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Original Article

Comparison of the Efficacy of Radial and Focused Extracorporeal Shock Wave Therapy in Dupuytren's Disease: A Pilot Study

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What is already known on this topic?

- *Dupuytren's disease is a common, progressive fibroproliferative disease characterized by thickening of the palmar fascia on the flexor side of the hand.*
- *In the conservative treatment of Dupuytren's disease, extracorporeal shock wave therapy can be used as an effective and safe non-invasive treatment option.*
- *Focused extracorporeal shock wave therapy or radial extracorporeal shock wave therapy has been shown to be effective in the treatment of Dupuytren's disease. However, there are no studies comparing the 2 different modes of extracorporeal shock wave therapy.*

What does this study add on this topic?

- *Both radial extracorporeal shock wave therapy and focused extracorporeal shock wave therapy are useful treatment methods in reducing pain, functionality and activity limitation scores due to Dupuytren disease.*
- *Radial extracorporeal shock wave therapy should be preferred in the treatment of Dupuytren's disease when pain and function are taken into account.*
- *Focused extracorporeal shock wave therapy should be preferred when nodule size and function are taken into account.*

ABSTRACT

Objective: The aim of this study was to compare the effects of focused extracorporeal shock wave therapy (f-ESWT) and radial extracorporeal shock wave therapy (r-ESWT) on pain, functionality, and nodule size measured by ultrasound (US) in patients with Dupuytren's disease (DD).

Methods: This prospective pilot study was carried out at the Physical Therapy and Rehabilitation Hospital's outpatient clinic between May 2023 and September 2024. A total of 22 patients over the age of 18 who were diagnosed with DD by clinical examination were included in the study. The first patient group received f-ESWT (0.35 mJ, 3-4 Hz 2000 pulses) and the second patient group received r-ESWT (3 bar 12 Hz 1400 pulses) twice a week for a total of 6 sessions using the Modus ESWT device over 3 weeks. Each patient was trained on tendon gliding movements and a home exercise program. Patients were evaluated pre- and post-treatment and at a 3-month follow-up. Assessments included the Visual Analog Scale (VAS), Southampton Dupuytren Scoring Scheme (SDSS), nodule size, and handgrip strength (HGS).

Results: The results showed that both r-ESWT and f-ESWT are useful treatment methods in reducing pain, functionality, and activity limitation scores due to DD. However, the decrease in VAS scores was statistically significant in the r-ESWT group ($P = .002$). There was a significant decrease in SDSS scores in the f-ESWT group ($P = .001$) and the r-ESWT group ($P < .001$). f-ESWT was more effective in reducing nodule size ($P = .009$) and no effect of different shock wave sizes was observed in HGS.

Conclusion: This is the publication to compare the effectiveness of extracorporeal shock waves with different wavelengths in the treatment of DD. While r-ESWT may be preferred in the treatment of DD when pain and function are considered, f-ESWT may be preferred when nodule size and function are taken into account.

Keywords: Dupuytren's disease, extracorporeal shock wave therapy, Southampton Dupuytren Scoring Scheme

Introduction

Dupuytren's disease (DD) is a common, progressive fibroproliferative disorder characterized by thickening of the palmar fascia on the palm and flexor side of the hand.[1,2] A recent meta-analysis calculated a worldwide prevalence of approximately 8%.[3] In the early stages (proliferative phase) of the disease, firm nodules develop in the palm. Over time, these nodules grow into fibrous collagen cords that extend into the fingers (involutional phase).[4] As the condition progresses, the cords thicken, mature, and contract, ultimately causing persistent flexion deformities in the fingers (residual phase).[5] The exact pathophysiology and epidemiology of this condition have not been entirely identified.

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Diagnosis is typically established through a combination of clinical presentation and physical examination. Ultrasonography (US) is a valuable tool for assessing nodule size and monitoring disease progression.[1] While patients may be asymptomatic in the early stages, presenting only with palmar fascia retraction associated with the nodules, as the contracture worsens, individuals may experience difficulties with object manipulation and pain.[6] The pain is believed to result from nerve fibers trapped within fibrous tissue or from the compression of local nerves. In many patients, deformities in the fingers and hands restrict their daily activities and have a negative impact on their quality of life.[7] Dupuytren's disease has a wide symptomatic variance or biologic severity, ranging from mild unnoticed disease to a devastating, rapidly evolving situation.[8]

Although DD is not curable, beneficial treatments are available. Treatment options for the disease include low-dose radiotherapy in the nodular phase, anti-inflammatory and/or anti-mitotic drugs such as tamoxifen, pharmacological treatments such as steroid or collagenase injection, surgical treatment such as releasing the affected fascia, and percutaneous needle fasciotomy.[9-11]

Extracorporeal shock wave therapy (ESWT) is another treatment option used in DD. Extracorporeal shock wave therapy transmits acoustic waves characterized by a sharp, sudden, and rapid pressure change with a speed higher than the speed of sound into the body. It is a safe and effective non-invasive treatment choice for various orthopedic conditions.[12] Although there are a few articles in the literature that use either focused ESWT (f-ESWT) or radial ESWT (r-ESWT) in DD, to the authors' knowledge, there is no study comparing the 2 types of ESWT so far. The purpose of this study was to evaluate the efficacy of f-ESWT and r-ESWT on DD and to compare the 2 different modes.

Materials and Methods

Study Design and Participant

Between May 2023 and September 2024, this prospective pilot study was conducted at the outpatient clinic of Ankara Bilkent City Physical Therapy and Rehabilitation Hospital. The study comprised a total of 22 adults over the age of 18 who had been clinically diagnosed with DD. Exclusion criteria were determined as being under 18 years of age, having received corticosteroid injections within the last 3 months, having undergone relevant surgery, being pregnant or suspected of being pregnant, using anticoagulants, and not accepting to participate in the study. Informed consent was acquired from the patients after they were briefed on the planned procedure. The Declaration of Helsinki's guiding principles were followed when conducting the study. In accordance with E2-23-3832, the Ankara Bilkent City Hospital Ethics Committee approved the study protocol (Date: 10.05.2023).

Demographic data (age, gender, comorbidity, occupation-risk factor) and symptom side were noted. All patients had their weight and height measured. Two groups of patients were randomly selected based on the sequence in which they attended the outpatient clinic.

Group 1 receives applications with odd numbers, while Group 2 receives those with even numbers. Figure 1 shows this study flowchart.

Treatment Protocols

Shockwave therapy was applied to the nodule on the palmar surface of the affected hand in both groups of patients. The first group of patients received f-ESWT (0.35 mJ/cm^2 3-4 Hz 2000 pulses), and the second group received r-ESWT (3 bar 12 Hz 1400 pulses), twice a week for 3 weeks, for a total of 6 sessions using a Modus ESWT device (Modus Radial and Focused Combined Extracorporeal Shock Wave Therapy Device, Türkiye) (Figures 2 and 3). Every patient received instruction in a home exercise program that included tendon gliding movements, stretching exercises, and friction massage. Exercises were controlled during weekly evaluations. None of the patients encountered the rarely seen symptoms of redness, pain, or swelling.

Clinical and Ultrasound Assessments

The patients were evaluated by a single investigator, blinded to the therapy groups, both before and after the treatment, as well as at the 3-month follow-up. Assessments included the Visual Analog Scale (VAS), the Southampton Dupuytren's Scoring Scheme (SDSS), nodule size, and hand grip strength (HGS).

The VAS was a 10-centimeter horizontal line with "no pain" (score: 0) at one end and "worst imaginable pain" (score: 10) at the other. Participants were asked to mark a point on the line. A numerical score (0-10) was recorded.[13]

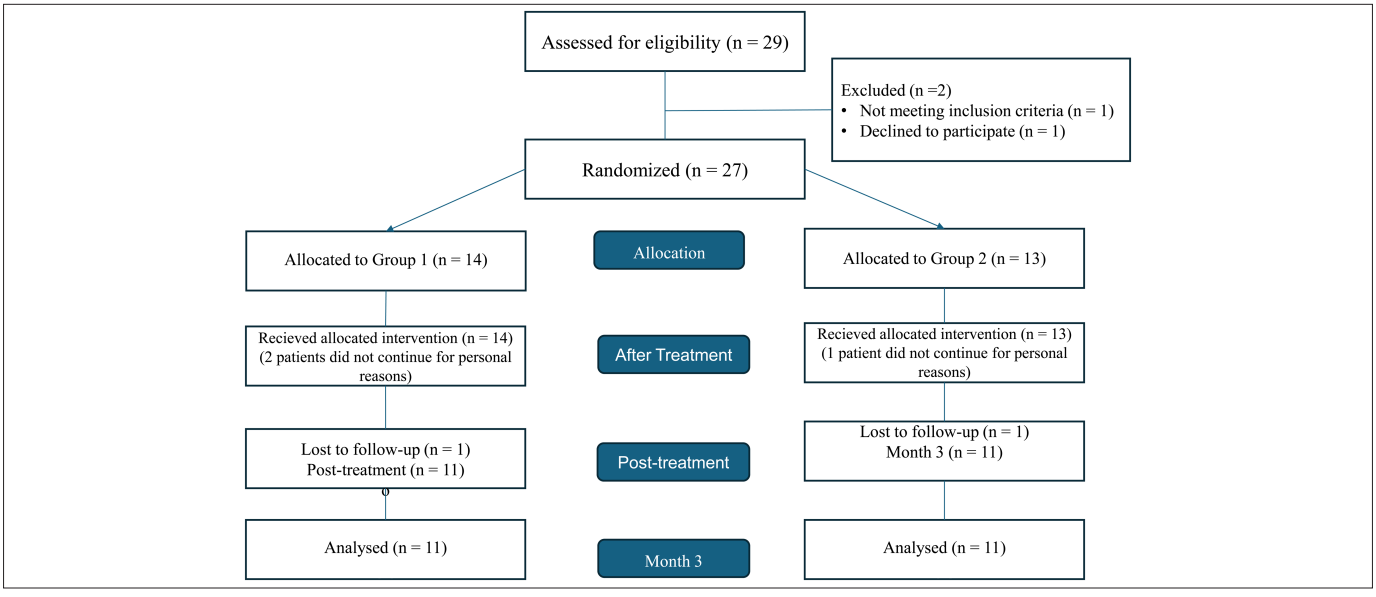

Figure 1. Flowchart of the study.

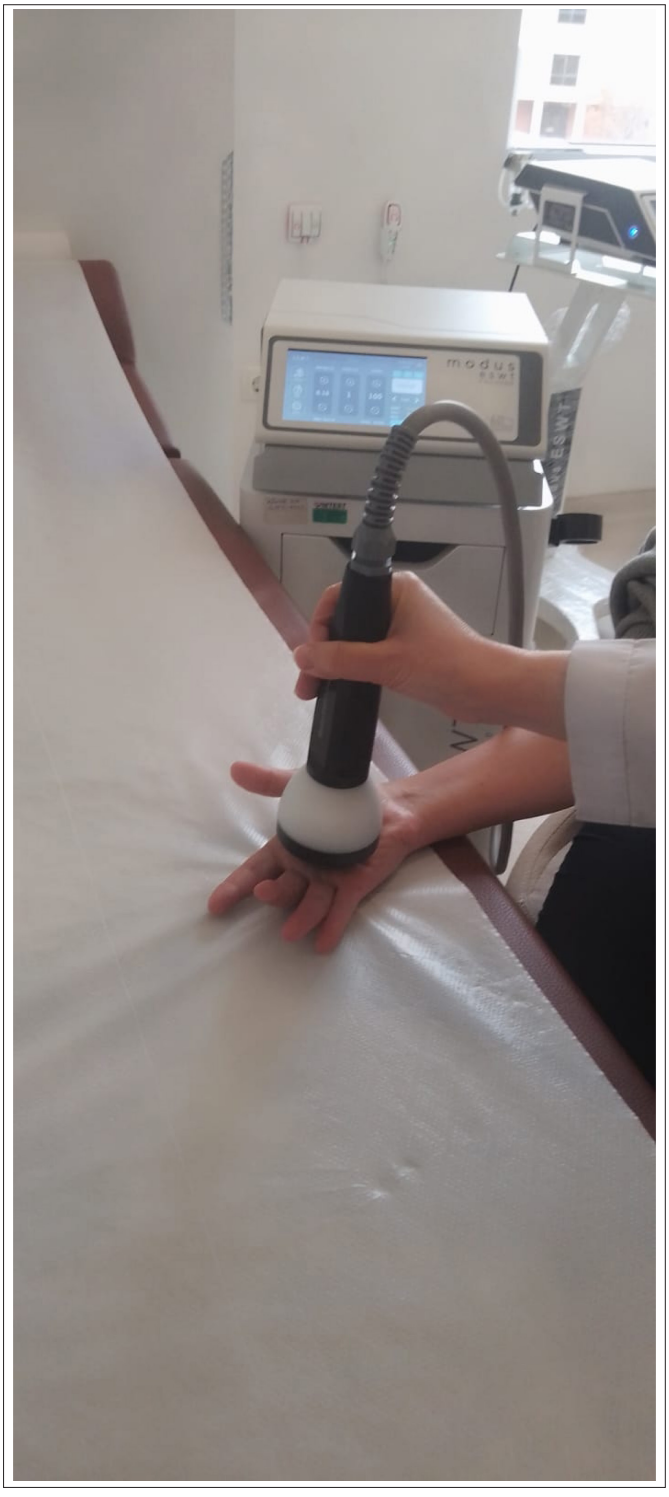

Figure 2. Focus extracorporeal shock wave therapy.

Figure 3. Radial extracorporeal shock wave therapy.

Functional and activity limitations due to DD were assessed using the SDSS. This is a 5-item questionnaire with proven validity and reliability in Turkish, scored on a scale of 0-20. A high score indicates severe discomfort.[14]

For each participant, transverse US images of the DD nodule were obtained, and measurements were made of the maximum diameter for width, depth, and cross-sectional area (CSA)[1] (Figure 4). The same physician, with 10 years of experience in musculoskeletal US, performed all of the US evaluations using a 12-MHz linear probe (Logiq P5, GE Medical Systems, Milwaukee, WI, USA).

Statistical Analysis

For the statistical analysis, SPSS 25.0 (IBM SPSS Corp.; Armonk, NY, USA) was employed. Non-parametric statistical approaches were used because the study's patient group was small, and most of the parameters were not normally distributed in the normal distribution analysis performed with the Shapiro–Wilk test. The median and interquartile range were used for ordinal and non-normally distributed data, and descriptive analyses for categorical variables were displayed as the number of cases (n) and percentage (%). To compare groups, the Mann–Whitney *U* test was used. Categorical variables were compared using the chi-square or Fisher tests. The Friedman test was

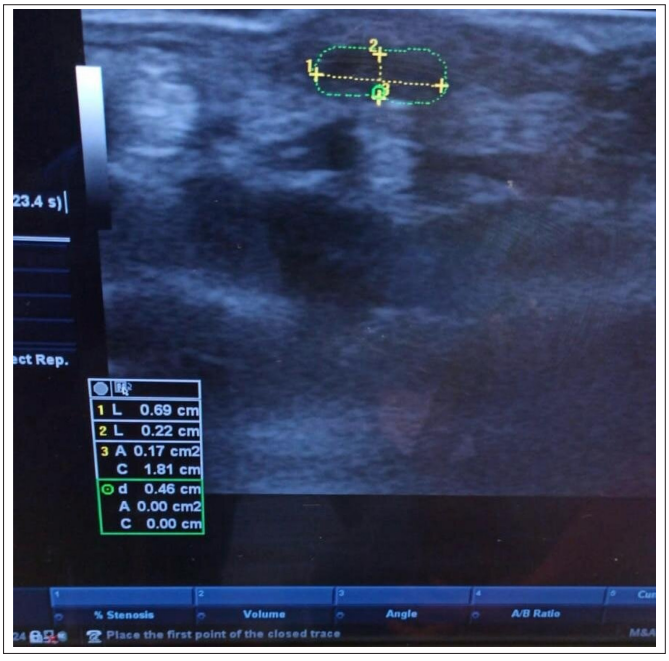

Figure 4. Transverse ultrasound image of Dupuytren's disease nodule: 1: width, 2: depth, and 3: cross-sectional area.

used to analyze intra-group comparisons. When the results were significant, the difference was identified using pairwise comparisons with Bonferroni corrections. A *P*-value of less than .05 was considered statistically significant.

As a result of the power analysis performed with the *t*-test to compare 2 independent groups, taking 90% power, a 0.05 alpha value, and a 1.6 effect size, and considering a possible data loss of 15%, a total of 22 patients were planned to be included, 11 in each group.[6]

Results

This pilot study included 12 female and 10 male patients. Patients were assigned to 2 groups based on Group 1 (f-ESWT) = 11 and Group 2 (r-ESWT) = 11. Table 1 shows the groups' demographic and clinical characteristics. Age, gender, employment, and BMI were all comparable among the groups (all $P > .05$).

The comparisons of patient pain, function and morphology according to treatment groups are given in Table 2. The VAS scores were similar between the groups at both the initial treatment and follow-up (all $P > .05$). Although a reduction in VAS scores was observed in both groups at follow-up compared to baseline, this decrease was statistically significant only in the r-ESWT group ($P = .002$). Additionally, a significant reduction in SDSS scores was noted at follow-up compared to baseline in both the f-ESWT and r-ESWT groups ($P = .001$ and $P < .001$, respectively). Handgrip strength did not change in either group (all $P > .05$). In US evaluations, f-ESWT had a statistically significant effect on the CSA ($P = .009$) and depth ($P = .041$) of the nodule.

Table 1. Demographic and Clinical Characteristics of the Patients

	Focus (n = 11)	Radial (n = 11)	*P*
Gender, n (%)			.087
Female	8 (72.7)	4 (36.4)	
Male	3 (27.3)	7 (63.6)	
Age (year)	58.6 ± 7.0	62.1 ± 7.9	.575
BMI (kg/m^2)	26.5 ± 2.5	27.7 ± 1.3	.055
Employment, n (%)			.513
Housewife	4 (36.4)	2 (18.2)	
Employed	2 (18.2)	4 (36.4)	
Retired	5 (45.5)	5 (45.5)	
Comorbidity, n (%)	8 (72.7)	10 (90.9)	.311
Smoking, n (%)	5 (45.5)	11 (100)	**.035**
Symptomatic side			.670
Right	5 (45.5)	6 (54.5)	
Left	6 (54.5)	5 (45.5)	

BMI, body mass index. Bold values indicate statistical significance (p<0.05).

Table 2. Comparison of Patient Pain, Function and Morphology Based on Treatment Groups

		Focus (n = 11)	Radial (n = 11)	*P*
VAS	Baseline	2 (0-4)	5 (3-6)[a]	.104
	Post-treatment	1 (0-5)	3 (2-5)[ab]	.370
	3rd month	1 (0-4)	3 (2-5)[b]	.101
	P	.327	**.002**	
SDSS	Baseline	4 (2-8)[a]	7 (5-10)[a]	**.027**
	Post-treatment	3 (2-6)[ab]	5 (4-7)[b]	.059
	3rd month	2 (2-5)[b]	5 (2-6)[c]	.142
	P	**.001**	**<.001**	
HGS	Baseline	18 (16-28)	22 (10-34)[a]	.767
	Post-treatment	20 (15-27)	22 (12-35)[a]	.947
	3rd month	20 (17-28)	21 (11-34)[a]	.767
	P	.209	**.048**	
Width of the nodule	Baseline	6 (5.7-6.3)	6 (4.3-8.1)	.869
	Post-treatment	6.5 (5-7.1)	5.2 (4.1-8.2)	.838
	3rd month	5.6 (4.2-7.3)	5.3 (4.2-7.4)	.935
	P	.092	.237	
Depth of the nodule	Baseline	2.2 (1.5-3.1)[a]	2 (1.5-2.6)	.743
	Post-treatment	1.7 (1.2-2.3)[a]	1.8 (1.4-2.9)	.567
	3rd month	1.7 (1.2-2.1)[a]	1.8 (1.3-2.8)	.539
	P	**.041**	.146	
CSA of the nodule	Baseline	12.5 (8-18.5)[a]	10 (9-13)	.565
	Post-treatment	10.5 (6.3-15.8)[a]	11 (7.5-14.5)	.594
	3rd month	7.5 (4-12)[b]	11 (6-21.5)	.177
	P	**.009**	.441	

Post hoc test results in within-group comparison are indicated by superscript letters a,b andc, which indicate the difference between time points ($P < .016$). The same letters represent statistical similarity, whereas different letters refer to statistical differences. Bold values indicate statistical significance.
CSA, cross-sectional area; HGS, hand grip strength; SDSS, The Southampton Dupuytren's Scoring Scheme; VAS, visual analog scale.

Discussion

Dupuytren's disease is a chronic progressive pathology defined by fibrosis and thickening of the palmar fascia, culminating in the formation of fibrous nodules and cords. It results in a loss of range of motion in the affected fingers and pain associated with tenosynovitis.[12] Recent research has demonstrated that ESWT can be used to improve function and reduce pain in the management of DD, in addition to the other therapeutic alternatives available. However, there is no consensus on which type of ESWT is used for DD. In this pilot study, f-ESWT was found to be effective on nodule size and function, and r-ESWT was effective on pain and function in the treatment of DD.

In DD, fibroblasts transform into myofibroblasts under mechanical stress and transforming growth factor beta 1 (TGF-β1), resulting in pathological fibrous cords in the high-stress areas between the dermis and fascia. Myofibroblast contraction contributes to disease progression. In healthy individuals, the process stops after stress is resolved due to myofibroblast apoptosis. However, an unknown factor blocks

this process in DD patients, allowing abnormal cells to continue to proliferate and respond to stress.[8] The disease is linked to genetic factors (80% causality), advancing age, and comorbidities. Men over 50, alcohol and smoking habits, thyroid dysfunction, liver disease, diabetes, previous hand trauma, anticonvulsant medication use, and working with vibrating tools for many years (>15) are also significantly associated with DD.[1,15] The disease primarily affects the ring finger, followed by the little finger and middle finger.[1] Extracorporeal shock wave therapy is one of the conservative therapy modalities for this condition, which causes pain and function loss in patients.[6]

Shock wave effects are still a precise process is still unknown. The decrease in substance P concentration in the stimulated area[16] and dorsal root ganglia calcitonin gene-related peptide is most likely the main cause of the shock wave's analgesic impact.[17] Extracorporeal shock wave therapy may be effective in treating DD through a variety of mechanisms, including cytokine regulation effector, nociceptor inhibition, initiation of neovascularization, stimulation of cellular proliferation, and accelerated regeneration of damaged tissue, which leads to pain relief and functional recovery.[18]

To the best of the authors' knowledge, no study has compared the therapeutic efficiency of focused and radial shock, despite the fact that numerous studies in the literature demonstrate the efficacy of ESWT in the management of DD. Radial low-to-moderate-energy shock waves, compared to focused high-energy shock waves, produce shock waves by accelerating a projectile with compressed air and then impinging on an applicator. Radial extracorporeal shock wave therapy devices focus their maximum energy at the tip of the probe, dispersing it radially into the surrounding tissue, while focused shock waves channel the energy deeply into the target area. As a result, r-ESWT has a broader, more superficial effect, while f-ESWT produces a narrower, deeper effect.[12]

A recent systematic review examined 7 studies using ESWT to treat DD and reported that ESWT showed positive results, although there was variability in protocol, frequency, and duration of intervention.[19] Saad et al evaluated whether incorporating r-ESWT into a conventional physical therapy protocol, which includes ultrasound, massage, stretching, and splinting, enhances participant outcomes.[20] It has been hypothesized that focused high-energy ESWT may relieve pain in Dupuytren's nodules.[6] In 4 of the 5 studies in this review, pain decreased from the initial to the final assessment. In 1 study, pain returned to baseline levels.[19] In the randomized controlled trial by Knobloch et al., at the 18-month follow-up, pain in the intervention group (f-ESWT) had decreased by about 47%, while in the placebo group, it had increased by about 35%.[6] In this study, pain was assessed with VAS, decreasing at follow-up in both shock waves, but the reduction in VAS score was statistically significant in the r-ESWT group.

Extracorporeal shock wave therapy contributes to functional improvement. Notarnicola et al[21] analyzed ESWT and high-energy laser therapy in DD; VAS decreased significantly in both groups at all 3-month follow-ups, while functional improvement continued in the long-term effect of ESWT. Similarly, in this pilot study, significant functional improvement was seen in both groups post-treatment and at the 3rd-month follow-ups. Furthermore, following ESWT treatment, HGS may increase. Saad et al observed a statistically significant improvement in grip strength among all participants, including those who did not receive ESWT, with a more pronounced increase in those who underwent r-ESWT.[20] In another study, it was found that r-ESWT in DD resulted in a significant improvement in VAS and an increase in grip strength compared to pre-treatment.[22] On the other hand, several other studies evaluating grip strength using ESWT in the treatment of DD found no significant change in grip strength.[6,23] Knobloch et al[6] conducted a study comparing f-ESWT with a placebo in 52 patients. They found a significant reduction in the VAS for pain in the ESWT group, while grip strength showed no significant change in either group. Similarly, in this study, HGS did not change in both groups.

The impact of ESWT on nodule size has only been examined in 1 case report so far. In this case study, Brunelli et al[12] noted that they observed r-ESWT reduce the size of nodules and cords in the palmar fascia region. However, in this study comparing r-ESWT with f-ESWT, it was found that f-ESWT was more effective in terms of nodule depth and CSA.

Strengths and Limitations

This pilot study is the first to compare the effectiveness of r-ESWT and f-ESWT in the treatment of DD is its main strength. Nevertheless, it has a number of limitations. The limited sample size, lack of a control group, and short follow-up period limit the generalizability of the results. This pilot study has a number of limitations even though it is the first to evaluate r-ESWT and f-ESWT in the treatment of DD. The limited sample size, lack of a control group, and short follow-up period limit the generalizability of the results.

Conclusion

The efficacy of extracorporeal shock waves at different wavelengths in treating DD is being compared for the first time in this study. The results showed that both r-ESWT and f-ESWT are useful treatment methods in reducing pain, functionality and activity limitation scores due to DD. In conclusion, r-ESWT may be preferable in the treatment of DD when pain and function are taken into account, but f-ESWT may be preferred when nodule size and function are considered. A larger sample size and longer follow-up study are required to compare the effectiveness of these treatments.

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of the Ankara Bilkent City Hospital Ethics Committee (Date: 10.05.2023; Approval no: E2-23-3832).

Informed Consent: Written informed consent was obtained from patients, who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – Ö.T., E.Y.; Design – Ö.T., E.Y., A.M.A.; Supervision – E.Y.; Resources – T.Y.; Materials – Ö.T., T.Y., Ö.U., A.M.A.; Data Collection and/or Processing – T.Y., A.M.A.; Analysis and/or Interpretation – A.M.A.; Literature Search – Ö.T., A.M.A.; Writing Manuscript – Ö.T., A.M.A.; Critical Review – E.Y.

Declaration of Interests: The authors declare that they have no competing interests.

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