Evaluation of Radial Extracorporeal Shock Wave Therapy on Treatment-Resistant Trigger Points Using Sonographic Shear Wave Elastography

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ABSTRACT

Objective: To assess the effectiveness of radial extracorporeal shock wave therapy (rESWT) on treatment-resistant myofascial trigger points (MTrPs) in the upper trapezius and evaluation of treatment efficacy by Sonographic Shear Wave Elastography (SWE) objectively.

Study Design: An experimental study.

Place and Duration of the Study: Department of Physical and Rehabilitation Medicine and Department of Radiology of Acibadem University Atakent Hospital, from August 2020 to June 2021.

Methodology: Forty-one patients with 70 active treatment-resistant trigger points in their upper trapezius muscles were included. The treatment involved rESWT with 1500 pulses, administered at 8 Hz and 1.5 bar pressure. Of the 1500 pulses, 1000 impulses targeted MTrPs, while 500 impulses were applied to the surrounding taut band. The treatment sessions were conducted at 1-week interval until the Visual Analog Score (VAS) reached below 2 or a maximum of 5 sessions. Baseline assessments of VAS, Neck Disability Index (NDI), and shear modulus of the upper trapezius MTrPs were performed and reevaluated after the last treatment sessions. Furthermore, a follow-up assessment of the VAS was conducted after a period of 3 months for long-term effects.

Results: There was a significant improvement in both NDI scores and pain relief between the pretreatment and posttreatment periods. Moreover, the shear modulus of the upper trapezius MTrPs showed a significant decrease from 41.5 kPa to 30 kPa after the treatment.

Conclusion: The treatment effectively alleviated pain, improved neck function, and reduced the shear modulus of the affected areas. SWE offered a reliable real-time measurement of soft tissue stiffness, providing valuable insights into the treatment's efficacy.

Key Words: S*hock wave therapy, Trigger points, Elastography, Neck pain, Myofascial pain.*

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INTRODUCTION

Neck pain ranks as the fourth leading cause of disability, significantly impacting daily activities, social life, and work productivity with a rate of 5.9 to 38.7% among adults (aged 15-74 years).[1] The primary cause of neck pain is attributed to myofascial trigger points (MTrPs), which arise from poor ergonomics and prolonged non-physiological neck and sitting postures in the workplace.[1,2]

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Common therapeutic approaches for neck pain include pharmacotherapy, such as nonsteroidal anti-inflammatory drugs, tricyclic antidepressants, steroids, oral skeletal muscle relaxants, or vasodilators, as well as injection therapy involving local anaesthetic injections or dry needling with or without corticosteroids at the MTrPs. Physical therapy and behaviour therapy are also employed.[3,4]

Extracorporeal shock wave therapy (ESWT), a novel, non-invasive, safe, and well-tolerated treatment for certain musculoskeletal conditions, uses a variety of shock wave generation techniques, including focused (electromagnetic, electrohydraulic, piezoelectric) and radial (pneumatic pressure) approaches. The optimal treatment procedure for MTrPs using ESWT has not been definitively established. Moreover, factors such as device type, dosage range, treatment frequency, and the use of local anaesthesia are still under debate. The heterogeneity of treatment protocols is a notable observation. Specifically, in the case of radial extracorporeal shock wave therapy

(rESWT), the number of shock waves administered varied considerably, ranging from 1000 to 4500. Additionally, the frequency of rESWT sessions also differed across studies. Typically, this intervention was provided once a week for 3 weeks in some studies, while in other studies, it was administered over four sessions.[5] However, Gezginaslan *et al.* took a different approach and conducted seven sessions with 3-day intervals, which deviated from the more conventional protocol. Such variations in treatment parameters can potentially impact the overall outcomes and efficacy of rESWT in treating MTrPs.[6]

Myofascial pain syndrome is characterised by musculoskeletal disease presenting with MTrP, which are hyperirritable palpable nodules causing local pain and limited movement.[7] Due to the diverse symptoms, such as head, neck, shoulder pain, and neuropathic pain, patients may not always receive a timely and accurate diagnosis, leading to potential oversight.[8]

In a meta-analysis conducted by Zang *et al*., it was found that extracorporeal shock wave therapy (ESWT) demonstrated significant improvement in pain reduction compared to sham ESWT or ultrasound treatment.[9] However, when compared to conventional treatments like dry needling, trigger point injection, and laser therapy, ESWT did not show a significant effect in terms of pain intensity and neck disability index. The aim of this study was to assess the clinical efficacy of radial ESWT in treating treatment-resistant active trigger points in the upper trapezius muscle of patients experiencing neck pain. Employing sonographic shear wave elastography to objectively evaluate the treatment outcomes.

METHODOLOGY

Forty-one adult patients of either gender who applied to the Physical Medicine and Rehabilitation outpatient clinic, Department of Physical and Rehabilitation Medicine and Department of Radiology of University Hospital, with neck and/or arm-shoulder pain were included in this study.

The inclusion criteria was neck and/or arm-shoulder pain, aged between 20 and 50 years. The presence of MTrPs was detected by the physiatrist by palpation according to Simon *et al*.'s standard clinical examination of the patients with a single active right, left, or bilateral MTrP in the upper trapezius. The study also included patients who received all conventional treatments but had treatment-resistant active trigger points.[10]

Subjects with cervical radiculopathy, myelopathy, neck or cervical surgery history, malignancy, blood coagulation disorder, pregnancy, active infection, pacemaker, and severe osteoporosis were excluded.

Demographic data such as age, gender, and education were recorded. While the patients sat upright, they were examined until painful spots were found in both upper trapezes, and these points were marked. Patients with a single active right, left or bilateral MTrP in the upper trapezius were accepted. The Visual Analog Score (VAS) was used to evaluate pain intensity, and it was assessed at three points: baseline, after the last treatment sessions, and during a 3-month follow-up. Pain intensity was scored on a scale from 0 to 10, where 0 represented no pain and 10 represented the most severe pain experienced by the patient. A reduction of 2.0 cm in VAS score was considered a clinically significant improvement.[11,12]

To assess functional disability caused by neck pain, the Neck Disability Index (NDI) was used. The NDI consisted of ten items describing the impact of pain on various daily activities. Each item was scored on a six-point Likert scale (ranging from 0 to 5), with 0 indicating no pain limitation and 5 indicating that the activity is not possible. The total score ranged from 0 to 50, with higher scores indicating greater disability.[13,14]

Ultrasonography Shear Wave method was used to measure the shear modulus of the upper trapezius muscle's trigger points before and after ESWT. Ultrasonography images were captured in B mode using an ultrasound machine (LOGIQ E9, GE Healthcare, Chalfont St Giles, UK) equipped with a 4- to 15-MHz linear array transducer (Figure 1). Elastography was performed prior to ESWT, with a one-week to one-month interval between evaluations.

The ESWT treatment involved applying radial shockwaves using The ShockMaster 500 device (low to medium energy radial shockwaves) once a week until the VAS score reached 2, with a maximum of 5 sessions. Each session consisted of 1500 pulses (1000 targeting MTrPs and 500 surrounding the taut band) at 8 Hz and 1.5 bar pressure. The treatment was administered by a physiatrist without using the local anaesthesia or anti-inflammatory drugs.[12]

During the treatment period, patients did not receive anti-inflammatory drugs or exercise therapy.

The patients who were determined to be included in the study were referred to a radiologist for pretreatment SWE measurements, with trigger points marked. After the measurements were taken, ESWT was initiated. The treatment was continued until the patients reached a VAS score of <2, with a maximum of 5 sessions. Once the decision was made to terminate the treatment, objective results were recorded by performing another measurement using SWE.

The study protocol was registered and approved by the Medical Ethics Committee of the University, and written informed consent was obtained from all participants.

The data were analysed using IBM SPSS V23. The conformity of the neck pain index, VAS, and Trapezius kPa values to the normal distribution were examined using the Shapiro-Wilk test. Wilcoxon and Friedman tests were used to compare the data that did not show normal distribution, while the paired t-test was used for normally distributed data. The relationship between age and the number of sessions and measurements were examined with Spearman's rho. Significance level was taken as $p<0.05$.

Table I: Demographic and clinical features of the study group.

	Mean (sd)	Median (min-max)
Age (year)	34.3 (9.0)	32 (20-58)
	Frequency	**%**
Gender		
Female	32	78.0
Male	9	22.2
Education		
Primary school	3	7.3
High school	4	9.8
Associate degree	8	19.5
License	26	63.4
Affected side		
Right	37	5.9
Left	33	47.1
Number of sessions		
1	6	8.6
2	10	14.3
3	35	50.0
4	10	14.3
5	9	12.9

Table II: The changes in pain intensity, neck disability, and SWE.

	Mean (sd)	Median (min-max)	Statistics	p-value
NDI				
Pretreatment	20.07 (3.35)	20 (15- 26)	-5.308[A]	<0.001
Posttreatment	3.86 (3.35)	3 (1- 15)		
VAS				
Pretreatment	7.17 (1.4)	7 (5- 10) [a]	120.627[B]	<0.001
Posttreatment	2.11 (2.55)	1.5 (0- 10) [b]		
3-month follow-up	1.63 (1.91)	1 (0- 8) [b]		
Trapezius kPa				
Pretreatment	44.06 (39.52)	41.5 (15- 357)	2.846[C]	0.006
Posttreatment	30.43 (8.59)	30 (12- 56)		

[A]Wilcoxon test; [B]Friedman test; [C] Paired t-test; [a-b]There is no difference between tenses with the same letter.

Table III: Correlation of age and number of ESWT sessions with pain intensity, neck disability, and SWE.

	Age		Number of Sessions	
	r	p	r	p
NDI				
Pretreatment	-0.004	0.981	-0.026	0.871
Posttreatment	-0.126	0.464	-0.221	0.188
VAS				
Pretreatment	0.237	0.055	0.087	0.474
Posttreatment	0.242	0.051	-0.461	<0.001
3-month follow-up	0.217	0.091	-0.258	0.040
Trapezius kPa				
Pretreatment				
Posttreatment	0.037	0.766	0.132	0.278
NDI	-0.070	0.588	0.093	0.455

r: Spearman's rho

RESULTS

Table I shows the demographic and clinical characteristics of the study group. Four out of 41 patients did not benefit from ESWT after one session, so their treatment was discontinued. Among these patients, two had trigger points in the trapezius muscles after receiving one session of ESWT, as indicated by number 6 in Table I.

The number of sessions for the 37 patients continuing the treatment is also provided in Table I. Out of 37 patients, 27 had bilateral trigger points, while 10 had trigger points on the right or left trapezius. There was a statistical difference between NDI values before and after the treatment ($p<0.001$). While the median value was 20 before the treatment, the median value was 3 after the treatment.

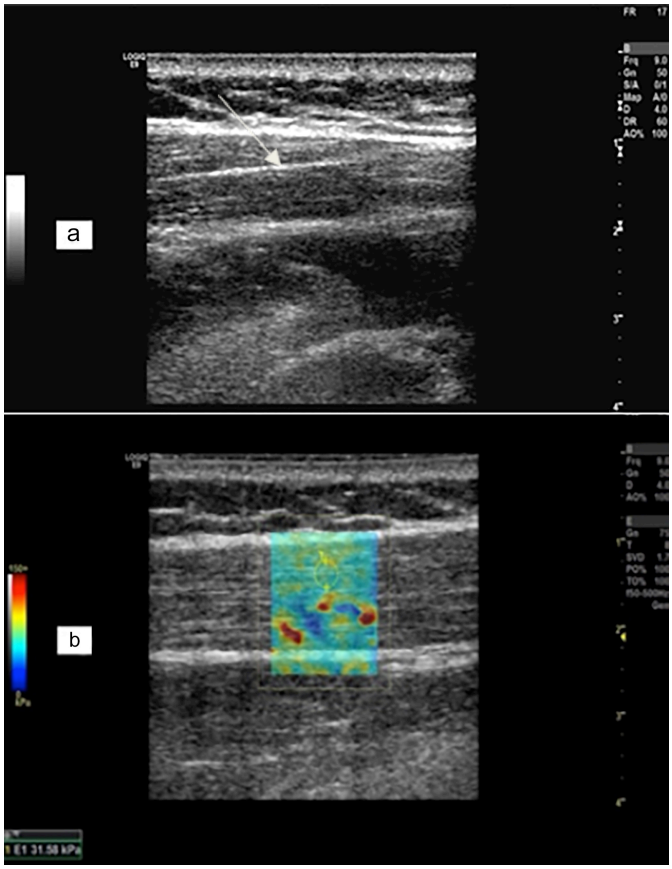

Figure 1: (a) Long-axis gray-scale US image of a 32-year woman with MTrPs (white arrow); (b) Shear-wave elastography image (colour elastogram) of the same region with quantitative measurement data in kilopascal (kPa).

The distributions of VAS values obtained at 3 different times differed ($p<0.001$). While the median value was 7 before the treatment, it was 1.5 after the treatment and 1 at the 3rd month. While the median values of the post-treatment and the 3rd month did not differ, the pretreatment values were higher. Trapezius kPa values differed according to the ESWT application. While the median value before ESWT was 41.5, the median value after ESWT was 30 (Table II). There was a negative significant correlation between the number of sessions and the posttreatment and 3rd month VAS values. There was no significant relationship between age and any value (Table III).

DISCUSSION

The pathophysiology of MTrPs contains a complex mechanism involving both the peripheral and central mechanism. The triggering of calcium ion reuptake and a continuous release in acetylcholine are seen. As a result, muscle ischemia occurs with the shortening of sarcomeres.[15] If MTrPs are inadequately treated, persistent pain caused by excessively irritable points may cause spinal segmental sensitisation. Neurotransmitters and cytokines accumulate in the extracellular fluid at the trigger points. It is regulated by the sympathetic nervous system, which is activated in situations such as anxiety and stress. MTrPs that cause spontaneous pain are called as active, whereas MTrPs that do not cause spontaneous pain and cause pain only with palpation are called as latent.[15,16]

The effect of the shock wave appears such as reducing pain, increasing blood flow in ischemic tissues, softening calcified tissues, treating tissue fibrosis and releasing adhesions, supporting tissue regeneration, and effectively breaking down calcification deposits in soft tissues.[2,17-19]

ESWT is a new approach to the treatment of peripheral arterial disease (PAD). The Shockwave system focuses on the gastrocnemius muscles in the lower leg during each PAD treatment session, which typically lasts for several minutes. Although the use of ESWT in the management of PAD is not widely accepted by the medical community, it is believed to have the potential to increase blood flow by stimulating the formation of collateral circulation in the limbs and delaying the process of arteriosclerosis in the lower limbs, thereby potentially alleviating symptoms.[20]

In this study, the effectiveness of ESWT on 70 active trigger points in the upper trapezius muscle was evaluated using different doses and session numbers (1000 pulse, 8 Hz, 1.5 bar once a week, max 5-min 1 session).

There were positive results for VAS, NDI, and SWE findings. Also, patients with more session numbers of ESWT had lower VAS values posttreatment and 3-month follow-up. In terms of application parameters, the number of sessions and device type of ESWT are still uncertain. There are some studies that compared different parameters. For example, in the study performed by Park *et al*., 30 patients with upper trapezius MTrPs were divided into 2 groups. High and low energy ESWT was applied for 2 sessions, once a week, at 1500 impulses. ESWT was found to be effective in measuring verbal numeric pain scale (VNS), NDI, neck range of motion (ROM), and PT in all patients. In the study by Zhang *et al*., 10 articles (n=477 patients) were analysed. In terms of pain intensity and NDI, the meta-analysis found that ESWT drastically enhanced pain reduction in comparison to sham ESWT or ultrasound treatment, but had no effect when compared with the traditional treatments (dry needling, trigger point injection, laser therapy).[21] This study's results indicated that ESWT can serve as a treatment option for relieving pain intensity and improving functional disability.

The parameters that lead to the reduction of patients' pain may vary, as pain is a subjective symptom. Myofascial pain syndrome was also diagnosed through clinical history and physical examination. Therefore, the authors terminated the sessions based on the patient's VAS score being 2 or below. The number of sessions, like ESWT parameters, varied greatly. In many studies, the weekly sessions and total number of sessions were different. In this study, it was observed that as the number of sessions increased, there was a tendency for a decrease in post-treatment and 3-

month posttreatment VAS values. Planning the number of sessions based on the patient's VAS value, rather than choosing a standard number of sessions, might be a more effective approach.

Luan *et al.* used Shear Ware Elastography (SWE) in their study and revealed that ESWT is just as effective as dry needling for relieving pain, improving function, and reducing shear modulus in MTrP patients.[2]

In the study conducted by Valera-calero *et al*., a single session of either real or sham dry needling (DN) applied to active MTrPs in the upper trapezius muscle did not produce detectable changes in stiffness at the MTrP or control locations. Real DN induced an immediate analgesic response at both the MTrP and control locations, while sham DN immediately induced an MTrP response.[22]

SWE was also utilised to objectively assess the efficacy of the treatment in this study. The findings demonstrated a significant decrease in the shear modulus of the upper trapezius MTrPs, from 41.5 to 30 kPa after the posttreatment period.

Indeed, sonoelastographic imaging, specifically SWE, is a valuable technique for evaluating tissue properties, particularly tissue elasticity.[23,24] SWE provides quantitative information about tissue stiffness or elasticity, which can be represented as a colour-coded elastogram on the ultrasonography screen. The elastogram displays shear-wave velocities in meters per second or tissue elasticity in kilopascals (kPa). In contrast to strain elastography, SWE imaging requires no manual compression, thus obtains optimal data independent of the operator. In this imaging modality, an acoustic impulse causes tissue leading deformation. This impulse is generated electronically and transmitted *via* the ultrasound transducer.

Many studies have been conducted to assess the efficacy of ESWT in the treatment of MTrPs. In the study by Kiraly *et al.,* 61 patients were divided into two groups and were applied ESWT and laser therapy and were compared in terms of the effects on pain and neck functionality. Specific surveys were used to assess VAS, functional status, and quality of life. It has been found that both laser and ESWT were effective in myofascial pain syndrome, but ESWT was slightly more beneficial.[5] In another study by Manafnezhad *et al*., there were two groups of 70 patients with active MTrPs of the upper trapezius muscle who received dry needling and ESWT treatment. ESWT was applied once a week, at 1000 impulses, 60 MJ, 16 Hz and for three sessions in total. As a result, there was no difference in Numerical Pain Rate Scale, NDI, or pressure threshold between the two groups (PT). Both methods of treatment had been shown to be effective.[17] Jeon *et al.* divided 30 patients with upper trapezius MTrPs into two groups: ESWT (1500 shock waves, 0.10 MJ/mm2, once a week, three times) and trigger point injections (TPI) + transcutaneous electrical nerve stimulation (TENS). As a result, in patients with MTrPs in the trapezius muscle, ESWT was found to be as effective as TPI and TENS in relieving pain and improving cervical range of motion.[25] The study conducted by Yoo *et al.* provided very low-level of evidence for the short-term relief of neck pain in MPS using focused ESWT. The limited sample size and the quality of these studies highlighted the need for large-scale, high-quality placebo-controlled trials in this field. The 5 studies reviewed in this meta-analysis were evaluated for changes in pain intensity. Compared to other treatments, focused ESWT was found to be more effective in reducing Visual Analog Scale (VAS) scores for pain in MPS.[15]

This study had some limitations that should be considered in the future research. The study only assessed the outcomes of the 3-month follow-up of VAS and did not have the outcomes of 3-month follow-up of SWE and NDI. The challenges posed by the COVID-19 pandemic also impacted the study as it made it difficult to reach patients. Additionally, the absence of a sham ESWT (a control group with ineffective parameters using an ESWT probe with the patient's consent) or a control group was another significant limitation that should be addressed in the future studies. By addressing these limitations, the future research can enhance the reliability and validity of the findings.

CONCLUSION

ESWT is a non-invasive, safe, and tolerable therapy option for reducing pain, improving function, and lowering shear modulus in patients with treatment-resistant MTrPs. SWE provides an objective measurement of soft tissue stiffness in real time through the shear module.

ETHICAL APPROVAL:
This study was approved by Acibadem Mehmet Ali Aydinlar University, Clinical Research Ethics Committee with decision number 2020-08/1 prior to the initiation of the research.

PATIENTS' CONSENT:
Informed consents were obtained from patients to publish the data.

COMPETING INTEREST:
The authors declared no competing interest.

AUTHORS' CONTRIBUTION:
IFK: Idea, concept and study design, statistical analysis, data collection, drafting, literature review, analysis, interpretation, and manuscript writing.
AAK: Idea, statistical analysis of data, review, literature review, proofreading, and manuscript writing.
All authors approved the final version of the manuscript to be published.

REFERENCES

1. Popescu A, Lee H. Neck pain and lower back pain. *Med Clin North Am* 2020; **104(2)**:279-92. doi:10.1016/j.mcna.2019.11.003.

2. Luan S, Zhu ZM, Ruan JL, Lin CN, Ke SJ, Xin WJ, *et al*. Randomised trial on comparison of the efficacy of extracorporeal shock wave therapy and dry needling in myofascial trigger points. *Am J Phys Med Rehabil* 2019; **98(8)**:677-84. doi: 10. 1097/PHM.0000000000001173.
3. Park KD, Lee WY, Park MH, Ahn JK, Park Y. High- *versus* low-energy extracorporeal shock-wave therapy for myofascial pain syndrome of upper trapezius: A prospective randomized single blinded pilot study. *Medicine (Baltimore)* 2018; **97(28)**: e11432. doi:10.1097/MD.0000000000011432.
4. Király M, Bender T, Hodosi K. Comparative study of shock-wave therapy and low-level laser therapy effects in patients with myofascial pain syndrome of the trapezius. *Rheumatol Int* 2018; **38(11)**:2045-52. doi:10.1007/s00296-018-4134-x.
5. Paoletta M, Moretti A, Liguori S, Toro G, Gimigliano F, Iolascon G. Efficacy and effectiveness of extracorporeal shockwave therapy in patients with myofascial pain or fibromyalgia: A scoping review. *Medicina (Kaunas)* 2022; **58(8)**:1014. doi: 10. 3390/medicina58081014.
6. Gezginaslan Ö, Başar G. Comparison of effectiveness of density and number of sessions of extracorporeal shock wave therapy in plantar fasciitis patients: A double-blind, randomized-controlled study. *J Foot Ankle Surg* 2021; **60(2)**: 262-8. doi: 10.1053/j.jfas.2020.08.001.
7. Gerwin, R. Myofascial trigger point pain syndromes. *Seminars in Neurol* 2016; **36(05)**: 469-73. doi:10.1055/s-0036-1586262.
8. Botanlioglu H, Kantarci F, Kaynak G, Unal Y, Ertan S, Aydingoz O, *et al*. Shear wave elastography properties of vastus lateralis and vastus medialis obliquus muscles in normal subjects and female patients with patellofemoral pain syndrome. *Skeletal Radiol* 2013; **42(5)**:659-6. doi: 10.1007/s00256-012-1520-4.
9. Zhang Q, Fu C, Huang L, Xiong F, Peng L, Liang Z, *et al*. Efficacy of Extracorporeal shockwave therapy on pain and function in myofascial pain syndrome of the trapezius: A systematic review and meta-analysis. *Arch Phys Med Rehabil* 2020; **101(8)**:1437-46. doi: 10.1016/j.apmr.2020.02.013.
10. Simons, DG, Travell JG, Simons LS. Myofascial pain and dysfunction: The trigger point Manual, 2. Baltimore: Williams and Wilkins; 1999.
11. Price DD, Bush FM, Long S, Harkins SW. A comparison of pain measurement characteristics of mechanical visual analogue and simple numerical rating scales. *Pain* 1994; **56(2)**:217-26. doi: 10.1016/0304-3959(94)90097-3.
12. Todd KH, Funk JP. The minimum clinically important difference in physician-assigned visual analog pain scores. *Acad Emerg Med* 1996; **3(2)**:142-6. doi: 10.1111/j.1553- 2712. 1996.tb03402.x.
13. Cleland JA, Fritz JM, Whitman JM, Palmer JA. The reliability and construct validity of the neck disability ındex and patient specific functional scale in patients with cervical radiculopathy. *Spine* 2006; **31**:598-602. doi: 10.1097/01.brs. 0000201241.90914.22.
14. Kim R, Wiest C, Clark K, Cook C, Horn M. Identifying risk factors for first-episode neck pain: A systematic review. *Musculoskelet Sci Pract* 2018; **33**:77-83. doi: 10.1016/j.msksp.2017.11.007.
15. Yoo JI, Oh MK, Chun SW, Lee SU, Lee CH. The effect of focused extracorporeal shock wave therapy on myofascial pain syndrome of trapezius: A systematic review and meta-analysis. *Medicine (Baltimore)* 2020; **99(7)**:e19085. doi:10. 1097/MD.0000000000019085.
16. Calvo-Lobo C, Diez-Vega I, Martínez-Pascual B, Fernández--Martínez S, de la Cueva-Reguera M, Garrosa-Martín G, *et al.* Tensiomyography, sonoelastography, and mechanosensitivity differences between active, latent, and control low back myofascial trigger points: A cross-sectional study. *Medicine (Baltimore)* 2017; **96(10)**:e6287. doi:10.1097/MD.0000000000006287.
17. Manafnezhad J, Salahzadeh Z, Salimi M, Ghaderi F, Ghojazadeh M. The effects of shock wave and dry needling on active trigger points of upper trapezius muscle in patients with non-specific neck pain: A randomised clinical trial. *J Back Musculoskelet Rehabil* 2019; **32(5)**:811-8. doi:10.3233/BMR-181289.
18. Liao CD, Xie GM, Tsauo JY, Chen HC, Liou TH. Efficacy of extracorporeal shock wave therapy for knee tendinopathies and other soft tissue disorders: A meta-analysis of randomized controlled trials. *BMC Musculoskelet Disord* 2018; **19(1)**:278. doi:10.1186/s12891-018-2204-6.
19. Digest Guidelines for Extracorporeal Shock Wave Therapy [Internet]. Updated 05/2019. Available from: http://www.shockwavetherapy.org/fileadmin/user_upload/ISMST_Guidelines.pdf.
20. Munir Z, Akash M, Jaiprada F, Abu Tarboush B, Ijaz O, Bseiso A, *et al*. Evaluation of the effects of extracorporeal shockwave therapy in patients with peripheral arterial disease: A meta-analysis of randomised control trials. *Cureus* 2023; **15(2)**: e34729. doi: 10.7759/cureus.34729.
21. Zhang Q, Fu C, Huang L, Xiong F, Peng L, Liang Z, *et al*. Efficacy of extracorporeal shockwave therapy on pain and function in myofascial pain syndrome of the trapezius: A systematic review and meta-analysis. *Arch Phys Med Rehabil* 2020; **101(8)**:1437-46. doi: 10.1016/j.apmr.2020.02.013.
22. Valera-Calero JA, Sánchez-Jorge S, Buffet-García J, Varol U, Fernández-de-Las-Peñas C, Álvarez-González J. Changes in stiffness at active myofascial trigger points of the upper trapezius after dry needling in patients with chronic neck pain: A randomised controlled trial. *Acupunct Med* 2023; **41(3)**:121-9. doi: 10.1177/09645284221104831.
23. Klauser AS, Miyamoto H, Bellmann-Weiler R, Feuchtner GM, Wick MC, Jaschke WR. Sonoelastography: Musculoskeletal applications. *Radiol* 2014; **272(3)**:622-33. doi: 10.1148/radiol.14121765.
24. Taljanovic MS, Gimber LH, Becker GW, Latt LD, Klauser AS, Melville DM, *et al*. Shear-wave elastography: Basic physics and musculoskeletal applications. *Radiographics* 2017; **37(3**):855-70. doi: 10.1148/rg.2017160116.
25. Jeon JH, Jung YJ, Lee JY, Choi JS, Mun JH, Yong Park W, *et al.* The effect of extracorporeal shock wave therapy on myofascial pain syndrome. *Ann Rehabil Med* 2012; **36(5)**:665-74. doi:10.5535/arm.2012.36.5.665.