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Comparison of the effect of prolotherapy and paraffin wax for hand osteoarthritis

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Abstract. – OBJECTIVE: Hand osteoarthritis (OA) is associated with considerable disability, especially in the elderly patient population. Paraffin wax (PW) and prolotherapy (P) are non-pharmacological treatment methods used in this setting. This study aimed to compare the therapeutic efficacy of P and PW in hand osteoarthritis.

PATIENTS AND METHODS: This study was designed as a single-center, randomized-controlled trial conducted at our Physical Medicine and Rehabilitation Clinic between February 2019 and July 2020. Patients with bilateral hand OA were divided into PW and P treatment groups. The PW group was treated 5 days per week for 2 weeks. The P group received an injection of dextrose solution into the ligaments of painful joints once weekly for three weeks. Visual analog scale (VAS), Duruoz Hand Index (DHI) scale, hand dynamometer for grip strength, and pinch meter for lateral pinch were used for baseline and post-treatment follow-up assessments.

RESULTS: Overall, 42 patients were included. The VAS scores significantly decreased in both PW and P groups (p=0.024 and p=0.014). Baseline and third-month post-treatment VAS scores did not significantly differ (p=0.581). The DHI scores improved significantly in both groups (p<0.001 and p<0.001), being higher in the P than in the PW group (p=0.042). Right- and left-hand grip strength increased significantly in PW and P groups (p<0.001, p=0.001; p=0.013, p=0.002, respectively).

CONCLUSIONS: Both treatment methods were effective regarding pain and grip strength; however, P improved the hand functions more significantly.

Key Words:
Hand osteoarthritis, Paraffin wax, Prolotherapy, Pain, Hand function, Physical therapy.

Introduction

Osteoarthritis (OA) is the most common joint disease, affecting approximately 10% of men and 20% of women over 60[1]. The most commonly affected sites are the knee, hip, hand, spine, and foot[2]. Hand OA is a heterogeneous disorder, including nodal interphalangeal OA, thumb base, and erosive OA[3,4]. Also, it may have significant functional consequences, such as pain, reduced hand mobility and grip force, and activity restriction.

Optimal management of hand OA necessitates pharmacological and non-pharmacological treatment strategies based on European Alliance of Associations for Rheumatology (EULAR) recommendations[5]. One of the non-pharmacological therapies for hand OA is prolotherapy (P), also known as regenerative injection therapy, involving injecting an irritant solution into painful ligaments, tendon insertions, and joint spaces to control the pain and promote tissue repair[6,7]. The most commonly preferred irritant solution is dextrose (d-glucose). D-glucose is the most common isomer of glucose found in the human body. Other irritant solutions that can be used for treating hand OA include combinations of polidocanol, manganese, zinc, human growth hormone, ozone, glycerin, and phenol[8].

It was suggested[9] that dextrose prolotherapy (dextrose P) alleviated degenerative joint disorders by creating a hyperosmolar environment, leading to cell rupture and the release of platelet-derived growth factors. Reeves and Hassanein[10] stated that dextrose P might be used to treat hand OA, and Jahangari et al[11] noted that dextrose P led to satisfactory pain relief and functional improvement in patients with thumb OA.

According to the EULAR recommendations[5,12], local application of heat [paraffin wax (PW) or hot pack] can be beneficial in the treatment of OA. In 2019, the American College of Rheumatology[13] (ACR) recommended PW as an adjunct method for hand OA. Local effects of paraffin include relaxation of the muscle fibers and arterioles and vasodilation in the peripheral blood vessels, resulting in hyperemia, increased mobilization of tissue fluids, lymph flow, and reabsorption of exudates[14,15].

In the present study, we compared the efficacies of P with PW in hand OA regarding pain, dexterity, strength, and activities of daily living (ADLs).

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Patients and Methods

This study was designed as a single-center, parallel-group, randomized controlled, single-blind study conducted at the Bakırköy Dr Sadi Konuk Training and Research Hospital, Department of Physical Medicine and Rehabilitation (PMR), between February 2019 and July 2020 (NCT03839108, https://clinicaltrials.gov/study/NCT03839108). The study was approved by the Ethical Review Committee of the same institution and followed the ethical principles reported in the Declaration of Helsinki (2018/419).

Written informed consent was obtained from all participants.

Study Design

Patients diagnosed with bilateral hand OA were randomly divided into PW and P groups. Randomization was performed by hospital staff using the envelope method.

Patients

Patients who visited the PMR outpatient clinic for symptoms consistent with bilateral hand OA were examined by a PMR specialist. Those aged between 40 and 70 and diagnosed with bilateral hand OA as per ACR classification criteria constituted the target population of this study[16].

Patients with carpal tunnel syndrome (CTS), de Quervain tenosynovitis, Dupuytren's contracture, inflammatory arthritis, secondary OA due to rheumatoid arthritis, chondrocalcinosis, psoriatic arthritis, hemochromatosis or trigger finger were excluded. Also, those with a history of upper extremity surgery, patients with neurological disorders, and those who received physiotherapy or joint injections during the last 6 months were omitted. All study participants were asked to cease taking medications that can interfere with the planned treatment 4 weeks before recruitment to the study groups. Demographic and clinical data of the patients, including body mass index (BMI), marital and education status, smoking history, and family history of hand OA, were recorded in a secured electronic database.

Interventions

In the PW group, the patients were asked to take off their jewelry and dip both hands into the melted wax bath at 52°C 10 times. Patients were instructed to keep their hands open and their wrists in a neutral position. They were treated by the same physiotherapy technician; the therapy included 10 sessions, 20 minutes a day, 5 days a week, for 2 weeks, as previously recommended in the literature[17-19].

On the other hand, in the P group, a 0.25-0.50 mL 15% dextrose solution was injected into the periarticular ligaments of the symptomatic proximal interphalangeal, distal interphalangeal, and carpometacarpal joints using a 27G needle until firm resistance was felt, as previously described by Reeves and Hassanein[10].

Assessments

The visual analog scale (VAS), Duruoz Hand Index (DHI) scale, grip strength, lateral pinch, two-point pinch, and three-point pinch strengths were assessed before the intervention and 2 weeks, 4 weeks, and 3 months after the intervention in both groups by a physician who was blinded to the treatment groups (Figure 1).

The pain intensity was measured by VAS: A ruler was used, and the VAS score was found by calculating the distance (mm) on the 10-cm line between the "no pain" anchor and the patient's mark, delivering a range of scores from 0-100. A higher score indicated greater pain intensity. Hand pain at rest and during ADL was measured as VAS at rest and VAS during activity scores, respectively.

Handgrip strength was measured by the Jamar plus hand dynamometer (Performance Health Supply, Cedarburg, WI, USA). The patient was seated with the elbow 90° flexed, forearm, and wrist in a neutral position without table support. The average of three measurements was calculated. In order to assess the pinch strength, two-point pinch, lateral pinch (key grip), and three-point pinch measurements were performed with a pinch meter (Performance Health Supply, Cedarburg, WI, USA). Again, three measurements were performed, and the average value was calculated, as previously suggested by Mathiowetz et al[20].

In our study, DHI was used to assess hand function. This scale is a self-reported questionnaire initially developed for patients with rheumatoid arthritis and subsequently validated for OA[21,22]. It includes 18 items regarding manual tasks that are carried out during daily activities. Patients are asked to rate their ability to carry out these tasks on a scale from 0 (no difficulty) to 5 (impossible).

In both groups, pre-treatment VAS scores, DHI scores, grip, lateral pinch, and two-point and three-point pinch strength were compared with the post-treatment values.

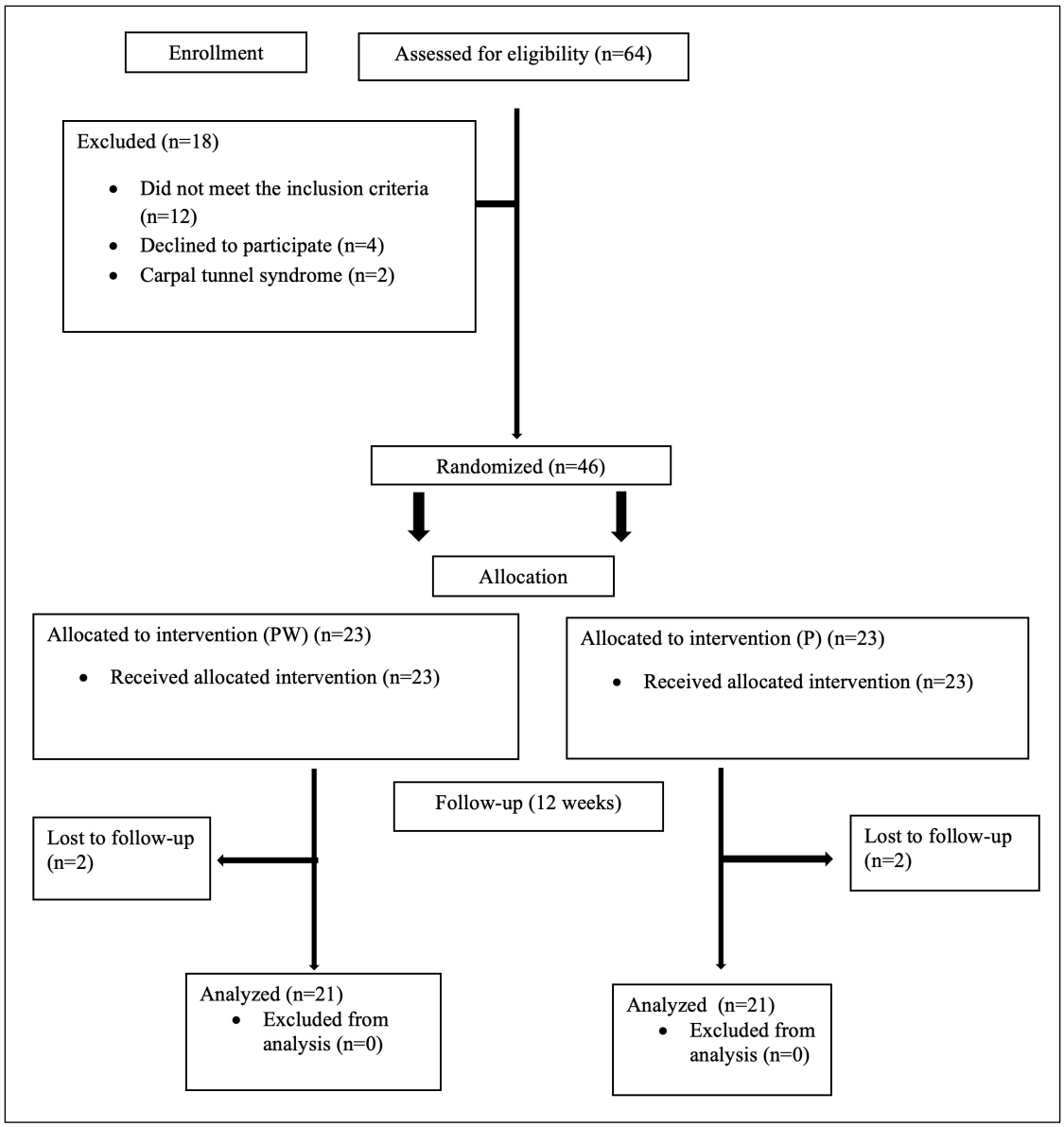

Figure 1. Flowchart demonstrating the study design.

Statistical Analysis

Descriptive data were given as means, standard deviations, medians, frequencies, and ranges [min-max]. The Mann-Whitney U test was used to compare differences between two independent groups when the dependent variable was either ordinal or continuous but non-normally distributed. For independent variables that did not show normal distribution, the Friedman test was used to analyze the changes in scores over time. The Dunn's test was used for post-hoc analysis. Statistical significance was considered at $p<0.05$. All statistical analyses were performed using NCSS 11 (Number Cruncher Statistical System, 2017 Statistical Software Kaysville, Utah, USA) and MedCalc Statistical Software version 18 (MedCalc Software bvba, Ostend, Belgium).

Results

Overall, 64 patients (58 female and 6 male) were evaluated. Among these patients, 12 did not meet the inclusion criteria. Two patients were excluded due to CTS, while 4 were omitted since they withdrew their consents. Thus, 46 patients were

enrolled in the study; however, 42 (21 in the PW, 21 in the P group) could complete it. While 3 patients who did not complete the study protocol were lost to follow-up for arbitrary reasons, 1 discontinued due to adverse effects. This patient was assigned to the P group, and she discontinued the treatment after completing the second session. She complained of increasing pain, and subsequently, a Heberden's nodule was detected in the pain site. The patient was excluded from the study.

All study patients were female. The mean age of the study participants was 60.4±7.4 and 59.5±6.9 years in the PW and P groups, respectively (p=0.68). The dominant hand of all patients was the right hand. The two patient groups were similar regarding BMI, marital and education status, smoking, and family history of hand OA (p>0.05) (Table I).

The comparison of the pre-treatment with the post-treatment VAS pain scores revealed a significant decrease in both PW and P groups (p=0.024, p=0.014). In the PW group, no significant difference was detected in pairwise comparisons. The pairwise comparisons revealed a significant decrease only 2 weeks after treatment (p<0.05). The VAS with activity scores decreased significantly

Table I. Demographic data of the patients.

		Total (n=42)	Paraffin wax (n=21)	Prolotherapy (n=21)	
		n (%)	n (%)	n (%)	p
Age (years)	*Min-Max (Median)*	48-75 (60)	48-75 (61)	48-72 (60)	[a]***0.684***
	Mean±SD	59.98±7.07	60.43±7.36	59.52±6.92	
BMI (kg/m²)	*Min-Max (Median)*	21-40.9 (28.2)	21-40.9 (26.6)	21.6-35.2 (29.1)	[a]***0.143***
	Mean±SD	28.08±3.98	27.18±4.14	28.98±3.68	
Marital status	**Married**	1 (2.4)	1 (4.8)	0 (0)	[c]***0.179***
	Single	36 (85.7)	16 (76.2)	20 (95.2)	
	Widow	5 (11.9)	4 (19)	1 (4.8)	
Number of children	*Min-Max (Median)*	0-6 (2)	0-4 (2)	1-6 (2)	[b]***0.789***
	Mean±SD	2.36±1.10	2.24±1.00	2.48±1.21	
	No child	1 (2.4)	1 (4.8)	0 (0)	
	1	6 (14.3)	3 (14.3)	3 (14.3)	
	2	19 (45.2)	9 (42.9)	10 (47.6)	
	3	12 (28.6)	6 (28.6)	6 (28.6)	
	≥4	4 (9.5)	2 (9.5)	2 (9.5)	
Occupation	**Housewife**	32 (76.2)	16 (76.2)	16 (76.2)	[c]***1.000***
	Officer	1 (2.4)	1 (4.8)	0 (0)	
	Worker	3 (7.1)	1 (4.8)	2 (9.5)	
	Retired	6 (14.3)	3 (14.3)	3 (14.3)	
Education	**Primary school**	21 (50)	11 (52.4)	10 (47.6)	[c]***0.859***
	Secondary school	6 (14.3)	2 (9.5)	4 (19.0)	
	High school	12 (28.6)	6 (28.6)	6 (28.6)	
	University	3 (7.1)	2 (9.5)	1 (4.8)	
Menopause status	**Premenopause**	1 (2.4)	1 (4.8)	0 (0)	[d]***1.000***
	Postmenopause	41 (97.6)	20 (95.2)	21 (100)	
Menopause age (year)	*Min-Max (Median)*	35-58 (49.5)	35-54 (50)	35-58 (48.5)	[a]***0.954***
	Mean±SD	48.0±5.42	47.95±5.38	48.05±5.60	
Family history of hand nodule	**No**	29 (69.0)	16 (76.2)	13 (61.9)	[e]***0.317***
	Yes	13 (31.0)	5 (23.8)	8 (38.1)	
Smoking	**No**	33 (78.6)	17 (81)	16 (76.2)	[d]***1.000***
	Yes	9 (21.4)	4 (19)	5 (23.8)	
Dominant hand	**Right**	42 (100)	21 (100)	21 (100)	[d]***1.000***
	Left	0 (0)	0 (0)	0 (0)	

[a]Student's *t*-test, [b]Mann-Whitney U Test, [c]Fisher Freeman Halton Exact Test, [d]Fisher's Exact Test, [e]Pearson's Chi-Square Test. SD: Standard deviation, BMI: Body-mass index.

in both groups (p<0.001). There was no significant difference between groups in VAS at rest and VAS with activity scores 3 months after treatment (p=0.581, p=0.307) (Table II).

Analysis of the DHI scores showed that the P group had higher pre-treatment and post-treatment 2-week scores than those in the PW group. The DHI scores improved significantly in both PW and P groups (p<0.001 and p<0.001, respectively). A statistically significant decrease was observed in pairwise comparisons when the post-treatment 2nd-week, 1st-month, and 3rd-month values were compared to the pre-treatment values in both PW and P groups. The DHI scores were significantly higher in the P than in the PW group 3 months after treatment (p=0.042).

Table II. VAS Scores of the patients during follow-up.

			Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p
VAS scores	**PreT**	*Min-Max (Median)*	0-6 (4)	1-7 (4)	*0.712*
		Mean±SD	3.95±1.63	3.86±1.96	
	2 weeks	*Min-Max (Median)*	0-5 (4)	0-5 (2)	*0.217*
		Mean±SD	3.00±1.97	2.29±1.85	
	1 month	*Min-Max (Median)*	0-5 (3)	0-6 (2)	*0.692*
		Mean±SD	2.90±1.48	2.86±1.90	
	3 months	*Min-Max (Median)*	0-6 (2)	0-5 (3)	*0.460*
		Mean±SD	2.52±1.75	2.86±1.15	
		f_p	***0.024***	***0.014***	
	Difference between postT 3-month and PreT scores	*Mean±SD*	-1.4±2.3	-1±1.8	*0.581*
	Paired comparisons; gp	**PreT-PostT 2nd week**	*0.335*	***0.020***	
		PreT-PostT 1st month	*0.189*	*0.438*	
		PreT-PostT 3rd month	*0.101*	*0.162*	
		PostT 2nd week-1st month	*1.00*	*1.00*	
		PostT 2nd week-3rd month	*1.00*	*1.00*	
		PostT 1st month-3rd month	*1.00*	*1.00*	
VAS scores with activity	**PreT mean±SD**	Min-Max (Median) 5.33±1.39	0-6 (4) 5.67±1.39	1-7 (4)	*0.537*
	2 weeks	Min-Max (Median)	0-7 (4)	1-7 (4)	*0.990*
		mean±SD	4.00±1.97	4.24±1.37	
	1 month	Min-Max (Median)	0-7 (4)	1-8 (4)	*0.789*
		mean±SD	3.57±1.75	3.71±1.85	
	3 months	Min-Max (Median)	0-7 (3)	1-5 (4)	*0.654*
		mean±SD	3.33±1.85	3.52±1.29	
		f_p	***<0.001***	***<0.001***	
	Difference between postT 3-month and PreT scores		***-2***±2	***-2.14***±1.62	*0.307*
	Paired comparisons; [g]p; [g]p	**PreT-PostT 2nd week**	***0.014***	***0.020***	
		PreT-PostT 1st month	***<0.001***	***<0.001***	
		PreT-PostT 3rd month	***0.001***	***<0.001***	
		PostT 2nd week-1st month	*1.000*	*0.8909*	
		PostT 2nd week-3rd month	*1.000*	*0.811*	
		PostT 1st month-3rd month	*1.000*	*1.000*	

[b]Mann-Whitney U Test, [f]Friedman Test, [g]Dunn Test, SD: Standard deviation, VAS: Visual analog scale, PreT: Pre-treatment, PostT: Post-treatment.

Table III. Evaluation of Duruoz Hand Index scores.

			Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p
DHI scores	**PreT**	*Min-Max (Median)*	3-21 (7)	5-41 (12)	**0.005**
		Mean±SD	8.90±5.38	16.76±10.73	
	2 weeks postT	*Min-Max (Median)*	1-19 (3)	2-28 (7)	**0.004**
		Mean±SD	4.52±4.23	9.43±7.49	
	1 month postT	*Min-Max (Median)*	0-12 (3)	1-14 (4)	*0.196*
		Mean±SD	4.00±3.38	5.86±4.22	
	3 months postT	*Min-Max (Median)*	0-12 (3)	1-14 (5)	*0.064*
		Mean±SD	3.90±3.69	5.57±3.57	
		f_p	**<0.001**	**<0.001**	
	Difference between PostT 3-month and PreT scores	*Min-Max (Median)*	-5±4.5	-11.2±9.8	**0.042**
		Mean±SD	-16-4 (-5)	-33-2 (-7)	
	Paired comparisons; gp	**PreT-PostT 2nd week**	**<0.001**	**0.017**	
		PreT-PostT 1st month	**<0.001**	**<0.001**	
		PreT-PostT 3rd month	**<0.001**	**<0.001**	
		PostT 2nd week-1st month	1.000	**0.030**	
		PostT 2nd week-3rd month	1.000	0.061	
		PostT 1st month-3rd month	1.000	1.000	

[b]Mann-Whitney U Test, [f]Friedman Test, [g]Dunn test, SD: Standard deviation, PreT: Pre-treatment, PostT: Post-treatment, DHI: Duruoz Hand Index.

Right-hand grip strength significantly improved in both PW and P groups (p<0.001 and p=0.001). In the PW group, pairwise comparisons revealed a significant increase in right-hand grip strength 2 weeks, 1 month, and 3 months after treatment. However, in the P group, a significant increase was observed in right-hand grip strength only 3 months after treatment. At 3 months post-treatment, there was no difference in right-hand grip strength compared with pre-treatment values in both groups (p=0.57) (Table III).

Left-hand grip strength significantly improved in both PW and P groups (p=0.013, p=0.002). In the PW group, pairwise comparisons revealed increased left-hand grip strength 3 months after treatment (p=0.011). In pairwise comparisons, left-hand grip strength 1 month and 3 months after treatment was significantly higher than pre-treatment values in the P group (p=0.036 and p=0.017). In both PW and P groups, the comparison of the post-treatment left-hand grip strength values with the pre-treatment did not reveal a significant difference (p=0.222).

Lateral pinch of the right and left hands did not differ significantly between groups before and after treatment (p>0.05) (Table IV).

The three-point hand pinch strength of the right and left hand improved significantly in the PW group (p<0.001, p=0.010). Pairwise comparisons revealed an increase in three-point pinch strength at the assessments performed 2 weeks, 1 month, and 3 months after treatment on the right side (p=0.016, p=0.002, p=0.001). A similar analysis showed a significant increase in the three-point pinch strength 3 months after treatment on the left side (p=0.009).

No significant increase was detected in three-point pinch strength in both the right and left hands of the patients in the P group (p=0.139, p=0.261). However, there was a significant difference in the three-point hand pinch strength of the left hand 3 months after completion of the treatment in both the PW and P groups (p=0.010, p=0.261).

After treatment, the two-point right-hand pinch strength significantly increased in the PW group but not in the P group (p=0.001, p=0.338). Pairwise comparisons revealed an increase in right two-point pinch strength only at week 2 after treatment (p=0.005).

The two-point left-hand pinch strength increased significantly in the PW and P groups (p=0.002, p=0.016). Herein, the pairwise comparisons revealed a significant increase 3 months after treatment in the PW group and at week 2 in the P group (p=0.004, p=0.005).

Table IV. Evaluation of the grip and lateral pinch measurements.

		Grip R			Grip L			Lateral Pinch R			Lateral Pinch L		
		Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo therapy (n=21)	[b]p
PreT	*Min-Max (Median)*	20.9-53.6 (33.7)	18.9-46.6 (30.5)	*0.421*	16.5-57 (30.2)	20.8-47.2 (30.3)	0.505	8-19 (11.5)	7.5-17 (11)	0.553	6.5-18 (11)	6.5-16 (11)	0.819
	Mean±SD	34.7±10.3	33.4±8.9		32.84±10.12	30.58±7.52		12.12±2.75	11.64±2.3		11.4±2.63	11.29±2.3	
2 weeks PostT	*Min-Max (Median)*	23.9-68.7 (43.2)	18.3-47.9 (33.2)	***0.015***	18.9-68.7 (33.8)	19.7-46.1 (32.1)	0.113	9-25 (12)	9-18 (12)	0.649	8-23 (11)	8-18 (11.5)	0.860
	Mean±SD	42.6±12.6	33.4±8.9		38.32±13.42	31.4±8.29		13.24±3.54	12.74±2.84		12.45±3.77	11.83±2.1	
1 month PostT	*Min-Max (Median)*	21.6-65.3 (44.3)	20.6-49.8 (37)	***0.036***	19.5-65.5 (39.2)	24.8-46.9 (34)	0.208	10.5-26 (12.5)	9.5-18 (11)	0.219	46-24 (12)	9-16.5 (11)	0.460
	Mean±SD	43.9±11.9	36.6±7.8		39.35±12.36	34.19±6.81		13.43±3.35	12.67±2.79		12.29±3.51	11.67±2.01	
3 months PostT	*Min-Max (Median)*	23.4-69.8 (45.2)	21.5-52.6 (39.9)	*0.083*	19.1-63.8 (42.5)	17.9-49.2 (37.6)	0.059	10-25 (12)	7.5-18 (12)	0.909	6-23 (12)	7-15 (11)	0.621
	Mean±SD	44.3±12.8	39.9±7.2		40.72±12.06	35.33±7.98		12.93±3.37	12.64±2.65		12.21±3.71	11.43±2.22	
	[f]***p***	***<0.001***	***0.001***		***0.013***	***0.002***		*0.055*	*0.091*		*0.237*	*0.793*	
Difference between	*Min-Max (Median)*	-3.6-23.5 (8.9)	-2.6-19.3 (6.7)	*0.571*	-4.8-21.2 (7.8)	-13.1-20.6 (4.7)	0.222	-4-6 (0.5)	-3.5-7.5 (1)	0.782	-4-5 (1)	-5-5 (0)	0.307
PostT 3 -month and PreT	*Mean±SD*	9.6±9.2	7.9±6.8		7.9± 7.8	4.7 ± 8.1		0.81±2.98	1±2.93		0.81± 2.1	0.14 ± 2.24	
Paired comparisons; [g]p	**PreT-PostT 2nd week**	**0.020**	1.00		0.384	1.00							
	PreT-PostT 1st month	***0.003***	0.101		0.086	**0.036**							
	PreT-PostT 3rd month	**0.001**	**0.001**		***0.011***	**0.017**							
	PostT 2nd week-1st month	1.00	0.721		1.00	0.072							
	PostT 2nd week-3rd month	1.00	**0.025**		1.00	**0.036**							
	PostT 1st month-3rd month	1.00	1.00		1.00	1.00							

[b]Mann-Whitney U Test, [f]Friedman Test, [g]Dunn test. SD: Standard deviation, PreT: Pre-treatment, PostT: Post-treatment.

Table V. Evaluation of two- and three-point pinch strength measurements.

		R Two-point pinch strength			L two-point pinch strength			R three-point pinch strength			L three-point pinch strength		
		Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo-therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo therapy (n=21)	[b]p	Paraffin wax (n=21)	Prolo therapy (n=21)	[b]p
PreT	*Min-Max (Median)*	5-11.5 (8)	6-12 (9)	*0.542*	2-11.5 (7)	5-10 (7.5)	*0.939*	7-18 (10)	6-14 (11)	*0.416*	4.5-16 (9.5)	7-13 (10)	*0.276*
	Mean±SD	8.21±1.73	8.69±1.89		7.48±2.6	7.38±1.49		10.19±2.35	10.29±1.85		9.36±2.8	9.98±1.68	
2 weeks PostT	*Min-Max (Median)*	7-12 (10)	6-15 (9.5)	*0.385*	4-12 (8)	6-11.5 (8)	*0.809*	7.5-20 (11)	8-15 (11)	*0.559*	4-14 (10)	8-14.5 (10.5)	*0.631*
	Mean±SD	9.81±1.54	9.5±2.27		8.24±2.47	8.48±1.74		11.5±2.65	11.02±1.95		10±2.76	10.62±1.72	
1 month PostT	*Min-Max (Median)*	7-12 (9)	7-14 (9)	*0.769*	4-12 (9)	6-11.5 (8)	*0.939*	9-19 (11)	8-16 (11)	*0.593*	4-14 (10)	6-12 (10.5)	*0.919*
	Mean±SD	9.29±1.65	9.21±1.81		8.36±2.25	8.52±1.63		11.52±2.08	11.26±2.23		10.1±2.66	10.19±1.63	
3 months PostT	*Min-Max (Median)*	6-12 (10)	21.5-52.5 (39.82)	*0.500*	5-12 (9.5)	5-11 (8)	*0.118*	8-19 (11.5)	8-16 (11)	*0.761*	6-15 (11)	5-15 (11)	*0.424*
	Mean±SD	9.52±1.65	39.35±7.17		9.12±1.99	8.29±1.42		11.67±2.31	11.45±2.24		10.79±2.36	10.1±2.55	
	[f]p	**0.001**	*0.338*		**0.002**	**0.016**		**<0.001**	*0.139*		**0.010**	*0.261*	
Difference between PostT 3 -month and PreT	*Min-Max (Median)*	-2-5 (1)	-2.5-3 (1)	*0.201*	-3-5.5 (1)	-2-4 (1)	*0.300*	-0.5-5.5 (1)	-1.5-4 (0.5)	*0.595*	-1-4.5 (1.5)	-5-3 (0)	**0.018**
	Mean±SD	1.31±1.81	0.55±1.67		1.64±2.23	0.19±1.55		1.48±1.50	1.17±1.85		1.43± 1.44	0.12 ± 1.88	
Paired comparisons; [g]p	**PreT-PostT 2nd week**	0.005			0.162	**0.043**		**0.016**			1.00		
	PreT-PostT 1st month	0.051			0.438	0.139		**0.002**			*0.566*		
	PreT-PostT 3rd month	0.051			**0.004**	0.162		**0.001**			**0.009**		
	PostT 2nd week-1st month	1.00			1.00	1.00		1.00			*1.00*		
	PostT 2nd week-3rd month	1.00			1.00	1.00		1.00			0.438		
	PostT 1st month-3rd month	1.00			0.640	1.00		1.00			0.811		

[b]Mann-Whitney U Test, [f]Friedman Test, [g]Dunn test. SD: Standard deviation, PreT: Pre-treatment, PostT: Post-treatment.

Nevertheless, the comparative analysis of the 3-month post-treatment and pre-treatment two-point hand pinch strength did not reveal a significant difference in both PW and P groups (p=0.20, p=0.30) (Table V).

Discussion

In this study, PW and P had similar efficacies in relieving the pain at rest and during activities in patients with hand OA. Both PW and P treatments could alleviate pain. Our analysis included assessments of the pain scores at different intervals after treatment. The results of this comparative analysis demonstrated that P led to a more rapid reduction in pain scores while the beneficial effects of PW began relatively slowly.

In recent years, the use of P has rapidly gained significant popularity, and the effectiveness of P has been reported[23] in various chronic musculoskeletal conditions.

Currently, it is recommended for knee and hip OA[24]. However, due to the lack of evidence based on the data reported by randomized-controlled trials, it is not recommended as a treatment option in the setting of hand OA in the consensus guidelines. To our knowledge, this is the first study comparing the effect of P and PW in hand OA.

In this study, we used DHI to assess ADL. Pain scores were similar between the patient groups, although baseline patient functionality was better in the PW group than in the P group. After completing the treatment regimens, functionality improved in both groups. Since the improvement in DHI might have led to bias, we also compared the changes in DHI scores in both PW and P groups. Of note, changes in DHI scores were significant at all visits in both groups; both PW and P improved hand function during the post-treatment follow-up period. However, the comparison of the 3-month post-treatment DHI scores with the pre-treatment values revealed a more significant improvement in the P group than in the PW group. Therefore, it can be suggested that P improves hand functionality better than PW.

It was previously reported[25] that it was reasonable to use grip and pinch strength parameters to evaluate functional integrity. Bagis et al[17] worked on postmenopausal Turkish women with hand OA and reported that these patients' grip and pinch strengths were lower than healthy controls. It was also stated that patients with pain, nodules, and tenderness had lower grip and pinch strengths[17]. In line with this finding, in our study, pain scores and functionality parameters improved simultaneously with right and left-hand grip strengths in both PW and P groups. However, lateral pinch strength parameters did not improve in both hands in both groups. While three-point pinch strength improved significantly in the PW group, no improvement was observed in the P group. Notably, the increase in three-point pinch strengths was more prominent in the PW group. Although there was a significant overall increase in two-point right-hand pinch strength in the PW group, a similar increase was not detected in the P group.

In addition, a significant increase in the two-point left-hand pinch strength measurement was found in both PW and P groups. However, the comparison of the 3-month post-treatment and pre-treatment two-point strength measurements did not reveal any significant changes.

Jahangiri et al[11] compared the beneficial effects of dextrose-based P and corticosteroid injection in hand OA patients with an affected first carpometacarpal joint. In the first month, pain scores, pinch strength, and functional scores were better in the latter group than in the former. However, the assessments performed 6 months after treatment revealed that P led to more favorable outcomes regarding pain control and functional parameters. Similar to these findings, in our study, P led to beneficial long-term effects lasting for at least three months. Although both P and PW could control the pain, patients in the P group had relatively more favorable functional outcomes than those in the PW group.

In their study, Reeves and Hassanein[10] evaluated 14 patients with hand OA and 14 healthy controls in a placebo-controlled design. These researchers stated that intra-articular 10% dextrose was significantly more effective in symptomatic pain relief than placebo. They noted no side effects in their cohort. In contrast, one of our patients in the P group was detected to develop a Heberden nodule during the study period following reporting increasing pain and swelling of the third distal interphalangeal joint of the right hand after the completion of the second session of treatment. To our knowledge, this side effect was not reported in the literature.

Some studies have shown the effectiveness of PW in patients with hand OA. In their study, Dilek et al[18] randomly divided 56 patients with hand OA into PW and control groups and followed them for 12 weeks. These authors concluded that PW treatment was effective concerning pain and strength.

Conversely, in a study comparing the effectiveness of PW and whirlpool baths in 58 patients with hand OA, Ucar et al[19] reported that both groups achieved considerable pain control and functional recovery. However, they noted that the whirlpool bath group had more favorable outcomes. In our study, PW was as effective as P regarding pain control and grip strength improvement.

Limitations

Our study has some limitations which should be considered while evaluating its findings. First, it has a relatively small sample size. Second, it did not include male patients; thus, it may be difficult to generalize our findings to both genders. Also, the study groups' baseline DHI scores were significantly different, and the follow-up duration was relatively short.

Conclusions

Despite the abovementioned limitations, we conclude that both P and PW can be used to treat patients with hand OA regarding pain and pinch strength. Considering that P was superior to PW regarding hand functionality, P can be preferred over PW for cases where functional outcomes are prioritized. However, each patient should be evaluated by an individualized approach. Studies with larger patient samples and extended follow-up periods are needed to validate our findings.

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Authors' Contributions

I.U. designed the study. I.U. and S.C. did the literature search. I.U. and S.C. collected the data. I.U. analyzed and interpreted the data and I.U. and S.C. wrote the manuscript. All of the authors read and approved the final manuscript.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval

This study was approved by the Ethical Review Committee of the Bakırköy Dr Sadi Konuk Training and Research Hospital (approval number 2018/419).
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Informed Consent

Written informed consent was obtained from all of the patients.

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