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Original Article

The comparison of the efficacy of extracorporeal shockwave therapy and high-intensity laser therapy in the treatment of de Quervain tenosynovitis

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ABSTRACT

Objectives: This study aims to investigate and compare the treatment efficacy of extracorporeal shockwave therapy (ESWT) and high-intensity laser therapy (HILT) regarding pain management and functionality in patients with de Quervain tenosynovitis (DQT).

Patients and methods: Between May 2022 and November 2022, a total of 60 patients with DQT (16 males, 34 females; mean age: 43.3±7.7 years; range, 18 to 65 years) were included in this study. The patients were randomly divided into two groups as follows: Group A (ESWT, n=29) and Group B (HILT, n=31). The patients were asked to refrain from all types of exercise 24 h before the experiment. The pain level of the patients at the time of presentation was evaluated via Visual Analog Scale (VAS), and the function outcome was evaluated with Quick Disabilities of Arm, Shoulder and Hand (QDASH) before and after the treatment. Muscle strength was evaluated with a Jamar hand dynamometer, and an algometer was used to measure pressure pain threshold (PPT). The Global Assessment Scale (GAS) was used to measure the treatment success.

Results: The intragroup comparisons revealed significant improvements in all parameters after the treatment in both groups ($p<0.05$). The VAS-rest score, the VAS-movement score, the QDASH score, pain-free grip strength (PFGS), and PPT showed a significant difference before treatment at three weeks and three months ($p<0.01$). The difference between the PPT values of the groups at three weeks was significant ($p<0.01$). The third-week PPT value of Group B was higher than the PPT value of Group A. The difference between GAS 1 and GAS 2 of both groups was statistically significant at three weeks and three months ($p<0.05$).

Conclusion: Both ESWT and HILT treatments are safe and effective in DQT treatment. The ESWT is a recent, non-invasive therapeutic modality which is effective, convenient, and safe in DQT. On the other hand, HILT is a non-invasive, reliable method which has a greater effect on DQT.

Keywords: De Quervain tenosynovitis, extracorporeal shockwave therapy, high-intensity laser therapy.

De Quervain tenosynovitis (DQT) affects the first extensor compartment of the wrist, and it is not rare, with an incidence of 0.94 per 1,000 individuals annually.[1] In general, the overuse or repetitive movements of the wrist or thumb constitutes the etiology. De Quervain tenosynovitis is usually diagnosed based on clinical findings.[2] Women are affected four times more than men. The prevalence is elevated among individuals of non-white ethnicity and those aged 40 years and above.[1] De Quervain tenosynovitis causes thickening in the first dorsal compartment and its tendons. The ability to perform grasping, lifting, and twisting activities involving the thumb may be compromised in tasks where the extensor pollicis brevis (EPB) and abductor pollicis longus (APL) muscles are involved.[3] De Quervain tenosynovitis is the inflammation of the tenosynovium surrounding the EPB and APL tendons. Typical findings of DQT include pain and swelling in the first dorsal compartment of the wrist. It can be diagnosed by using the Finkelstein test, and focal tenderness over the first compartment is apparent during physical examination.[4] Recommended treatments are analgesics, thumb

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spica splints, physical therapy modalities, rest, corticosteroid injections, and surgery.[5] Surgery can provide definitive treatment, when conservative treatment fails to relieve symptoms; however, non-operative treatment can be preferred if symptoms are relievable.[6]

Extracorporeal shockwave therapy (ESWT) can be effectively used in the treatment of musculoskeletal pathologies involving tendons, ligaments, muscles, joints, and bones.[7] It induces a biological response cascade and molecular changes, including neovascularization and upregulation of angiogenetic growth factors, causing improved blood supply and tissue regeneration.[8] High-intensity laser therapy (HILT) encompasses photochemical and photothermic effects, potentially stimulating collagen production within tendons and promoting increased blood flow and vascular permeability. Moreover, it exhibits anti-inflammatory properties.[9,10] The effectiveness of HILT regarding tendinopathies has been revealed in randomized-controlled trials.[11-13] Thus, HILT and ESWT may have a positive effect on the repair of the damaged tissue and remove the pain stimulus.

To date, there is no clinical study comparing the efficacy of ESWT and HILT in the treatment of DQT. In the present study, we aimed to investigate and compare the treatment efficacy of ESWT and HILT regarding pain management and functionality in DQT patients.

PATIENTS AND METHODS

This prospective randomized study was conducted at Batman Training and Research Hospital, Department of Physical Medicine and Rehabilitation between May 2022 and November 2022. A total of 60 patients with DQT (16 males, 34 females; mean age: 43.3±7.7 years; range, 18 to 65 years) were included. These participants experienced radial-sided wrist pain accompanied by limited extension or abduction of the thumb, along with tenderness over the styloid process in the first dorsal extensor compartment. Additionally, they tested positive for the Finkelstein test. Furthermore, individuals under medical care for a minimum of six weeks (ranging from four to six weeks) with the administration of oral and local non-steroidal anti-inflammatory drugs (NSAIDs) and those exhibiting a lack of response to treatment or dissatisfaction with the provided intervention, were also considered eligible for the study. Patients with acute trauma and neoplasm involving wrist joint on physical examination and patients who had conventional radiographs, previous surgery history or steroid injection, or had any disease that may cause cervical shoulder, hand or arm pain, perception problems, a neurological disease that may affect the upper extremity, and a history of systemic or rheumatic disease that may involve the joints were excluded from the study. A written informed consent was obtained from each patient. The study protocol was approved by the Ministry of Health Batman Training and Research Hospital Scientific Research Ethics Committee (date: 25.04.2022, no: 305). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients were asked to refrain from all types of exercise 24 h before the experiment. The randomization of 60 patients was performed with the closed envelope method, and two groups were formed with 29 (Group A, ESWT) and 31 (Group B, HILT) participants, respectively (Figure 1).

De Quervain tenosynovitis was determined in the presence of pain at the radial styloid process reflecting through the thumb and forearm. Local tenderness was present during the physical examination, and some patients had swelling together with crepitation during palpation.

A pre-tested questionnaire was used to collect the data. Two groups were formed as follows: Group A was treated with ESWT, and Group B with HILT. Visual Analog Scale (VAS) scoring between 0 (no pain) to 10 (severe pain) was used to evaluate the pain at the time of presentation. The assessment of functionality involved the use of the shortened form of the Quick Disabilities of the Arm, Shoulder, and Hand (QDASH) questionnaire both before and after the treatment. Muscle strength was evaluated utilizing a hand dynamometer (Jamar; Sammons Preston, Inc., IL, USA), while the pressure pain threshold (PPT) was measured using an algometer (Baseline® Dolorimeter; Fabrication Enterprises Inc., NY, USA). The VAS, QDASH, PFGS, and PPT values of the patients were measured before the treatment and at three weeks and three months during follow-up. The Global Assessment Scale (GAS) was used to measure the effectiveness of the treatment. The GAS values of the patients were measured at three weeks and three months during follow-up.

Intervention

Extracorporeal shock therapy

Utilizing single pulsed acoustic waves generated externally, ESWT is a non-invasive technique that targets specific areas of the body. Previous research

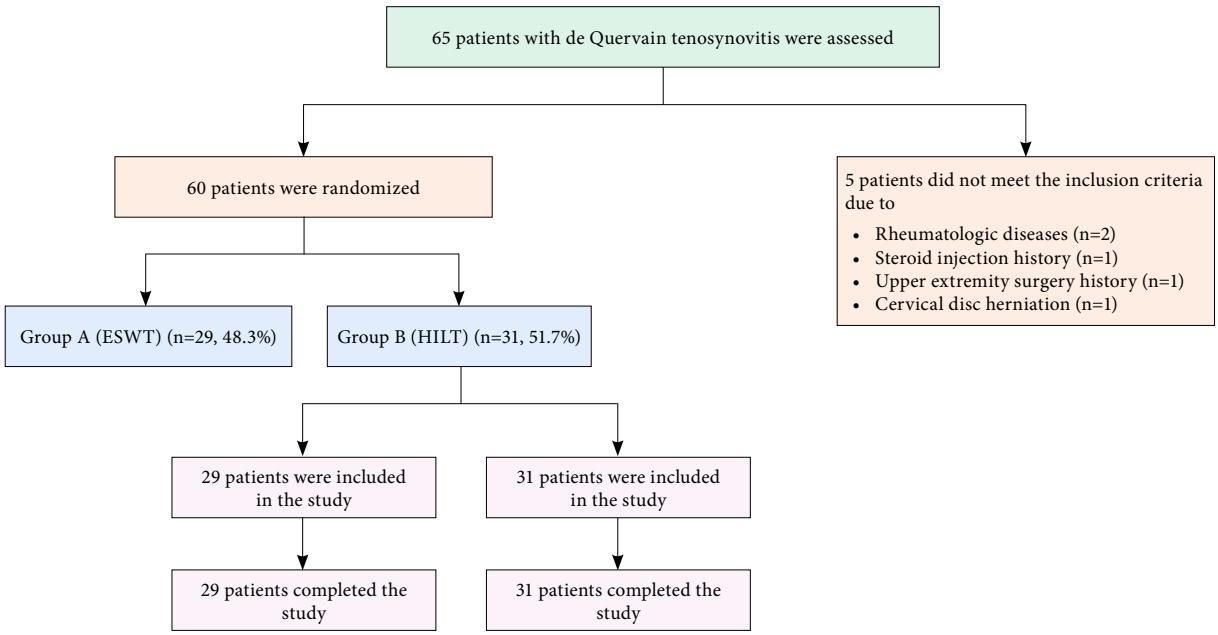

Figure 1. Study flowchart.
ESWT: Efficacy of extracorporeal shockwave therapy; HILT: High-intensity laser therapy.

has consistently highlighted ESWT as an effective and enduring method for alleviating pain in soft tissue conditions like plantar fasciitis and Achilles tendinopathy. The shockwaves induce various molecular reactions, stimulating axonal regeneration in peripheral nerves. Extracorporeal shockwave therapy achieves pain management by inducing biochemical changes in nerve fibers and concurrently alleviates soft tissue inflammation.[14,15] Additionally, ESWT fosters revascularization and plays a role in stimulating or reactivating the enhancement of connective tissues, encompassing tendons and bones.[16] In our study, we planned for a total of five sessions of ESWT with two-day intervals for three weeks, applied from 1,000 beats/18 Hz frequency/1.8 bar intensity point to 1,000 beats/21 Hz frequency/1.4 bar intensity using an ESWT device (MASTERPULS® MP200 Elite; Storz Medical AG, Kreuzlingen, Switzerland).

High-intensity laser therapy

Laser photobiomodulation (PBM) therapy stands as a non-invasive and pain-free modality within contemporary physiotherapy, offering both systemic and local effects.[17-20] The impact of PBM on tissues is contingent upon several factors, including wavelength, pulse time interval, pulse duration, irradiation mode (continuous or pulse), energy, fluence, power output, and irradiance.[17] By stimulating cells in peripheral tissues, including pain receptors and the immune system, PBM induces vasodilation and analgesic effects, making it a widely employed approach for pain reduction.[17,19] Moreover, laser therapy exhibits the potential to foster the improvement of damaged tissues and peripheral nerves, thereby facilitating neurological regeneration.[17,20,21] In our study, we planned for a HILT of five sessions per week for a total of 10 sessions, applied at a dose of 8 W - 6 J/cm^2 (analgesic) for 1 min and 15 sec and a dose of 4 W - 120 J/cm^2 (biostimulation) for 12 min and 30 sec using a HILT device (BTL-6000; BTL Industries, Ashford, UK). The patients and the practitioner used protective glasses to protect their eyes from the laser beam. Photobiomodulation was performed by the same physiotherapist.

Measurements

Pain assessment

A VAS using a 10-cm-long ruler was used to assess pain severity (0=no pain and 10=most severe pain).[22] The patients stated their pain score at rest (VAS-rest) and in motion (VAS-movement) separately.

Functional assessment

The QDASH questionnaire serves as a prevalent tool for assessing the efficacy of diverse treatment

approaches in addressing and enhancing disability among individuals with upper extremity disorders. A more concise iteration, the QDASH, streamlines the assessment by utilizing 11 items instead of the original 30 to evaluate musculoskeletal disorders, physical function, and symptoms in patients.[23] At least 10 of the 11 headings must be answered to obtain the QDASH score. Responses to each question are rated on a five-point scale, contributing to a final score that spans from 0 (indicating no disability) to 100 (signifying severe impairment).

Pain-free grip strength (PFGS)

Pain-free grip strength refers to the level of grip force generated through an isometric contraction preceding the onset of pain.[24] In our study, muscle strength was assessed using a Jamar hand dynamometer. Participants were guided to sit on a chair with their feet firmly planted on the floor throughout the measurement. The assessment was conducted with the shoulder in adduction, the elbow flexed at 90 degrees, and the forearm in a neutral position. Detailed instructions were provided to participants on the proper utilization of the dynamometer. Following instructions, the researcher assisted patients in supporting the dynamometer's weight, ensuring unrestricted movement. Participants were instructed to gradually elevate their grip strength, maintaining the onset of pain strength for approximately three seconds during the evaluation. The third range of the dynamometer served as the standardized reference. Grip force was quantified in kilogram-force units, and PFGS was measured thrice, with 1-min intervals between assessments. The average of the three measurements was calculated and taken into consideration.

Pressure pain threshold

The pressure at which participants initially experience pain is termed the PPT.[24] Consistency was maintained, as the same investigator conducted the PPT test under uniform conditions, including consistent room temperature and test equipment, all focused on the radial side of the wrist. The device's power unit was configured to measure in Newton/cm^2, with a gradual pressure increase of 1 N/s until pain detection by the device probe. The test concluded upon the patient's issuance of the "Stop" command and the recorded value displayed on the screen. This measurement process was repeated three times, and the average of the three recorded values was documented.

Global Assessment Scale

Considering the patient's recovery at the final follow-up, the level of social, occupational, and mental functionality was determined. This GAS is scored as: –1=worsening, 0=no change, 1=slight improvement, 2=significant improvement, and 3=near-normal improvement.[25]

Statistical analysis

Statistical analysis was performed using the IBM SPSS for Windows version 25.0 software (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the normality assumption of the variables. Descriptive data were expressed in mean ± standard deviation, median (25th and 75th percentiles), or number and frequency, where applicable. The Fisher-Freeman-Halton exact, chi-square, independent samples t-test, Mann-Whitney U, and Wilcoxon tests were used for the univariate analysis of the variables

TABLE 1
Patients' demographic characteristics

	Total			Group A (n=29)			Group B (n=31)			
	n	%	Mean±SD	n	%	Mean±SD	n	%	Mean±SD	*p*
Age (year)			43.3±7.7			45.4±7.2			42.4±7.8	0.061
Sex										0.459
Male	16	26.7		9	31.0		7	22.6		
Female	44	73.3		20	69.0		24	77.4		
Profession										0.400
Farmer	7	11.7		5	17.2		2	6.5		
Housewife	35	58.3		16	55.2		19	61.3		
Worker	11	18.3		6	20.7		5	16.1		
Official	3	5.0		0	0.0		3	9.7		
Others	4	6.7		2	6.9		2	6.5		

SD: Standard deviation.

depending on the variable type and the availability of assumptions. Comparisons of more than two dependent groups were made using the Friedman test, while paired comparisons of the dependent groups with significant differences as a result of the Friedman test were made using the Wilcoxon signed-rank test. The results were evaluated by applying the Bonferroni correction (0.05/group number). A *p* value of <0.05 was considered statistically significant.

RESULTS

Demographic and baseline characteristics of the patients are given in Table 1. A total of 58.3% of the patients were housewives, 18.3% were workers, 11.7% were farmers, 5.0% were civil servants, and 6.7% were in the other occupational groups. The difference between the distribution of the patients to groups in terms of age, sex, and occupation, defined as demographic characteristics was not statistically significant (p=0.061, p=0.459, and p=0.400, respectively), indicating that the groups were homogeneous.

The VAS-rest, VAS-movement, QDASH, PFGS, and PPT values of the patients measured before the treatment and at three weeks and three months are shown in Table 2. The differences between the pre-treatment and third-week follow-up, between the pre-treatment and third-month follow-up results, and between the third-week and third-month follow-up results were statistically significant in both groups in all parameters (p<0.001).

The highest VAS-rest score was observed before the treatment and the lowest at three months. In both study groups, the mean QDASH value peaked prior to treatment and reached its lowest point during the three-month follow-up. There were no statistically significant differences between the two treatment groups regarding VAS and QDASH scores before the

TABLE 2
The group measurements' comparison was performed before the treatment and Week 3 and Month 3

	Before treatment (1)		Follow-up at Week 3 (2)		Follow-up at Week 3 (3)			1-2	1-3	2-3
	Median	25^{th}-75^{th} Percentile	Median	25^{th}-75^{th} Percentile	Median	25^{th}-75^{th} Percentile	*p**	*p*†	*p*†	*p*†
VAS-rest										
Group A	8	7.5-9	2	2-3	1	1-1.5	<0.001	<0.001	<0.001	<0.001
Group B	8	7-9	2	1-3	1	0-2	<0.001	<0.001	<0.001	<0.001
p	0.654		0.175		0.482					
VAS-movement										
Group A	9	9-10	3	3-4	2	1.5-2.5	<0.001	<0.001	<0.001	<0.001
Group B	9	9-9	3	2-4	2	1-2	<0.001	<0.001	<0.001	<0.001
p	0.071		0.145		0.293					
QDASH										
Group A	86	75.5-90	32	26-39	28	24-34	<0.001	<0.001	<0.001	<0.001
Group B	80	75-87	31	28-35	29	25-32	<0.001	<0.001	<0.001	<0.001
p	0.153		0.656		0.830					
PFGS										
Group A	37	33-43	63	56-75	65	61-75	<0.001	<0.001	<0.001	<0.001
Group B	38	32-43	65	56-88	66	50-100	<0.001	<0.001	<0.001	<0.001
p	0.778		0.547		0.864					
PPT										
Group A	2.1	1.3-3.2	3.8	2.4-5.9	3.4	2.3-5.8	<0.001	<0.001	<0.001	<0.001
Group B	2.2	1.4-2.7	4.3	2.6-6.0	4.4	2.3-6.0	<0.001	<0.001	<0.001	0.737
p	0.462		0.001		0.001					

VAS: Visual analog scale; QDASH: Quick Disabilities of the Arm, Shoulder, and Hand questionnaire; PFGS: Pain-free grip strength; PPT: Pressure pain threshold; * Friedman test; † Wilcoxon signed-rank test; ‡ Mann-Whitney U test.

TABLE 3
Descriptive statistics of Global 1 and Global 2 Assessment Scale scores

	GAS 1 Follow-up at Week 3		GAS 2 Follow-up at Week 3		
	Median	25th-75th Percentile	Median	25th-75th Percentile	*p*
Group A	2	2-2.5	2	1.5-2.0	<0.001
Group B	2	2-3	2	1-2	<0.001
*p**	0.788		0.673		

GAS: Global Assessment Scale; * Mann-Whitney U test; † Wilcoxon signed-rank test.

initiation of treatment, as well as at the three-week and three-month follow-up assessments (p>0.05). In both groups, the mean PFGS value was the lowest before the treatment and the highest at three months of follow-up. The difference between the groups in terms of PFGS values measured before the treatment and at three weeks and three months was not statistically significant (p>0.05). The mean PPT value was the highest at three weeks in Group A and at three months in Group B. The difference between the two groups in terms of PPT values before the treatment was not statistically significant (p>0.05), whereas the difference between the groups in terms of PPT values at three weeks was statistically significant (p<0.01). The mean PPT value in Group B was significantly higher than that of Group A at three weeks and three months (both p=0.001). On the other hand, in Group B, the difference between the three-week and three-month follow-up PPT values was not statistically significant (p>0.05).

The GAS scores are given in Table 3. The difference between GAS 1 and GAS 2 values of both groups was statistically significant. The difference between the groups in terms of GAS 1 and GAS 2 values was not statistically significant (p>0.005).

DISCUSSION

Although ESWT and HILT have been used in various tenosynovitis cases before, the literature does not hold any information about their application in DQT. Therefore, our study is a first in the literature. However, in our study, both ESWT and HILT were applied in our patients and their efficacies were compared, and we concluded that both treatment modalities could be used effectively in DQT. We observed a significant decrease in VAS and QDASH values and a significant improvement in PFGS and PPT values with both treatment modalities.

High-intensity laser therapy, employing pulsed Nd: YAG laser therapy, has found application across diverse disorders such as knee osteoarthritis,[26] low back pain,[27] facial paralysis,[20] subacromial impingement syndrome,[28] and lateral epicondylitis.[29] Notably, HILT has demonstrated efficacy in swiftly alleviating inflammation and pain.[30] An apparent increase in the range of motion occurs with the reduction of pain, which increases patients' the quality of life. High-intensity laser therapy uses a specific waveform. The waves exhibit consistent peaks at regular intervals in both time and amplitude values to mitigate thermal deposition. High-intensity laser therapy promotes swift enhancements in blood flow, vascular permeability, and cell metabolism, thereby inducing rapid photochemical and photothermic effects in deep tissues.[31] Furthermore, the photothermic effects and photochemical properties of HILT contribute to the stimulation of collagen production in tendons, increased blood flow, enhanced vascular permeability, and anti-inflammatory response. Consequently, HILT has the potential to facilitate the repair of damaged tissue and alleviate pain stimuli.[26,27] This modality, utilizing HILT radiation, results in gradual and minimal light absorption by chromophores and melanin.[32] This absorption, in turn, enhances mitochondrial oxidative reactions and the synthesis of adenosine triphosphate, ribonucleic acid (RNA), and deoxyribonucleic acid (DNA), producing photochemical effects and triggering the stimulation of tissues, as observed in photobiological effects.[33] Since DQT is an inflammatory process, we applied this treatment and observed that the VAS and QDASH values decreased significantly at three weeks after treatment. Dundar Ahi et al.[34] reported HILT as a non-invasive, safe, and reliable method, which could increase grip strength via decreasing pain rapidly in DQT patients.

Extracorporeal shockwave therapy has been in use for over two decades in the treatment of

soft tissue and bone-related musculoskeletal disorders. The adequacy of ESWT in chronic pain syndromes is known. To date, ESWT is widely used in the treatment of diseases such as plantar fasciitis, lateral epicondylitis, tendinopathies, stress fractures, non-healing fractures, and myofascial pain syndrome.[35] Nevertheless, its application in DQT has not been explored previously, and the full understanding of its treatment mechanism remains elusive. Key physical parameters crucial for shockwave therapy in treating orthopedic disorders encompass pressure distribution, energy flow density, and total acoustic energy. In contrast to lithotripsy, a procedure utilizing shockwaves to disintegrate kidney stones, orthopedic shock waves are not employed to break down tissue, but rather to instigate interstitial and extracellular responses, microscopically fostering tissue regeneration.[36,37] We also observed that ESWT reduced the inflammatory process in DQT, and on this occasion, it decreased both the VAS and QDASH values. According to the GAS scores, which subjectively evaluate the effectiveness of the treatment in terms of functionality, there was a statistically significant difference between the third-week and third-month follow-up results. Based on our results, both treatment modalities were successful in the treatment of DQT.

Nonetheless, there are some limitations to this study. Unfortunately, there is a lack of long-term follow-up data for the patients. The usage of analgesic medications among the patients was not documented, and the monitoring of patients' daily activities and adherence to prescribed exercises could not be fully regulated. Additionally, the study was devoid of a control group, limiting our capacity to assert causation. Furthermore, it is conceivable that patients might have experienced recovery merely due to the passage of time and the avoidance of strenuous activity during the treatment period. However, to date, there is no study comparing different physical therapy approaches regarding their effectiveness. Thus, we anticipate that the outcomes of our study would provide valuable insights for devising effective rehabilitation programs tailored to individuals with DQT. The optimal frequency and dosing parameters for HILT still remain uncertain. Consequently, our study may be regarded as a pilot investigation exploring the duration, dosage, and wavelength of laser applications; nonetheless, additional research may be necessary to ascertain the optimal settings.

In conclusion, ESWT emerges as a contemporary and non-invasive therapeutic approach, characterized by its convenience and safety. Notably, it has demonstrated superior effectiveness in alleviating pain associated with DQT. This innovative therapeutic modality holds promise for potentially replacing surgery in numerous orthopedic disorders, offering a treatment alternative devoid of associated surgical risks. On the other hand, HILT was shown to have greater benefits for DQT, offering low complication rates. The results of the current study are encouraging; however, further studies with larger cohorts, long-term findings, and possible comparisons with other conservative interventions or control groups are needed to confirm the effectiveness of physical therapy interventions in DQT.

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

Author Contributions: Design, control/supervision, writing the article, materials: Z.K.G.; Data collection and/or processing, critical review, references and funding: Z.K.G., E.G.; Analysis and/or interpretation, literature review: E.G.

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