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AN EXPERIMENTAL STUDY ON EFFECT OF THORACIC SPINE MANIPULATION ON PAIN, RANGE OF MOTION, MUSCLE STRENGTH, AND FUNCTIONAL DISABILITY IN PATIENTS WITH FROZEN SHOULDER SYNDROME

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KEYWORDS

Frozen shoulder, adhesive capsulitis, thoracic spine manipulation, regional interdependence, DASH, range of motion.

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Abstract

Background: Frozen shoulder (also called adhesive capsulitis) is a common musculoskeletal condition characterized by a gradual onset of pain and capsular restriction of shoulder movements. The mechanics of the glenohumeral is also affected by thoracic spine mobility, so thoracic spine manipulation is suggested to be a helpful adjunct to standard exercise therapy.
Objective: To evaluate the effect of thoracic spine manipulation combined with exercise versus exercise alone on pain shoulder range of motion, muscle strength, and functional disability in patients with frozen shoulder syndrome
Methods: Sixty patients with clinically diagnosed adhesive capsulitis were randomly selected by chit method into Group A (thoracic spine manipulation + exercises,n= 30) and Group B (exercises alone, n=30) for 6 weeks. VAS, DASH, goniometric ROM and MMT were recorded at baseline, 3rd week and 6 th week.
Results: Both groups were significantly improved within group ($p<0.001$) but Group A showed significantly greater improvement than Group B in between group comparison across pain, DASH, flexion ROM and flexion MMT from the 3rd week onwards ($p<0.001$).
Conclusion: Thoracic spine manipulation combined exercises are found to be significantly more effective than exercises alone for improving pain, shoulder range of motion, muscle strength, and functional disability in frozen shoulder syndrome, and are recommended to be included in physiotherapy protocols.

INTRODUCTION

Frozen shoulder syndrome, also called adhesive capsulitis, is a chronic musculoskeletal disorder that involves gradual increase in shoulder pain together with marked limitation in active and passive movement of the glenohumeral joint.The disorder is caused by inflammation and progressive fibrosis of the joint capsule, and individual affected by it struggle in daily activities that require full and pain-free arc shoulder range of motion, including reaching over their head, dressing, grooming and lifting items.It is gradual in onset and often occurs without any any clear precipitating injury: patients will typically report a diffuse, poorly localized pain that increases over weeks to months, especially with movement and at night, frequently distribing sleep and compromising functional independence far before stiffness becomes the dominant complaint.

Adhesive capsulitis is understood to progress clinically through three overlapping phases.During the freezing stage, pain gradually worsens and is a accompanied by increasing stiffness. In the Frozen stage – Pain may be somewhat reduced but stiffness becomes the dominant symptom with active and passive range of motion significantly restricted. During the thawing stage,mobility gradually is returned as underlying capsular inflammation subsides.Although the condition is generally considered self-limiting and expected to resolve spontaneously within one to three years, extended follow-up studies indicate that a significant proportion of patients in reality continue to suffer from persistent pain and limited range of motion in their affected upper limb years after onset – meaning adhesive capsulitis should be regarded as a significant and sometimes chronic, cause of upper-limb disability in adult patients rather than a purely transient complaint.

Epidemiologically adhesive capsulitis is estimated to affect 2-5% of the general population, with highest incidence in the 40-60 year age group and a slightly greater occurrence in women, although the reason for this gender difference remains unclear.The condition may be primary, arising without an identifiable cause, or secondary, occurring in association with trauma, rotator cuff disease, fracture or previous surgery. Diabetes mellitus is the most consistently and strongly associated systemic risk factor - diabetic patients are significantly more likely to develop frozen shoulder and tend to have more severe symptoms and a more gradual, prolonged recovery, than their non- diabetic counterparts. Other medical conditions associated with this condition, include thyroid disorders, cardiovascular disease, autoimmune disorders and neurological conditions such as post-stroke hemiplegia along with pronlonged immobilization, all of which are believed to accelerate the fibrocapsular process and and reduce synovial turnover.

The exact tissue level cause of adhesive capsulitis remains poorly understood, but the general consensus is that a combination of inflammatory, fibrotic and biochemical changes within the glenohumeral capsule drives the disease. Histological examination have demonstrated synovial inflammation and fibroblasts proliferation within capsule along increased type III collagen production, leading to reduced capsular elasticity and progressive stiffness. Elevated level of Inflammatory cytokines, including transforming growth factor-β and interleukins, have been found in affected capsular tissue, suggesting that an initial inflammatory event may trigger the fibrotic process. As the disease's progression, the rotator interval and the coracohumeral ligament become significantly thickened and contracted, reducing the effective volume of the glenohumeral joint, and accounting for the characteristic early loss of external rotation that clinicians use to distinguish adhesive capsulitis from other shoulder conditions such as rotator cuff tears or subacromial impingement syndrome.Alongside these capsular changes, altered scapulohumeral rhythm and reflexive inhibition of the surrounding musculature further compromises shoulder mechanics, often producing shoulder hiking and/or trunk side-bending patterns when the arm is raised.

It is important to note that the shoulder does not function as a single joint. Efficient arm movement relies on coordinated motion through the glenohumeral, scapulothoracic, sternoclavicular and acromioclavicular joints, a pattern termed the scapulohumeral rhythm, in which the glenohumeral articulation moves at roughly a 2:1 ratio relation to the scapula.The thoracic spine plays a supporting, but essential role within this chain: adequate thoracic extension will allow more posterior tilting and upwardly rotation of the scapula, which in turn allow greater glenohumeral elevation without impingement .Restricted thoracic mobility - whether from postural changes, ageing or habitual flexed posture, has been shown to reduce shoulder mobility and strength, even in normal, non-diseased shoulders, indicating that the thoracic spine is not a silent bystander in shoulder pathology but an active contributor.This observation underlies the concept of regional interdependence,: dysfunction in one body region can meaningfully affect, and be treated through an anatomically distant region, rather than being treated independently.

Building on this reasoning, manipulation of the thoracic spine - a manual therapy technique involving a high velocity-low amplitude thrust directed towards a restricted thoracic segment, has been assessed as an adjunct in the management of shoulder pain and stiffness.Proposed mechanisms include activation of descending, centrally mediated pain-inhibitory pathways , restoration of thoracic extension ,improved scapular positioning and increased neuromuscular drive to shoulder-girdle musculature .A number of studies have examined thoracic manipulation in related shoulder conditions such as subacromial pain syndrome, shoulder impingement, and rotator cuff–related pain, generally reporting short-term improvements in pain and range of motion. However, comparatively few controlled trials have include the thoracic spine manipulation as an adjunct to a structured exercise programme specifically in patients with frozen shoulder syndrome, specifically, and the available studies in this smaller population tend to have small sizes, short follow-up periods and inconsistently reporting of strength and disability outcomes alongside pain and mobility data. Given the prevalence of frozen shoulder and its significant impact on daily function, a controlled study evaluating whether thoracic manipulation, combined with an exercise program, is more effective than an exercise program alone - as measured by pain, ROM, strength, and functional disability is clinically relevant and timely.The present study was designed to address this gap.

MATERIAL AND METHOD

Research design: Experimental study (randomized, two-arm)

Study setting: Department of Physiotherapy, Pacific Medical College and Hospital, Bedla, Udaipur, Rajasthan.

Sampling method: Chit method of Simple random sampling

Study population: Clinically diagnosed patients with adhesive capsulitis, aged 40-70 years**.**

Sample size: 60 calculating using $n = Z^2p(1-p)/d^2$ (prevalence 20.7%, 95% CI, 10% precision), giving n≈63 was rounded down to 60 for feasibility.

Study duration: 8 months after ethical clearance**.**

Treatment of duration: 6 weeks

Groups: Group A (n=30) the thoracic spine manipulation + conventional exercises; Group B (n=30) conventional exercises only.

Inclusion criteria: Age range 40-70 years; clinical diagnosed adhesive capsulitis (unilateral/bilateral), including post-traumatic/post-operative presentations; able to understand instructions and provide consent

Exclusion criteria: Deformity of the shoulder, wrist, or elbow; systemic inflammatory illness, progressive neurological disorder, or malignancy; fibromyalgia/chronic regional pain syndrome; infection of upper-extremity joints or cervical spine; cervical radiculopathy or long thoracic/ spinal accessory nerve palsy; De Quervain's tenosynovitis; carpal tunnel/ thoracic outlet syndrome; ankylosing spondylitis; osteoporosis; pregnancy; and patients that are uncooperative.

Outcome measures: VAS pain intensity, DASH upper limb disability, active ROM (flexion, abduction, internal rotation, external rotation) using an universal goniometer, MMT (MRC scale) for strength. All measures were taken at baseline, 3rd week and 6th week.

Procedure: After ethical clearance, patients attending the physiotherapy and orthopaedics OPD were screened, the study was explained to then and written informed consent obtained .60 eligible subjects were randomized in Group A and B by chit method. Group A recevied graded prone thoracic spine manipulation (posteroanterior high velocity, low amplitude thrust at the restricted thoracic segment) combined with a 10-exercise shoulder programme (pendulum exercise, wand-assisted flexion/abduction/external rotation, wall climbing into flexion and abduction, posterior and anterior capsular stretches, towel stretch of internal rotation and scapular retraction) over 6 weeks.Group B received the same exercise programme, without manipulation over the same period.

Statistical analysis: Descriptive statistics (mean ± SD).The paired t-tests were used for within-group comparison across the three time points, and the independent t-tests were used for between-group comparison at every time point; statistical significance was set at $p<0.05$.

RESULTS

Sixty patients completed the study with no dropouts. Group A and B were comparable at baseline in age (51.53 ± 6.13 vs 52.00 ± 6.40 years, $p>0.05$), gender distribution ($p>0.05$), and side involved ($p>0.05$), confirming successful randomisation.

Table 1: Between-group comparison of VAS

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	7.32 ± 0.76	7.64 ± 0.78	>0.05
3rd week	4.39 ± 0.81	5.54 ± 0.82	<0.001
6th week	2.88 ± 0.84	4.30 ± 0.80	<0.001

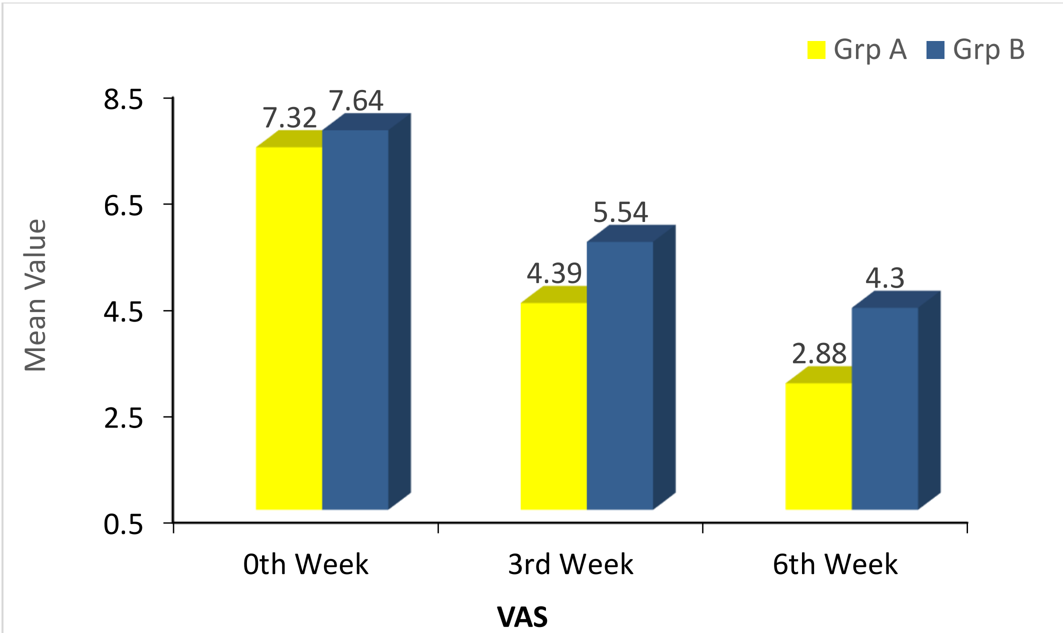

Table 2: Between-group comparison of DASH score

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	67.40 ± 4.14	67.87 ± 4.47	>0.05
3rd week	45.37 ± 5.10	56.93 ± 4.94	<0.001
6th week	26.90 ± 5.70	42.50 ± 5.73	<0.001

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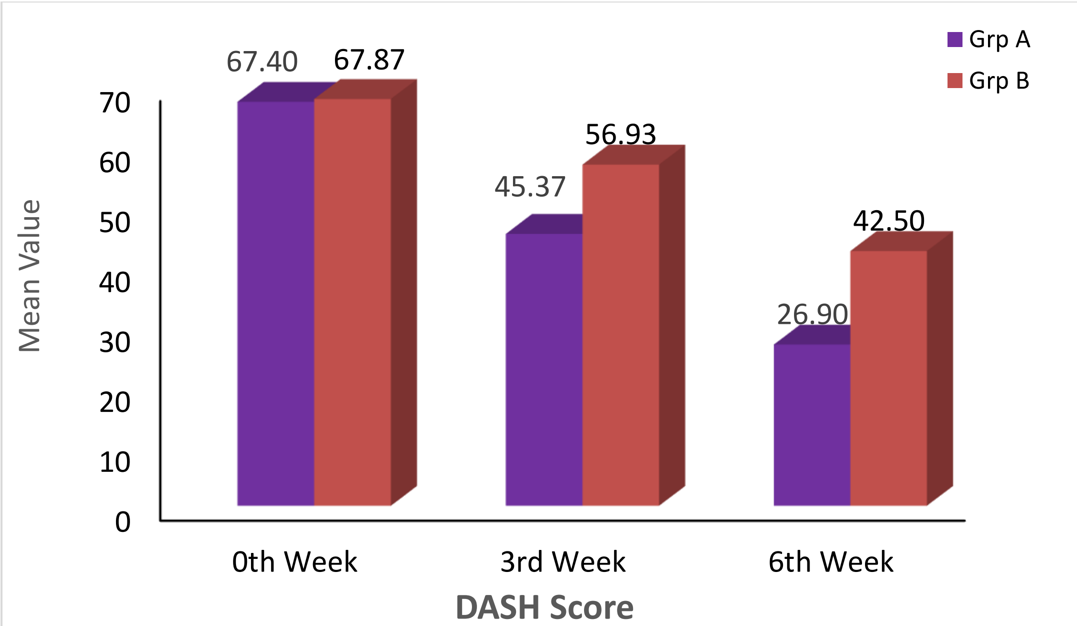


Table 3: Between-group comparison of flexion ROM

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	96.07 ± 9.16	96.40 ± 9.63	>0.05
3rd week	120.67 ± 9.69	113.40 ± 10.23	<0.05
6th week	148.80 ± 10.75	133.00 ± 10.24	<0.001

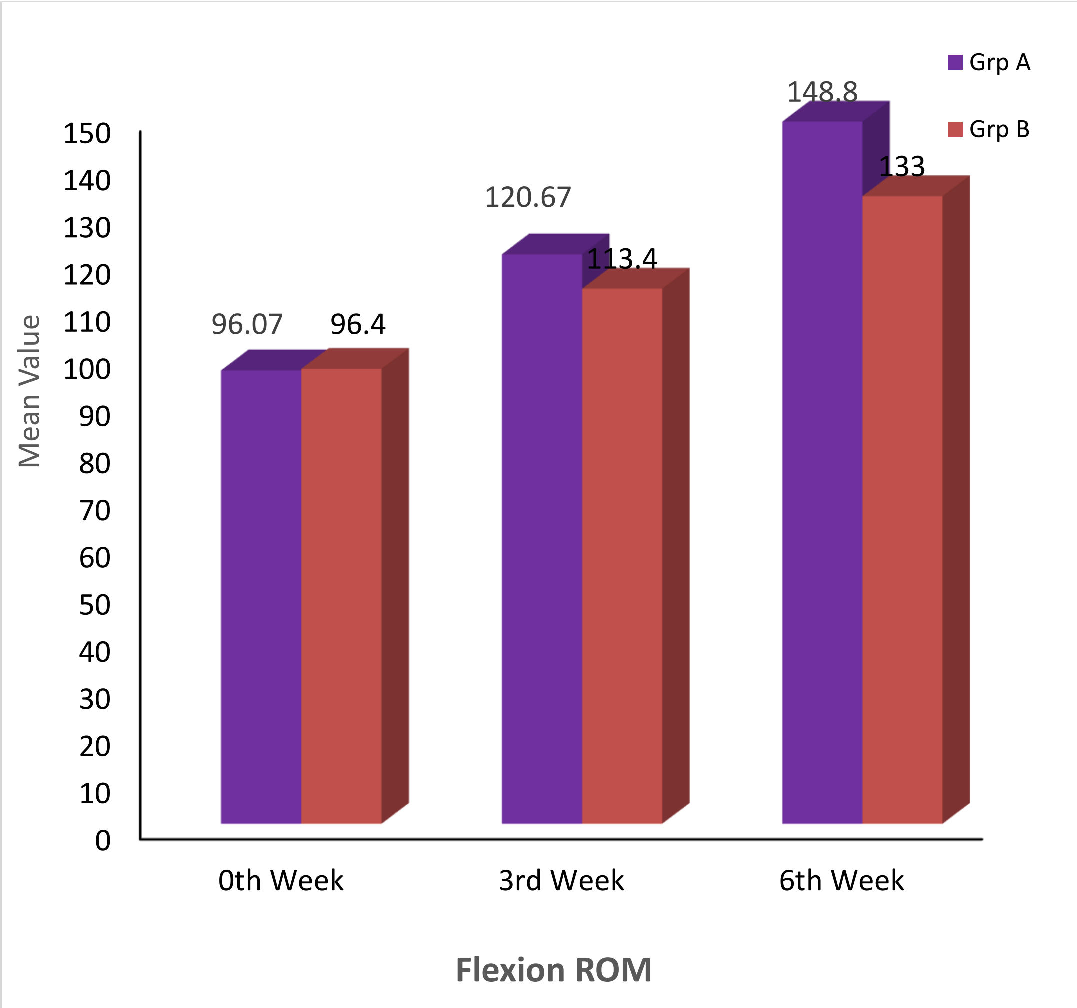


Table 5: Between-group comparison of Abduction ROM

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	85.10 ± 7.61	89.50 ± 8.81	>0.05
3rd week	107.73 ± 7.44	105.53 ± 9.99	>0.05
6th week	133.00 ± 8.61	125.50 ± 11.40	<0.05

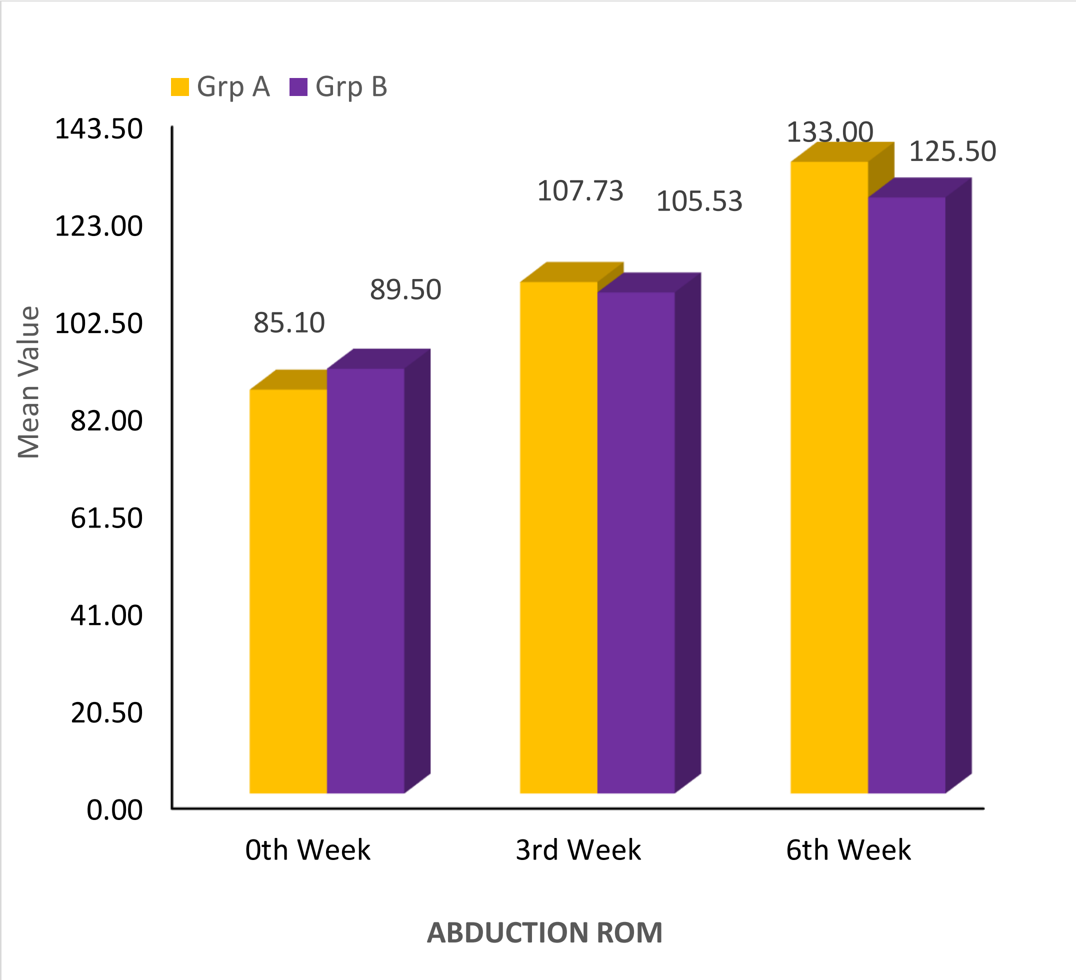


Table 6: Between-group comparison of Internal Rotation ROM

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	41.40 ± 5.51	42.87 ± 6.22	>0.05
3rd week	52.23 ± 5.43	51.00 ± 6.07	>0.05
6th week	65.47 ± 5.11	61.07 ± 5.84	<0.05

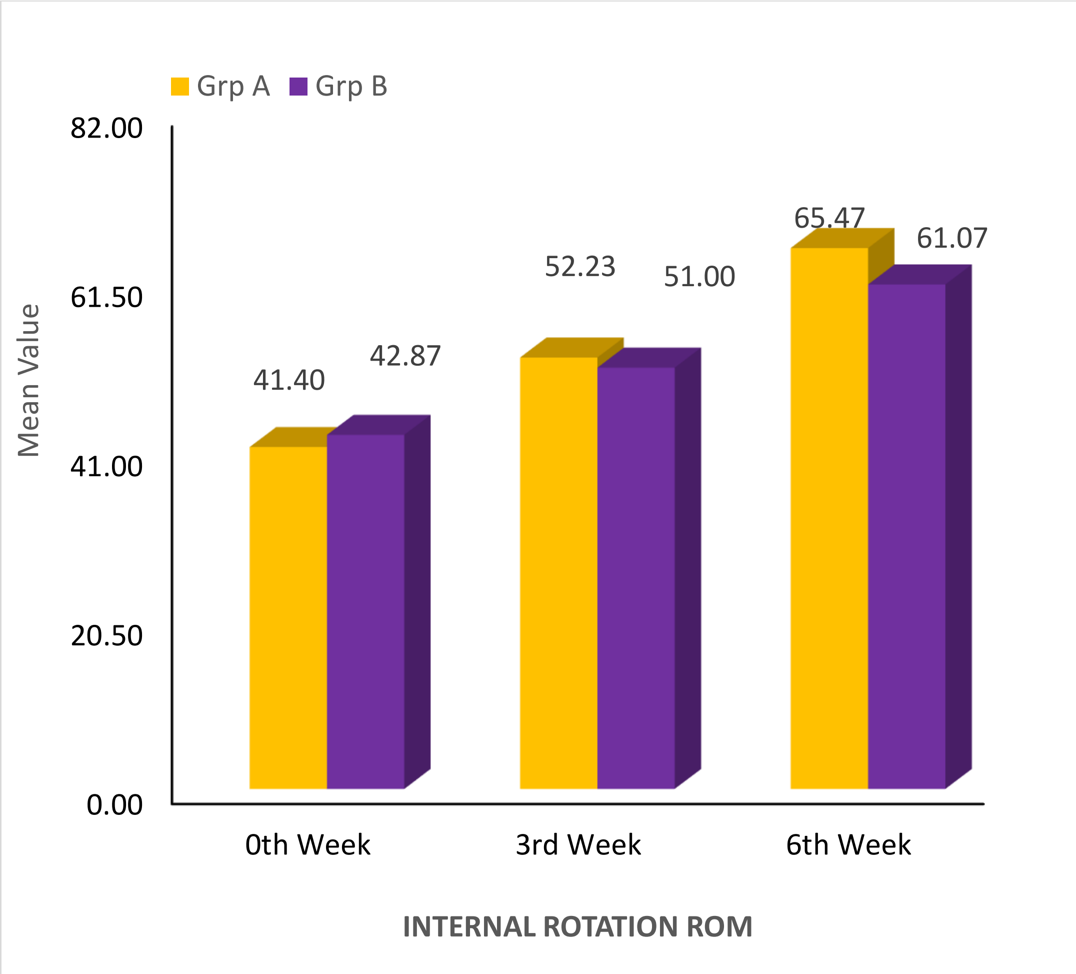


Table 7: Between-group comparison of External Rotation ROM

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	20.73 ± 3.94	23.20 ± 4.40	<0.05
3rd week	34.53 ± 5.10	32.23 ± 4.62	>0.05
6th week	49.77 ± 5.21	43.63 ± 4.47	<0.001

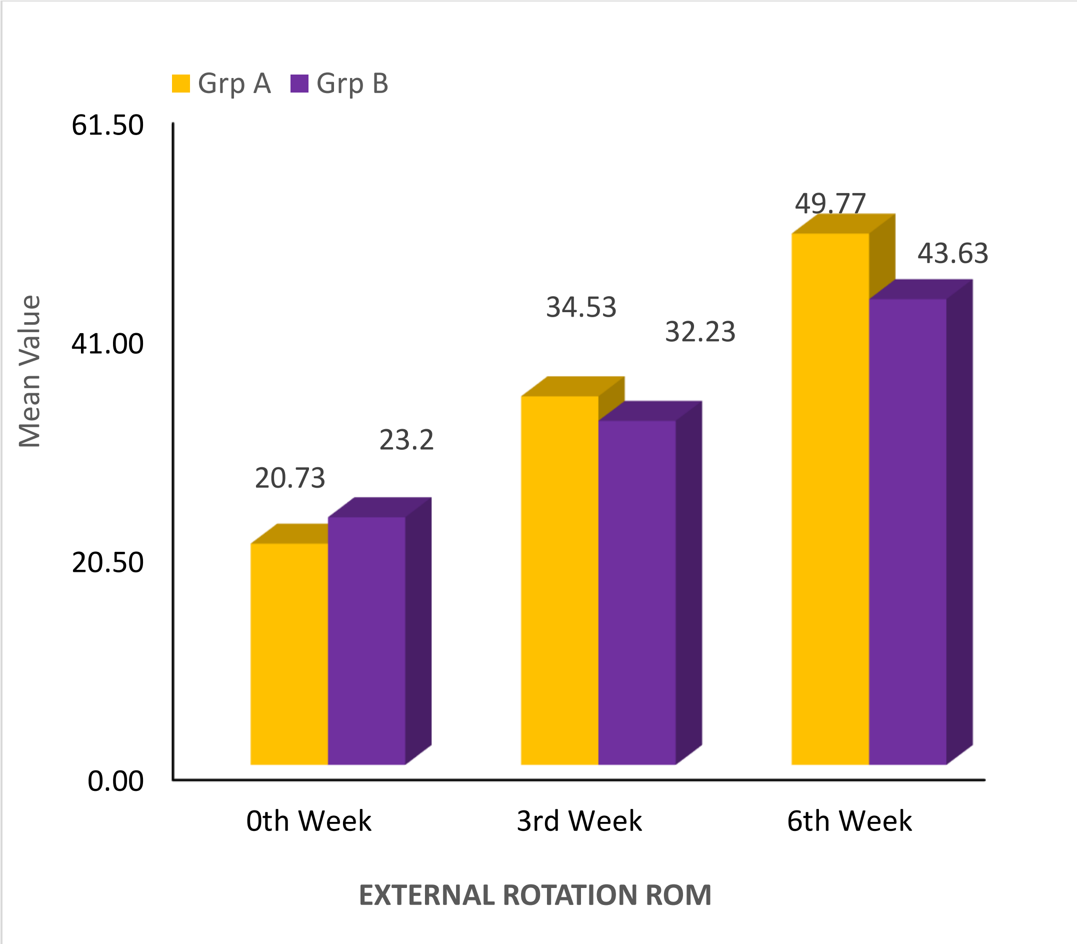


Table 8: Between-group comparison of flexion MMT

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	3.27 ± 0.45	3.33 ± 0.48	>0.05
3rd week	4.27 ± 0.45	3.60 ± 0.56	<0.001
6th week	4.60 ± 0.50	3.93 ± 0.69	<0.001

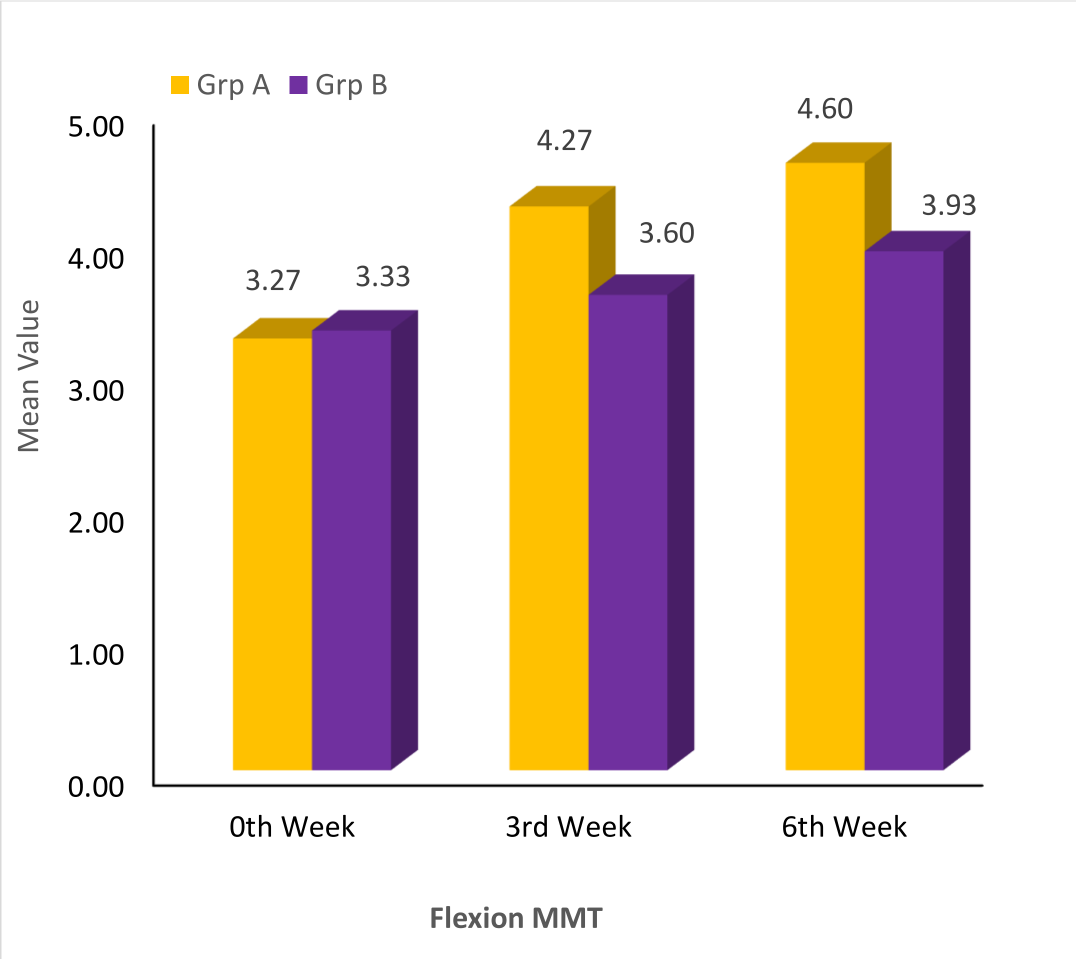


Table 9: Between-group comparison of Abduction MMT

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	3.27 ± 0.45	3.17 ± 0.38	>0.05
3rd week	4.27 ± 0.45	3.67 ± 0.66	<0.001
6th week	4.67 ± 0.48	4.27 ± 0.83	<0.05

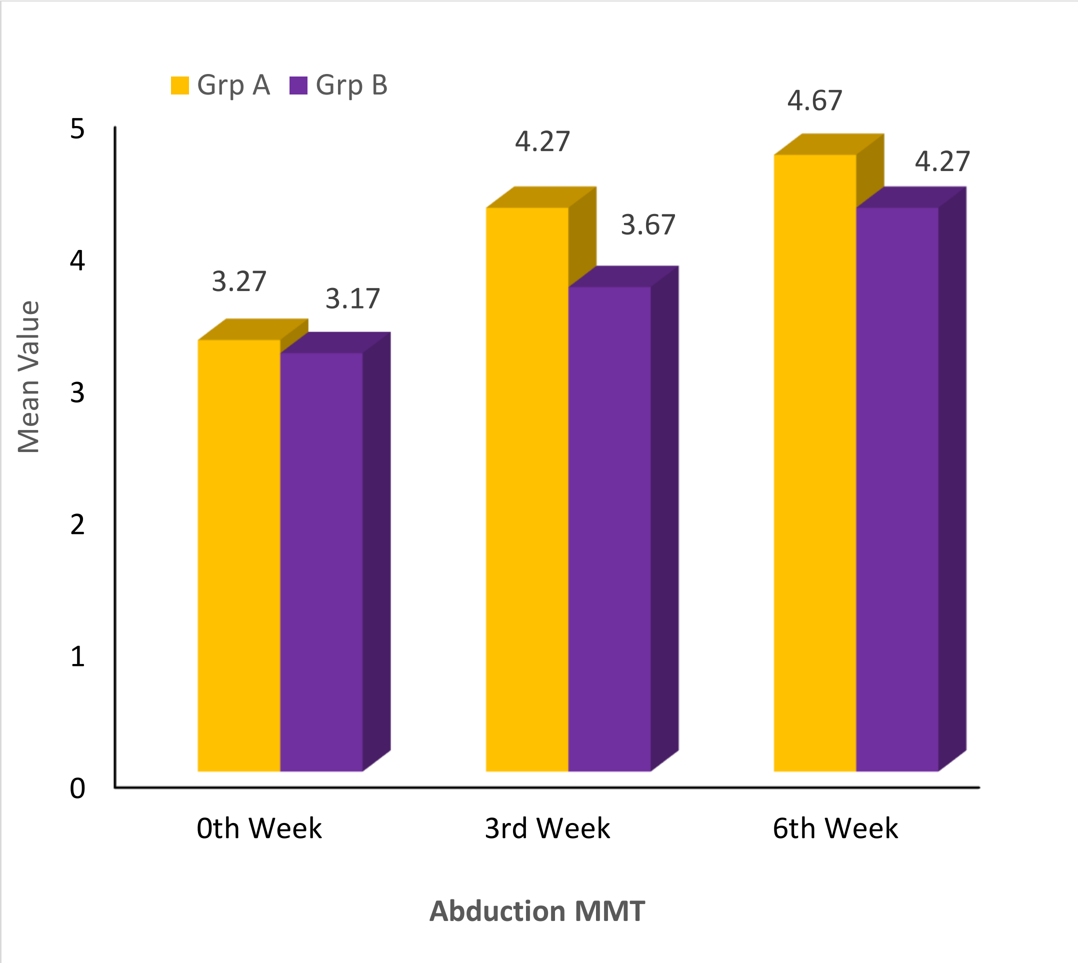
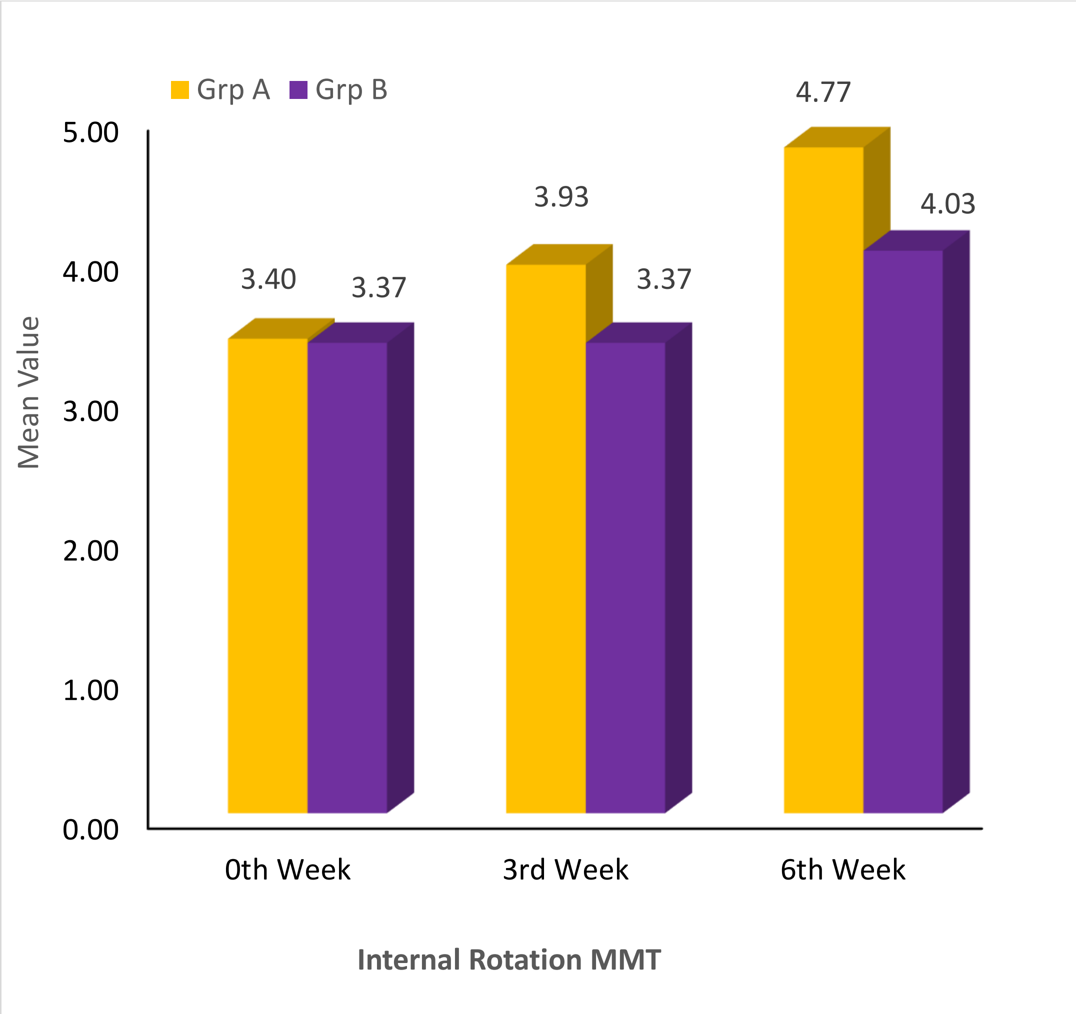


Table 10: Between-group comparison of Internal Rotation MMT

Timepoint	Group A (Mean ± SD)	Group B (Mean ± SD)	p value
0th week	3.40 ± 0.50	3.37 ± 0.49	>0.05
3rd week	3.93 ± 0.64	3.37 ± 0.49	<0.001
6th week	4.77 ± 0.43	4.03 ± 0.67	<0.001



Abduction, internal rotation, and external rotation ROM, and MMT of abduction, internal rotation and external rotation, followed the same pattern: significant within group gains in both group, with Group A showing significantly larger gains than Group B from the 3rd week onwards (p<0.001 for most comparisons).

DISCUSSION

This study determined whether adding thoracic spine manipulation to a conventional exercise programme improve outcomes in frozen shoulder syndrome (FSHS) compared to exercise alone. The two groups were comparable at baseline , so between group difference at later time point can be attributed to the intervention and rather than to a pre- existing imbalance.

This significant pain reduction in Group A is consistent with El AM et al. (2024)[15] and Jahangir et al. (2022)[16] who both reported significant pain reduction with thoracic manipulation in adhesive capsulitis and with Silva et al., (2019)[17] who also reported pain reduction following spinal manipulation in shoulder disorders. A possible mechanism is a activation of descending pain-inhibitory pathways that occurs with spinal manipulation.

The larger DASH improvement in Group A is consistent with Bilal et al. (2021)[18] and El AM et al. (2024)[15] The greater ROM gains are consistent with the biomechanical principle demonstrated by Kalita etal.(2022)[19] and Belon-Perez and Cuesta-Vargas (2018)[20], showing that thorarcic extension facilitates arm elevation. The increased strength gains in Group A are consistent with Hegarty et al.(2021)[21], who found increased neuromuscular drive following spinal manipulation.

Together these findings support the concept regional interdependence between the thoracic spine and shoulder girdles as described by Sueki et al. (2013)[11] : restriction in thoracic mobility affect the mechanics of the glenohumeral and scapulothoracic joints, and improving thoracic mobility may help to promote recovery of movement and strength in the glenohumeral joint.

CONCLUSION

Thoracic spine manipulation combined with exercises was more effective than exercises alone in reducing pain, shoulder ROM, muscle strength and functional disability over 6 weeks in patients with frozen shoulder syndrome. Thoracic spine manipulation should be considered useful adjunct to the conventional physiotherapy approach to the management of frozen shoulder.

Limitations: Moderate sample size (n=60); 6-week follow-up limits assessment of longer term outcomes; clinical outcome tools were not instrumented or evaluated in kinematics.

Recommendations: future studies should include larger multi-centre trials, longer follow up (up to 6 months), comparison between various manual therapy techniques and various phases of adhesive capsulitis.

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Conflict of Interest: There are no conflicts of interest to disclose.

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