Effectiveness of Scapular Mobilization Combined with TENS in Post-Stroke Frozen Shoulder: A Randomized Controlled Trial

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***Abstract*—Background: One of the most common disabilities associated with cerebrovascular disease is shoulder discomfort following a stroke. The quality of life might be affected. A cerebrovascular accident causes impairments to the upper motor neurons, which can lead to a variety of muscular paralysis around the shoulder joint, soft tissue abnormalities, and changes in muscle tone. The shoulder joint condition known as "frozen shoulder" is characterized by discomfort and a constant restriction of joint mobility in all directions, which leads to physical issues and a reduction in functional activity.**

Objectives: This review sought to provide an overview of stroke, explain the origins and contributing factors of hemiplegic shoulder pain, and demonstrate the impact of scapular mobilization using TENS methods on shoulder pain following a stroke.

Methods: 45 individuals with a history of stroke and a diagnosis of frozen shoulder participated in a randomized clinical study. At ANS Hospital in Jaipur, participants were divided into three equal groups at random. Group C got both scapular mobilization (half of the time Gp-A) and TENS (half of the period Gp-B), whereas Group A received scapular mobilization and Group B received TENS. For six weeks, each group received daily supervised therapy sessions in addition to shoulder exercises. The Shoulder Pain and Disability Index (SPADI) for functional evaluation, the Numeric Pain Rating Scale (NPRS) for pain assessment, and goniometric measurement for shoulder range of motion were among the outcome measures. At baseline, three weeks, and six weeks, assessments were conducted. For significant changes ($p < 0.05$), an ANOVA was performed.

Results: Over the course of the trial, all groups showed substantial within-group gains in all end measures ($p < 0.05$). Group C outperformed Groups A and B in both the NPRS pain ratings and the SPADI disability index, according to between-group comparison.

Conclusion: For people with frozen shoulder, both the scapular mobilization and TENS technique were successful in reducing discomfort, shoulder mobility, and functional impairment. However, only TENS has been shown to be more helpful in relieving pain, while the scapular mobilization approach showed considerably greater success in increasing shoulder range of motion. Therefore, combining the two approaches may be beneficial as a focused manual therapy intervention for the treatment of frozen shoulder.

***Index Terms*—Stroke, frozen shoulder, scapular mobilization, transcutaneous nerve stimulation, NPRS, SPADI**

I. Introduction

All types of pain felt in the hemiparetic (weakened) shoulder and upper arm following a stroke are collectively referred to as post-stroke shoulder pain (PSSP). About 50% of those with moderate weakness and 80% of people with severe weakness may be affected (1). One of the most common disabilities associated with cerebrovascular disease is shoulder discomfort following a stroke. The quality of life might be affected.

A cerebrovascular accident causes impairments to the upper motor neurons, which can lead to a variety of muscular paralysis around the shoulder joint, soft tissue abnormalities, and changes in muscle tone (2). In order to minimize pain and prevent disengagement from early rehabilitation, which can have a disastrous effect on long-term results, PSSP should be identified and treated as soon as feasible (3). Although the terms "post-stroke shoulder pain" and "hemiplegic shoulder pain" (HSP) are often used, they are just descriptive and do not identify the underlying contributing diseases that may be targets for treatment (4). Effective care of PSSP is hampered by stroke physicians' frequent lack of trust in their ability to diagnose the underlying causes (5). The debilitating musculoskeletal condition known as "frozen shoulder" is typified by a slow development of shoulder discomfort, increasing stiffness, and a noticeable limitation in both active and passive glenohumeral range of motion. Because of its protracted course and the profound functional damage it causes in those who are afflicted, it is a major clinical issue. According to epidemiological research, frozen shoulder affects 2–5% of the general population, with a higher frequency among those in their fifth and sixth decades of life. According to reports, women are more likely than males to be afflicted, and the non-dominant upper limb is commonly impacted (6). Three overlapping stages are frequently identified in the natural history of adhesive capsulitis: the painful "freezing" stage, the stiff "frozen" stage, and the healing or "thawing" stage. Patients may endure varied degrees of discomfort and limited mobility throughout these periods, which can last for a long time, usually one to three years (7). Both active and passive shoulder motions, especially external rotation, are gradually restricted as a result. The disorder is more common in women. Although discomfort is usually restricted to the anterior shoulder, it can spread to the anterolateral arm and seriously hinder quality of life and functional activities. However, about 22–23% of stroke survivors experience hemiplegic shoulder discomfort, and the number of people with shoulder conditions such frozen shoulder, scapular adhesions, and shoulder subluxation is increasing every year (8). There is no recognized intrinsic shoulder pathology associated with this unidentified aetiological illness, which is characterized by a substantial limitation of both active and passive shoulder mobility. The thickening of the synovial capsule, contracted soft tissues, adhesion to the biceps tendon, and/or obliteration of the axillary fold due to adhesion are the hallmarks of this condition, which causes a gradual and subtle loss of both active and passive mobility in the GH joint as a result of joint contracture (9). Subscapularis trigger points (TrPs) are frequently the cause of "frozen shoulder" condition, according to a 1983 study by Travell and Simons. Referred pain from subscapularis TrPs is concentrated in the posterior deltoid region and may radiate medially over the scapula, down the posterior side of the arm, and then skip to a band around the wrist. Abduction and lateral rotation of the arm may become increasingly uncomfortable as a result of this TrPs (10). Shoulder periarthritis can be brought on by myofascial trigger points in the shoulder girdle muscle, particularly the subscapularis. Shoulder abduction and external rotation will be limited if this muscle is guarded (11).

Without defined criteria, a comprehensive history and physical examination are used to diagnose frozen shoulder. Significant limitations of active and passive shoulder motion in more than one plane to less instead of 100◦ and 50% or greater than 30◦ loss of passive rotation externally (at the side), painful end range motion in all movements, significant pain/weakness of the internal rotators, normal radiological appearance, and no secondary causes are the most commonly used criteria in prior studies to diagnose frozen shoulder (12,13,14). Scapular-mobility exercises and scapular mobilization (SM) procedures are commonly employed in the treatment of shoulder musculoskeletal issues. It entails a therapist manually applying a prolonged mobilization to the scapulothoracic joint in four directions (15). Joint mobilization treatments reduce discomfort and increase range of motion and shoulder function by stretching tight soft tissues and improving natural shoulder capsule extensibility. By releasing muscles and breaking adhesions, scapula mobilization can increase scapular motions. Increased scapular motions may also be associated with improved shoulder movement (16). In order to lessen pain, TENS applies low frequency current—a type of pulsed rectangle current—through surface electrodes on the patient's skin. Current is often produced by a tiny battery-operated device. They have a particular stimulating impact. The mainstay of therapy for frozen shoulder is range-of-motion exercises, which TENS frequently enables patients to engage in more successfully (17). Gate control theory and pain modulation are essential to the effectiveness and use of TENS. Pain is an unpleasant, disturbed feeling that results from nociceptor activation. Pain is a multifaceted, subjective experience (18). TENS is frequently used to relieve shoulder discomfort in cases of frozen shoulder. Enhance patient comfort during physical activity, encourage involvement in programs for stretching and mobility, and perhaps reduce the need for painkillers. Everyone working in physiotherapy will be aware that the Cochrane review found that although TENS may be beneficial, high-quality RCTs are required to prove conclusive benefits.

Materials and methods

The current investigation was a randomized controlled experiment that took place between September and November of 2025 in the outpatient Department of Physical Medicine and Rehabilitation (PMR), ANS Hospital, Jaipur, Rajasthan, India.The institutional Research Committee gave their approval to the project. Convenient sampling was used to determine the sample size within the allotted time. Ten of the 55 patients with primary frozen shoulder, ages 45 to 60, were eliminated, leaving 45 patients in the research sample. The patients gave their consent.

The study's inclusion criteria included being h/o post-stroke, having a condition that lasted between three and twelve months, having reduced active and passive range of motion, being unilaterally affected, not being restricted by gender, showing no signs of GH joint arthritis, and having mobility limits as a capsular pattern. Use of locally administered steroids, prior h/o shoulder surgery or trauma such as RTA, and neurological conditions causing shoulder joint muscle weakness, such as autoimmune illnesses, were the exclusion criteria.

Study procedure

After screening for selection criteria, patients were informed about the purpose, study method and informed consent obtained for participation individually. Demographic data were collected. Subjects were

randomly allocated into three groups. Group A (N=15) patients received scapular mobilisation and home exercises. Group B (N=15) patients received TENS and home exercises. Group C (N=15) patients received both scapular mobilization and TENS with shoulder exercises. Pre, intermittent and post treatment score, primarily on pain intensity and shoulder diability were measured by NPRS and SPADI respectively. Pre, intermittent and post treatment evaluation were compared and statistically analyzed. Post assessment evaluation was done at the end of six week. The total duration of treatment was six weeks, frequency was one session per day, and the patient were allowed to continue their regular
medication (analgesics) as prescribed by the physician.

Outcome measures

NPRS: The numerical pain rating scale is a self-assessment instrument that is 10 cm long and has numbers 0–10 on it, with 0 denoting no pain and 10 denoting the worst possible agony. Before the readings were obtained, each participant was asked to indicate how much shoulder discomfort they were now experiencing(19).

SPADI: The 13-item Shoulder Pain and Disability Index (SPADI) is a self-administered survey. The remaining eight questions gauge the degree of disability, while five assess the degree of pain brought on by different arm motions. Instruction was provided to the subjects to assess each item on a scale from 0 (no pain or impairment) to 10 (worst pain imaginable) that best represents their shoulder during the last week(20). Final score was determined by summing all the recorded scores and then divided by the highest score and lastly the entire score was multiplied by 100(21).

II. Interventions

Scapular mobilization: it is basically performed as 2 sets of repetition with 15sec rest intervals. *Scapular superior glide*: The therapist inserts one hand's index finger beneath the afflicted side's midline scapular edge while the other hand holds the scapula's superior edge as the patient rests on the side with no impact. For superior glide, the scapula is moved superiorly. *Scapular inferior glide*: The patient is made to recline easily on their unaffected side by the therapist. Next, the therapist puts one hand's index finger beneath the afflicted side's medial scapular edge while the other hand holds the scapula's top edge. It moves the scapula inferiorly. *Scapular upward rotation*: When doing the scapular vertically rotation, the patient lies on the sound side. The therapist inserts one hand's index finger beneath the scapula's medial edge while the other hand grasps the scapula's top edge and rotates upward. *Scapular downward rotation*: The patient lies on the sound side while the therapist performs the scapular retrograde movement. The therapist inserts the index finger of one hand beneath the scapula's medial edge while the other hand grasps the scapula's superior edge. *Scapular distraction*: The patient is in a side lying position, arm at side. Ulnar fingers below the medial scapular border and distracts the scapula from the thorax. Each sequel done 5 repetitions for patient of group A and Group C.

TENS: Transcutaneous electrical nerve stimulation done by a battery operated low frequency current device, having 4 electrodes placed around the affected shoulder for 20mins as co-planer method, by means a beat frequency produced around the shoulder. 80ma with brust frequency used for Group B patients, as well as for Group C patients also.

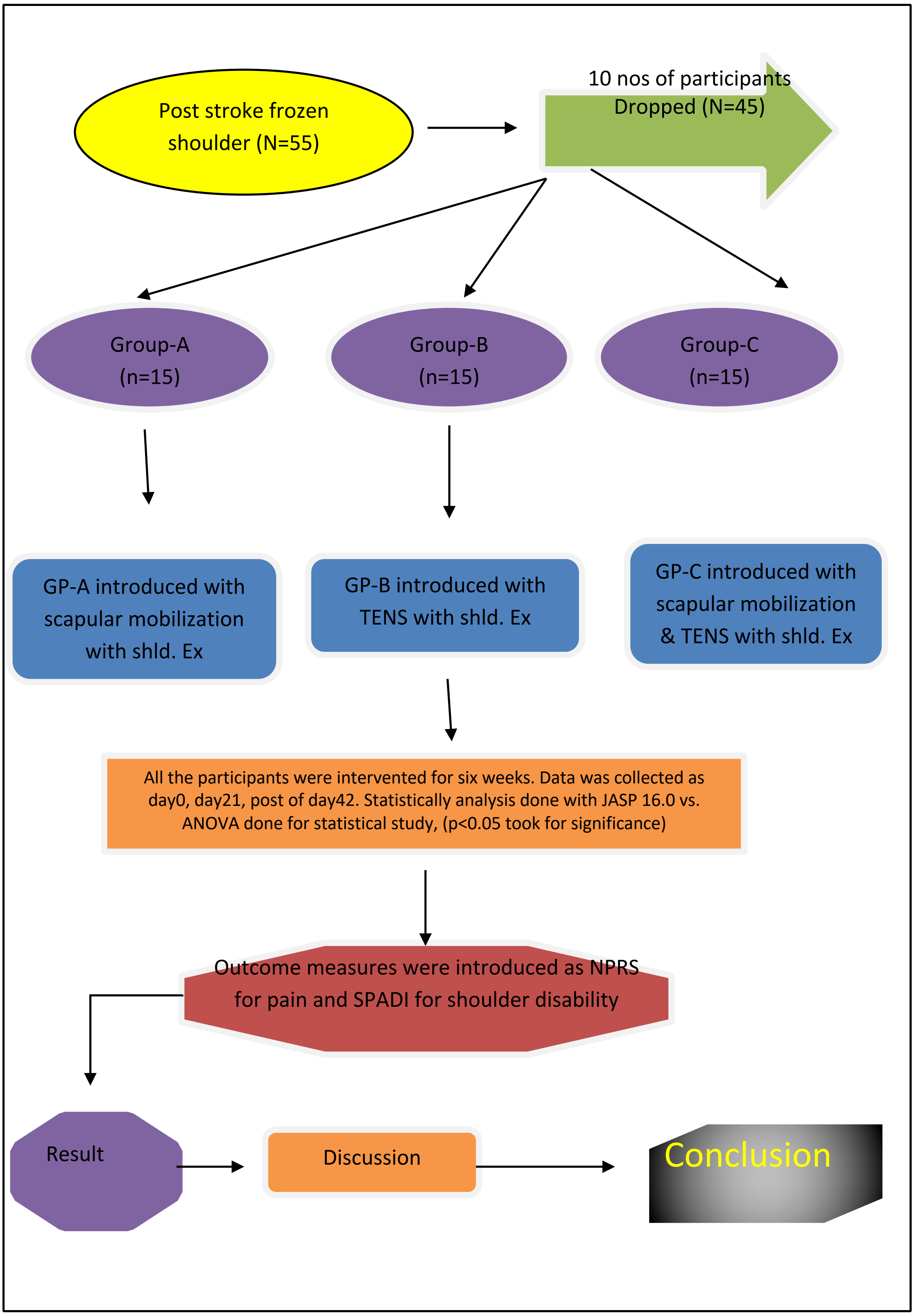
Shoulder exercise: shoulder exercises were introduced to the patient as a home program as pendulum exercise, finger on wall rolling, over head clapping, rotation of shoulder wheel. These exercises were done for 15 min for each patient after the intervention.

For being the patients of Group C introduced with scapular mobilization as half period of Group A and TENS as half period of Group B. Hence the shoulder exercise introduced as same as Group A and Group B.

Statistical analysis

Data analysis was done using JASP 16.0 version. The pre- intermittent-post change in the group was assessed by Paired Samples Test and the changes between the groups was assessed by ANOVA. The severity of the pain and functional disability in the groups was assessed by Mauchly's test. Statistical significance level was set as $p<0.05$.

Consert flow chart



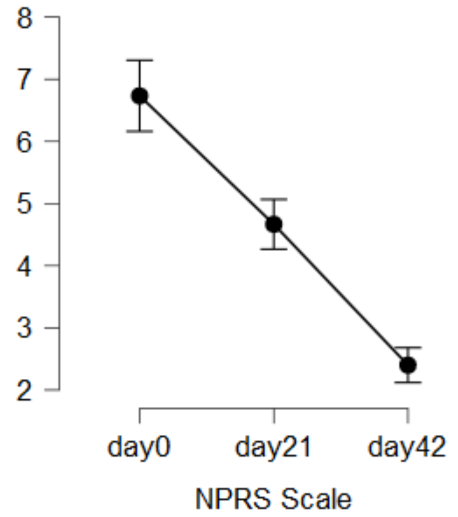
III. Result

ANOVA for Gp A:

Descriptives

NPRS Scale	Mean	SD	N
day0	6.733	1.033	15
day21	4.667	0.724	15
day42	2.400	0.507	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η^2	η^2_G
NPRS Scale	140.933	2	70.467	255.138	1.062e -18	0.948	0.845
Residuals	7.733	28	0.276				

Note. Type III Sum of Squares

Post Hoc Comparisons - NPRS Scale

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	p_{holm}
day0	day21	2.067	1.578	2.555	0.192	10.770	1.828e -11 ***
	day42	4.333	3.845	4.822	0.192	22.581	4.928e -19 ***
day21	day42	2.267	1.778	2.755	0.192	11.812	4.323e -12 ***

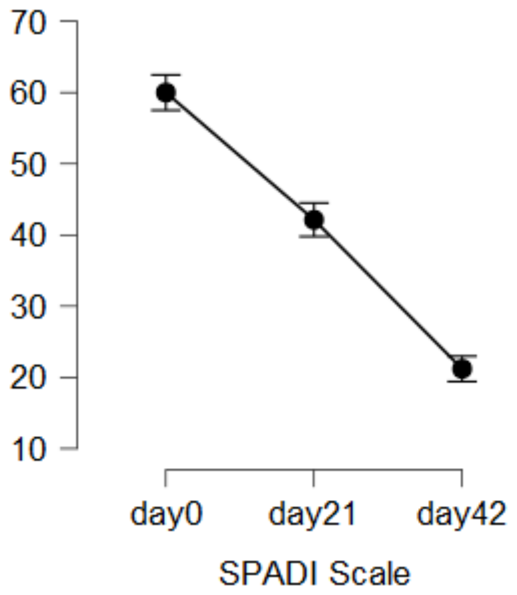
*** p < .001

IV. SPADI

Descriptives

SPADI Scale	Mean	SD	N
day0	60.000	4.488	15
day21	42.133	4.257	15
day42	21.200	3.212	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η^2	η^2_G
SPADI Scale	11314.311 [a]	2 [a]	5657.156 [a]	567.698 [a]	2.188e-23 [a]	0.976	0.943
Residuals	279.022	28	9.965				

Note. Type III Sum of Squares

[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated ($p < .05$).

Post Hoc Comparisons - SPADI Scale

			95% CI for Mean Difference				
		Mean Difference	Lower	Upper	SE	t	p_{holm}
day0	day21	17.867	14.931	20.802	1.153	15.500	2.867e-15 ***
	day42	38.800	35.865	41.735	1.153	33.661	1.021e-23 ***
day21	day42	20.933	17.998	23.869	1.153	18.161	1.003e-16 ***

*** $p < .001$

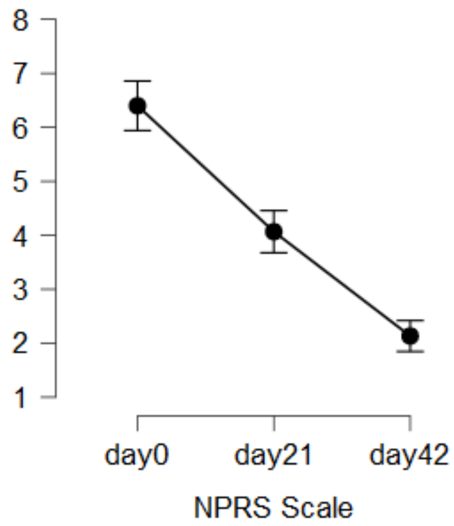
Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Anova for Gp-B

Descriptives

NPRS Scale	Mean	SD	N
day0	6.400	0.828	15
day21	4.067	0.704	15
day42	2.133	0.516	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η^2	η^2_G
NPRS Scale	136.933	2	68.467	378.368	5.421e-21	0.964	0.871
Residuals	5.067	28	0.181				

Note. Type III Sum of Squares

Post Hoc Comparisons - NPRS Scale

		Mean Difference	95% CI for Mean Difference		SE	t	p_{holm}	
			Lower	Upper				
day0	day21	2.333	1.938	2.729	0.155	15.022	1.259e-14	***
	day42	4.267	3.871	4.662	0.155	27.469	2.572e-21	***
day21	day42	1.933	1.538	2.329	0.155	12.447	6.259e-13	***

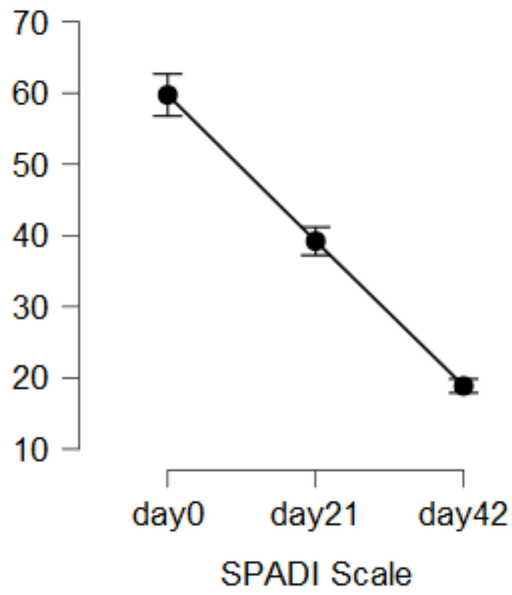
*** p < .001

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Descriptives

SPADI Scale	Mean	SD	N
day0	59.733	5.338	15
day21	39.200	3.570	15
day42	18.867	1.767	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η^2	η^2_G
SPADI Scale	12525.733 [a]	2 [a]	6262.867 [a]	1025.899 [a]	6.426e -27 [a]	0.987	0.953
Residuals	170.933	28	6.105				

Note. Type III Sum of Squares
[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated ($p < .05$).

Post Hoc Comparisons - SPADI Scale

		Mean Difference	95% CI for Mean Difference		SE	t	p_{holm}
			Lower	Upper			
day0	day21	20.533	18.236	22.831	0.902	22.759	2.666e -19 ***
	day42	40.867	38.569	43.164	0.902	45.297	2.899e -27 ***
day21	day42	20.333	18.036	22.631	0.902	22.537	2.666e -19 ***

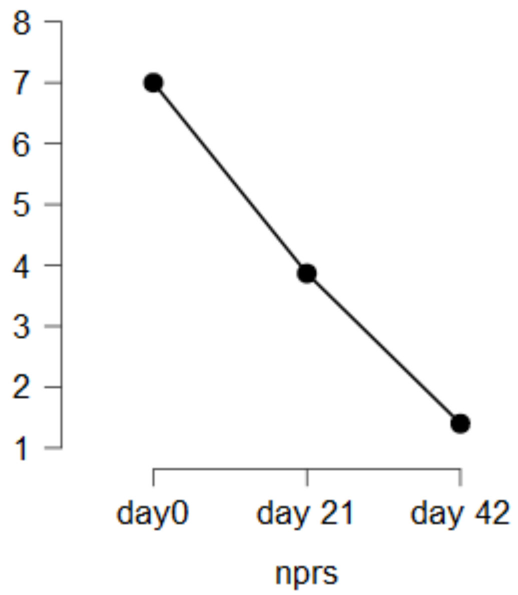
*** $p < .001$
Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Anova gor Gp-C

Descriptives

nprs	Mean	SD	N
day 21	3.867	0.640	15
day 42	1.400	0.507	15
day0	7.000	0.756	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
nprs	236.311	2	118.156	658.743	2.857e -24	0.979
Residuals	5.022	28	0.179			

Note. Type III Sum of Squares

Post Hoc Comparisons - nprs

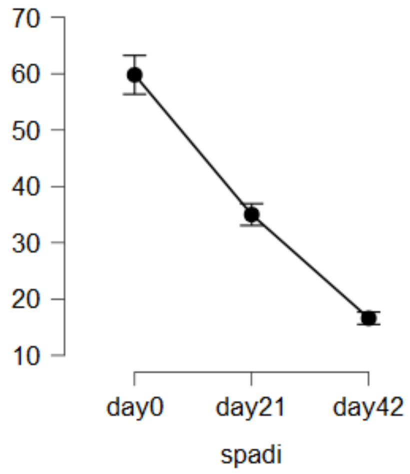
		Mean Difference	SE	t	p_{holm}
day0	day.21	3.133	0.155	20.261	5.770e -18
	day.42	5.600	0.155	36.212	1.380e -24
day.21	day.42	2.467	0.155	15.950	1.391e -15

Note. P-value adjusted for comparing a family of 3

Descriptives

spadi	Mean	SD	N
day0	59.800	6.213	15
day21	35.000	3.485	15
day42	16.600	1.957	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η^2
spadi	14099.200 [a]	2 [a]	7049.600 [a]	845.469 [a]	9.259e -26 [a]	0.984
Residuals	233.467	28	8.338			

Note. Type III Sum of Squares
[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated (p < .05).

Post Hoc Comparisons - spadi

		Mean Difference	95% CI for Mean Difference Lower	95% CI for Mean Difference Upper	SE	t	Cohen's d	p_{holm}
day0	day21	24.800	22.115	27.485	1.054	23.521	6.073	1.109e -19 ***
	day42	43.200	40.515	45.885	1.054	40.971	10.579	4.625e -26 ***
day21	day42	18.400	15.715	21.085	1.054	17.451	4.506	1.402e -16 ***

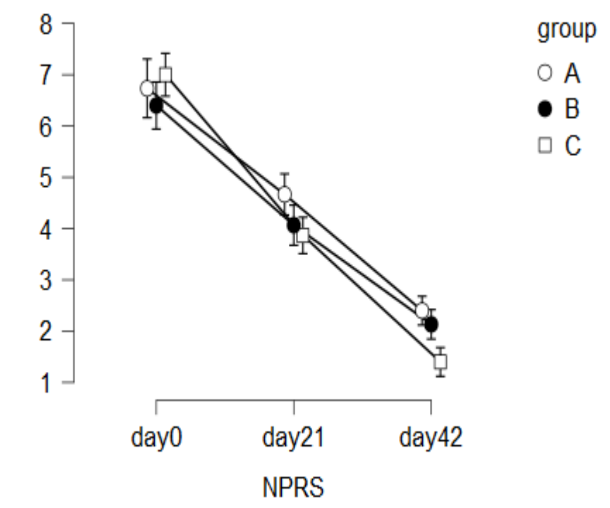
*** p < .001
Note. Cohen's d does not correct for multiple comparisons.
Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Anova for NPRS scale between the group study

Descriptives

NPRS	group	Mean	SD	N
day0	A	6.733	1.033	15
	B	6.400	0.828	15
	C	7.000	0.756	15
day21	A	4.667	0.724	15
	B	4.067	0.704	15
	C	3.867	0.640	15
day42	A	2.400	0.507	15
	B	2.133	0.516	15
	C	1.400	0.507	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
NPRS	504.726 [a]	2 [a]	252.363 [a]	1189.441 [a]	2.394e -62 [a]	0.864
NPRS ✻ group	9.452 [a]	4 [a]	2.363 [a]	11.137 [a]	2.696e -7 [a]	0.016
Residuals	17.822	84	0.212			

Note. Type III Sum of Squares

[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated (p < .05).

Between Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
group	6.504	2	3.252	2.992	0.061	0.011
Residuals	45.644	42	1.087			

Note. Type III Sum of Squares

Post Hoc Comparisons - NPRS

		Mean Difference	95% CI for Mean Difference Lower	Upper	SE	t	Cohen's d	p holm	
day0	day21	2.511	2.274	2.748	0.097	25.859	3.855	1.846e-41	***
	day42	4.733	4.496	4.971	0.097	48.744	7.266	6.667e-63	***
day21	day42	2.222	1.985	2.459	0.097	22.884	3.411	7.500e-38	***

*** p < .001

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Note. Results are averaged over the levels of: group

Post Hoc Comparisons - group

		Mean Difference	95% CI for Mean Difference Lower	Upper	SE	t	Cohen's d	p holm
A	B	0.400	-0.148	0.948	0.220	1.820	0.271	0.152
	C	0.511	-0.037	1.059	0.220	2.326	0.347	0.075
B	C	0.111	-0.437	0.659	0.220	0.506	0.075	0.616

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

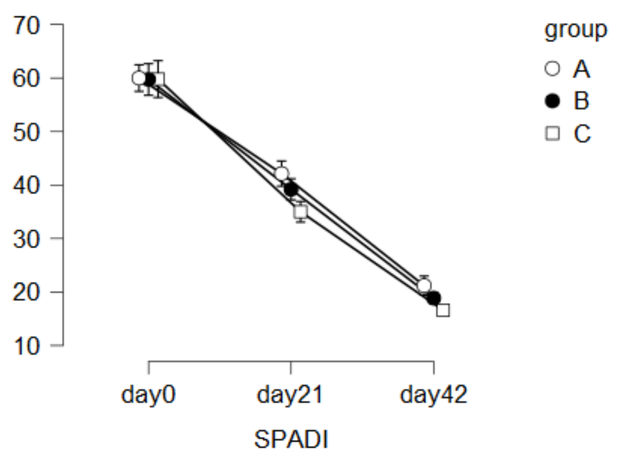
Note. Results are averaged over the levels of: NPRS

Anova for SPADI scale between the group study

Descriptives

SPADI	group	Mean	SD	N
day0	A	60.000	4.488	15
	B	59.733	5.338	15
	C	59.800	6.213	15
day21	A	42.133	4.257	15
	B	39.200	3.570	15
	C	35.000	3.485	15
day42	A	21.200	3.212	15
	B	18.867	1.767	15
	C	16.600	1.957	15

Descriptives plots



Within Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
SPADI	37750.948 [a]	2 [a]	18875.474 [a]	2320.000 [a]	3.153e-74 [a]	0.935
SPADI ∗ group	188.296 [a]	4 [a]	47.074 [a]	5.786 [a]	3.667e-4 [a]	0.005
Residuals	683.422	84	8.136			

Note. Type III Sum of Squares

[a] Mauchly's test of sphericity indicates that the assumption of sphericity is violated (p < .05).

Between Subjects Effects

Cases	Sum of Squares	df	Mean Square	F	p	η²
group	356.637	2	178.319	5.420	0.008	0.009
Residuals	1381.778	42	32.899			

Note. Type III Sum of Squares

Post Hoc Comparisons - group

		Mean Difference	95% CI for Mean Difference		SE	t	Cohen's d	p holm	
			Lower	Upper					
A	B	1.844	-1.171	4.860	1.209	1.525	0.227	0.170	
	C	3.978	0.962	6.993	1.209	3.290	0.490	0.006	**
B	C	2.133	-0.882	5.149	1.209	1.764	0.263	0.170	

** p < .01

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Note. Results are averaged over the levels of: SPADI

Post Hoc Comparisons - SPADI

		Mean Difference	95% CI for Mean Difference		SE	t	Cohen's d	p holm	
			Lower	Upper					
day0	day21	21.067	19.598	22.536	0.601	35.033	5.222	1.347e-51	***
	day42	40.956	39.487	42.425	0.601	68.108	10.153	8.377e-75	***

Post Hoc Comparisons - SPADI

			95% CI for Mean Difference					
		Mean Difference	Lower	Upper	SE	t	Cohen's d	p_{holm}
day21	day42	19.889	18.420	21.358	0.601	33.075	4.930	6.120e-50 ***

*** p < .001

Note. Cohen's d does not correct for multiple comparisons.

Note. P-value and confidence intervals adjusted for comparing a family of 3 estimates (confidence intervals corrected using the bonferroni method).

Note. Results are averaged over the levels of: group

V. Discussion

Physiological Effects of TENS in Frozen Shoulder: TENS (Transcutaneous Electrical Nerve Stimulation) is primarily used to reduce pain and facilitate movement in patients with frozen shoulder (Adhesive Capsulitis). Its physiological effects include:

Pain Modulation (Gate Control Theory): TENS stimulates large-diameter A-beta sensory fibers. These fibers inhibit transmission of pain signals carried by A-delta and C fibers at the spinal cord level. This "closes the gate" to pain, reducing pain perception.

Endogenous Opioid Release: TENS can stimulate the release of Endorphins, Enkephalins, Dynorphins. These natural pain-relieving substances decrease pain sensitivity.

Improved Blood Circulation: Muscle contractions and neurovascular responses induced by TENS may increase local blood flow. Enhanced circulation can improve tissue nutrition and removal of inflammatory metabolites.

Reduction of Muscle Guarding: Pain often causes protective muscle spasm around the shoulder. By reducing pain, TENS decreases muscle guarding and allows better relaxation of peri-scapular and shoulder muscles.

Facilitation of Movement: Reduced pain enables patients to participate more effectively and this can help prevent further stiffness.

Improved Functional Performance: Decreased pain and muscle guarding may improve activities such as daily activities.

TENS does not directly break capsular adhesions or restore capsule extensibility, Long-term improvement in frozen shoulder depends mainly adjoined with some mobility and shoulder exercises. TENS acts mainly through pain inhibition, endogenous opioid release, improved circulation, and reduction of muscle guarding, thereby creating a more favorable environment for therapeutic exercise and restoration of shoulder mobility.

Physiological Effects of Scapular Mobilization: Scapular mobilization is a commonly used physiotherapy intervention for patients with frozen shoulder (Adhesive Capsulitis). It aims to restore normal scapulothoracic movement and improve overall shoulder function.

Restoration of Scapulohumeral Rhythm: Frozen shoulder often disrupts the normal coordination between the scapula and humerus. Scapular mobilization helps restore normal scapulohumeral rhythm during arm movements. This improves movement efficiency and reduces compensatory patterns.

Increased Shoulder Range of Motion (ROM): Mobilization of the scapula enhances scapular upward rotation, posterior tilt, and external rotation. These movements contribute to improved shoulder flexion and abduction ROM.

Reduction of Pain: Mobilization stimulates joint and soft-tissue mechanoreceptors. This can inhibit pain through neurophysiological mechanisms similar to the gate control theory. Reduced pain allows more comfortable movement and exercise participation.

Decreased Muscle Tightness and Guarding: Scapular mobilization helps reduce muscle guarding and improve muscle flexibility.

Improved Circulation: Rhythmic mobilization enhances local blood flow. Increased circulation may improve oxygen delivery and removal of metabolic waste products from peri-scapular tissues.

Enhanced Proprioception: Mobilization stimulates proprioceptors within muscles, ligaments, and joint structures. Improved proprioceptive input enhances neuromuscular control of the shoulder complex.

Reduction of Mechanical Stress on the Glenohumeral Joint: Improved scapular mobility distributes movement more effectively across the shoulder complex. This decreases excessive stress on the stiff glenohumeral joint capsule and Improvement in Functional Activities.

Scapular mobilization alone may provide modest benefits, but it is generally most effective when combined with another electro modalities like TENS or IFT.

VI. Discussion

Physiological Effects of TENS in Frozen Shoulder: TENS (Transcutaneous Electrical Nerve Stimulation) is primarily used to reduce pain and facilitate movement in patients with frozen shoulder (Adhesive Capsulitis). Its physiological effects include:

Pain Modulation (Gate Control Theory): TENS stimulates large-diameter A-beta sensory fibers. These fibers inhibit transmission of pain signals carried by A-delta and C fibers at the spinal cord level. This "closes the gate" to pain, reducing pain perception.

Endogenous Opioid Release: TENS can stimulate the release of Endorphins, Enkephalins, Dynorphins. These natural pain-relieving substances decrease pain sensitivity.

Improved Blood Circulation: Muscle contractions and neurovascular responses induced by TENS may increase local blood flow. Enhanced circulation can improve tissue nutrition and removal of inflammatory metabolites.

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Scapular mobilization alone may provide modest benefits, but it is generally most effective when combined with another electro modalities like TENS or IFT.

VII. Conclusion

The results of the current study suggest that the addition of either scapular mobilization therapy or TENS alone did not significantly improve pain or disability in individuals with frozen shoulder. Both groups, on average, had clinically significant improvements in pain and disability, despite the chronic nature of the symptoms. Scapular mobilization did not add any additional benefit over exercise alone. Similarly TENS therapy did not contribute any additional benefit. A greater percentage of the individuals in the scapular mobilization with TENS plus shoulder exercise group experienced a successful outcome or acceptability of symptoms on the pain and dysfunction with frozen shoulder, respectively, at 3 weeks, and at 6 weeks on the NPRS and SPADI. Hence Group C placed much better outcomes as compared than Group A and Group B.

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