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# To Compare the Effectiveness of Therapeutic Ultrasound with Scapular Mobilization Versus Transcutaneous Electrical Nerve Stimulation with Capsular Stretching in Frozen Shoulder

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**Abstract:** ***Background: Adhesive capsulitis (frozen shoulder) is characterized by pain and progressive restriction of both active and passive shoulder movements, leading to functional disability. Various physiotherapy interventions are used to reduce pain and improve range of motion (ROM), yet comparative evidence between commonly used modalities remains limited. Objective: To evaluate the efficacy of transcutaneous electrical nerve stimulation (TENS) in conjunction with capsular stretching vs therapeutic ultrasound in conjunction with scapular mobilization in patients suffering from frozen shoulder. Methods: 60 patients with frozen shoulder were randomly assigned to two groups (n = 30 each) for comparative research. Group B received TENS with capsular stretching, and Group A received therapeutic ultrasound with scapular mobilization. For three weeks, interventions were given once a day, five days a week. The Visual Analogue Scale (VAS) was used to quantify pain intensity, the Shoulder Pain and Disability Index (SPADI) was used to measure functional status, and a universal goniometer was used to measure shoulder range of motion. Paired and independent t-tests were used to assess pre- and post-intervention data, with a significance level of p<0.05. Results: Following the intervention, both groups showed statistically significant improvements in pain, range of motion, and functional status (p<0.05). While between-group differences were not statistically significant for all metrics, Group A demonstrated a higher percentage improvement in VAS and ROM than Group B. Conclusion: For patients with frozen shoulder, both TENS with capsular stretching and therapeutic ultrasound with scapular mobilization are useful in lowering discomfort and enhancing shoulder function. Scapular mobilization in conjunction with ultrasound showed somewhat better clinical results, indicating its value as a recommended intervention in the treatment of adhesive capsulitis with physical therapy.***

**Keywords:** Adhesive capsulitis, frozen shoulder, TENS, capsular stretching, scapular mobilization, therapeutic ultrasound, VAS, SPADI, ROM

## 1. Introduction

Adhesive capsulitis, another name for frozen shoulder, is a common musculoskeletal disorder marked by increasing discomfort, stiffness, and limitations in the glenohumeral joint's ability to move both actively and passively [1]. It typically affects people in their 40age to 60age and is often linked to metabolic diseases like diabetes mellitus [2]. Daily living activities and quality of life are greatly impacted by the condition [3,4,5]. Inflammation of the synovial lining, followed by capsular fibrosis and adhesion formation, is the pathophysiology of frozen shoulder, which results in decreased joint volume and limited mobility [6]. Clinically, the illness develops in three stages: freezing, frozen, and thawing. Each stage has unique pain and stiffness symptoms [7]. A key component of the conservative treatment of frozen shoulder is physiotherapy. Because of its mechanical and thermal properties, therapeutic ultrasound is frequently used to promote healing, enhance tissue elasticity, and lessen discomfort [8]. By optimizing shoulder biomechanics and scapulothoracic rhythm, scapular mobilization increases functional range [9].

On the other hand, capsular stretching attempts to restore joint mobility by lessening capsular tightness, whereas TENS is frequently used for pain modulation using gate control systems [10,11].

Despite the widespread use of these therapies, there is little data comparing their relative efficacy. Thus, the current study sought to compare the efficacy of TENS with capsular stretching vs therapeutic ultrasound with scapular mobilization in those suffering from frozen shoulder.

## 2. Materials and Methods

**Study Design:**
Comparative analysis of experiments.

**Study Setting:**
Kempegowda Institute of Physiotherapy and Kempegowda Institute of Medical Sciences Hospital, Bangalore.

**Sample Size:**
There were sixty patients with frozen shoulder.

**Participants:**
After obtaining informed agreement, patients with unilateral frozen shoulder between the ages of 40 and 60 who satisfied the inclusion criteria were enlisted.

**Inclusion Criteria:**
- Frozen shoulder with a clinical diagnosis.
- Both sexes.
- Patients with and without diabetes.
- Willingness to engage.

**Exclusion Criteria:**

- Past injuries or fractures to the shoulder.
- Joint inflammatory diseases.
- Spondylosis or cervical radiculopathy.
- Participation of both shoulders.
- Prior injections of corticosteroids.

**Intervention Protocol:**

**Group A**: Scapular mobilization strategies are used after therapeutic ultrasound (1 MHz, continuous mode, 1.5 W/cm² for 10 minutes).
**Group B:** Capsular stretching exercises are performed after 15 minutes of TENS (100 Hz, pulse duration 0.05–0.07 ms).

For 5 days a week for 3 weeks, both interventions were given.

**Outcome Measures:**

**Visual Analogue Scale (VAS):** It has been demonstrated that the VAS has a linear scale for qualities for mild to moderate pain, making it a standard measurement instrument in pain research and clinical practice. The VAS is a self-reported tool with a 10-cm straight line that can be oriented vertically or horizontally. The line's left end the patient is shown a 10-cm line on a piece of paper with a pen to symbolize "NO PAIN" and "Unbearable pain [12]."

**Shoulder Pain and Disability Index (SPADI):**
An index of shoulder pain and impairment is called the SPADI. Thirteen evaluation questions, including those about pain and functional activities, make up the form. Five questions on the patient's pain irritability make up the pain section, while eight functional questions about shoulder joint mobility make up the functional activity. When assessing shoulder pain and disability, SPADI shows a high degree of dependability [13].

**Shoulder ROM using universal goniometer:**
The glenohumeral joint's active and passive ranges of motion are typically measured with a universal goniometer. The global goniometer is recognized all throughout the world [14].

**Statistical Analysis:**
SPSS version 26 was used to analyse the data. For within-group analysis, the paired t-test was utilized, and for between-group comparison, the independent t-test. For categorical variables, the chi-square test was used. The significance threshold was set at $p<0.05$.

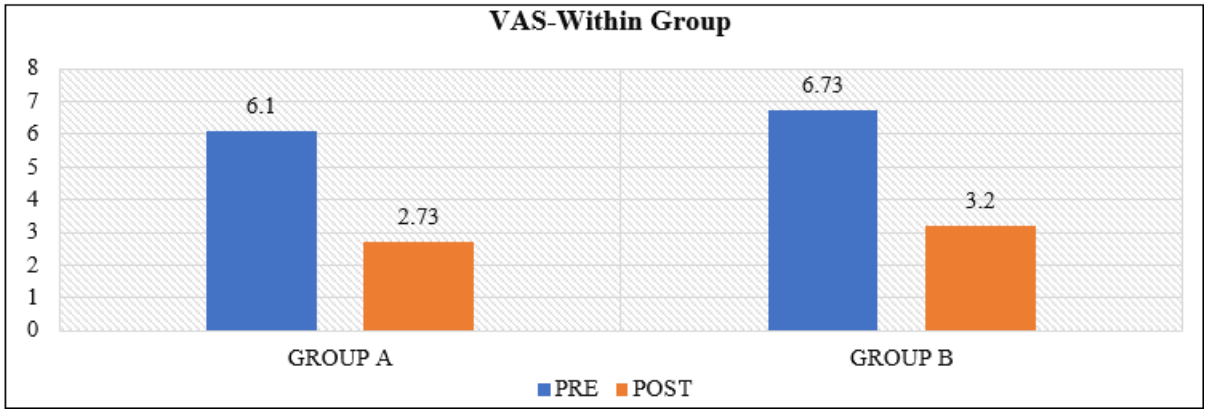
## 3. Results

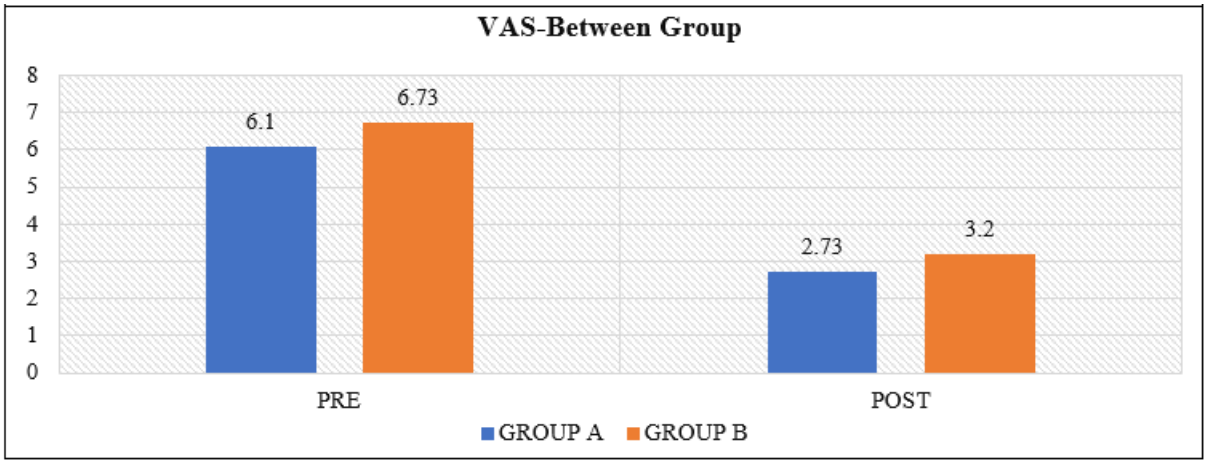
**Visual Analogue Scale (VAS):**

**Table 1:** Between and within group comparison of 'VAS'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| VAS | Pre | 6.1±1.32 | 6.73±1.23 | 1.91 | 0.06 |
| | Post | 2.73±1.21 | 3.2±1.04 | 1.61 | 0.11 |
| Difference | | 3.37±1.28 | 3.53±1.18 | | |
| Z Value | | 10.30 | 12.00 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 55.2% | 52.4% | | |

Table1 presents pre- and post-treatment Visual Analogue Scale (VAS) scores for both groups. Group A showed a reduction from $6.1 \pm 1.32$ to $2.73 \pm 1.21$, while Group B improved from $6.73 \pm 1.23$ to $3.2 \pm 1.04$. Between-group comparisons showed no statistically significant differences at baseline ($p = 0.06$) or post-treatment ($p = 0.11$). However, within-group improvements were statistically significant in both groups ($Z = 10.30$ and $12.00$; $p = 0.0001$*), with percentage reductions of 55.2% in Group A and 52.4% in Group B.



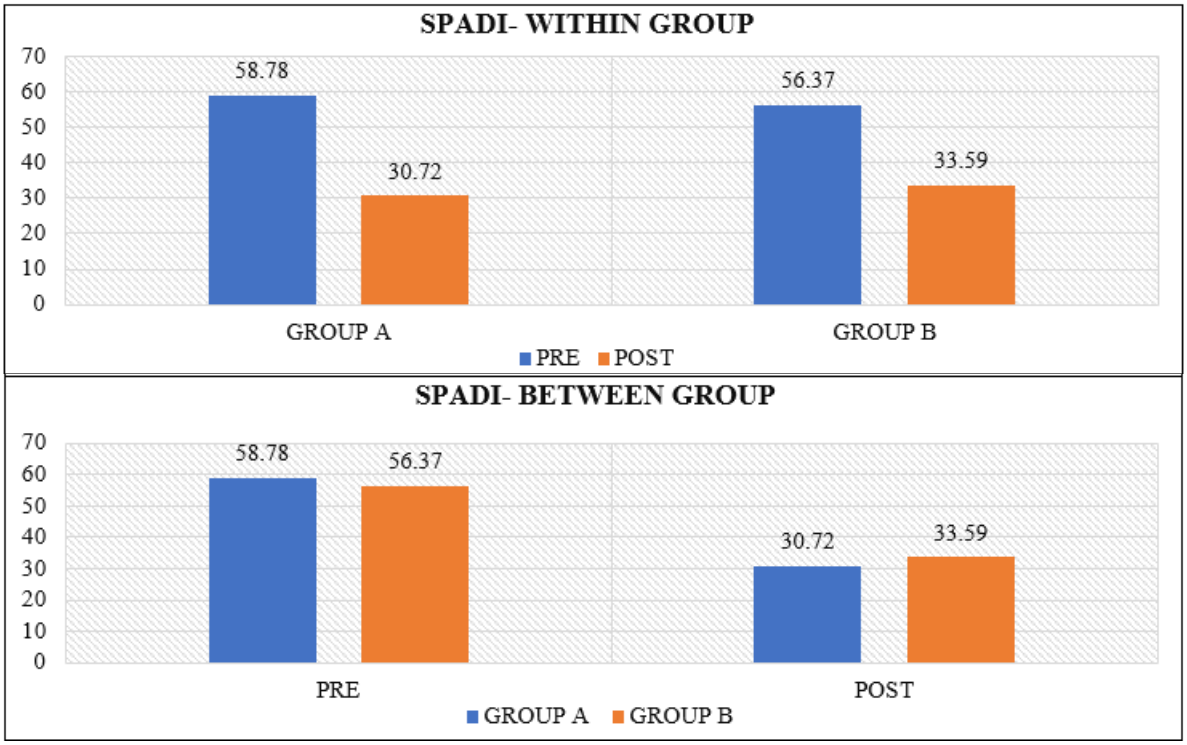



**Shoulder Pain and Disability Index:**

**Table 2:** Between and within group comparison of 'SPADI'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| SPADI | PRE | 58.78±11.14 | 56.37±13.95 | 0.73 | 0.46 |
| | POST | 30.72±6.69 | 33.59±11.86 | 1.15 | 0.25 |
| Difference | | 28.06±8.13 | 22.78±12.03 | | |
| Z Value | | 11.82 | 6.81 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 47.7% | 40.4% | | |

Table 2 shows SPADI (Shoulder Pain and Disability Index) scores before and after treatment. Group A improved from 58.78 ± 11.14 to 30.72 ± 6.69, while Group B improved from 56.37 ± 13.95 to 33.59 ± 11.86. Between-group differences were not statistically significant at baseline (p = 0.46) or post-treatment (p = 0.25). However, both groups demonstrated statistically significant within-group improvements (Z = 11.82 for Group A, Z = 6.81 for Group B; p = 0.0001*), with percentage reductions of 47.7% in Group A and 40.4% in Group B.




**Range of Motion:**

Group A represent significant improvement in Flexion, Extension, Abduction, Internal Rotation and External Rotation.

**Table 3:** Between and within group comparison of 'FLEXION'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| Passive | Pre | 130.43±17.18 | 138.2±15.04 | 1.86 | 0.06 |
| | Post | 158.36±9.34 | 160.93±11.92 | 0.92 | 0.35 |
| Difference | | 27.93±12.13 | 22.73±13.02 | | |
| Z Value | | 7.82 | 6.48 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 21.41% | 16.44% | | |
| Active | Pre | 125.13±18.23 | 132.9±14.26 | 1.83 | 0.07 |
| | Post | 153.5±9.74 | 156.76±11.99 | 1.15 | 0.25 |
| Difference | | 28.37±14.02 | 23.86±12.98 | | |
| Z Value | | 7.51 | 7.01 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| | | 22.67% | 17.95% | | |

Table 3 compares passive and active shoulder flexion (in degrees) before and after treatment in both groups.

- **Passive Flexion**:

Group A improved from 130.43 ± 17.18 to 158.36 ± 9.34 (21.41% increase), while Group B improved from 138.2 ± 15.04 to 160.93 ± 11.92 (16.44% increase). Between-group differences were not statistically significant at baseline (p = 0.06) or post-treatment (p = 0.35), but within-group improvements were significant (Z = 7.82 and 6.48; p = 0.0001*).

- **Active Flexion:**

Group A improved from 125.13 ± 18.23 to 153.5 ± 9.74 (22.67% increase), and Group B from 132.9 ± 14.26 to 156.76 ± 11.99 (17.95% increase). No significant between-group differences were observed (p = 0.07 pre, p = 0.25 post), but both groups showed significant within-group improvement (Z = 7.51 and 7.01; p = 0.0001*).

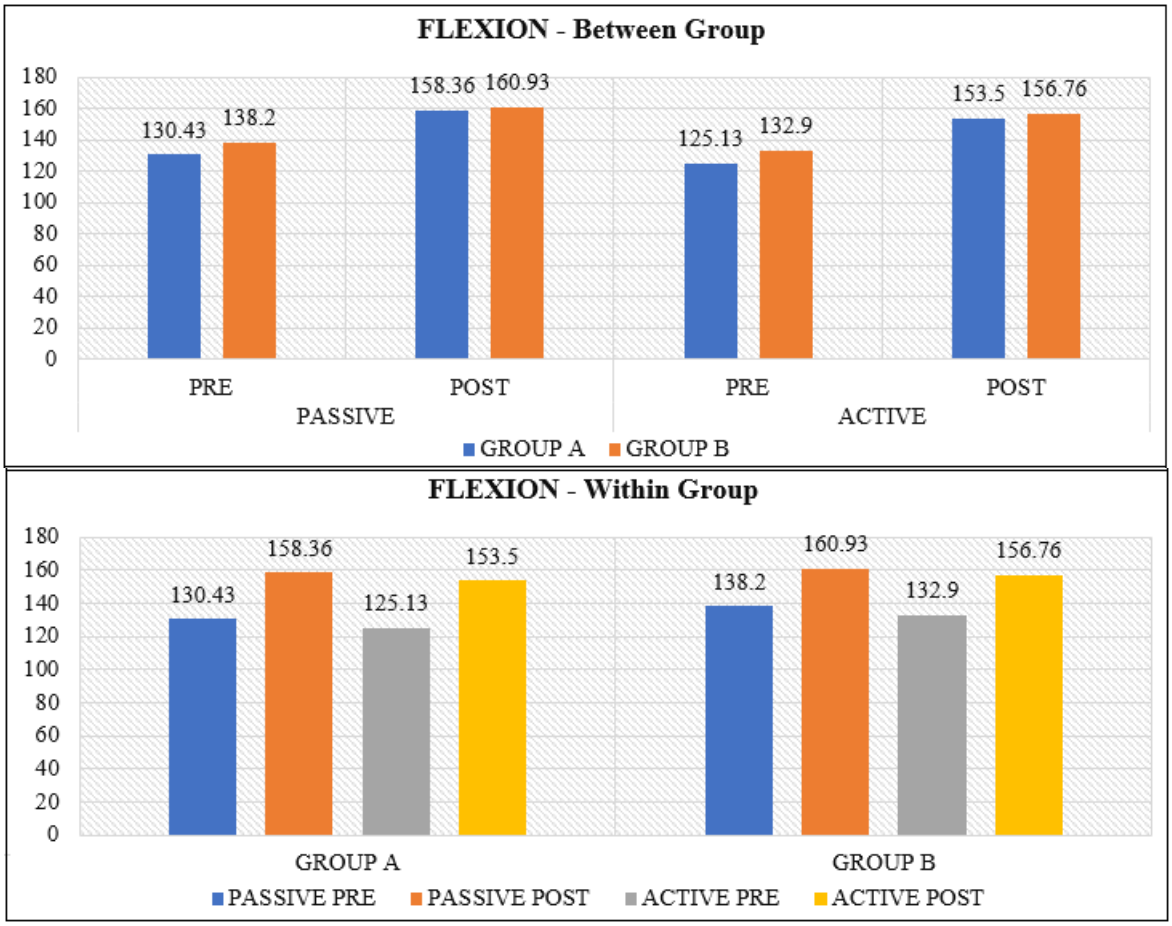


**Table 4:** Between and within group comparison of 'EXTENSION'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| Passive | Pre | 29.7±3.54 | 28.76±4.21 | 0.93 | 0.35 |
| | Post | 42.7±8.11 | 33.16±4.78 | 5.55 | 0.0001* |
| Difference | | 13±5.03 | 4.4±4.38 | | |
| Z Value | | 8.04 | 3.78 | | |
| P Value (Paired T test) | | 0.0001* | 0.0004* | | |
| Percentage difference | | 43.77% | 15.29% | | |
| Active | Pre | 26.97±3.15 | 26.9±5.47 | 0.06 | 0.95 |
| | Post | 40.1±7.58 | 31.97±4.71 | 4.98 | 0.0001* |
| Difference | | 13.13±5.08 | 5.07±5.12 | | |
| Z Value | | 8.76 | 3.84 | | |
| P Value (Paired T test) | | 0.0001* | 0.0003* | | |
| | | 48.68% | 18.84% | | |

Table 4 presents passive and active shoulder extension values (in degrees) for Groups A and B before and after treatment.

- **Passive Extension:**

Group A improved significantly from 29.7 ± 3.54 to 42.7 ± 8.11 (43.77% increase), while Group B showed a more modest improvement from 28.76 ± 4.21 to 33.16 ± 4.78 (15.29% increase). The between-group difference post-treatment was statistically significant (T = 5.55, p = 0.0001*). Both groups had significant within-group improvements (Z = 8.04 for Group A, Z = 3.78 for Group B; p < 0.001).

- **Active Extension:**

Group A improved from 26.97 ± 3.15 to 40.1 ± 7.58 (48.68% increase), whereas Group B improved from 26.9 ± 5.47 to 31.97 ± 4.71 (18.84% increase). Post-treatment differences were statistically significant between the groups (T = 4.98, p = 0.0001*). Within-group improvements were also significant (Z = 8.76 for Group A, Z = 3.84 for Group B; p < 0.001).

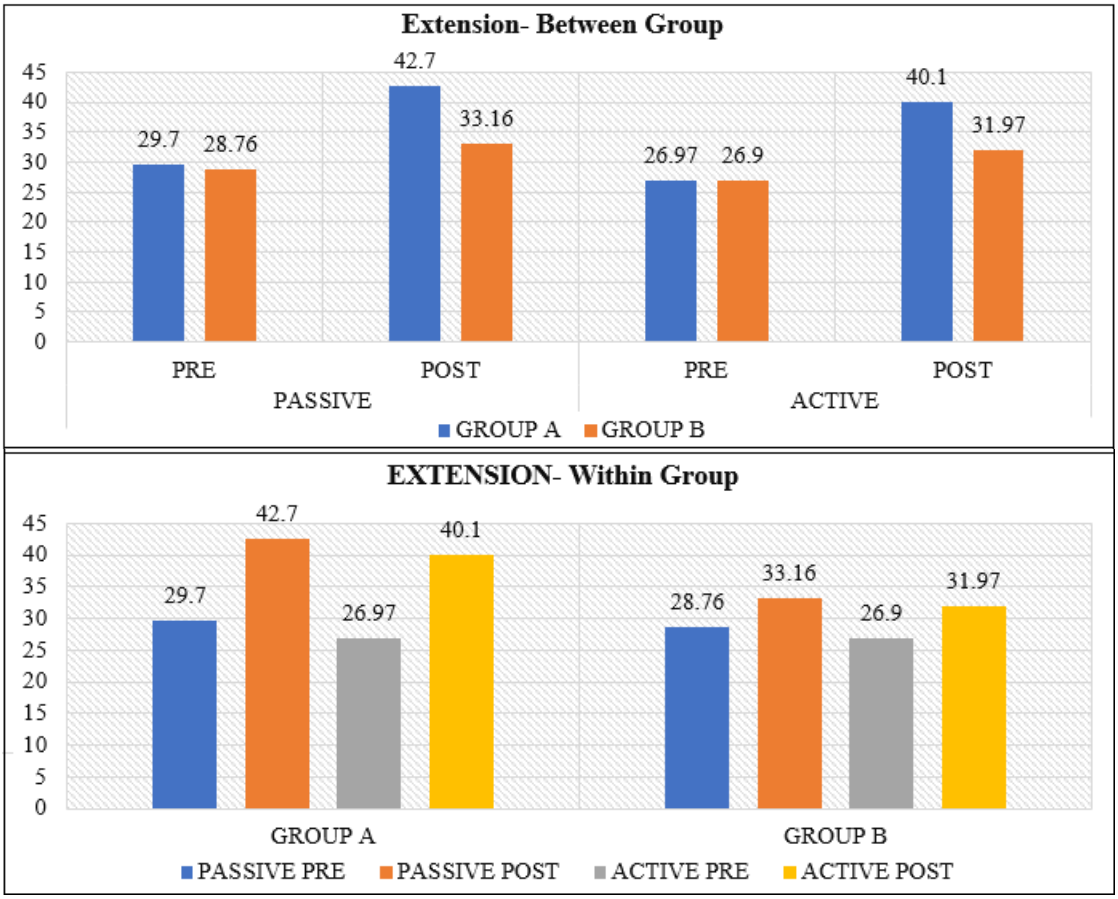


**Table 5:** Between and within group comparison of 'ABDUCTION'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| Passive | Pre | 112.33±14.26 | 120.2±18.29 | 1.85 | 0.06 |
| | Post | 146.3±11.04 | 149.06±11.35 | 0.95 | 0.34 |
| Difference | | 33.97±13.09 | 28.86±15.18 | | |
| Z Value | | 10.31 | 7.34 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 30.24% | 24.00% | | |
| Active | Pre | 110.86±15.82 | 105.2±15.51 | 1.39 | 0.16 |
| | Post | 146.67±10.02 | 140.73±10.37 | 2.25 | 0.02* |
| Difference | | 35.81±12.45 | 35.53±13.04 | | |
| Z Value | | 10.47 | 10.43 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| | | 32.30% | 33.77% | | |

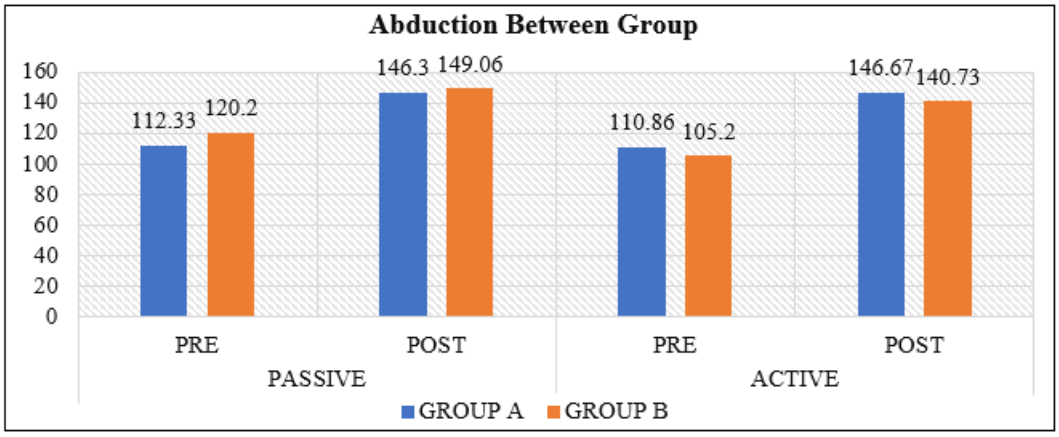
Table 5 displays changes in shoulder abduction (in degrees) in Groups A and B before and after treatment.

- **Passive Abduction**

Group A improved from 112.33 ± 14.26 to 146.3 ± 11.04 (30.24% increase), and Group B from 120.2 ± 18.29 to 149.06 ± 11.35 (24.00% increase). Between-group differences were not statistically significant at baseline (p = 0.06) or post-treatment (p = 0.34). However, both groups showed statistically significant within-group improvements (Z = 10.31 and 7.34; p = 0.0001*).

- **Active Abduction:**

Group A improved from 110.86 ± 15.82 to 146.67 ± 10.02 (32.30% increase), while Group B improved from 105.2 ± 15.51 to 140.73 ± 10.37 (33.77% increase). A statistically significant between-group difference was observed post-treatment (T = 2.25, p = 0.02*). Within-group improvements were also significant for both groups (Z = 10.47 and 10.43; p = 0.0001*).



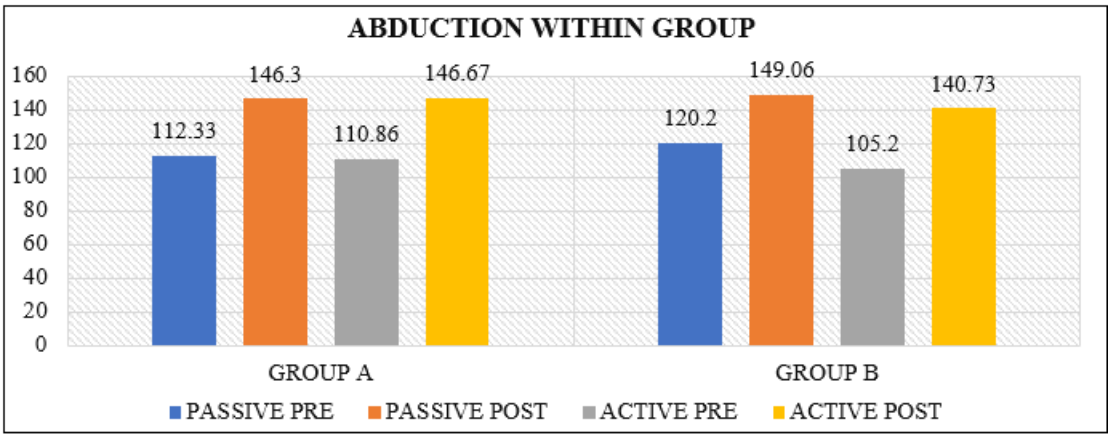



**Table 6:** Between and within group comparison of 'IR'

| | | Group A | Group B | T Value (T Test) | P Value |
|---|---|---|---|---|---|
| Passive | Pre | 46.3±10.29 | 49.73±8.56 | 1.40 | 0.16 |
| | Post | 63.46±7.28 | 60.06±6.72 | 1.87 | 0.06 |
| Difference | | 17.16±8.36 | 10.33±7.16 | | |
| Z Value | | 7.45 | 5.19 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 37.06% | 20.77% | | |
| Active | Pre | 42.73±11.18 | 45.83±9.57 | 1.15 | 0.25 |
| | Post | 59.7±9.41 | 55.67±6.91 | 1.89 | 0.06 |
| Difference | | 16.97±10.02 | 9.84±7.49 | | |
| Z Value | | 6.36 | 4.56 | | |
| P Value (Paired T test) | | 0.0001* | 0.0001* | | |

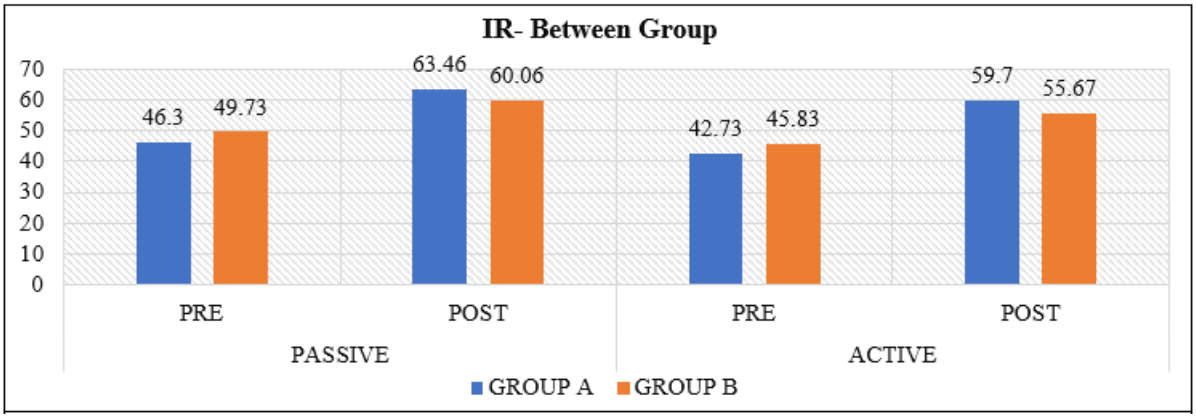
Table 6 compares changes in shoulder internal rotation for both passive and active movements in Groups A and B before and after treatment.

- **Passive IR**:

Group A improved from 46.3 ± 10.29 to 63.46 ± 7.28 (37.06% increase), while Group B improved from 49.73 ± 8.56 to 60.06 ± 6.72 (20.77% increase). The post-treatment between-group difference approached significance (T = 1.87, p = 0.06), but was not statistically significant. Both groups showed significant within-group improvements (Z = 7.45 and 5.19; p = 0.0001*).

- **Active IR:**

Group A improved from 42.73 ± 11.18 to 59.7 ± 9.41 (increase of 16.97°), and Group B from 45.83 ± 9.57 to 55.67 ± 6.91 (increase of 9.84°). Again, the between-group post-treatment difference approached significance (T = 1.89, p = 0.06). Both groups showed statistically significant within-group improvements (Z = 6.36 and 4.56; p = 0.0001*)



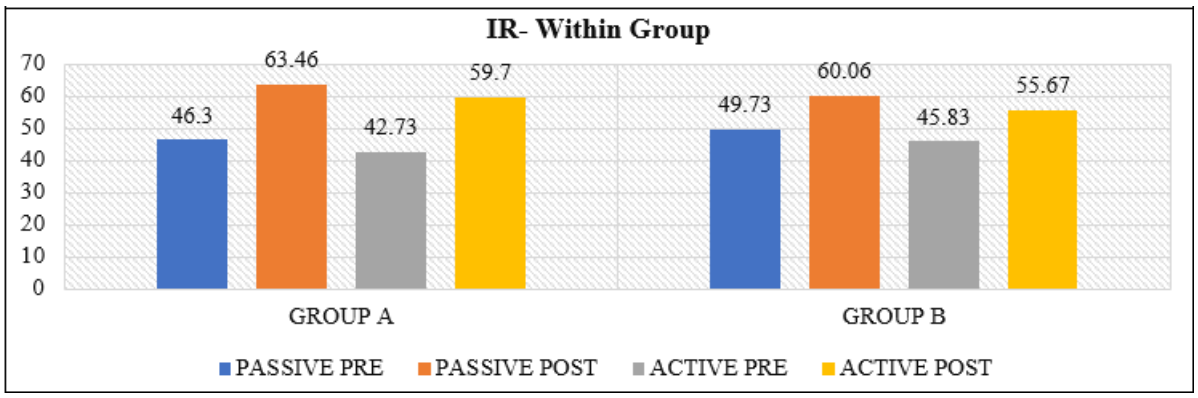



**Table 7:** Between and within group comparison of 'ER'

| | | GROUP A | GROUP B | T VALUE (T TEST) | P VALUE |
|---|---|---|---|---|---|
| PASSIVE | PRE | 34.42±7.49 | 38.83±7.37 | 2.29 | 0.02* |
| | POST | 51.6±8.46 | 51.03±6.53 | 0.29 | 0.77 |
| DIFFERENCE | | 17.18±7.99 | 12.2±7.01 | | |
| Z VALUE | | 8.32 | 6.78 | | |
| P VALUE (Paired T test) | | 0.0001* | 0.0001* | | |
| Percentage difference | | 49.91% | 31.41% | | |
| ACTIVE | PRE | 31.3±7.74 | 35.23±7.61 | 1.98 | 0.05* |
| | POST | 49.7±8.22 | 47.43±6.63 | 1.17 | 0.24 |
| DIFFERENCE | | 18.4±8.04 | 12.2±7.05 | | |
| Z VALUE | | 8.92 | 6.62 | | |
| P VALUE (Paired T test) | | 0.0001* | 0.0001* | | |
| | | 58.78% | 34.62% | | |

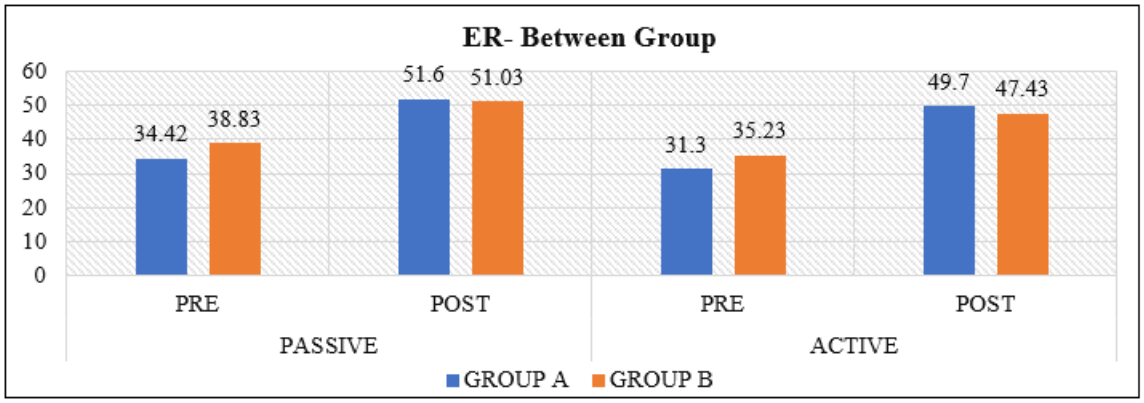
Table 7 outlines pre- and post-treatment values for shoulder external rotation, both passive and active, in Groups A and B.

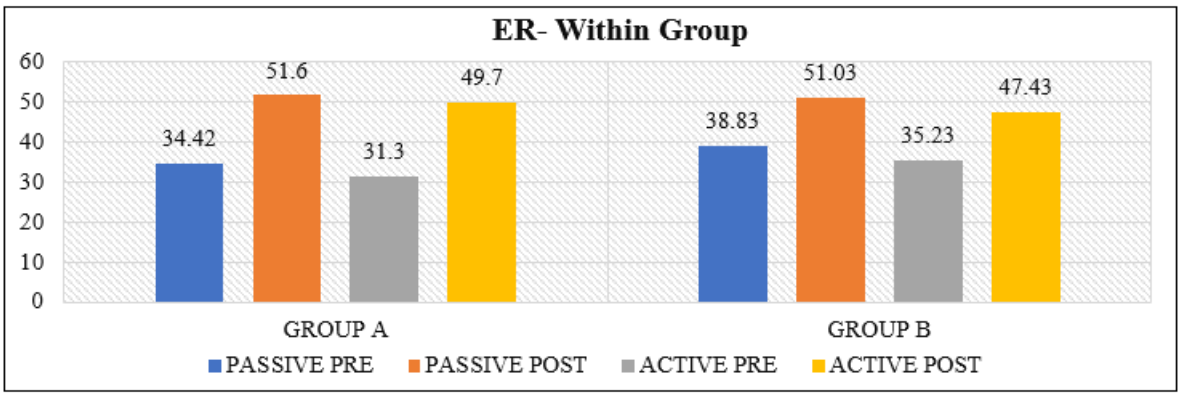
- **Passive ER**:

Group A improved from 34.42 ± 7.49 to 51.6 ± 8.46 (49.91% increase), and Group B from 38.83 ± 7.37 to 51.03 ± 6.53 (31.41% increase). The baseline difference was statistically significant (T = 2.29, p = 0.02*), while the post-treatment difference was not (p = 0.77). Both groups showed significant within-group improvements (Z = 8.32 and 6.78; p = 0.0001*).

- **Active ER:**

Group A improved from 31.3 ± 7.74 to 49.7 ± 8.22 (58.78% increase), while Group B improved from 35.23 ± 7.61 to 47.43 ± 6.63 (34.62% increase). The between-group difference at baseline was borderline significant (T = 1.98, p = 0.05*), with no significant difference post-treatment (p = 0.24). Within-group improvements were significant for both groups (Z = 8.92 and 6.62; p = 0.0001*).




After the intervention period, both groups had statistically significant improvements in pain, range of motion, and functional status (p<0.05). The groups' baseline demographic characteristics did not differ significantly from one another. Group A outperformed Group B in terms of % improvement in VAS and ROM; nevertheless, no statistically significant differences were found for all end measures in between-group comparisons.

## 4. Discussion

The results of this study show that both intervention procedures work well for treating frozen shoulder. The combined thermal effects of ultrasound and the biomechanical advantages of scapular mobilization, which promote scapulohumeral rhythm and capsular extensibility, may be responsible for Group A's improvement. Group B also shown notable improvements, most likely as a result of mechanical capsule stretching and TENS pain modulation.

The findings are in line with earlier research showing the advantages of electrotherapy and mobilization for adhesive capsulitis. The slightly better results in Group A imply that treating scapular mechanics in addition to deep heating techniques may provide further therapeutic benefits.

## 5. Clinical Implications

The results of this study indicate that for the treatment of frozen shoulder, therapeutic ultrasound in conjunction with scapular mobilization is a more successful physiotherapeutic strategy than TENS in conjunction with capsular stretching. By restoring scapulothoracic–glenohumeral coordination, scapular mobilization combined with ultrasound may increase shoulder range of motion, reduce discomfort, and promote improved functional recovery. To get better clinical results and quicker functional improvement, clinicians could think about giving this combined intervention top priority in standard rehabilitation protocols for patients with frozen shoulder.

## 6. Conclusion

In patients with frozen shoulder, both intervention procedures were successful in lowering discomfort, increasing shoulder range of motion, and improving functional capacity. In contrast to TENS with capsular stretching, therapeutic ultrasonography in conjunction with scapular mobilization showed better results. According to the results, scapular mobilization combined with ultrasound may offer more clinical advantages in the treatment of frozen shoulder.

## 7. Limitations

- Brief duration of the intervention.
- Absence of long-term monitoring.
- One-centre research.

**Recommendations**
It is advised that future research include functional performance testing, longer follow-up times, and larger sample groups.

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