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Original Article

Effectiveness of static, dynamic and combined dry needling techniques in the management of myofascial pain syndrome: A three-group study

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ABSTRACT

Objectives: This study aims to evaluate and compare the therapeutic effectiveness of static dry needling (S-DN), dynamic dry needling (D-DN), and a combined technique (CT) for managing myofascial pain syndrome (MPS).

Patients and methods: Between January 1, 2023 and April 15, 2023, a total of 38 patients (9 males, 29 females; mean age: 40.5±12.7 years; range, 22 to 63 years) with MPS who experienced neck pain for less than six months and had at least one painful myofascial trigger point in the trapezius, rhomboids, or levator scapula muscle were included in the study. The patients were divided into three groups: D-DN, S-DN, and CT. Measurements included the Visual Analog Scale (VAS), range of motion (ROM), Neck Disability Index (NDI), and the European Quality of Life 5 Dimensions 3 Level Version (EQ5D3L). All measurements were made at baseline (T0), after the first treatment session (T1), after the final session (T2), and one-month post-treatment (T3).

Results: The group treated with S-DN showed less significant improvement in ROM scores compared to other treatment methods. Both the D-DN and S-DN groups showed decreased VAS scores at rest and during motion across all time points, compared to the CT group. The NDI scores decreased in all groups, while the EQ5D3L scores exhibited no variations between groups or across any time point irrespective of the treatment method employed.

Conclusion: Our study results suggest that all three methods are effective in treating MPS, with D-DN potentially being the preferred method over S-DN and CT due to its time efficiency.

Keywords: Dynamic dry needling, myofascial pain syndrome, static dry needling.

Myofascial pain syndrome (MPS) is a prevalent cause of musculoskeletal pain, characterized by discomfort originating from myofascial trigger points (MTrPs) in taut muscle bands or fascia. It is often linked with muscle spasms, tenderness, restricted range of motion (ROM), stiffness, fatigue, and autonomic dysfunction.[1] Active MTrPs are identified by consistent tenderness and a tight band, while latent MTrPs are marked by localized or radiating pain upon palpation, possibly associated with diminished ROM without pain during routine activities.[2]

A variety of modalities are employed in managing MPS. These include non-steroidal anti-inflammatory drugs, physical therapy techniques, exercise, ischemic compression, stretch and spray techniques, local steroid injections, local anesthetic injections, Kinesio taping, and dry needling (DN).[3] Dry needling is a recognized and effective method for MPS management due to its ease of application, economic viability, and safety.[4]

Dry needling is a procedure where a needle without medication (dry needle) is inserted to penetrate MTrPs. Traditionally, treating MTrPs involves multiple needle insertions in various directions to pinpoint sensitive areas within the MTrP zone. However, this method can lead to potential tissue damage due to needle side movements and the occurrence of an elicited local twitch response (LTR). To mitigate these risks,

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a modified technique with rapid movements has been developed, which is commonly used for MTrP injection or needling currently.[5]

In general, two primary DN techniques are prevalent: dynamic DN (D-DN) and static DN (S-DN). The former entails a quick insertion and removal of a dry needle into an MTrP.[6] In contrast, the latter involves leaving the needle in place or rotating it to engage the surrounding fascia or soft tissues of the MTrP.[7] While both methods are extensively utilized, there remains a lack of definitive evidence regarding the superiority of one technique over the other or the efficacy of their combined use.[8,9] In the present study, we aimed to evaluate and compare the therapeutic effectiveness of the S-DN and D-DN techniques, as well as their combined application, in the treatment of MPS.

PATIENTS AND METHODS

Study design and study population

This single-center, parallel-group, prospective, randomized study was conducted at Sultan 2. Abdulhamid Han Training and Research Hospital, Department of Physical Medicine and Rehabilitation between January 1, 2023 and April 15, 2023. Patients eligible for this study were those with MPS who experienced neck pain for less than six months and had at least one painful MTrP in the trapezius, rhomboids, or levator scapula muscle, and consented to treatment. Exclusion criteria included a history of cervical or shoulder surgery, radiculopathy signs on examination, any injections in the targeted area within the past three months, a diagnosis of fibromyalgia as per the 2016 American College of Rheumatology (ACR) criteria,[10] cervical disc herniation as seen on magnetic resonance imaging (MRI) within the last year, pregnancy or suspected pregnancy, allergy to silver, history of malignancy, positive red flags, any known rheumatic disease, cognitive impairment, or local infection at the application site. Finally, a total of 38 patients (9 males, 29 females; mean age: 40.5±12.7 years; range, 22 to 63 years) were included in the study. The study flowchart is shown in Figure 1.

Randomization and interventions

Patients meeting the criteria were randomly assigned to one of three groups using the sealed envelope method. This involved opaque envelopes containing a paper with group allocation information. A computer program generated the allocation sequence, and the envelopes were then sealed and numbered.[11] The study employed a parallel-group randomized controlled trial design with a 1:1:1 allocation ratio for the three groups. The groups were as follows: Group 1 with a standard exercise program and D-DN method at one-week intervals; Group 2 with the same exercise program and S-DN administered across four sessions at one-week intervals; and Group 3 with the standard exercise program and a combination of D-DN and S-DN methods (combined technique [CT]) across four sessions at one-week intervals.

Before injection, bilateral trapezius, rhomboids, and levator scapulae muscles were palpated for MTrP identification. The diagnosis of MTrP followed criteria by Travell and Simons.[12] The skin was cleaned with an antiseptic, and the painful MTrP was palpated again between the thumb and index fingers before guiding the needle to the identified MTrPs. Stainless steel 25×25-mm needles were used for DN, applied once a week for a total of four weeks in all groups, combined with a standard neck muscle exercise program.

In the D-DN group, the needle was inserted and removed rapidly until the LTR disappeared, performed at least 10 times at each point.[6] The S-DN group involved spinning the inserted needle counterclockwise at each MTrP and leaving it for up to 15 min.[7] In the CT group, after needle insertion and removal, the needle was spun counterclockwise at least 10 times at each point, with each session lasting 15 min until the LTR disappeared.[6,7]

The exercise program consists of cervical strengthening, cervical-upper trapezius stretching, and cervical joint ROM exercises was administered to all groups.[13] It included three sets of 10 repetitions per day, starting on the same day as the DN sessions. A physiotherapist with 15 years of experience instructed the patients, and each training session lasted at least 30 min. Exercise compliance, accuracy, and continuity were monitored during the weekly DN sessions, continuing until the end of the fourth control.

Outcome measurements

Demographic data including age, sex, profession, height, weight, and duration of symptoms were recorded for each patient. The study encompassed patients who provided data at baseline (T0), after the first treatment session (T1), after the final session (T2), and one-month post-treatment (T3). Outcome measures evaluated at each visit included the Visual Analog Scale (VAS) for pain at rest, pain at night, and

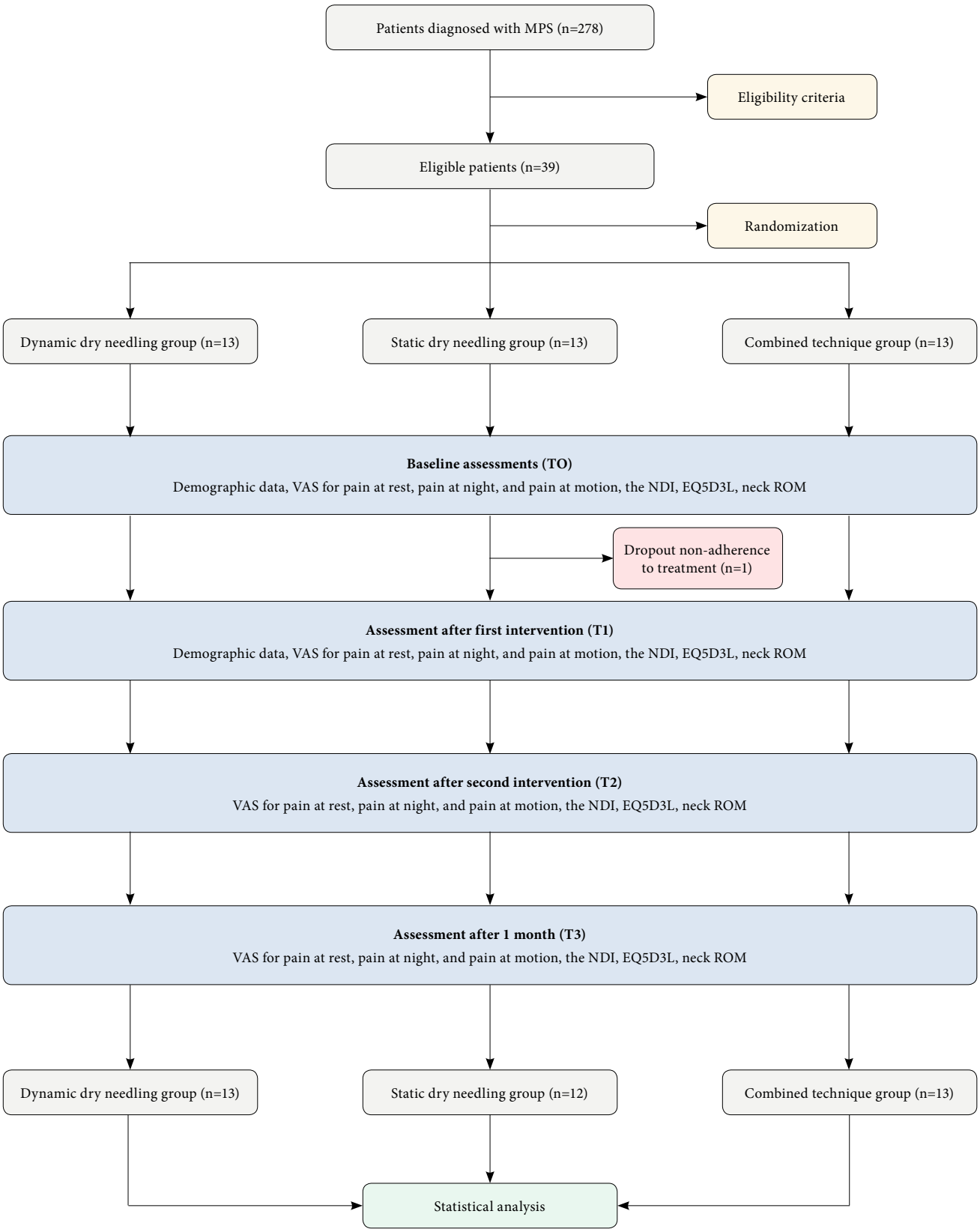

Figure 1. Flowchart of the study.
MPS: Myofascial pain syndrome; VAS: Visual Analog Scale; NDI: Neck disability index; EQ5D3L: European Quality of Life 5 Dimensions 3 Level version; ROM: Range of motion.

pain during motion; the Neck Disability Index (NDI); the European Quality of Life 5 Dimensions 3 Level Version (EQ5D3L); and neck ROM. Assessments were conducted by an investigator who was blinded to the treatment allocation.

The VAS uses a 10-cm line with endpoints representing the extreme values of the parameter being assessed. Patients indicate their perceived level of pain or discomfort by marking a point on this line.[14]

The NDI is a validated questionnaire comprising 10 items that gauge the impact of neck pain on daily activities like sleeping, personal care, driving, reading, and concentration. Each item is scored from 0 to 5, with the total score ranging up to 50, where higher scores denote greater disability and pain.[15] The Turkish validation of the NDI was conducted by Aslan et al.[16]

The EQ5D3L is a standardized instrument designed to evaluate health-related quality of life. It consists of two parts: firstly, a health profile defined across five dimensions (mobility, self-care, social life, pain, and psychological well-being), with three levels of difficulty in each dimension. Secondly, it incorporates a VAS to assess overall health status.[17] As the EQ5D3L has been already translated into multiple languages, including Turkish, by its development team, additional validation studies were not required.

Neck ROM was measured in degrees using a goniometer. This involved measuring the maximum angles of lateral bending, rotation to the right and left, and flexion and extension of the neck. Each angle was measured three times, with the highest value being selected. The mean of these highest values from both directions was calculated and recorded as the final ROM measurement.[18]

Statistical analysis

A preliminary analysis with a sample size of 15 (n=15) focused on the VAS-rest scores, revealing an effect size of 0.25. Using the G*Power version 3.1.9.7 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany), with an alpha (α) error set at 0.05 and a power (1-β) of 0.95, analysis of variance (ANOVA) testing (F-Test) was employed to determine the required sample size for the analysis, calculated to be 36. Anticipating a 20% dropout rate, the study planned to include a total of 44 patients.

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to assess data normality, while the Levene test evaluated variance homogeneity. Continuous data were presented in mean ± standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. Categorical variables between groups were compared using Fisher exact test. For normally distributed data, repeated measures ANOVA was applied to analyze treatment-related changes. The Friedman test was used as the non-parametric alternative. Mean differences among the groups were assessed using one-way ANOVA or the Kruskal-Wallis test, supplemented by the Mann-Whitney U test for pairwise comparisons. Post-hoc analyses were employed using either a Bonferroni correction or Scheffe's method. The Wilcoxon signed-rank test was used to evaluate multiple comparisons between time points for non-parametric data and paired samples t-test for parametric data. A p value of <0.05 was considered statistically significant with 95% confidence interval (CI).

RESULTS

Demographic and clinical data for each group are detailed in Table 1. One participant from the S-DN group withdrew due to non-adherence to the treatment protocol. No significant differences were found in the demographic and clinical characteristics among the groups (p>0.05).

Intra-group assessments revealed significant improvements in all movement directions for Groups 1 and 3. In Group 2, significant improvements were observed in all movements, except for right lateral flexion and left rotation. While comparing changes over time among the groups, left lateral flexion from T3 to T1 showed significant differences in Group 2 compared to Groups 1 (p=0.04) and 3 (p=0.02) (Table 2).

The VAS scores for rest, motion, and night did not significantly differ among groups at any time point. Within group analyses indicated significant reductions in VAS rest scores for Group 1 at T1 (p=0.011), T2 (p<0.001), and T3 (p<0.001), and for Group 2 at T1 (p=0.002), T2 (p<0.001), and T3 (p<0.001) compared to T0. Group 3 showed no significant change in VAS rest scores (p>0.05). For VAS motion scores, Group 1 displayed significant reductions at T1 (p=0.014), T2 (p<0.001), and T3 (p=0.001) compared to T0, while Groups 2 and 3 showed significant decreases at T2 (p=0.001 and p=0.003, respectively) and T3 (p=0.018 and p=0.007, respectively). The VAS night

scores in Groups 1 and 3 significantly decreased at T2 ($p<0.001$ and $p=0.023$, respectively) compared to T0, with significant reductions also noted from T0 to T3 ($p=0.003$ and $p=0.042$, respectively). In Group 2, only the T2 score ($p=0.039$) showed a significant decrease from baseline. While comparing changes among groups regarding pain scores, Pain at rest scores between T1 and T0 time points were significantly different between Group 1 and Group 2 ($p=0.01$) and Group 1 and Group 3 ($p=0.001$). Pain at rest scores between T2 and T0 time points were significantly different between Group 1 and Group 3 ($p=0.03$). Pain at night scores were significantly different for T0 and T1 ($p=0.001$) and T0 and T2 ($p=0.02$) time points between Group 1 and Group 3 (Table 2).

The NDI and EQ5D3L scores did not differ significantly among the groups. However, all groups experienced significantly lower NDI scores at T2 ($p<0.001$) and T3 ($p=0.002$) compared to T0. The EQ5D3L scores in Groups 1 and 3 increased significantly at T2 ($p=0.023$ and $p<0.001$, respectively) and T3 ($p<0.001$ and $p=0.002$, respectively) compared to baseline. Group 2 only showed a significant increase at T2 ($p=0.033$). No statistically significant differences were observed in the changes of NDI and EQ5D3L scores between the groups over time (Table 2).

No side effects were reported during or after treatment in any of the groups.

DISCUSSION

In this study, we demonstrated significant improvements in pain intensity, ROM, and quality of life across all intervention groups compared to their baseline measures. Overall, there were no significant differences in outcomes among the groups, except for in some ROM measurements. Notably, no side effects were observed in any group during or after treatment. To the best of our knowledge, this is the first study to extensively evaluate and compare these therapeutic techniques, both individually and in combination.

The likely mechanism behind the immediate and complete pain relief observed with D-DN is hyperstimulation analgesia through the descending pain inhibitory system. This effect occurs when intense pressure stimulation from rapid needle movements triggers strong neural impulses to dorsal horn cells in the spinal cord, disrupting the pain-spasm-pain cycle through the descending pain inhibitory pathway.[19]

In contrast, S-DN stimulates TRPv1 receptors on peripheral nerve endings during needling. Recent

TABLE 1
Demographic and clinical data and comparison of trigger point locations for each group

	Group 1 (n=13)				Group 2 (n=12)				Group 3 (n=13)				
	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	n	%	Mean±SD	Min-Max	*p**
Age (year)			41±13.5	19-65			43.5±9.5	23-58			36.9±12.1	23-57	0.378*
Sex													0.265**
Female	8	61.5			11	91.7			9	69.2			
Height (cm)			168.6±12.7	144-190			160.6±8.4	150-172			164.9±9.7	153-180	0.178*
Weight (kg)			74.8±15.8	53-110			63.7±9.4	50-87			67.3±11	50-90	0.089***
Pain duration (month)			4.2±1.2	2-6			4.9±0.7	4-6			5.2±1	3-6	0.069***
MTrP in Trapezius muscle (right)	13	100			11	91.7			12	92.3			0.670**
MTrP in Trapezius muscle (left)	12	92.3			12	100			11	84.6			0.546**
MTrP in Levator Scapulae muscle (right)	6	46.2			6	50			8	61.5			0.780**
MTrP in Levator Scapulae muscle (left)	7	53.8			5	41.7			8	61.5			0.659**

SD: Standard deviation; MTrPs: Myofascial trigger points; * One-way ANOVA test; **Fisher exact test; *** Kruskal-Wallis test, significance level $p<0.05$.

TABLE 2
Comparisons across time points between and within groups

Outcomes and Groups		T0 Mean±SD	T1 Mean±SD	T2 Mean±SD	T3 Mean±SD	*p*†, *p*¶
Flexion	D-DN	41.53±4.73	42.69±3.88	47.69±3.33	47.3±3.33	<0.001†
	S-DN	40.00±4.77	42.08±3.34	42.91±2.57	41.25±4.33	0.011†
	CT	42.3±3.30	43.46±2.4	48.46±2.4	45±3.53	<0.001†
	*p**	0.455	0.584	<0.001a	0.003b	
Extension	D-DN	39.23±5.34	40.38±5.18	45.76±4	45±4.08	<0.001†
	S-DN	39.58±5.41	42.08±3.96	42.91±2.57	40.83±4.17	0.024†
	CT	41.15±4.63	41.92±4.34	47.69±2.59	44.61±3.2	<0.001†
	*p**	0.610	0.658	0.004c	0.042d	
Right lateral flexion	D-DN	36.53±5.15	39.23±4.49	45±2.88	43.46±4.27	<0.001†
	S-DN	38.75±5.69	40.41±4.98	41.66±3.25	40.41±4.5	0.174†
	CT	40±5	40.38±4.31	46.15±2.99e	44.23±2.77	<0.001†
	*p**	0.219	0.738	0.005	0.063	
Left lateral flexion	D-DN	35.76±5.34	38.07±4.80	43.84±3.62	43.46±3.15	<0.001†
	S-DN	38.75±5.69	42.08±3.96	42.5±3.37	40±5.22	0.023†
	CT	39.61±5.18	40.76±4.49	46.15±2.99f	44.61±2.46	<0.001†
	*p**	0.174	0.079	0.029	0.035g	
Right rotation	D-DN	49.23±7.02	51.53±6.25	56.92±5.21	56.92±5.21	<0.001†
	S-DN	48.33±11.93	52.08±6.55	55.75±6.13	52.5±5.83	0.009†
	CT	52.3±4.83	52.69±4.88	58.84±5.06	55.76±4.49	<0.001†
	*p**	0.357	0.769	0.301	0.133	
Left rotation	D-DN	49.23±7.02	50.38±5.93	56.53±4.73	56.15±5.06	<0.001†
	S-DN	49.58±12.33	51.25±7.11	54.16±5.57	52.5±5.83	0.091†
	CT	53.07±4.34	53.07±4.34	58.84±5.06	55.76±4.49	<0.001†
	*p**	0.328	0.442	0.110	0.196	
Pain at rest	D-DN	7.23±1.36	5.84±1.81	2.84±1.14	3.76±1.23	<0.001¶
	S-DN	7.00±1.86	5.66±2.26	3.58±1.72	4.33±1.92	0.001¶
	CT	5.54±2.18	5.76±2.27	4.15±2.03	4±1.91	<0.001¶
	p‡	0.432	0.542	0.132	0.479	
Pain at motion	D-DN	7.31±2.13	6.38±1.66	3.76±1.09	4.53±1.19	<0.001†
	S-DN	6.92±2.02	5.58±2.23	4.08±2.19	4.33±2.53	<0.001¶
	CT	6.77±2	6.38±2.21	4.46±1.56	4.46±1.99	<0.001¶
	p‡	0.422	0.335	0.295	0.771	
Pain at night	D-DN	6.23±2.12	5.15±2.03	2.84±1.06	3.53±1.50	<0.001¶
	S-DN	6.33±3.2	5.66±2.49	3.75±2.09	4.33±2.53	0.005¶
	CT	6.15±2.44	5.46±2.50	4.07±1.97	3.84±2.15	0.006¶
	p‡	0.603	0.514	0.429	0.822	
NDI	D-DN	18.15±6.31	16.69±5.63	10.76±3.89	12.23±4.41	<0.001†
	S-DN	22.00±5.77	19.66±6.48	13.58±6.93	15±7.5	<0.001¶
	CT	18.62±6.71	17.84±8.9	11.53±5.86	13.69±6.76	<0.001¶
	*p**	0.499	0.315	0.592	0.446	
EQ5D3L	D-DN	63.4±25.6	69.0±21.9	85.1±10.3	79.6±12	<0.001†
	S-DN	77±13.3	76.6±13.5	83.6±11.8	79.8±10.6	0.020†
	CT	72.6±18.8	60.6±23.3	84.1±13.5	80.1±12.1	<0.001†
	*p**	0.215	0.534	0.298	0.502	

SD: Standard deviation; * Kruskal-Wallis test; ‡ One-way ANOVA test; † Friedman test; ¶ Repeated measures ANOVA; a: Group 2 < Group 1 (p=0.002) and Group 3 (p<0.001); b: Group 2 < Group 1 (p=0.002); c: Group 2 < Group 3 (p=0.002); d: No significant difference; e: Group 2 < Group 1 (p=0.039) and Group 3 (p=0.005); f: Group 2 < Group 3 (p=0.027); g: Group 2 < Group 3 (p=0.040); NDI: Neck Disability Index; EQ5D3L: European Quality of Life 5 Dimensions 3 Level Version.

evidence suggests that manual needle insertion and rotation for 30 min can trigger intracellular Ca2+ wave propagation, increase extracellular adenosine triphosphate (ATP) and adenosine levels, and facilitate tissue remodeling via rho kinase activation. Needle rotation is crucial in this process, as it binds connective tissue to the needle, enhancing mechanotransduction and amplifying mechanical signals.[20]

Zhang et al.[21] reported that needle rotation significantly activates C-fibers, distal superficial and deep mechanoreceptors, and stretch receptors compared to other needling techniques. Conversely, Perreault et al.[20] proposed that enhancing LTRs involves a technique that combines needle rotation and repeated insertion in and out of MTrPs, known as the "screwing in-and-out technique." Chou et al.,[19] however, reported that a "multiple rapid insertion" technique is preferable for immediate and complete MTrP deactivation. Sanal Toprak et al.[8] found that DN using a fast-in and fast-out technique effectively managed pain and disability in neck pain due to MTrPs. Similarly, Imani et al.[22] compared the effectiveness of deep DN technique, Hong's DN technique, and routine physical therapy for subacromial impingement syndrome, noting the superior efficacy of the deep DN technique alongside routine physical therapy.

In the current study, we observed consistent enhancements in ROM across all groups, with no significant differences between groups, except in specific measurements. The increase in ROM might be linked to a decrease in pain intensity, as suggested by various research.[23] Mejuto-Vázquez et al.[24] observed increased neck ROM following a single DN session in patients with acute mechanical neck pain, attributing this to reduced pain intensity. Cruz et al.[25] also highlighted DN's efficacy in improving ROM by increasing pressure pain threshold levels. Passigli et al.[26] suggested that the rise in ROM post-DN might be associated with reduced pain levels. Previous literature indicates a potential connection between analgesic effects and joint mobility.[27] Therefore, while the increase in ROM could be attributed to the analgesic effects of DN, further research is needed to fully understand the relationship between DN and its impact on joint mobility.

The pathophysiology of MTrPs remains elusive, with various hypotheses proposed. Characterized by a complex cascade involving both central and peripheral mechanisms, the pathophysiology of MTrPs highlights the intricate nature of this condition.[28] The divergent findings across studies, including those in our study, may be attributed to the complexity of MTrPs and the variance in contributing factors across different disease groups.

The use of the static S-DN technique, which involves retaining the needle in the patient's body, may pose an increased risk of significant adverse events. Boyce et al.,[29] reported that while infrequent in DN, forgotten needles are among the top three most commonly observed severe adverse events. The act of leaving the needle *in situ* heightens the risk of overlooking its presence, potentially leading to complications. Conversely, the D-DN technique, which does not involve needle retention, may reduce the risk of such adverse events. Notably, our study observed no side effects in any of the groups during or after treatment.

The S-DN technique's practice of retaining the needle may also impact the time allocated for each patient. Considering that time is a critical factor in patient-doctor relationships and healthcare costs, the D-DN technique, which is potentially quicker, may be more effective and allow for increased patient interaction time.[30]

Based on our study results, the D-DN technique emerges as a preferable option in terms of quality of life, ROM, and pain levels. Its potential speed advantage over the CT and S-DN, along with a possibly lower risk of adverse events, may make D-DN a safer and more efficient choice for patients and healthcare providers. However, further research is necessary to validate these findings and comprehensively evaluate the benefits and drawbacks of each technique. Factors such as cost-effectiveness and patient preferences should also be considered in selecting a DN technique.

Nonetheless, this study has certain limitations, including the absence of a comparison with superficial DN, another DN variant. This limits the scope of our comparisons across different DN modalities. The lack of pain threshold measurements might have influenced the subjective nature of our findings. Additionally, the absence of a control group that only underwent exercise could limit the generalizability of our results. Future studies with longer follow-up periods and larger sample sizes are essential to provide more conclusive evidence.

In conclusion, our study results showed significant improvements in all three intervention groups. The D-DN technique stands out as a potentially preferred

treatment option, considering its positive effects on quality of life, ROM, and pain levels. Additionally, the D-DN technique's potential for quicker treatment times and a possibly lower risk of adverse events further supports its preference. However, it is essential to emphasize that additional research is required to confirm these findings. Future studies should consider various factors, including cost-effectiveness and patient preferences, to provide a more comprehensive understanding of the most effective DN techniques. These considerations are vital for making informed decisions about DN treatment options.

Ethics Committee Approval: The study protocol was approved by the Hamidiye Clinical Research Ethics Committee (date: 15.10.2022, no: 2022/15-15/38). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

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

Author Contributions: Contributed to the idea and concept of the study: E.A., T.Ö.Ü.; The design: M.A., M.A.G., E.A.; Were responsible for control and supervision: T.Ö.Ü.; Data collection and processing: M.H.T.; Conducted the analysis and interpretation: E.K., M.A., M.A.G., M.H.T.; The literature review: E.A.; The article was written by E.A., M.A.G., M.H.T., and T.Ö.Ü.; While the critical review: E.A., T.Ö.Ü., E.K.; Managed the references and funding: M.A.; Materials were provided: M.H.T.

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