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Ultrasound-guided techniques in the treatment of myofascial pain syndrome: a comparison of superficial and deep dry needling

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Abstract

Aims: To compare the effectiveness of ultrasound (US)-guided superficial dry needling (SDN) and deep dry needling (DDN) in patients with myofascial pain syndrome (MPS) of the upper trapezius muscle. **Material and methods:** This prospective, single-blind, randomized study included 80 patients with upper trapezius MPS. Patients were assigned to SDN or DDN groups. Under US guidance, needles were inserted into the subcutaneous deep fascia in the SDN group and directly into muscle trigger points in the DDN group. Both groups received a one-week home exercise program. Outcomes were evaluated before and one week after treatment using the numeric pain rating scale (NPRS), neck Bournemouth questionnaire (NBQ), neck disability index (NDI), pressure pain threshold (PPT), and cervical range of motion (ROM). **Results:** Both groups showed significant improvements in NPRS, NBQ, NDI, and PPT ($p<0.001$). Cervical ROM improved in flexion, extension, right/left lateral flexion and rotation in the DDN group ($p<0.001$), but only in flexion and right rotation in the SDN group ($p<0.05$). Between-group comparisons showed that the DDN group demonstrated more favorable outcomes across all parameters. **Conclusion:** Both techniques were safe and effective for upper trapezius MPS. However, DDN demonstrated greater improvements in pain, functional status, daily activities, and biopsychosocial outcomes.

Keywords: dry needling; myofascial pain syndromes; trigger points; ultrasonography

Introduction

Myofascial Pain Syndrome (MPS) is a pain disorder characterized by the presence of highly sensitive myofascial trigger points (MTrPs) within palpable taut bands of skeletal muscle and is associated with sensory, motor and autonomic symptoms [1,2]. It is a painful clinical condition originating from localized hyperirritable areas involving muscle tissue (myo-) and the surrounding connective tissue (fascia) [3,4]. Cervical MPS is responsible for approximately 90% of cases presenting with chronic nonspecific neck pain [5]. Among postural muscles, cervical MPS most commonly involves the upper trapezius muscle [6]. Upper trapezius MPS is a complex pain condition involving not only trigger points, but also superficial and deep fascial structures within the subcutaneous tissue, peripheral nerves, and the cutaneous branches of the dorsal rami of spinal nerves [5,7,8].

Dry needling is commonly used by clinicians in the treatment of upper trapezius MPS. [1,9]. This treatment modality involves the use of thin filiform acupuncture needles without the administration of any medication [1,3]. Dry needling is classified as superficial or deep based on the depth of needle insertion. Superficial dry needling (SDN) involves inserting the needle into the subcutaneous tissue, approximately 10 mm deep, without reaching the muscle. In contrast, deep dry needling

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(DDN) targets MTrPs located within the muscle tissue, specifically addressing the muscular component of myofascial pain [10,11]. Dry needling is commonly performed based on manual palpation, without the use of imaging guidance [12]. However, in recent years, ultrasound (US)-guided dry needling has become increasingly preferred in pain management practices [5,13,14]. In this approach, real-time visualization of needle penetration into the target muscle or subcutaneous tissue is achieved, while reducing the risk of complications involving neural and vascular structures [5,15].

Several studies in the literature have compared SDN and DDN techniques in the treatment of MPS [10,16-18]. To the best of our knowledge, there are no published studies that have directly compared these two techniques of US-guided dry needling in the treatment of MPS. Without US-guidance, distinguishing the subcutaneous fascia from the upper trapezius muscle and visualizing the depth of needle penetration becomes difficult, making it challenging to accurately standardize SDN and DDN techniques [7,8,15]. The aim of this study was to compare the effectiveness of US-guided SDN and DDN techniques in patients diagnosed with MPS of the upper trapezius muscle, in terms of pain, functional status, activities of daily living, and biopsychosocial outcomes. This approach was intended to enable a more reliable assessment of the therapeutic effects of needle insertion depth.

Material and methods

Study design and setting

This study was designed as a prospective, single-blind, randomized controlled trial. It was initiated following approval by the Clinical Research Ethics Committee (decision no: 2024/143, dated June 4, 2024). Verbal and written informed consent was obtained from all participants who met the inclusion criteria. This study was conducted in accordance with the principles of the Declaration of Helsinki, and its design, conduct, and reporting adhered to the CONSORT 2010 statement [19].

Study participants

Between August 11, 2024, and March 1, 2025, patients presenting with neck pain persisting for more than three months were screened for eligibility. Participants were included if they met the diagnostic criteria for MPS of the upper trapezius muscle. The clinical diagnosis of MPS was confirmed by the presence of all five major criteria and at least one minor criterion [20].

The inclusion criteria were defined as follows: (i) a diagnosis of MPS in the upper trapezius muscle based on the criteria of Travell and Simons; (ii) age between 20 and 50 years; and (iii) no prior treatment involving injection, dry needling, or physical therapy modalities applied to the cervical region within the past three months.

The exclusion criteria were as follows: (i) presence of coagulation disorders; (ii) history of trauma to the neck or shoulder; (iii) presence of malignancy, infection, rheumatic diseases, degenerative joint disease, fibromyalgia, cervical radiculopathy, neuropathy, myelopathy, myopathy, adhesive capsulitis, or any other condition that may affect neck and shoulder pain; (iv) incomplete clinical evaluation for any reason; and (v) participants who declined to complete the assessments.

Randomization

Participants were randomized into two groups: SDN and DDN. Randomization was carried out by having each participant randomly select one envelope marked with the letter A or B.

Treatment protocol

All participants were seated upright in a chair with their back supported, head in a neutral position, and arms resting alongside the body. The region between the spinous process of the seventh cervical vertebrae and the acromion process was palpated to identify the most sensitive MTrP of the upper trapezius muscle, where MTrPs are most commonly located. Once the most tender MTrP on the painful right and/or left upper trapezius muscle was identified, two additional points were marked 1 cm medial and 1 cm lateral to the primary point resulting in three needling sites.

A sterile filiform acupuncture needle (Hua Long, Wujiang, China) measuring 0.25×25 mm was used for the SDN group, and 0.25×40 mm for the DDN group. Following standard antiseptic procedures, a linear US probe was positioned longitudinally in the coronal plane over the marked point to visualize the muscle fibers in parallel alignment. Using real-time US guidance, the needle was inserted perpendicularly to the skin with an out-of-plane approach targeting the designated anatomical structure in a single session. The needle was retained in place for five minutes, then rotated clockwise and left for an additional five minutes, resulting in a total of 10 minutes of needle retention before removal.

In both groups, a home exercise program consisting of upper trapezius stretching (10 seconds, 10 repetitions, three sets, twice daily) was prescribed for one week following the intervention. Participants were instructed not to receive any additional pharmacological or non-pharmacological treatments during the study period.

SDN treatment group

The acupuncture needle was inserted perpendicularly into the deep fascia of the subcutaneous tissue at each of the marked trigger points.

DDN treatment group

The acupuncture needle was inserted perpendicularly into the deeper region of the upper trapezius muscle at each of the marked trigger points (fig 1).

Outcome measures

Participants were assessed twice: pre-treatment and one week after treatment. The primary outcome measures were the numeric pain rating scale (NPRS), neck disability index (NDI), neck Bournemouth questionnaire (NBQ), cervical range of motion (ROM), and pressure pain threshold (PPT) measured using an algometer.

Pain severity was assessed using the NPRS. Patients were asked to select the number on the scale that best represented their current pain level, where 0 indicated no pain and 10 indicated the worst imaginable pain [21]. Functional status was assessed using the NDI, originally developed by Howard Vernon. The Turkish version, validated by Kesiktas et al., was used in this study [22,23]. Each item is scored on a scale from 0 (no disability) to 5 (complete disability), with a total score ranging from 0 to 50. Higher scores indicate greater levels of disability. Based on the total score, disability is categorized as none, mild, moderate, or severe [22].

Biopsychosocial status was assessed using the NBQ, developed by Bolton and Humphreys and adapted into Turkish by Yılmaz et al. [24,25]. Each item is scored on a scale from 0 to 10. The total score ranges from 0 to 70, with higher scores indicating greater disability [25].

Cervical ROM was measured in flexion, extension, lateral flexion, and rotation using a goniometer and the Neutral-0 method [26]. PPT measurements were performed using a manual pressure algometer (Baseline® Dolorimeter, Fabrication Enterprises, Inc., NY, USA) to assess pain sensitivity and pressure perception [27]. The device consists of a metal probe with a 1 cm² surface and a gauge that measures in kilograms-force (kgf). Measurements were performed three times over the most tender trigger point identified by palpation and the average of the three readings was used for analysis.

Secondary outcomes included MTrPs distribution (left/right/bilateral), local twitch response, skin and subcutaneous tissue thickness measured by US, and adverse events (e.g., procedural pain, burning sensation, nausea, dizziness).

Statistical methods

Statistical analyses were performed using SPSS version 20 (Statistical Package for the Social Sciences, Chicago, IL, USA). The distribution characteristics of continuous variables were assessed using the Kolmogorov-Smirnov test, and since normal distribution was confirmed, parametric tests were applied. For the comparison of demographic data, independent samples t-test was used for continuous variables, and the chi-square test was used for categorical variables. Paired samples t-test was used to evaluate pre- and post-treatment changes within groups, while independent samples t-test was used for between-group comparisons. In addition, correlations between skin and subcutaneous tissue thickness and height, weight, and body mass index (BMI) were assessed using Pearson correlation analysis. A 95% confidence interval was used for all analyses, and a p-value of <0.05 was considered statistically significant.

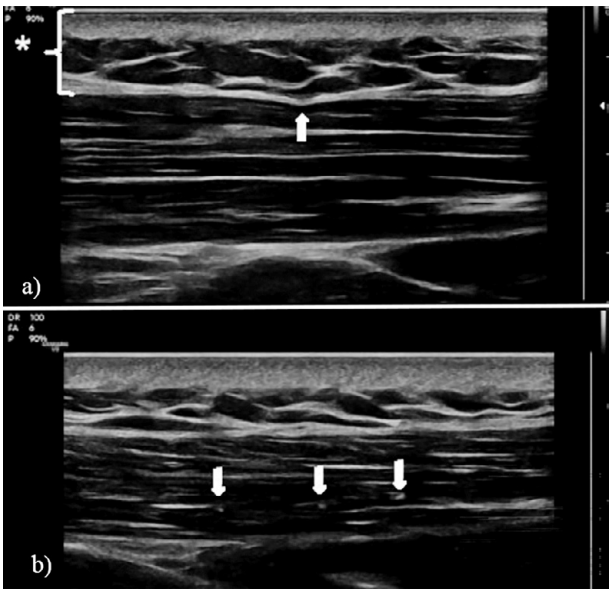

Fig 1. a) In the SDN, needle's penetration into the deep fascia of the subcutaneous tissue is indicated by the arrowhead; b) in the DDN, needle's penetration into the upper trapezius muscle is indicated by the arrowheads (needle tip). * The skin and subcutaneous tissue thickness was measured using the ultrasound device's electronic caliper.

Results

A total of 105 patients were initially evaluated. Eight patients did not meet the inclusion criteria, and five declined to provide informed consent. The remaining 92 patients were randomized into two groups: SDN and DDN. Twelve patients were excluded from the analysis due to failure to complete the study for various reasons. As a result, the study was completed with 80 patients, with 40 participants in each group (fig 2).

As presented in Table I, there were no statistically significant differences between the SDN and DDN groups in terms of demographic variables such as sex, age, height, weight, and BMI (p>0.05). The duration of neck pain was similarly distributed in both groups, and the mean durations were comparable, with no significant difference between the groups (p>0.05).

As presented in Table II, there were no statistically significant differences between the SDN and DDN groups in terms of MTrP localization distribution (left, right, or bilateral) ($p>0.05$). The table also presents the subcutaneous tissue thickness measured by ultrasonography at MTrP sites. According to Pearson correlation analysis, skin and subcutaneous tissue thickness showed a moderate positive correlation with body weight ($p<0.001$), a strong positive correlation with BMI ($p<0.001$), and a weak but statistically significant negative correlation with height ($p<0.05$).

As presented in Table III, a statistically significant increase in PPT was observed in both groups at the one-week follow-up ($p<0.001$). The increase observed in the DDN group was more pronounced than in the superficial group, and the between-group difference was statistically significant ($p<0.001$). In addition, among the secondary outcomes not presented in the table, local twitch responses were observed at 23 MTrP sites exclusively in the deep group, but not in the superficial group. Statistically significant improvements were observed in NPRS, NBQ, and NDI scores in both groups after treatment ($p<0.001$). However, clinical improvement and reduction in disability were more pronounced in the DDN group, with statistically significant between-group differences across all parameters ($p<0.001$).

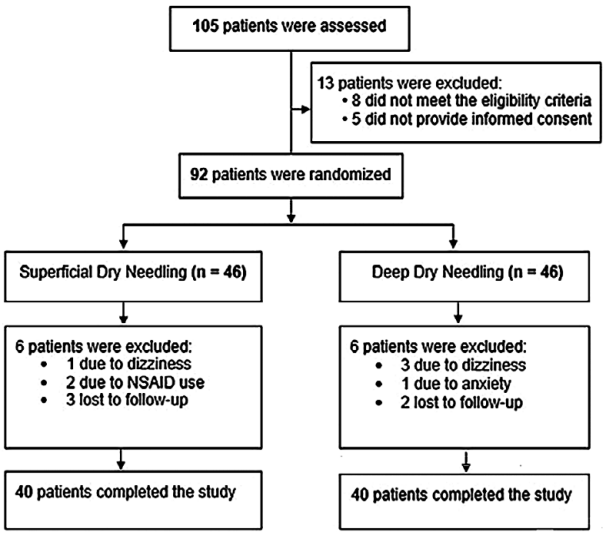

Fig 2. Flow chart of patient recruitment, randomization, and follow-up in the study.

As presented in Table IV, while the SDN group showed significant improvements only in cervical flexion and right rotation ($p<0.05$), the DDN group demonstrated significant improvements in all directions of cervical ROM ($p<0.001$).

In addition, pain during the procedure was reported in 27 patients (67.5%) in the SDN group and 39 patients

Table I. Demographic and baseline clinical characteristics of the participants

Variable	Superficial group (n=40)	Deep group (n=40)	p-value
Age (years)	38.03±9.99	36.15±9.76	>0.05
Height (m)	1.64±0.09	1.65±0.08	>0.05
Weight (kg)	72.85±13.30	68.55±11.71	>0.05
BMI (kg/m²)	27.07±4.92	25.07±4.29	>0.05
Pain duration (months)	13.37±9.29	12.15±9.06	>0.05
Gender (F/M)	33 (82.5%) / 7 (17.5%)	35 (87.5%) / 5 (12.5%)	>0.05

Continuous variables are presented as mean±standard deviation; categorical variables are expressed as number (percentage). Between-group comparisons were made using independent samples t-test for continuous variables and Chi-square test for categorical variables. SD: Standard Deviation, BMI: Body Mass Index, F/M: Female/Male

Table II. Myofascial trigger points (MTrPs) distribution and skin and subcutaneous tissue thickness correlation with anthropometric measures

MTrPs distribution	Total n	Left n	Right n	Bilateral n	p-value
Superficial	40	12	14	14	>0.05
Deep	40	5	22	13	
Skin + SubQ Thickness (US/mm)*	n	Min	Max	Mean	SD
Superficial	54	4.2	13.1	8.87	2.28
Deep	53	5.7	12.5	7.75	1.56
Skin + SubQ Thickness and Anthropometric Variables**	Height		Weight	BMI	
Pearson Correlation / *p*-value	r=-0.259 / p<0.05		r=0.550 / p<0.001	r=0.704 / p<0.001	

SD: Standard Deviation, US: Ultrasonography, BMI: Body Mass Index, Skin + SubQ: Skin and Subcutaneous Tissue. * Ultrasonographic measurement of skin and subcutaneous tissue thickness (in millimeters, mm) at the MTrP sites. ** Pearson correlation and p-values between ultrasonographic skin + subcutaneous tissue thickness and anthropometric parameters

(97.5%) in the DDN group with the difference found to be statistically significant ($p<0.001$). A burning sensation was reported in 5 patients (12.5%) in the superficial group and in 17 patients (42.5%) in the deep group ($p<0.05$).

Discussion

In this study, the effectiveness of US-guided DDN and SDN techniques was compared in patients diagnosed with MPS of the upper trapezius muscle, in terms of pain, functional status, daily living activities, and biopsychosocial outcomes. Both techniques showed statistically significant improvements in NPRS, NBQ, NDI, PPT, and cervical ROM after treatment. However, the DDN group exhibited a superior clinical response to SDN across all parameters. Clinical significance can be evaluated in relation to established Minimal Clinically Important Difference (MCID) values. In this context, MCID values of approximately 1.5–2.5 points for the NPRS have been reported in neck pain research and changes below 1.5 points may have limited clinical relevance in chronic neck pain [28,29]. Accordingly, the observed reduction of 1.45 points in the SDN group was below this threshold, indicating limited clinical improvement. Similarly, the observed reduction in the NDI did not reach the MCID of approximately 15% (7.5/50 points) reported in a systematic review [30]. These findings indicate that, although the improvement in the SDN group was statistically significant, its clinical significance may be limited. In contrast, the DDN group exceeded MCID thresholds and demonstrated both statistical and clinical significance.

Table III. Comparison of pre- and post-treatment clinical outcomes within and between groups

Outcome Measure	Group	n	Pre-treatment	Post-treatment	Within-group p*	Change	Between-groups p**
Algometry (kg/cm²)	Superficial	54	2.25±0.49	2.62±0.52	<0.001	+0.36±0.39	
	Deep	53	2.12±0.40	3.35±0.46	<0.001	+1.23±0.42	**<0.001**
NPRS	Superficial	40	7.78±1.05	6.32±1.35	<0.001	-1.45±1.13	
	Deep	40	8.25±1.08	4.03±1.37	<0.001	-4.22±1.42	**<0.001**
NBQ	Superficial	40	49.25±8.31	40.53±8.28	<0.001	-8.72±7.22	
	Deep	40	52.80±9.39	26.68±10.39	<0.001	-26.12±9.44	**<0.001**
NDI	Superficial	40	22.55±3.77	18.73±3.94	<0.001	-3.82 ± 2.97	
	Deep	40	23.88±4.87	12.15±4.96	<0.001	-11.72±3.79	**<0.001**

Continuous variables are presented as mean ± standard deviation. Pre: before treatment, Post: after treatment, Change: post-pre difference, NPRS: Numeric Pain Rating Scale, NBQ: Neck Bournemouth Questionnaire, NDI: Neck Disability Index, SD: Standard Deviation
*Within-group comparisons were performed using the paired samples t-test to evaluate pre- and post-treatment changes. **Between-group comparisons were performed using the independent samples t-test based on the difference in change scores (post–pre) between the groups.

Table IV. Pre- and post-treatment changes in cervical range of motion within and between groups.

ROM	Group	n	Pre	Post	Within-group p*	Change	Between-groups p**
Flexion	Superficial	40	48.13±5.95	49.13±5.97	**<0.05**	1.00±2.58	
	Deep	40	45.38±5.24	50.00±5.19	**<0.001**	4.62±3.98	**<0.001**
Extension	Superficial	40	56.25±5.03	56.87±5.02	≥0.05	0.62±2.02	
	Deep	40	54.63±5.93	57.88±5.87	**<0.001**	3.25±3.31	**<0.001**
Right lateral flexion	Superficial	40	41.13±3.49	41.38±3.58	≥0.05	0.25±1.10	
	Deep	40	39.75±4.23	42.87±2.75	**<0.001**	3.12±3.52	**<0.001**
Left lateral flexion	Superficial	40	40.12±4.87	40.63±4.56	≥0.05	0.50±1.89	
	Deep	40	38.87±4.60	43.00±3.36	**<0.001**	4.12±3.73	**<0.001**
Right rotation	Superficial	40	80.00±5.99	80.88±6.29	**<0.05**	0.87±1.92	
	Deep	40	75.38±9.02	81.25±6.18	**<0.001**	5.87±5.64	**<0.001**
Left rotation	Superficial	40	78.88±5.83	79.50±5.52	≥0.05	0.62±2.57	
	Deep	40	74.63±8.87	81.50±7.00	**<0.001**	6.87±4.62	**<0.001**

Continuous variables are presented as mean ± standard deviation. Pre: before treatment, Post: after treatment, Change: post-pre difference, ROM: Range of Motion, SD: Standard Deviation
*Within-group comparisons were performed using the paired samples t-test to evaluate pre- and post-treatment changes. **Between-group comparisons were performed using the independent samples t-test based on the difference in change scores (post–pre) between the groups.

US guidance was not employed in previous studies comparing the efficacy of SDN and DDN techniques for MPS management, and differences in needle penetration depths were observed [11,18]. Baldry et al, who first described SDN, applied the needle to a depth of 5–10 mm within the subcutaneous tissue, a range also cited by Kalichman et al. [11,31]. A meta-analysis comparing the needle depths classified superficial needling as <10 mm and deep needling as >10 mm [18]. In comparative studies, the absence of US guidance and the variability in needle penetration depth are considered to have rendered the impact on outcomes uncertain.

In our study, appropriate needle lengths were selected based on individual BMI and subcutaneous tissue thickness, and anatomical penetration was visualized using ultrasonography. US guidance enhanced anatomical accuracy, optimized treatment efficacy, and reduced the risk of complications. US measurements demonstrated that skin and subcutaneous tissue thickness was directly correlated with body weight and BMI. It was determined that the commonly used needling depth of 5–10 mm in SDN procedures could reach the muscle tissue, particularly in individuals with low BMI. These findings suggest that US-guided application of both SDN and DDN is essential to ensure anatomical accuracy and to objectively assess treatment efficacy. In a supporting study, Sudarshan et al. proposed a grading scale based on needle penetration depth in dry needling and noted that, in the absence of US guidance, distinguishing between needling into the superficial fascia and beyond the deep fascia can be challenging [15].

In SDN, stimulation of mechanoreceptors and nociceptive afferents (Aδ and C fibers) provides central pain modulation, whereas in DDN, the relaxation of intramuscular contractile fibers and increased local circulation reduce hypoxia, resulting in a therapeutic effect [5,15]. Accordingly, in our study, US guidance was used to determine the target location for needling in myofascial pain, which contributed to a more reliable evaluation of treatment efficacy and allowed for a more objective analysis of clinical outcomes. Furthermore, it allowed for a more sensitive comparison of the effects of dry needling on both myo- and fascial components.

There are different opinions in the literature about superficial and deep needling. Baldry et al. suggested that although SDN and DDN are similar in terms of efficacy, SDN should be preferred in most patients due to its ease of application and lower risk of adverse effects [31]. Kalichman et al. acknowledged that SDN is an effective technique but stated that it is less effective compared to DDN. However, they recommended the use of the superficial technique in high-risk areas such as the lungs and major blood vessels [11]. Hoseininejad et al. reported that both SDN and DDN, applied in a single session to 47 female patients with active trigger points in the upper trapezius muscle, resulted in significant reductions in VAS and NDI scores; however, no statistically significant difference was found between the groups. Nonetheless, a significant increase in EMG activity observed in the deep needling group was considered to be beneficial in terms of muscle function [16]. US-guided DDN, applied by targeting the deeper layers of the muscle, resulted in statistically significant improvements in NPRS, NBQ, and NDI scores. Moreover, it was found to be clinically more effective than SDN across all parameters ($p<0.001$).

Ezzati et al observed significantly greater improvements in cervical lateral flexion and functional outcomes on days 7 and 15 in the DDN group with upper trapezius MPS compared to the SDN group [32]. However, the treatment protocol did not include upper trapezius stretching. In the present study, the DDN group showed significant improvements in all directions ($p<0.001$) and these improvements were found to be clinically more pronounced compared to the SDN group, consistent with the literature [17,32]. These findings suggest that DDN is more effective in enhancing cervical mobility.

A systematic review and meta-analysis comparing the effectiveness of superficial and deep needling in reducing pain and disability in spine-related pain conditions reported that both techniques led to clinically significant improvements in pain scores over time. The review emphasized the need for standardization of superficial and deep needling techniques by taking into account factors such as the anatomical location and depth of the lesion [18]. In the present study, the determination of an anatomical target for needling depth allowed for a more objective analysis of treatment efficacy and clinical outcomes. In US-guided SDN and DDN, the distinction between the two techniques was more clearly defined by visualizing the target tissues, which contributed to a more controlled application. Based on this standardized approach, DDN demonstrated greater clinical effectiveness than SDN in terms of pain, disability, and functional status.

Itoh et al. reported that in their study investigating the effects of needling depth on extensor digitorum muscle pain, deep needling was more effective than superficial acupuncture in reducing pain and increasing PPT. The same study also emphasized that the fascia and muscle are the most sensitive tissues, and that stimulation of the muscle with a needle increased the electrical pain threshold over the fascia [33]. In the present study, US-guided dry needling was applied to 54 superficial sites on the right, left, or both sides and 53 deep sites. In the DDN group, the increase in PPT was found to be significant-

ly greater compared to the superficial group ($p<0.001$). This finding supports the conclusion that DDN exerts a stronger analgesic effect.

In the literature, adverse effects have been reported more frequently in association with DDN treatment [34]. Taşoğlu et al. reported that the pistoning technique used in DDN was associated with increased pain sensation [35]. In another study, needle rotation has been proposed as an alternative to this technique [34]. In the present research, this method was also preferred for the comparison of the two techniques. Consistent with the literature, pain, sensory, and autonomic symptoms during the procedure were observed more frequently in the DDN group. However, when applied as US-guided DDN, it provides an advantage by reducing the risk of potential complications such as pneumothorax or neurovascular injury. In real-world clinical settings, these adverse effects may affect patient compliance and treatment preference. Patients who are more sensitive to pain may be less willing to receive DDN and less likely to continue with repeated sessions, which may reduce compliance and lead to a preference for less painful alternatives. In contrast, the lower discomfort associated with SDN may improve patient compliance and increase patient preference. Therefore, while DDN may provide greater clinical benefit, SDN may be preferred due to its better tolerability and potential to enhance patient compliance.

There are several limitations that should be considered in this study. First, only the upper trapezius muscle was targeted, and further research is needed to compare SDN and DDN techniques in different muscle groups. In addition, MTrPs could not be directly visualized using US and no specific sonographic features were used to identify them. The use of advanced imaging modalities, such as sonoelastography, in future studies may help achieve more precise localization of the needling site. Furthermore, long-term follow-up and placebo-controlled trials are needed to better evaluate the sustained therapeutic responses in patients. The lack of long-term follow-up limits the clinical interpretation of these findings. It remains unclear whether the observed improvements are sustained over time, which is critical for determining the durability of treatment effects in routine clinical practice. Moreover, the lack of follow-up at 1 and 3 months prevents the assessment of subacute and long-term outcomes, as well as the potential recurrence of symptoms. Therefore, while the results demonstrate short-term efficacy, caution is warranted when extrapolating these findings to long-term clinical effectiveness.

In **conclusion**, both superficial and deep US-guided dry needling treatments were found to be safe and effective in the management of MPS of the upper trapezius muscle. US-guided anatomical targeting is considered to enhance methodological standardization when comparing these techniques. US-guided DDN was observed to be clinically more effective in terms of pain, disability, and functional outcomes. Based on these findings, US-guided DDN may be considered a preferable treatment approach in clinical practice.

Conflict of interest: none

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