and SF-12 physical values were statistically significantly better in favor of Group 1 at the second and eighth weeks compared to pre-treatment. When the situation was evaluated from the second week to the eighth week, there was no significant difference between both groups in all parameters ($p > 0.05$) (Table 3).

All participants tolerated the treatment, and there were no adverse effects of the treatment.

Discussion

This study showed that paraffin therapy combined with a home exercise program and thumb spica splint provides effective pain control and is more effective in improving functional

Fig. 1 Flow diagram



status, HGS, and quality of life than the combination of exercise program and thumb spica splint.

Both degenerative and inflammatory processes play a role in DQT (Batteson et al. 2008; Ferrara et al. 2020). Although there is no consensus on the treatment, rest, physical therapy modalities, analgesics, thumb spica splint, corticosteroid injection, and surgical methods are used (Huisstede et al. 2018). İn the literature, various physical therapy modalities among conservative treatments for DQT have been described. It has been shown that laser therapy and therapeutic ultrasound, which are the most used physical treatments for DQT, have provided clinical, functional, and radiological improvement by increasing grip strength and decreasing pain. In these studies, it was emphasized that changes in dosage or duration of treatment might affect the treatment results (Sharma et al. 2015; Sharma et al. 2002). In another study, the combination of laser and ultrasound therapy was found to be less effective in increasing grip strength and reducing pain compared to corticosteroid injection. This study reported that corticosteroid injection treatment provided gradually increasing improvement in terms of HGS and pain in the follow-up at 2, 4, 6, and 12 months, but complication rates were higher (Kumar and Mittal 2018). In our study, we did not observe any complications with paraffin therapy. However, our follow-up times were short. The only study in the literature involving paraffin baths among therapeutic combinations is the study of Homayouni et al. (Homayouni et al. 2013). In this study, a paraffin bath was applied (every 3 days for 10 sessions and

Table 1 Comparison of the demographic characteristics of the patients and pre-treatment evaluation parameters

W0		Group 1 (n = 26)	Group 2 (n = 25)	p value
Age		51.15 ± 6.11	49.76 ± 8.36	0.540
Gender	Female	24 (%92.3)	21 (%84)	0.362
	Male	2 (%7.7)	4 (%16)	
BMI (kg/m^2)		25.15 (19.70–39.10)	24.90 (18.00–35.40)	0.665
Duration of pain (Week)		6 (4–12)	5 (4–10)	0.076
VAS		8 (4–10)	8 (5–10)	0.721
PPT		5 (2–10)	6 (4–10)	0.061
HGS (kg)		24.05 (20–31.30)	24.00 (20–31.90)	0.858
FPS (kg)		5 (3–15)	6 (3–10)	0.841
QDASH		71 (42.50–100)	70 (50–95)	0.643
SF-12 physical component		35.49 (27.38–43.34)	36.78 (27.38–44.39)	0.418
SF-12 mental component		46.74 (39.83–56.44)	44.81 (38.94–57.90)	0.074

W0, week 0; *BMI*, body mass index; *VAS*, visual analog scale; *PPT*, pain pressure threshold; *HGS*, handgrip strength; *FPS*, finger pinch strength; *QDASH*, quick arm–shoulder–hand score; *SF-12*, short form 12; mean ± SD is used for values with normal distribution and median (min–max) is used without normal distribution. $p < 0.05$ statistically significant

application time 10 minutes) in combination with therapeutic ultrasound, TENS, and friction massage, and this combination of treatment provided less benefit than kinesiology taping in pain control (Homayouni et al. 2013). In this study, the assessment was made at the end of treatment (1 month) and only on the pain. Our study combined paraffin therapy with thumb spica splint and exercise program and compared this treatment combination with thumb spica splint and exercise program. In our study, paraffin was applied as ten sessions 5 days a week, and the application time was 20 minutes. Significant improvement was found in pain, handgrip, and pinch strength, QDASH, and SF-12 physical values in both groups. In the paraffin-free group, improvement in QDASH did not increase in the second week. The paraffin group provided more effective pain control than the paraffin-free group and was also more effective in improving functional status, HGS, and quality of life. In our study, paraffin was applied as ten sessions 5 days a week. Compared to Homayouni's study, the differences in results may be due to differences in treatment combinations, treatment options compared, and administration.

Paraffin bath is a local therapeutic agent frequently used to treat hand diseases such as osteoarthritis, rheumatoid arthritis, scleroderma, and carpal tunnel syndrome and is often combined with other treatments (Dilek et al. 2013; Ordahan and Karahan 2017; Sandqvist et al. 2004; Ayling and Marks 2000). Studies of rheumatoid arthritis evaluating tenderness, pain, grip strength, dexterity, and function have shown that paraffin wax relieves pain and stiffness immediately after treatment and for the third week afterward but does not provide any functional or symptomatic benefit after 6 weeks (Ayling and Marks 2000). In our study, the improvement in pain values in both groups was increasing until the eighth week. The improvement in other parameters did not change until the eighth week after the second week, and there was no difference between the groups.

In vivo studies have shown that paraffin bath treatment causes an increase of 7.5 degrees in the joint capsule and 4.5 degrees in the muscle, and this effect is more pronounced than ultrasound therapy or diathermy at depths of up to 1.2 cm (Borrell et al. 1980). Also, it has been reported that the melted paraffin immersion method increases the tissue temperatures to a higher level than hot water and retains the heat for a longer time (Ayling and Marks 2000).

Local heat applications reduce peripheral nerve conduction velocity, increase peripheral endorphin production, and inhibit pain transmission by acting as a peripheral stimulus, thereby raising the pain threshold (Melzack and Wall 1965). Relieving muscle spasms and pain and accelerating metabolism and vasodilation are among the therapeutic effects of physiological effects (Bender et al. 2005). When the tissues are heated, their viscoelastic properties increase. For this effect to be permanent, it is recommended to apply with exercise. Studies have reported that paraffin treatment with an exercise program provides a more effective hand function improvement than an exercise program alone. This effect has been attributed to the ability to perform hand exercises effectively by relieving pain and stiffness and by increasing hand tissue temperatures with melted paraffin applications. (Sandqvist et al. 2004; Ayling and Marks 2000). The purpose of therapeutic exercises is to increase the APL and EPB tendons' slippage in the first dorsal compartment (Goel and Abzug 2015). Conservative treatment completed with eccentric training in DQT caused a decrease in pain intensity and a significant increase in the hand and wrist functionality (Földvári-Nagy et al. 2020). Studies have also shown that treatment combinations applied with the thumb spica splint

Table 2 Intragroup comparison of post-treatment and 8th week values

		(W0)	Aftertreatment (W2)	(W8)	*p* value (W0–W2)	*p* value (W0–W8)	*p* value (W2–W8)
VAS	Group 1 (n = 26)	8 (4–10)	6 (3–10)	6 (4–10)	< 0.001	< 0.001	0.001
	Group 2 (n = 25)	8 (5–10)	7 (2–10)	7 (0–10)	< 0.001	0.008	0.023
PPT	Group 1 (n = 26)	5 (2–10)	5 (3–10)	6 (3–12)	0.026	0.039	0.648
	Group 2 (n = 25)	6 (4–10)	7 (3–11)	7 (4–11)	0.039	0.013	0.523
HGS (kg)	Group 1 (n = 26)	24.05 (20–31.30)	27.35 (22–36)	27.55 (22–41.20)	< 0.001	< 0.001	0.858
	Group 2 (n = 25)	24.00 (20–31.90)	24.50 (20.90–31)	24.20 (20.50–31)	0.005	0.008	0.307
FPS (kg)	Group 1 (n = 26)	5 (3–15)	7 (4–15)	7 (3–14)	< 0.001	< 0.001	0.346
	Group 2 (n = 25)	6 (3–10)	6 (3–12)	6 (3–15)	0.004	0.001	0.307
QDASH	Group 1(n = 26)	71 (42.50–100)	62.50 (30.50–95)	66.25 (40–95)	< 0.001	0.001	0.151
	Group 2 (n = 25)	70 (50–95	70 (27.50–90)	70 (25–97.50)	0.003	0.586	0.586
SF-12 physical component	Group 1 (n = 26)	35.49 (27.38–43.34)	39.76 (29.79–46.42)	39.39 (28.08–47.92)	< 0.001	< 0.001	0.391
	Group 2 (n = 25)	36.78 (27.38–44.39)	38.95 (28.08–51.61)	38.40 (27.83–54.77)	< 0.001	0.003	0.381
SF-12 mental component	Group 1 (n = 26)	46.74 (39.83–56.44)	46.37 (40.53–55.96)	46.74 (39.83–57.90)	0.909	0.882	0.253
	Group 2 (n = 25)	44.81 (38.94–57.90)	44.81 (39.83–53.13)	44.71 (39.28–57.09)	0.376	0.179	0.546

*Median (min–max) *VAS*, visual analog scale; *PPT*, pain pressure threshold; *HGS*, handgrip strength; *FPS*, finger pinch strength; *QDASH*, quick arm–shoulder–hand score; *SF-12*, short form 12; *W0*, week 0; *W2*, week 2; *W8*, week 8

The Wilcoxon signed-rank test was used for intragroup comparisons; $p < 0.05$ statistically significant

provide a more effective recovery than treatment modalities applied alone (Abi-Rafeh et al. 2019; Awan et al. 2017). The splint provides hand rest by preventing ulnar deviation of the wrist and flexion of the thumb and reduces the friction of the APL and EPB tendons in the first compartment of the hand, contributing to reducing inflammation (Nemati et al. 2017). On the contrary, Harvey et al. advocated mobilization that resulted in prolonged improvement in pain symptoms in 80% of cases (Harvey et al. 1990). Our study recommended that the splint be removed during exercise three times a day and while sleeping at night. In this way, we tried to prevent the drop in hand performance, which could be a side effect of the splint (Hsu et al. 2008). As a matter of fact, our results showed that both groups of patients showed significant improvement in handgrip and pinch strength. We think that pain relief and exercise are useful in this. Handgrip strength was better in the paraffin group than in the paraffin-free group. The improvement in pinch grip was similar in both groups.

Study limitations

The most important limitation of our study is that patients were evaluated in a short period. We recommend that future

Table 3 Comparison of the difference scores between the groups

	W2-W0			W8-W0			W8-W2		
	Group 1	Group 2	*p* value	Group 1	Group 2	*p* value	Group 1	Group 2	*p* value
VAS	-2 (-4–0)	-1 (-5–0)	0.001	-1 (-4–0)	0 (-7–0)	0.004	1 (-2–3)	0 (-2–2)	0.158
PPT	1 (-2–2)	0 (-1–2)	0.552	0 (-2–4)	0.50 (-1–3)	0.859	0 (-1–2)	0 (-2–1)	0.545
HGS (kg)	3 (0.50–7.70)	0.80 (-1,90–4)	< 0.001	2.65 (-0.30–13.70)	0.50 (-1.90–4)	< 0.001	0.05 (-2–6)	0 (-1–0.60)	0.348
FPS (kg)	1 (0–5)	1 (-2–4)	0.066	1 (-1–5)	1 (-1–5)	0.310	0 (-1–3)	0 (-2–3)	0.230
QDASH	-5.25 (-20–2.50)	-2.50 (-37.50–2.50)	0.001	-2.50 (-27.50–5)	0.00 (-40–5)	0.007	0 (7.5–11.50)	0 (-2.5–10	0.961
SF-12 physical component	4.11 (0.55–12.04)	1.61 (-0.56–12.25)	< 0.001	3.91 (0.25–11.02)	0.56 (-1.31–15.41)	< 0.001	-0.3 (-5.68–5.11)	-0.25 (-8.61–3.16)	0.814
SF-12 mental component	0.15 (-13.15–12.17)	-0.74 (-13.48–9.09)	0.685	-0.03 (-15.71–12.10)	-1.02 (-11.87–7.02)	0.361	-0.99 (-9.22–15.51)	0 (-10.69–7.10)	0.346

*Median (min–max); *VAS*, visual analog scale; *PPT*, pain pressure threshold; *HGS*, handgrip strength; *FPS*, finger pinch strength; *QDASH*, quick arm–shoulder–hand score; *SF-12*, short form 12; *W0*, week 0; *W2*, week 2; *W8*, week 8; the Mann–Whitney *U* Test was used for the inter-group comparisons; $p < 0.05$ statistically significant

studies investigate treatment options that have larger group sizes and evaluate longer-term outcomes. Another limitation of ours is that we chose to use DASH to evaluate the functionality of the hand. This scale evaluates upper extremity functionality globally. However, it is not specific for the hand. The functional index for hand osteoarthritis (FIHOA) is a specific scale for the hand evaluating functionality and is recommended by international scientific associations for use in scientific research (Dreiser et al. 2000; Gandini et al. 2012). It is recommended to include the FIHOA functionality scale in future studies.

Conclusion

Considering the small sample size, the present study is only a preliminary study. This study showed that paraffin bath combined with spica splint and exercise was more beneficial than spica splint and exercise in managing the symptoms of De Quervain's disease. Paraffin bath therapy seems to potentiate the effect of spica splint and exercise. This triple combination therapy can be considered among the noninvasive treatment options that can be used safely.

Author contribution All the authors equally contributed to this manuscript.

Declaration

Conflicts of interest The authors declare no competing interests.

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