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Comparison of the Efficacy of Extracorporeal Shock Wave Therapy and Traditional Physiotherapy in Myofascial Trigger Points

Miyofasiyal Tetik Noktalarda Ekstrakorporeal Şok Dalga Tedavisi ve Geleneksel Fizyoterapinin Etkinliğinin Karşılaştırılması

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ABSTRACT Objective: The main purpose of this study is to compare the efficacy of radial-extracorporeal shock wave therapy (r-ESWT) and traditional physiotherapy (TP) in the treatment of myofascial trigger points in the upper trapezius muscle. **Material and Methods:** A total of 74 patients with myofascial trigger points were randomly separated into the ESWT (n=37) group and the TP (n=37) group. The groups received treatment for 2 weeks. A total of 66 (r-ESWT, n=30; TP, n=36) patients completed the study. Neck pain and disability were evaluated with Visual Analogue Scale (VAS), Quick-Disabilities of Arm, Shoulder and Hand Questionnaire (Q-DASH), and the Nottingham Health Profile (NHP). Active trigger points were evaluated using ultrasound shear wave elastography (SWE). All outcome measurements were assessed before treatment, then at 2 weeks, and 1 month after the completion of the treatment. **Results:** Significant improvements of VAS, Q-DASH, NHP, and SWE scores were observed at all time points after treatment in both treatment groups. When the change levels were compared between the groups, the decrease in VAS, and the improvement in Q-DASH and NHP scores were significantly higher in the TP group than in the ESWT group. There was no significant difference between the groups in terms of the amount of change in SWE. **Conclusion:** The both methods were useful in alleviating pain, improving function, and reducing shear modulus in myofascial trigger points, although TP seemed to be more effective than ESWT.

Keywords: Extracorporeal shock wave therapy; myofascial trigger point; traditional physiotherapy

ÖZET Amaç: Bu çalışmanın amacı, üst trapez kasındaki miyofasiyal tetik noktaların tedavisinde radyal-ekstrakorporeal şok dalga tedavisi [radial-extracorporeal shock wave therapy (r-ESWT)] ve geleneksel fizyoterapinin (GF) etkinliğini karşılaştırmaktır. **Gereç ve Yöntemler:** Miyofasiyal tetik noktaları olan toplam 74 hasta, randomize şekilde ESWT (n=37) ve GF (n=37) olarak 2 gruba ayrıldı. Her iki grup da 2 hafta tedavi aldı. Çalışmayı 66 (ESWT, n=30; GF, n=36) hasta tamamladı. Boyun ağrısı ve disabilite Vizüel Analog Skala (VAS), Kol, Omuz ve El Hızlı Engellilik Anketi (Q-DASH) ve Nottingham Sağlık Profili (NHP) ile değerlendirildi. Ayrıca tüm hastaların aktif tetik noktaları shear wave elastografi (SWE) kullanılarak değerlendirildi. Tüm ölçümler tedaviden önce, tedavi bitiminde (2. hafta) ve tedavinin tamamlanmasından 1 ay sonra değerlendirildi. **Bulgular:** Her iki grupta tedavi sonunda tüm değerlendirme zamanlarında VAS, Q-DASH, NHP ve SWE skorlarında anlamlı iyileşmeler gözlendi. Gruplar arasında değişim miktarları karşılaştırıldığında, TP grubunda VAS, Q-DASH ve NHP puanlarındaki iyileşme ESWT grubuna göre anlamlı olarak daha yüksekti. SWE'deki değişim miktarı yönünden gruplar arasında anlamlı fark yoktu. **Sonuç:** GF, miyofasiyal tetik noktaların tedavisinde ESWT'den daha etkili görünse de her iki yöntem de ağrıyı azaltmada, fonksiyonu iyileştirmede ve miyofasiyal tetik noktalarda SWE'yi azaltmada etkilidir.

Anahtar Kelimeler: Ekstrakorporeal şok dalga tedavisi; miyofasiyal tetik nokta; geleneksel fizyoterapi

Myofascial pain syndrome (MPS) is a regional pain syndrome characterized by the presence of trigger points on the involved muscles and/or fascial bands, which can cause a certain pattern of radiating pain and tenderness when exposed to pressure or stretching. Stimulation of these trigger points results

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in pain and local twitch response.[1] The trapezius muscle is one of the most commonly affected muscles in MPS. The etiology of MPS has long been a topic of discussion and its mechanism of action has not been completely elucidated.[2] Although there have been numerous studies to explain underlying reasons for MPS, acute muscle trauma or chronic injuries due to repetitive micro-traumas (or overuse) and genetic factors, fatigue, and stress, is one of the main causes of the disease.[3]

The management of trigger points in the upper trapezius muscle is difficult and results may not always be satisfactory. The main objective of treatment is breaking the vicious cycle (spasm-pain-spasm cycle). Physical therapy modalities are applied in addition to various treatment approaches. The main treatment methods include stretching exercises, trigger point injection, dry needling, electrotherapy [transcutaneous electrical nerve stimulation (TENS), ultrasound (US), laser, phonophoresis, etc.], massage, acupuncture, Botulinum toxin A, ischemic compression, and extracorporeal shock wave therapy (ESWT).[4,5] Although these treatment options have been shown to be effective in reducing pain and improving function, the mechanisms of action and effects have not been demonstrated, in part because of a lack of objective measures of pain and the trigger point status. Pain assessment is based on a patient self-report and pain threshold. The status of the trigger point can only be evaluated through physical examination by a trained examiner.[6] Therefore, there is a need to develop objective, repeatable, and reliable measures to assess the response to treatments.

ESWT is recently considered an effective treatment for myofascial pain syndrome. It's been proven to be effective in musculoskeletal diseases such as nonunion of pseudoarthrosis or fracture, calcific tenosynovitis and plantar fasciitis. Although the pathophysiology is not clear, the effectiveness of ESWT in MPS has been studied. Generally, shock waves can be classified as focused shock waves (f-ESWT) and radial shock waves (r-ESWT). The application of radial ESWT in MPS has not been fully investigated.[7]

The resting stiffness of the muscles involved in trigger points is high. The stiffness of these muscles can be determined by US elastography.[8] US elastography has been widely used in many tissues and organs, including the breast, thyroid, liver, and muscles/tendons.[9] Although there are several techniques, the most reliable elastography method is shear wave elastography (SWE). Due to the ability of detecting micro-environmental changes earlier than US and providing quantitative information about tissue stiffness, the utilization of SWE has been increasing day by day.[10]

The primary and secondary aims of this study were as follows: *(a)* To compare the efficacy of r-ESWT and traditional physiotherapy (TP) in the treatment of myofascial trigger points in the upper trapezius muscle. *(b)* To determine whether SWE can provide an objective and reproducible measure of a change in the status of trigger points as determined by physical examination.

MATERIAL AND METHODS

STUDY POPULATION

This randomized prospective study included a total of 66 (mean age, 33.4±11.5 years; range, 18-57 years; 12 males, 54 females) patients with a confirmed diagnosis of MPS according to the *Travell & Simons* criteria, who were referred to our outpatient clinic of Mustafa Kemal University Medical School between July 2017 and January 2018.[11]

The main inclusion criterion was the presence of myofascial trigger points in the upper trapezius muscle for at least 2 weeks. Patients were excluded from the study if they were aged <18 years or had servical disc disorders (herniation, radiculopathy, myelopathy), malignancy, history of neck surgery, pregnancy, or any other neurological disorder contributing to symptoms. The study was approved by the Medical Ethics Committee of Mustafa Kemal University (no: 2017/140, date: october 5, 2017). Written informed consent was obtained from all participants. The study was conducted in accordance with the principles of the Declaration of Helsinki.

The group allocation was made using a simple random approach with a table of random numbers to place each patient in either the r-ESWT or TP group. As a result of the randomization procedure, there were 37 patients in the r-ESWT group, and 37 patients in the TP group. A total of 66 (r-ESWT, n=30; TP, n=36) patients completed the study.

TP GROUP: HOT-PACK+THERAPEUTIC US+TENS

A total of 10 sessions of the physical therapy programs were applied to the TP group, for 2 weeks (5 days/week). TENS therapy was applied with a 2-channel portable TENS unit (BTL-4620, Czech Republic) on the upper thoracic and neck region for 30 minutes. Using 2 electrodes, in conventional mode, at a frequency of 100 Hz and a pulse width of 60 ms and intensity was adjusted according to the threshold for each individual without causing pain or muscular contraction. Therapeutic US sessions were administered every day for a total of 10 sessions, a power of 1 W/cm^2, a frequency of 1 MHz, continuously, 5 minutes daily (BTL-4000 professional, Czech Republic). Hot-pack therapy was applied for 30 minutes per session for a total of 10 sessions as a part of traditional physiotherapy.

ESWT GROUP: r-ESWT

The patients received r-ESWT of continuous frequency and intensity (1,000 shocks per session of 1.5-2.0 bar pressure with 10 Hz frequency) in 2 sessions per week for 2 weeks. ESWT was applied using a radial shock wave therapy system (A Vibrolith Ortho ESWT, ELMED Türkiye). ESWT treatment was applied on the upper trapezius trigger points. Patients' position was prone, affected side was exposed, and the applicator was directed in the most tender point over the upper trapezius affected side and gently moved around the trigger point in each treatment session. Transmission gel was applied between the device and the subjects' skin with no local anesthetic.

EXERCISE

Both group also underwent a home-based exercise program 5 times a week for 2 weeks (a total of session). The program consisted of active isotonic strengthening exercises for 15 min, and stretching and relaxation exercises for 15 min.

OUTCOME EVALUATION

All the clinical outcomes were assessed before treatment, then at 2 weeks and 4 weeks after treatment. Pain severity was measured using a Visual Analogue Scale (VAS) ranging from 0 (no pain) to 10 (worst possible pain). The functional status of patients was measured using the Quick-Disabilities of Arm, Shoulder and Hand Questionnaire (Q-DASH). The Q-DASH contains 11 items measuring an individual's ability to complete tasks, absorb forces, and the severity of symptoms. The Q-DASH tool uses a 5-point scale from which the patient can select an appropriate number corresponding to his/her severity and function level. Like the original version, the Q-DASH score ranges from 0 (no disability) to 100 (severest disability). The quality of life of the patients was evaluated using the Nottingham Health Profile (NHP).

The ultrasonographic evaluation was performed by the same radiologist, who had 5 years of experience in musculoskeletal US and was blinded to the clinical evaluation. A 7-9 MHz linear probe (Logiq E9, GE Medical Systems, WI, USA) was oriented in the transverse plane over the region of interest on the upper trapezius muscle, and the probe was manipulated until the muscle fibers appeared parallel. The boundaries of the transducer were then marked on the skin to standardize the transducer position. Once a clear image was acquired in B mode, supersonic shear imaging mode was used to obtain the shear modulus map of the muscle for the region of interest. Three elastography images were acquired, and the average of the shear modulus values (kPa) were recorded.

STATISTICAL ANALYSIS

The data were analyzed using SPSS software (Version 22.0 SPSS Inc., Chicago, IL, USA). Conformity of continuous variables to normal distribution was assessed using the Shapiro-Wilk test. Descriptive statistical results were shown as mean±standard deviation or median (minimum-maximum). Demographic data were analyzed using the independent samples t-test or the Mann-Whitney U test for continuous data and the chi-square test for categorical data. The time-variance of the scores of the groups was assessed with the repeated measures analysis of variance (ANOVA) test. Differences between the groups were compared using the Mann-Whitney U test. A value of $p<0.05$ was accepted as statistically significant.

RESULTS

There was no significant difference between the groups in terms of demographic or clinical data. The demographic and clinical features are given in Table 1. In both groups, there were statistically significant differences between the before and after treatment (at 2, and at 4 weeks after treatment) in terms of all clinical assessments: VAS, Q-DASH, NHP, and SWE.

The VAS scores, the Q-DASH scores, the NHP scores and the SWE scores were improved in both groups. The baseline and follow-up results of the clinical measurements are given in Table 2. The percentage change of improvement in VAS, Q-DASH and the NHP scores was greater in the TP group. No significant difference was found between the 2 groups in respect of percentage change in SWE (Table 3). The flowchart for the study is shown in Figure 1. Shear wave images of the upper trapezius muscle and myofascial trigger points are shown in Figure 2 before (A) and at 1 month after treatment (B).

DISCUSSION

This study compared the effects of TP and ESWT in patients with MPS, and the results showed that both TP and ESWT treatments are effective in reducing pain, improving function, and reducing muscle stiffness in myofascial pain syndrome. Furthermore, the effectiveness of TP was seen to be superior to that of ESWT, with regard to VAS, Q-DASH, and NHP.

TP is a more common treatment for MPS. Many studies have reported the positive effect of TP.[12-14] Although there are many treatment modalities, none of them has been accepted as the gold standard. Conservative treatments are the basis of the initial approach for most cases.

ESWT is used in the treatment of some musculoskeletal disorders such as lateral epicondylitis, shoulder calcification, and plantar fasciitis. In ESWT, waves are formed with electromagnetic, piezoelectric, and electrohydraulic methods. ESWT has been considered as an alternative therapeutic approach for MPS over the last 2 decads, especially in the subjects with symptoms resistant to conventional treatments.[15-17] The exact mechanism of ESWT in MPS has not yet been fully clarified. It is thought that MPS stems from an abnormal increase in the production and release of acetylcholine inducing sustained depolarization of the postjunctional membrane of the muscle fiber, and possibly causing a continuous release and uptake of calcium ion, resulting in muscle ischemia due to sustained shortening of sarcomeres and the release of sensitizing substances [substance P, bradykinin, calcitonin gene-related peptide, tumor necrosis factor alpha, interleukin (IL)-1B, IL-6, IL-8]. Through this pathophysiology, the vicious cycle is completed when the nociceptors are sensitized and

TABLE 1: Demographic and clinical features of the groups.

	ESWT (n=30)	TP (n=36)	p values
Age, years	30 (20-57)	31 (18-57)	0.857
Gender-M/F, n (%)	5 (16.7)/25 (83.3)	7 (19.4)/29 (80.6)	0.771
Weight, kg	60 (46-93)	60.5 (44-79)	0.597
Height, cm	162.5 (156-180)	165 (155-180)	0.416
Baseline evaluations			
VAS for pain	8 (6-10)	8 (5-10)	0.135
Q-DASH	42 (13-84)	38 (13-75)	0.762
NHP	16.5 (4-32)	14 (4-28)	0.160
SWE (kPa)	21 (9-44)	23 (6.4-44)	0.283

ESWT: Extracorporeal shock wave therapy; TP: Traditional physiotherapy; VAS: Visual Analogue Scale; Q-DASH: Quick-Disabilities of Arm, Shoulder and Hand Questionnaire; NHP: Nottingham Health Profile; SWE: Shear wave elastography.
Bold p values show statistical significance (p<0.05).
Datas were given as median (minimum-maximum).

TABLE 2: Baseline and post-treatment (2. and 4. week) follow-up results of clinical measurements of the groups.

	ESWT (n=30)		TP (n=36)	
VAS for pain				
Baseline	8 (6-10)		8 (5-11)	
After treatment				
2nd week	5 (4-8)	<0.001*	3.5 (0-10)	<0.001*
4th week	4 (3-7)	<0.001*	2 (0-7)	<0.001*
Q-DASH				
Baseline	42 (13-84)		38 (13-75)	
After treatment				
2nd week	37.5 (11-70)	0.002*	20 (2-65)	<0.001*
4th week	28.5 (8-47)	<0.001*	15.5 (0-70)	<0.001*
NHP				
Baseline	16.5 (4-32)		14 (4-28)	
After treatment				
2nd week	13.5 (5-28)	<0.001*	6 (2-30)	<0.001*
4th week	14 (5-30)	0.001*	4 (0-32)	0.002*
SWE (kPa)				
Baseline	21 (9-44)		23 (6-44)	
After treatment				
2nd week	14.5 (9-20)	<0.001*	13.5 (6-26)	<0.001*
4th week	13.5 (7-27)	<0.001	13.5 (5-28)	<0.001*

ESWT: Extracorporeal shock wave therapy; TP: Traditional physiotherapy; VAS: Visual Analogue Scale; Q-DASH: Quick-Disabilities of Arm, Shoulder and Hand Questionnaire; NHP: Nottingham Health Profile; SWE: Shear wave elastography.
Repeated measures analysis of variance; *p<0.001 with baseline.
Datas were given as median (minimum-maximum).

muscle ischemia is aggravated.[18-20] Considering the pathophysiology of ESWT in other diseases, it was thought that ESWT may promote angiogenesis, increase perfusion, and alter the pain signaling in ischemic tissues caused by calcium influx.[5,21,22]

There is currently no defined standard treatment protocol for the application frequency, the energy intensity and total shots for the use of r-ESWT in MPS. Reported pulse repetition frequency varies between 10 Hz and 16 Hz, and practice with 10 Hz is more common.[23] Studies have demonstrated the intensity and total shots in a range of 1.0 to 2.0 bar, and 1,000 to 4,000 shots. In the present study, the more frequently used applications in literature was preferred and r-ESWT was applied with 1,000 shots, 1.5-2.0 bar intensity of energy, and frequency of 10 Hz.[24]

The results of this study showed a reduction in pain and functional improvement with a significant clinical change after the 2nd and 4th weeks in both groups. Hence, this study confirms the effectiveness of ESWT in reducing the pain and improving function in patients suffering from MPS in the short-term period. The results also support claims in the literature that ESWT can be considered as an option in the treatment of MPS. In a study by Müller-Ehrenberg H et al., patients were treated with 800-1,000 shock waves, of 6 Hz and 0.04-0.26 mJ/mm^2. VAS was determined to have decreased after 3 months of treatment.[25] Ji HM et al, also showed that ESWT is effective for the relief of pain in MPS of the upper trapezius after 4 therapy sessions in 2 weeks. Those patients were treated for 2 sessions per week, with 0.056 mJ/mm^2 and 1,000 impulses at each taut band, resulting in a significant reduction in pain.[5] In the current study, the ESWT group received the treatment in 2 sessions per week for 2 weeks, using 1,000 shocks per session of 1.5-2.0 bar pressure with 10 Hz frequency. The VAS score decreased from 8 to 5

TABLE 3: Comparison of difference between VAS, Q-DASH, NHP and SWE scores of the groups.

	ESWT (n=30)	TP (n=36)	*p value
VAS for pain			
Baseline	8 (6-10)	8 (5-10)	
After treatment			
2nd week	-0.38	-0.54	0006
4th week	-0.50	-0.76	<0.001
Q-DASH			
Baseline	42 (13-84)	38 (13-75)	
After treatment			
2nd week	-0.11	-0.41	<0.001
4th week	-0.31	-0.51	0.002
NHP			
Baseline	16.5 (4-32)	14 (4-28)	
After treatment			
2nd week	-0.18	-0.42	<0.001
4th week	0.0	-0.15	0.042
SWE (kPa)			
Baseline	21 (9-44)	23 (6-44)	
After treatment			
2nd week	-0.30	-0.35	0.515
4th week	-0.03	-0.03	0.329

ESWT: Extracorporeal shock wave therapy; TP: Traditional physiotherapy; VAS: Visual Analogue Scale; Q-DASH: Quick-Disabilities of Arm, Shoulder and Hand Questionnaire; NHP: Nottingham Health Profile; SWE: Shear wave elastography.
*Mann-Whitney U test.
Datas were given as median (minimum-maximum).

within 2 weeks, and from 8 to 4 within 4 weeks. The present study also showed that the VAS values in the TP group decreased from 8 to 3.5 in 2 weeks, and 8 to 2 in 4 weeks. The reduction in VAS scores was statistically significant in the TP group compared to the ESWT group. The therapeutic effects of ESWT refer to the direct beneficial pulses at the target points, and the secondary effects refer to the biological effect, which may induce tissue repair and regeneration.

In the current study, the Q-DASH score was also measured before treatment, and at 2 and 4 weeks after the last session. The results showed an improvement from 42 before the treatment to 37.5 in the 2nd week and 28.5 in the 4th week in the ESWT group. There was also a statistically significant improvement of Q-DASH scores in the TP group, with the results showing an improvement from 38 before the treatment to 20 in the 2nd week and 15.5 in the 4th week. Comparison of the difference between the scores of the groups showed significantly superior improvements in the TP group. In a study by Bron et al., 12-week comprehensive treatment of trigger points in shoulder muscles was reported to reduce the number of active trigger points and be effective in reducing symptoms and improving Q-DASH scores in patients with chronic shoulder pain.[26] In the present study, both the TP and ESWT groups improved functional status. According to these results, ESWT should be considered when traditional treatments have failed.

Elastography is a newly developed and non-invasive sonographic technique which can assess the elasticity and the stiffness of tissues in real time. There are 2 main elastographic techniques widely used: strain elastography and SWE.[27] SWE is an objective method and uses shear waves produced by the interaction of conventional US waves within the tissue.[28] In the present study, both TP and ESWT treatments were found to change the SWE

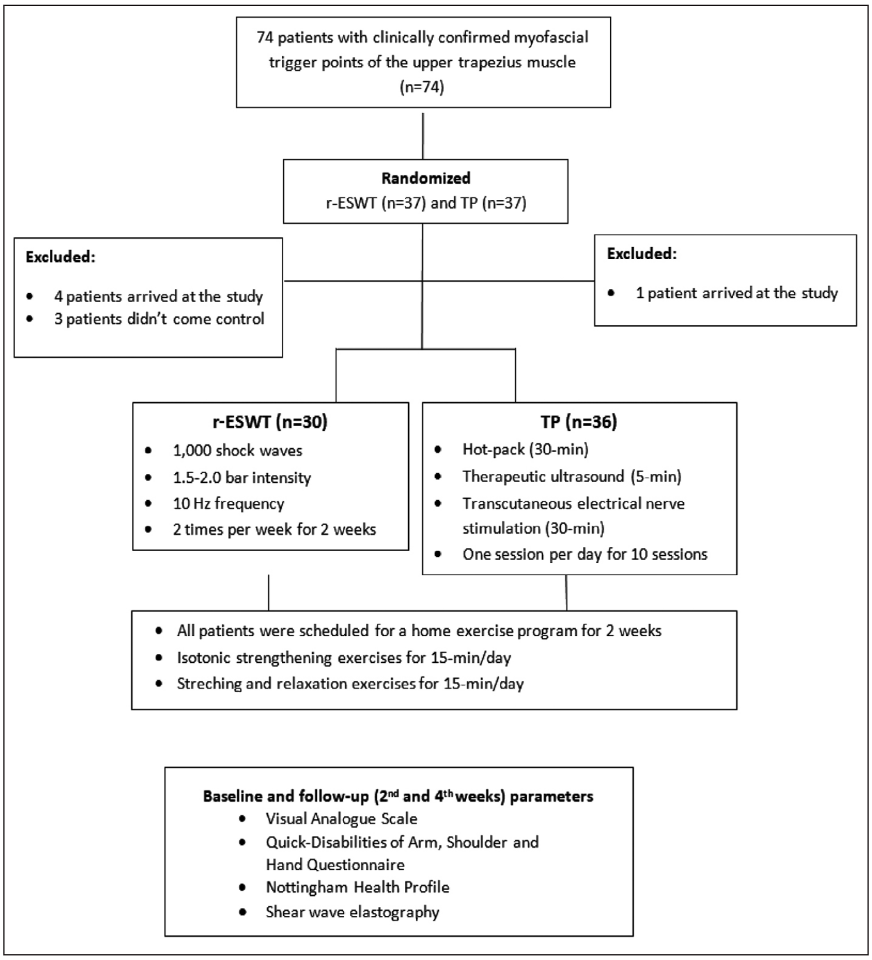

FIGURE 1: Flowchart of the study. **rESWT:** Radial-extracorporeal shock wave therapy; **TP:** Traditional physiotherapy.

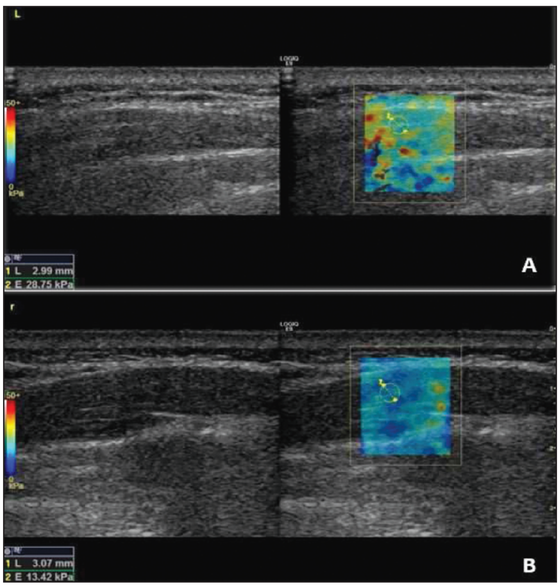

FIGURE 2: Image showing an example of measurement in shear modulus in the upper trapezius muscle before **(A)** and after treatment **(B)**.

values. In the comparison of the before and after treatment values (2 and 4 weeks after treatment), the SWE values were determined to have significantly decreased in both groups. Our results confirmed that the SWE reduced tissue stiffness in both the TP and ESWT groups. The mechanism of recovery after the TP and ESWT were still unclear, but there may a causal link between the tissue stiffness and pain level.

CONCLUSION

In conclusion, this study revealed that both methods were useful in alleviating pain, improving function, and reducing shear modulus in myofascial trigger points. However, it was observed that ESWT was not superior to traditional physiotherapy. ESWT should be considered when TP have failed.

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