ORIGINAL ARTICLE

IJPHY

DRY NEEDLING WITH AND WITHOUT PARASPINAL NEEDLING IN PATIENTS WITH ADHESIVE CAPSULITIS. A RANDOMIZED CLINICAL TRIAL

[1]Varun Kalia
[*2]Suresh Mani

ABSTRACT

Background: Adhesive Capsulitis (AC) of the shoulder joint is a chronic disabling musculoskeletal condition affecting 2% to 5.3% of the world's general population. It results in pain, restricted ROM, impaired myofascial kinetics due to fibrosis of capsules and ligaments. Myofascial trigger points (MTrPs) that could further restrict shoulder movements by inducing girdle muscle tightness. MTrP dry needling (MDN) intervention and other conservative therapies in subjects with AC of the shoulder would enhance the clinical outcome. However, insufficient evidence available to support the local MDN with paraspinal dry needling (PSDN) for the AC management. The study's objective is to evaluate the efficacy of local MDN with and without PSDN in AC patients.

Methods: A total of 210 (98 male, 112 female) clinically diagnosed subjects with AC were recruited from a multi-specialty hospital and then randomly assigned to one of three groups. G1: Local MDN group (n=70) G2: Local MDN with PSDN group (n=70) G3: Conventional physiotherapy group (n=70). The outcome measures included pain intensity (VAS), shoulder ROMs (Goniometer), disability (SPADI), and pressure pain threshold (pressure algometer) were assessed at baseline and 12th day of the intervention.

Results: The statistically significant ($p < 0.05$) improvement in all shoulder ROMs (except lateral rotation), pain intensity, SPADI, and PPT in "G1" and "G2" compared to "G3" but no significant difference in between "G1" and "G2".

Conclusion: Local MDN is an effective treatment technique and conventional physiotherapy intervention, but PSDN does not have an additive effect on outcome measures in AC subjects.

Keywords: Adhesive Capsulitis, Physiotherapy, Pain, Disability, Impairment.

Received 30th August 2020, accepted 02nd December 2020, published 09th December 2020

www.ijphy.org

10.15621/ijphy/2020/v7i6/837

CORRESPONDING AUTHOR

[*2]**Suresh Mani**

Associate Professor, Department of physiotherapy, School of Applied Medical Sciences, Lovely Professional University, Punjab, India.
e-mail: suresh.22315@lpu.co.in

[1]Ph.D. Scholar, Program of Physiotherapy, Department of physiotherapy, School of Applied Medical Sciences, Lovely Professional University, Punjab, India. e-Mail: varunkalia935@gmail.com

INTRODUCTION

Adhesive Capsulitis (AC) is a chronic disabling musculoskeletal condition of the shoulder joint affecting 2% to 5.3% of the general population globally [1,2]. The beginning of shoulder pain accompanied by a diminished range of motion (ROM) is predominantly expressed by subjects with AC. The AC might either be primary (idiopathic) or secondary. There is no definite etiology or underlying pathology associated with primary AC. Primary AC occurs spontaneously, and they are least understood but the most common; on the other hand, secondary AC results from trauma [3]. Over 3.8% & 4.3% of secondary AC reported were linked to thyroid disease and diabetes mellitus, respectively [2,4]. Women are more affected by AC (approximately 70%) than men, but there is more risk for a longer recovery period and more significant disability in men [5].

While AC can impose a significant disability on individuals, it would also substantially burden healthcare expenditure. Literature reported that $7,000 and $8,000 are the estimated cost of annual health care and non–health care of AC per episode, and the societal cost was estimated at $55 per session (6). $53 per hour was the cost of home nursing care after hospitalization to treat AC with manipulation under anesthesia and acromioplasty. Home care services also cost $30 per hour [7]. So the evaluated significant burden on the subject, and the community suggested to achieve speed up healing, effective early management of AC is warranted [6].

While chronic inflammation-induced fibrosis of shoulder capsules and coraco-humeral ligaments [8] could have restricted shoulder ROM, the recent evidence elucidates impaired myofascial kinetics, shoulder girdle muscle tightness, and myofascial trigger points (MTrPs) that could further restrict shoulder movement [9]. In regular clinical practice, AC with restricted ROM has been managing various treatment approaches; however, the most successful treatment for this chronic disability condition remains debatable, and no specific treatment protocol has yet been developed [10]. Furthermore, the literature reported several treatment options such as electrotherapy modalities, dynamic splinting, continuous passive motion, total end range time, joint mobilization (10). Still, complete recovery was not attained with existing treatment protocols. Several studies have shown that the patient experiences long-term pain, stiffness, and disability despite regular conservative treatment [11,12]. It was reported 15% of AC subjects were still reported long-term disability, 7 to 15% permanent functional loss, and persistent symptoms in 40% following conservative interventions [12]. Therefore, there is a need for effective early treatment strategies that can help in the early recovery of AC subjects.

MTrP in the shoulder girdle muscles may be a possible non-articular source of pain and restricted ROM in AC [13]. The MTrPs are focal, hyperirritable areas of increased tension within a muscle. Recently, there is growing evidence to support the clinical efficacy of MDN for MTrP for the effective treatment of various musculoskeletal pain conditions [14]. In the process of dry needling, a solid monofilament needle is inserted into the muscle area with motor anomalies (i.e., taut bands) to decrease discomfort and promote expected muscle functions [15]. Page and Labbe (2010) reported that MTrPs in the subscapularis muscle induced a restricted flexion and external shoulder joint rotations [9]. In another study, Clewley et al. (2014) concluded in a case series that the introduction of MTrP dry needling intervention and other conservative therapies in subjects with AC of the shoulder would enhance the clinical outcomes [16]. Besides, Hyuk et al. (2007) have recommended myofascial dry needling (MDN) of MTrP along with paraspinal dry needling (PSDN), which improves pain, depression, and cervical ROM in elderly subjects with upper trapezius MTrP [17]. However, there is insufficient evidence to recommend the clinical efficacy of local MDN and PSDN for the management of subjects with AC. Therefore, the purpose of this study was to evaluate the efficacy of MDN with and without PSDN in AC subjects.

MATERIAL AND METHODS

Study Design and ethical approval

This study was a single-blinded, randomized controlled, three-arm parallel-group clinical trial accepted by the Clinical Research Ethical Committee of Lovely Professional University of Applied Medical Sciences (LPU/IEC/2018/01/04). In this clinical trial presentation, Consolidated Standards of Reporting Trials (CONSORT) guidelines were used.

Participants

The participants were recruited via the physician referral from an OPD of three multi-specialty hospitals. Subjects who were (a) medically diagnosed patients of AC based on the medical history, physical examination, and imaging if necessary (b) aged between 40-65 years (c) male or female (d) having pain and restriction in the shoulder for three months or more along with tender, taut, palpable band or nodule within muscles around the shoulder joint and (e) having normal cognitive function were taken into study. Additionally, the participants who had (a) skin disease around shoulder and neck (b) surgical history around the neck (c) taken anticoagulant medication within three days before study recruitment (e) history of malignancy-related pain within six months prior study (f) received injections in the trigger points to be punctured within three months prior study (g) extreme fear of needles (h) uncooperative behavior were eliminated from the study. Prior to the study, each subject was informed about the study procedure and received written informed consent. The sample size was determined using the clinical superiority design formula with minimal detectible change (MDC 95%) as 18 points on a SPADI with a standard deviation of 19 points from previous studies [18,19]. Assuming a 95 percent confidence interval and 80 percent of power, the calculated sample size was 70 subjects per group, with 210 subjects [20,21].

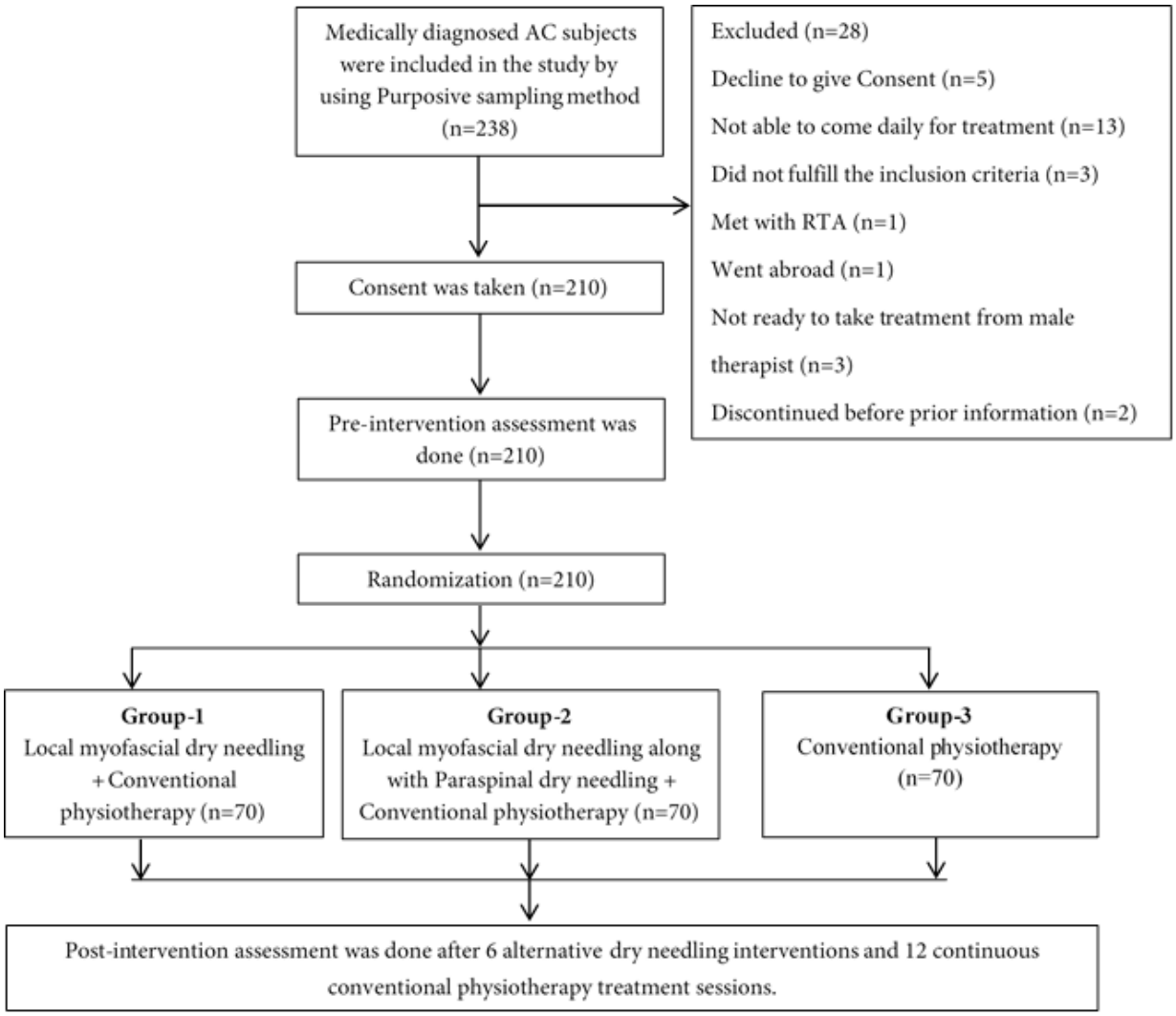
Randomization

Participants were allocated to one of the three groups using a simple randomization process.; local MDN group (G1), local MDN along with PSDN group (G2), or conventional physiotherapy group (G3).

Procedure

Each subject underwent a pre-intervention assessment of pain intensity, joint ROM, disability, and PPT trigger points of the muscles shoulder girdle (Supraspinatus, Subscapularis, Teres minor, Infraspinatus, Pectoralis major, Teres major, Deltoid and Upper trapezius muscles). Consequently, participants were randomly allocated to one of the three groups (a) G1 (n=70 (33 male, 37 female)), subjects received MTrP MDN for ten minutes in a session for the affected muscles for six alternative days and conventional physiotherapy treatment for twelve days. (b) G2 (n=70 (35 male, 35 female)), subjects received local MDN for ten minutes in a session for the affected muscles along with PSDN group of multifidus muscles at the nerve root levels of affected muscles around the shoulder joint for six alternative days and conventional physiotherapy treatment for continuous twelve days, (c) G3 (n=70 (30 male, 40 female)), subjects received conventional physiotherapy treatment includes SWD (one session of 20 minutes per day), therapeutic Ultrasound (one session of 10 minutes per day), TENS (one session of 20 minutes per day), joint mobilization (three sets of 10 repetitions with a rest interval of 30 seconds between each set), passive stretching exercises and active exercise (one session of 10 minutes per day) for continuous twelve days. The post-intervention assessment was measured at the end of two weeks.

Figure 1: Consort flowchart diagram



Dry needling procedure

The MTrPs were identified during a detailed physiotherapy assessment. If found, the trigger point was treated with the acupuncture needles (Suzhou Tianxie) of a 0.25 mm gauge of either 25 mm or 40 mm long targeted muscle and size of the subjects [22]. Table.1 describes the positions of the patient and joint and needle insertion techniques for different muscles of the shoulder girdle. Fast-in/out movement technique of needle in a conical form employed to target various sensitive loci and looked for the local twitch response. The needle remained in the affected muscle for ten minutes. After ten minutes, the needle was taken out, and the hemostasis was maintained. The needle was discarded into a sharps container (Table 1) [23].

Table 1: Details of dry needling techniques includes patient & shoulder position, palpation technique & Direction of needle insertion

Sl. No	Muscle Name	Patient position	Shoulder position	Palpation Technique	Direction of needle insertion
1	Supraspinatus	Prone lying	Neutral	Flat palpation	Longitudinal to frontal plane
2	Infraspinatus	Prone lying	Neutral	Flat palpation	Directed toward scapula
3	Teres minor	Prone lying	90° Abduction	Flat palpation	Directed toward lateral border of scapula
4	Subscapularis	Supine lying	90° abduction & 90° ER	Pincer palpation	Directed parallel to the ribcage
5	Deltoid	Anterior fiber- Supine Middle fiber- Side lying Posterior fiber- Prone lying	Slight Abduction	Flat palpation	Directed perpendicularly
6	Pectoralis major	Supine lying	Slight Abduction	Flat palpation	Directed toward shoulder
7	Teres major	Prone lying	Slight Abduction	Pincer palpation	Ventral and lateral direction

Electrotherapeutic Intervention

In addition to DN, electrotherapeutic interventions with Shortwave diathermy (SWD) Therapeutic Ultrasound and Transcutaneous electrical nerve stimulation (TENS) were also administered on the affected shoulder joint. The SWD (27.12 MHz) was applied using a contra-planner method with eightfold towel wide spacing for 20 minutes. According to the subject's feedback, the intensity was adjusted to produce comfortable warmth. Pulsed Ultrasound was applied with 1:4 pulse ration and 1.5 W/cm2 of intensity for ten minutes [24]. For TENS, the electrodes were placed on deltoid muscle and trapezius bellies and treated with the parameters (frequency 100 Hz, 0.05ms duration, modulation pulse shape, 9 volts) (25) aimed to stimulate A-delta fiber for 20 minutes to relieve pain. The current intensity was boosted until the subject reported light tingling sensation without any observational muscle contraction [25].

Mobilization Exercises

The affected gleno-humoral joint was treated with the passive oscillatory glides, including posteroanterior, anteroposterior, caudal, and caudal progression glides. Each glide was given for 30 seconds at the speed of 2-3 glides every second. Each glide was given for five sets with 30 seconds intervals between each set. Additionally, the conventional passive stretching of shoulder girdle muscles was also demonstrated and encouraged to perform at home. Each stretch should be held three times for 30 seconds, with 15 seconds of the interval between stretches [26] and active exercises using a towel for 5 minutes [27].

Outcome Measures

The Shoulder Pain and Disability Index (SPADI)

SPADI is a self-assessed questionnaire that consists of two subscales, i.e., pain and disability. SPADI has ICC ≥ 0.89, which shows it's a reliable tool with high internal consistency (Cronbach α typically greater than 0.90) and construct validity [28].

Pressure Pain Threshold (PPT)

A handheld pressure algometer examined PPT. A pressure algometer is a device with a 1 cm^2 metallic probe area that measures the force that eliciting a pressure pain threshold. The algometer was positioned in a vertical direction over a muscle's trigger point region and then pushed against the tester muscle with a steady rate of 1 kg / cm2 while increasing compressive pressure. Subjects were told to say "pain" when only minimal abnormal discomfort was felt. This process has been repeated three times with 5-minute rest in between each repetition [29]. This device has high validity [30] and good intra and inter-rater reliability of pressure rate application [31].

Pain intensity

Visual Analog Scale (VAS) was used to examine pain intensity. It is described as a 100-mm horizontal line where two extreme points represent "no pain at all" & "worst pain imaginable." Thus, it is a simple, reliable & valid optimal method that describes severe or intense pain with its ratio scale properties [32].

Range of motion (ROM)

A universal goniometer was used to assess shoulder ROM, as in the earlier published study [33]. The goniometric shoulder joint ROM assessment has excellent intra-rater reliability ($ICC_{3,1} \geq 0.94$) [34].

Statistical analysis

The Statistical Program for Social Sciences (SPSS, v21) was used to evaluate the collected data. Demographic data such as age, gender, and BMI were analyzed descriptively. Based on Shapiro-Wilk, skewness, and kurtosis statistics, the data's normality was determined, and all the parameters' data shows the normal distribution. Homogeneity of the data was determined using Levene's test, and all the shoulder ROMs, VAS, and SPADI showed homogeneity, but PPT did not have homogeneity. For between-group comparisons of all shoulder ROMs, VAS, and SPADI, analysis of covariance (ANCOVA) was used. In statistically significant ANCOVA outcomes, post hoc comparisons were performed using the Fisher least significant difference (LSD) test. Because of non-homogenous but normally distributed PPT data, Welch's ANOVA was used for between-group comparison. Post hoc comparisons were made using the Games-Howell test in statistically significant results. A probability value of less than 0.05 was considered significant.

RESULTS

Out of 238 subjects screened for eligibility, a total of 210 (98 male, 112 female) subjects with AC were recruited. The baseline demographic characteristics of all three groups were displayed in Table 2 and demonstrated the homogeneity.

Table 2: Baseline Demographic characteristics and Homogeneity of study subjects

Measure	Group – 1 n=70	Group – 2 n=70	Group – 3 n=70	*p- value*
	M ± SD	*M ± SD*	*M ± SD*	
Gender	Male= 33 (47.1%) Female = 37 (52.9%)	Male = 35 (50.0%) Female = 35 (50.0%)	Male = 30 (42.9%) Female = 40 (57.1%)	
Age (Years)	54.4 ± 5.67	54.5 ± 5.50	54.5 ± 5.64	0.99**
Height (Feet)	5.51 ± 0.31	5.53 ± 0.29	5.49 ± 0.33	0.80**
Weight (Kg)	67.5 ± 6.69	67.1 ± 6.67	67.2 ± 6.94	0.70**
BMI (kg/m^2)	24.52 ± 1.32	24.01 ± 1.37	24.38 ± 1.58	0.15**

Note. *SD* – Standard deviation, Group = 1 represents Local myofascial dry needling group (G1), Group- 2 represents Local myofascial dry needling along with paraspinal dry needling group (G2), Group – 3 represents Conventional physiotherapy group (G3). *BMI* – Body Mass Index, ***p* > 0.05.

There was a significant effect of MDN on shoulder ROMs in flexion [F(2, 206) = 18.01, p = 0.000], extension [F(2, 206) = 9.35, p = 0.000], abduction [F(2, 206) = 5.60, p = 0.004] medial rotation [F(2, 206) = 5.49, p = 0.005], Shoulder pain (VAS) [F(2,206) = 112.7, p = 0.000] and SPADI [F(2, 206) = 309.1, p = 0.000], but not a significant ROM for lateral rotation [F(2, 206) = 2.03, p = 0.13] for the three conditions. Post hoc comparisons using the Fisher's least significant difference (LSD) test showed that for flexion, extension, medial rotation, abduction range of motions, VAS and SPADI; the mean score for the local MDN condition and local MDN along with PSDN condition was significantly different than the conventional physiotherapy condition. However, the local MDN condition did not significantly differ from the local myofascial DN along with PSDN condition (Table 3).

Analysis using Welch's ANOVA showed that there was a significant effect of MDN on PPT for the three groups in supraspinatus muscle [F(2, 52.5) = 38.20, p = 0.000], infraspinatus muscle [F(2, 29.33) = 439.5, p = 0.000], teres minor muscle [F(2, 23.04) = 594.7, p = 0.000], subscapularis muscle [F(2, 29.11) = 434.7, p = 0.000], deltoid muscle [F(2, 16.79) = 246.0, p = 0.000], pectoralis major muscle [F(2, 20.43) = 231.19, p = 0.000], teres major [F(2, 14.37) = 353.9, p = 0.000] and upper trapezius muscle [F(2,45.41) = 45.94, p = 0.000]. The post hoc comparisons showed that all the tested muscles for PPT, the mean score for the local myofascial DN and local myofascial DN along with PSDN were significantly different than the conventional physiotherapy. However, the local MDN condition did not significantly differ from the local MDN along with PSDN condition (Table 3).

Table 3: *Analysis of Covariance (ANCOVA) and Welch's ANOVA show the changes in the shoulder specific outcome measures over twelve days of dry needling based intervention and post hoc analysis*

			Group 1-2			Group 2-3			Group 1-3		
	OM	F	MD	95% CI		MD	95% CI		MD	95% CI	
AR OM^	Flexion	18.01*	1.53	-1.03	4.11	5.97*	3.40	8.54	7.51*	4.89	10.1
	Extension	9.35*	-1.18	-3.22	0.85	4.33*	2.29	6.38	3.15*	1.11	5.18
	Abduction	5.60*	1.57	-0.59	3.74	2.24*	0.03	4.45	3.81*	1.56	6.07
	Medial rotation	5.49*	1.74	-0.66	4.15	2.29	-0.11	4.70	4.04*	1.62	6.45
	Lateral rotation	2.03	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pa in^	VAS	112.7*	0.10	-0.07	0.27	-1.1*	-1.35	-1.01	-1.0*	-1.25	-0.9
Disability^	SPADI	309.1*	-0.60	-1.91	0.70	-14.0*	-15.3	-12.7	-14.6*	-15.9	-13.3
	SSP	38.20*	-0.03	-0.32	0.24	1.17*	0.82	1.52	1.13*	0.79	1.48
	IS.	439.5*	-0.10	-0.36	0.15	1.59*	1.37	1.80	1.48*	1.33	1.64
	TMin	594.7*	-0.07	-0.28	0.13	1.56*	1.39	1.73	1.48*	1.34	1.63
PP T^^	SSC	434.7*	-0.02	-0.25	0.19	1.39*	1.23	1.56	1.36*	1.20	1.53
	Delt	246.0*	-0.05	-0.39	0.28	1.56*	1.29	1.83	1.50*	1.26	1.74
	PM	231.1*	0.09	-0.23	0.43	1.44*	1.21	1.67	1.54*	1.27	1.81
	TMaj	353.9*	0.10	-0.16	0.37	1.41*	1.22	1.61	1.51*	1.30	1.73
	UTpz	45.94*	-0.03	-0.24	0.18	1.22*	0.89	1.54	1.18*	0.87	1.50

Note. OM = Outcome measure, AROM = Active range of motion, CI = Confidence interval, MD = Mean Difference, Group 1-2 = between Local myofascial dry needling group and Local myofascial dry needling along with paraspinal dry needling group, Group 2-3 = Between Local myofascial dry needling along with paraspinal dry needling group and Conventional physiotherapy group, Group 1-3 = Local myofascial dry needling group and Conventional physiotherapy group, SSP = Supraspinatus muscle, IS = Infraspinatus muscle, TMin = Teres minor muscle, SSC = Subscapularis muscle, Delt = Deltoid muscle, PM = Pectoralis major muscle, TMaj = Teres major muscle, UTpz = Upper trapezius muscle, VAS = Visual Analog Scale, ^ = Parameter analyzed using ANCOVA test, ^^ = Parameter analyzed using Welch's ANOVA, * = p <0.05.

DISCUSSION

This study aimed to evaluate the effect of MDN & PSDN in subjects with AC and hypothesized that the MDN therapy for MTrP might improve pain, ROM, disability, and pressure pain threshold of MTrP associated with AC. This study added substantial evidence to support the potential clinical effect of MDN among subjects with AC [13,16] that the pain arising from the MTrPs of shoulder girdle muscles could restrict the ROM and impose a further burden on the disability associated with AC. Although AC is a disorder that affects the shoulder joint's capsule, myofascial dysfunction may superimpose more pain, movement restriction, and disability on already inflamed shoulder capsules. Besides, the pain and restricted ROM may be partly due to these developed MTrPs, mainly in

later AC stages. Several studies have demonstrated that subjects with AC experience long-term pain, shoulder stiffness, and disability even after regular physiotherapy management [11,12]. Over 15% of AC subjects suffered permanent functional disability, and persistent symptoms [12]/ Integration of MDN and regular therapy could enhance the overall clinical outcomes among subjects with AC.

While AC is a chronic inflammatory painful condition, the shoulder pain intensity was improved significantly in both G1 and G2 compared with G3. The MTrP in the shoulder girdle muscles may be the source of pain. Biochemically, the release of acetylcholine due to abnormal sympathetic activity and local hypo-perfusion in the MTrPs results in hypoxia that causes a decrease in pH level releases bradykinin, potassium, substance P, and cytokines, which stimulate the free nerve ending in the muscle, and causes pain [35]. Treating MTrPs using a dry needle induces a micro-trauma and bleeding. Literature reported that the dry needling induced hyperemia could dilute the pain sensitizing substances and relieves the pain. Also, Fernández et al. (2019) [36] reported dry needing also releases the endogenous opioids such as β-endorphin, which inhibit the release of the substance P. Despite there was no literature on the efficacy of MDN on the AC population, there is emerging evidence to demonstrate the clinical efficacy of MDN for the management of myofascial pain syndrome [36]. Calvo-Lobo et al. (2018) [37] reported a single dry needling session significantly reduced both local and distal pain in elderly adults with non-specific shoulder pain.

In this study, the shoulder ROM except shoulder lateral rotation showed significant improvement in both G1 & G2 compared with the conventional physiotherapy group (G3). It was postulated that the MTrPs, localized, painful, hyperirritable sustained muscle fascicular contractions could restrict the shoulder ROM [9]. Treating the MTrPs in the shoulder girdle muscle with the dry needle could induce the twitch response and release the muscle fascicular contraction, thus improved the shoulder function. However, dry needling of MTrPs of shoulder muscles did not show a significant improvement in the external rotation. This may be due to the pathological characteristic of the chronic inflammation and subsequent fibrosis of glenohumeral joint capsule AC resulting in the typical external rotation restriction.

The PPT shows significant improvement in both G1 and G2 as compared with the G3. The successful effect of the dry needle on PPT may be attributed to the mechanical pressure caused by the needle combined with its rotation polarizes the continuative tissue, which has an implicit piezoelectricity character. This mechanical pressure is converted into electrical energy, which enhances tissue reconstruction. When the needle is inserted, an axonal reflex strikes the terminal network of A-delta and C fibers related to the liberation of many substances with vasoactive action [38,39]. They cause vasodilatation and inflation of local blood flow, which decreases the number of algogenic substances and decreases the activity of nociceptors, resulting in resolution of peripheral sensitization [40]. The clinical studies reported treating an MTrPs with DN would improve the PPT [41] in upper trapezius [42] and Levator Scapulae [43] muscles.

Similarly, patients have demonstrated a significant reduction in shoulder disability in both G1 and G2 compared with G3. Neutralizing the MTrPs, the source of pain, and joint restriction resulted in improvement in disability following DN. Literature supports our findings that DN, along with exercise found to be beneficial in reducing impairment and quality of life in subjects with shoulder myofascial pain [44], chronic rotator cuff tendinopathy [45], and subacromial pain syndrome [46,47].

Finally, the study results indicate no substantial difference between the MDN and PSDN groups in shoulder pain severity, ROM, PPT, and disability. It implies that introducing the PSDN and MDN does not have any clinical implications that fail to reflect on the outcomes measures in patients with AC of the shoulder joint. Few studies claim that subjects treated with PSDN demonstrated substantial improvement in pain and joint function in acute facet joint dysfunction of the neck, [48] myofascial pain syndrome of upper trapezius [17] and non-specific thoracic pain syndrome [49]. It is noteworthy that in those conditions, the source of pain or restriction has a direct anatomical attachment with the spine; hence PSDN produced a substantial improvement. The other possible reason for the improvement in the joint function may be due to paraspinal muscle spasms themselves being a source of pain and joint restriction in facet joint dysfunction and myofascial pain syndrome.

Strength and limitation

This study has included a sufficient sample of 210 subjects with AC, whereas earlier studies reported single case series and an RCT with small sample size. The present study is not having long-term follow-up. AC is a slowly progressive disorder of the shoulder capsule; it is recommended that future studies evaluate DN's long-term effect in improving pain, ROM, and associated disability in AC subjects.

CONCLUSION

Local MDN treatment is an effective treatment technique along with conventional physiotherapy intervention in subjects with AC. The outcomes showing significant improvement in shoulder ROMs (except shoulder lateral rotation ROM), pain intensity, disability, and PPT after local MDN management indicate a potential benefit of DN intervention in subjects with AC. Still, PSDN is not having an additive effect on outcome measures.

Funding sources and conflict of interest

For this study, no funding sources or conflicts of interest were reported.

CRediT authorship contribution statement

VK: Investigation, Resources, data curation, Writing -

original draft. **SM**: Conceptualization, Methodology, Formal analysis, Writing - review & editing, Visualization, Supervision.

Acknowledgment

The authors extend our thanks to Dr. Jashneev Kapoor, Orthopedic Surgeon, Kapoor Bone & Child Hospital, for referring subjects for this study. We are also grateful to Mrs. Veena Dada, Director, St. Soldier College (Co-Ed), for her encouragement and support to complete this study. We extend our gratitude to Mrs. Minni Sharma for reading and correcting the English grammatical part of this manuscript.

REFERENCES

[1] Manske RC, Prohaska D. Diagnosis and management of adhesive capsulitis. Curr Rev Musculoskelet Med. 2008;1:180–9.

[2] Lundberg BJ. The frozen shoulder. Clinical and radiographical observations. The effect of manipulation under general anesthesia. Structure and glycosaminoglycan content of the joint capsule. Local bone metabolism. Acta Orthop Scand. 1969;119:1–59.

[3] Walker, K. L., Gabard, D. L., Bietsch, E., Masek-VanArsdale, D. M. & Robinson BL. A profile of patients with adhesive capsulitis. J hand Ther. 1997;10(3):222–8.

[4] Bridgman JF. Periarthritis of the shoulder and diabetes mellitus. Ann Rheum Dis. 1972;31(1):69–71.

[5] Le H V, Lee SJ, Nazarian A, Rodriguez EK. Adhesive capsulitis of the shoulder : review of pathophysiology and current clinical treatments. Shoulder Elb. 2017;9(2):75–84.

[6] Van den Hout WB, Vermeulen HM, Rozing PM, Vliet Vlieland TPM. Impact of adhesive capsulitis and economic evaluation of high-grade and low-grade mobilisation techniques. Aust J Physiother. 2005;51(3):141–9.

[7] Van den Berg B, Brouwer W, van Exel J, Koopmanschap. Economic valuation of informal care: The contingent valuation method applied to informal caregiving. Health Econ. 2005;14:169–83.

[8] Neviaser J. Adhesive capsulitis of the shoulder: a study of the pathological findings in periarthritis of the shoulder. J Bone Jt Surg Am. 1945;27(2):211–22.

[9] Page P, Labbe A. Adhesive capsulitis: use the evidence to integrate your interventions. N Am J Sports Phys Ther. 2010 Dec;5(4):266–73.

[10] Jason JI, Sundaram S G, Subramani M V. Physiotherapy Interventions for Adhesive Capsulitis of Shoulder: a Systematic Review. Int J Physiother Res. 2015;3(6):1318–25.

[11] Hand C, Clipsham K, Rees JL, Carr AJ. Long-term outcome of frozen shoulder. J Shoulder Elb Surg. 2008;17(2):231–6.

[12] Koh KH. Corticosteroid injection for adhesive capsulitis in primary care: A systematic review of randomised clinical trials. Singapore Med J. 2016;57(12):646–57.

[13] Sukumar S, Lawrence M. Effects of intramuscular manual therapy on improving abduction in adhesive capsulitis - a single blinded RCT. Glob J Multidiscip Stud. 2014;3(12):41–50.

[14] Puentedura EJ, Buckingham SJ, Morton D, Montoya C, Fernandez De Las Penas C. Immediate Changes in Resting and Contracted Thickness of Transversus Abdominis After Dry Needling of Lumbar Multifidus in Healthy Participants: A Randomized Controlled Crossover Trial. J Manipulative Physiol Ther. 2017;40:615–23.

[15] Dommerholt J. Dry needling - peripheral and central considerations. J Man Manip Ther. 2011;19(4):223–37.

[16] Clewley D, Flynn T, Koppenhaver S. Trigger Point Dry Needling as an Adjunct Treatment for a Patient With Adhesive Capsulitis of the Shoulder. J Orthop Sport Phys Ther. 2014;44(2):92–101.

[17] Hyuk G, Choi JH, Park CH, Yoon HJ. Dry needling of trigger points with and without paraspinal needling in myofascial pain syndromes in elderly patients. J Altern Complement Med. 2007;13(6):617–23.

[18] Tveitå EK, Ekeberg OM, Juel NG, Bautz-Holter E. Responsiveness of the Shoulder Pain and Disability Index in patients with adhesive capsulitis. BMC Musculoskelet Disord. 2008;9(161):1–8.

[19] Zhong B. How to calculate sample size in randomized controlled trial? J Thorac Dis. 2009;1(1):51–4.

[20] Angst F, Goldhahn J, Pap G, Mannion AF, Roach KE, Siebertz D, et al. Cross-cultural adaptation, reliability and validity of the German shoulder pain and disability index (SPADI). Rheumatology. 2007;46(1):87–92.

[21] Schmitt J, Di Fabio R. Reliable change and minimum important difference (MID) proportions facilitated group responsiveness comparisons using individual threshold criteria. J Clin Epidemiol. 2004;57(10):1008–18.

[22] Baima J, Isaac Z. Clean versus sterile technique for common joint injections: a review from the physiatry perspective. Curr Rev Musculoskelet Med. 2008;1(2):88–91.

[23] Osborne NJ, Gatt IT. Management of shoulder injuries using dry needling in elite volleyball players. Acupunct Med. 2010;28(1):42–6.

[24] Ansari SN, Lourdhuraj I, Shah S, Patel N. Effect of ultrasound therapy with end range mobilization over cryotherapy with capsular stretching on pain in frozen shoulder – a comparative study. Int J Curr Res Rev. 2012;4(24):68–73.

[25] Pantaleão MA, Laurino MF, Gallego NLG, Cabral CMN, Rakel B, Vance C, et al. Adjusting pulse amplitude during transcutaneous electrical nerve stimulation (TENS) application produces greater hypoalgesia. J Pain. 2011;12(5):581–90.

[26] Kumar A, Kumar S, Aggarwal A, Kumar R, Das PG. Effectiveness of Maitland Techniques in Idiopathic

Shoulder Adhesive Capsulitis. ISRN Rehabil. 2012;2012:1–8.
[27] Pajareya K, Chadchavalpanichaya N, Painmanakit S, Kaidwan C, Puttaruksa P, Wongsaranuchit Y. Effectiveness of physical therapy for patients with adhesive capsulitis: A randomized controlled trial. J Med Assoc Thail. 2004;87(5):473–80.
[28] Hill CL, Lester S, Taylor AW, Shanahan ME, Gill TK. Factor structure and validity of the shoulder pain and disability index in a population-based study of people with shoulder symptoms. BMC Musculoskelet Disord. 2011;12:8–13.
[29] Park G, Kim CW, Park SB, Kim MJ, Jang SH. Reliability and Usefulness of the Pressure Pain Threshold Measurement in Patients with Myofascial Pain. Ann Rehabil Med. 2011;35(3):412–7.
[30] Kinser AM, Sands WA, Stone MH. Reliability and validity of a pressure algometer. J Strength Cond Res. 2009;23(1):312–4.
[31] Nussbaum EL, Downes L. Reliability of clinical pressure-pain algometric measurements obtained on consecutive days. Phys Ther. 1998;78(2):160–9.
[32] Katz J, Melzack R. Measurement of pain. Surg Clin North Am. 1999;79(2):231–52.
[33] Vairo GL, Duffey ML, Owens BD, Cameron KL. Clinical descriptive measures of shoulder range of motion for a healthy, young and physically active cohort. Sport Med Arthrosc Rehabil Ther Technol. 2012;4(1):1–7.
[34] Kolber MJ, Fuller C, Marshall J, Wright A, Hanney WJ. The reliability and concurrent validity of scapular plane shoulder elevation measurements using a digital inclinometer and goniometer. Physiother Theory Pract. 2012;28(2):161–8.
[35] Gallego-Sendarrubias GM, Rodríguez-Sanz D, Calvo-Lobo C, Martín JL. Efficacy of dry needling as an adjunct to manual therapy for patients with chronic mechanical neck pain: a randomised clinical trial. Acupunct Med. 2020;00(0):1–11.
[36] Fernández-de-las-peñas, César N, Jo. Trigger point dry needling for the treatment of myofascial pain syndrome: current perspectives within a pain neuroscience paradigm. J Pain Res. 2019;12:1899–911.
[37] Calvo-Lobo C, Pacheco-Da-Costa S, Hita-Herranz E. Efficacy of deep dry needling on latent myofascial trigger points in older adults with nonspecific shoulder pain: A randomized, controlled clinical trial pilot study. J Geriatr Phys Ther. 2017;40(2):63–73.
[38] Cagnie B, Dewitte V, Barbe T, Timmermans F, Delrue N, Meeus M. Physiologic effects of dry needling. Curr Pain Headache Rep. 2013;17(8):348–55.
[39] Dommerholt J, Bron C, Franssen J. Myofascial Trigger Points : An Evidence-Informed Review. J Man Manip Ther. 2006;14(4):203–21.
[40] Sorour N, Zaied A, Shehab M. Low Intensity Pulsed Ultrasound Therapy Versus dry needling for inactivation of myofascial trigger points: Randomized clinical study. Oral Surg. 2020;66:861–72.
[41] Tesch R, Macedo L, Fernandes F, Filho G, Goes C. Effectiveness of dry needling on the local pressure pain threshold in patients with masticatory myofascial pain. Systematic review and preliminary clinical trial. Cranio J Craniomandib Sleep Pract. 2019;1–9.
[42] Ziaeifar M, Arab AM, Karimi N, Nourbakhsh MR. The effect of dry needling on pain, pressure pain threshold and disability in patients with a myofascial trigger point in the upper trapezius muscle. J Bodyw Mov Ther. 2014;18(2):298-305.
[43] Garcia-de-Miguel S, Pecos-Martin D, Larroca-Sanz T, Sanz-de-Vicente B, Garcia-Montes L, Fernandez-Matias R, et al. Short-Term Effects of PENS versus Dry Needling in Subjects with Unilateral Mechanical Neck Pain and Active Myofascial Trigger Points in Levator Scapulae Muscle: A Randomized Controlled Trial. J Clin Med. 2020;9(6):1665.
[44] Griswold D, Wilhelm M, Donaldson M, Learman K, Cleland J. The effectiveness of superficial versus deep dry needling or acupuncture for reducing pain and disability in individuals with spine-related painful conditions: a systematic review with meta-analysis. J Man Manip Ther. 2019;27(3):128–40.
[45] Saylor-Pavkovich E. Strength exercises combined with dry needling with electrical stimulation improve pain and function in patients with chronic rotator cuff tendinopathy: A retrospective case series. Int J Sports Phys Ther. 2016;11(3):409–422.
[46] Koppenhaver S, Embry R, Ciccarello J, Waltrip J, Pike R, Walker M, et al. Effects of dry needling to the symptomatic versus control shoulder in patients with unilateral subacromial pain syndrome. Man Ther. 2016;26:62–9.
[47] Morgan BC, Deyle GD, Petersen EJ, Allen CS, Koppenhaver SL. Dry needling in the management of patients meeting clinical diagnostic criteria for subacromial pain syndrome: A case series. Int J Sports Phys Ther. 2019;14(4):637–654.
[48] Shanmugam S, Mathias L. Immediate effects of paraspinal dry needling in patients with acute facet joint lock induced wry neck. J Clin Diagnostic Res. 2017;11(6):YM01–3.
[49] Anandkumar S, Manivasagam M. Effect of fascia dry needling on non-specific thoracic pain–A proposed dry needling grading system. Physiother Theory Pract. 2017;33(5):420–8.