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Integrated Interventions for Adhesive Capsulitis: A Randomized Pilot Study on Thoracic Spine, Shoulder Manipulation, Glenohumeral Mobilization, PNF Technique with Thermotherapy and Home Program

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ABSTRACT

A common shoulder ailment called adhesive capsulitis (AC) causes a gradual decrease in shoulder joint mobility, which in turn causes functional limits. Many medical professionals suggest that manipulative procedures like High-Velocity Low Amplitude (HVLA) thrusts are effective for treating a range of musculoskeletal disorders. Research on the efficacy of these techniques in conjunction with conventional physiotherapy for the treatment of AC is, however, lacking. Therefore, research on how these treatment tools affect AC patients is necessary to reduce pain and rehabilitate them to their highest level of independence and functional ability. The main objective of the study is to find out if, in the management of AC, integrated interventions reduce VAS, SPADI score, recovery time, and achieve functional range of motion more quickly than traditional physiotherapy. Ten patients each from the experimental and control groups comprised the twenty AC patients. Thoracic spinal and shoulder manipulation was administered to patients in the experimental group once a week for four weeks. Additionally, patients received scapular mobilization, Glenohumeral End Range Mobilization, Contact Relax Proprioceptive Neuromuscular Facilitation Technique, and Thermotherapy (moist heat) five times a week for four weeks (20 sessions). The patients also underwent a home exercise program consisting of Codman pendular exercises, self-stretching exercises, active range of motion exercises, and strengthening exercises (that began after the second week), twice a day for five days a week for four weeks. The traditional therapy was administered to the Control Group without the manipulations. The information was recorded and statistically examined. The data analysis revealed that while both treatment protocols were effective, the experimental group exhibited greater relief from the condition compared to the control group by the fourth week. This suggests that the administered protocol can lead to faster or earlier results in managing adhesive capsulitis. Consequently, it can be inferred that the experimental group protocol represents a superior combination of treatment tools for this condition.

Keywords: *Adhesive Capsulitis, Functional Range of Motion, Glenohumeral Joint mobilization, HVLA thrust, Proprioceptive Neuromuscular Facilitation, Shoulder manipulation, Thoracic manipulation, Thermotherapy.*

1. INTRODUCTION

The human body is thought to be the most intricate living machine, and for it to operate at its best, biomechanical forces and alignments must be in balance. Among all the joint complexes in the human body, the shoulder is considered the most mobile.[1,2] The synchronous motion of the entire shoulder girdle, working in concert with the spine, provides tremendous mobility. Restoring and preserving a normal range of motion at the shoulder girdle is the major goal of shoulder rehabilitation experts. [3]

The words frozen shoulder and adhesive capsulitis (primary) are currently used to characterize a gradual onset of painful glenohumeral joint stiffness.[4,5,6] Conversely, secondary adhesive capsulitis is linked to a recognized predisposing shoulder

condition (e.g., humerus fracture, shoulder dislocation, avascular necrosis, osteoarthritis).[7,8,9] Numerous correlations exist with systemic disorders, such as cardiovascular disease[10]and thyroid dysfunction[11]and breast cancer treatments.[12]

Adhesive capsulitis is more common in patients with diabetes, myocardial infarction, and cerebrovascular accidents..[10,13,14] Diabetes is linked to a markedly worse prognosis, a higher likelihood of requiring surgery, and worse-than-ideal outcomes.[15]

The most common cause of shoulder pain and dysfunction in people 40–70 years old is primary adhesive capsulitis, which affects 2%–3% of the overall population.[7]

The impairment of range of motion (ROM) resulting from primary adhesive capsulitis can have an effect on a patient's capacity to engage in self-care and occupational tasks.[4,9] Even though this condition is thought to be self-limiting and the majority of patients experience spontaneous recovery within three years, some patients may experience pain and limited shoulder motion far after the three-year mark.[5,16,17,18,8] The majority of experts concur that inflammation of the joint capsule and synovium, which can potentially lead to the development of capsular contractures, is the cause of adhesive capsulitis.[19,20,21,22,23,24] Contrary to what the word "adhesive" suggests, the capsule contracts to firmly hold the humeral head against the glenoid fossa rather than adhering to the humerus.[23] Clinically, the glenohumeral joint exhibits an overall loss of both passive and active range of motion,[25,26,27] with external rotation typically exhibiting the greatest degree of physiologic restriction.[28] The majority of affected arm types are non-dominant..[29,30]

Patients often experience pain that prevents them from completing activities of daily life, especially during the initial stages of adhesive capsulitis of the shoulder.[31,32,33] The patient's ability to do ADLs, personal care tasks, and occupational duties is restricted during the second phase of active motion restrictions. A gradual improvement in mobility occurs throughout the third phase, culminating in a complete or nearly complete recovery. The durations of the first, second, and third phases are 2.5–9 months, 4–12 months, and 5–26 months, respectively.[34]

It is acknowledged that physiotherapists are crucial to the treatment of patients with adhesive capsulitis. The primary objectives of physiotherapy treatment are to: 1) reduce the patient's pain using various interventions, such as transcutaneous electrical nerve stimulation, ultrasound, interferential therapy, applications of heat or ice etc. 2) improving the joint's overall functional capacity by applying various physiotherapeutic tools, such as active and passive range-of-motion (ROM) exercises, Proprioceptive neuromuscular facilitation (PNF) techniques[35]Specific ligament stretching techniques[36] and mobilization techniques[25,37,38,39] in an effort to achieve the joint's functional range of motion (FROM) as soon as possible to enable the patient to perform activities of daily living.

Previous studies have evaluated that to complete all tasks of daily living, a substantially less ROM is required to perform the functional tasks and concluded that the shoulder joint of a healthy person requires around 120^{o} of forward elevation, extension of 45^{o}, abduction of 130^{o}, 115^{o} of cross-body shoulder adduction, 60^{o} of shoulder external rotation, and internal rotation of 100^{o} [40,41] Although attaining full motion is always the final goal but achieving the FROM happens to be the initial goal of all shoulder treatments. Present physiotherapeutic protocols that are practiced in India for the management of AC produce promising results, but generally take a longer duration of recovery periods and are limited in making clinical recommendations.

Furthermore, various clinicians use manipulative techniques such as HVLA thrusts and claim that these methods work well for various musculoskeletal conditions. [42,43] However, there is a dearth of research on the effectiveness of these methods when combined with traditional physiotherapy for the treatment of AC. So there is a need to study the effects of these tools as a whole on patients of AC for decreasing the pain and rehabilitating them to their optimum functional ability and independence.

The primary goal of the research is to investigate whether the combination of Thoracic Spinal Manipulation, Shoulder Manipulation along with Glenohumeral End Range and scapular mobilization, Contact Relax Proprioceptive Neuromuscular Facilitation Technique and Thermotherapy with a home exercise program decreases VAS, SPADI score, and recovery time to attain the FROM than conventional Physiotherapy in the management of Adhesive Capsulitis.

The hypothesis of the Study:

H_{01}: There is no significant difference between the VAS scores of the experimental group and the control group.

H_{02}: There is no significant difference between the SPADI scores of the experimental group and the control group.

H_{03}: There is no significant difference between the recovery time to attain the FROM between the experimental group and the control group.

2. METHODOLOGY

The present study focuses on experimental research. 20 individuals with AC identified by orthopaedic doctors who were directed to physical therapy with shoulder discomfort as their predominant complaint made up the study's sample.

Individuals, both male and female, between the ages of 40 and 65 who were experiencing joint restrictions in one or more

degrees of freedom for at least three months and did not take analgesics during treatment were chosen for the study.

Exclusion criteria of the study were if the Patients had any shoulder pain resulting from systemic disease like infection, rheumatoid arthritis, fracture, tumours, etc., a rotator cuff injury, and tendon calcification confirmed by MRI, findings of physical investigation consistent with shoulder adhesive capsulitis. Exclusion criteria also included the presence of uncooperative patients, moderate or severe osteoarthritis, or patients on calcium supplements for the treatment of osteoporosis.

Subjects who fulfilled all eligibility criteria were asked to sign a written informed consent form before participation, in which they received a detailed explanation of the nature of the disease and the proposed course of therapy. The samples were obtained from the Physiotherapy Outpatient Department of Assam Down Town University in Panikhaiti and the Down Town Hospital in Guwahati. The Declaration of Helsinki protocol was followed for conducting the study. The protocol followed the CONSORT guidelines for reporting of non-pharmacological interventions (Figure 1). The study proposal has been accepted by the Ethics Committee, Assam down town University (Memo No: adtu/Ethics/Ph.D. Scholar/ 2019/001) and Ethics Committee, down town Hospitals, Guwahati (IEC/dth/2019/MS/16).

2.1 OUTCOME MEASURES

VAS[44], goniometry[45] and SPADI[46] were used for assessing pain, ROM, and Shoulder Joint Disability.

2.2 PROCEDURE

A trained orthopaedic manual physical therapist, the primary investigator, examined and treated all subjects. Random selection of 10 subjects was done, and Group A (Experimental Group) and Group B (Control Group) were formed. A pre-intervention assessment was conducted by VAS for assessing pain, a Goniometer for assessing Glenohumeral active ROM, and SPADI for assessing Disability at week 0, followed by a post-intervention assessment for the same after 2 weeks and after 4 weeks. Following a thorough physical examination and a proper explanation of the treatment protocol and manipulation techniques, the interventions were applied to the patients. The results were recorded and analyzed statistically.

Experimental group (Group-A) patients received Thoracic Spinal and Shoulder Manipulation once every week for 4 weeks along with Glenohumeral End Range Mobilization, Scapular mobilization, Contact Relax Proprioceptive Neuromuscular Facilitation Technique and Thermotherapy (moist heat) treatment 5 times a week for 4 weeks (20 sessions) with Home exercise program (Codman pendular exercises, self-stretching exercises, active ROM exercises and strengthening exercise started after 2nd week) 2 times every day for 5 days a week for 4 weeks.

Control group (Group-B) patients received Glenohumeral End Range Mobilization, Scapular mobilization, Contact Relax Proprioceptive Neuromuscular Facilitation Technique and Thermotherapy (moist heat) treatment 5 times a week for 4 weeks (20 sessions) with home exercise program (Codman pendular exercises, self-stretching exercises, active ROM exercises and strengthening exercise started after 2nd week) 2 times every day for 5 days a week for 4 weeks.

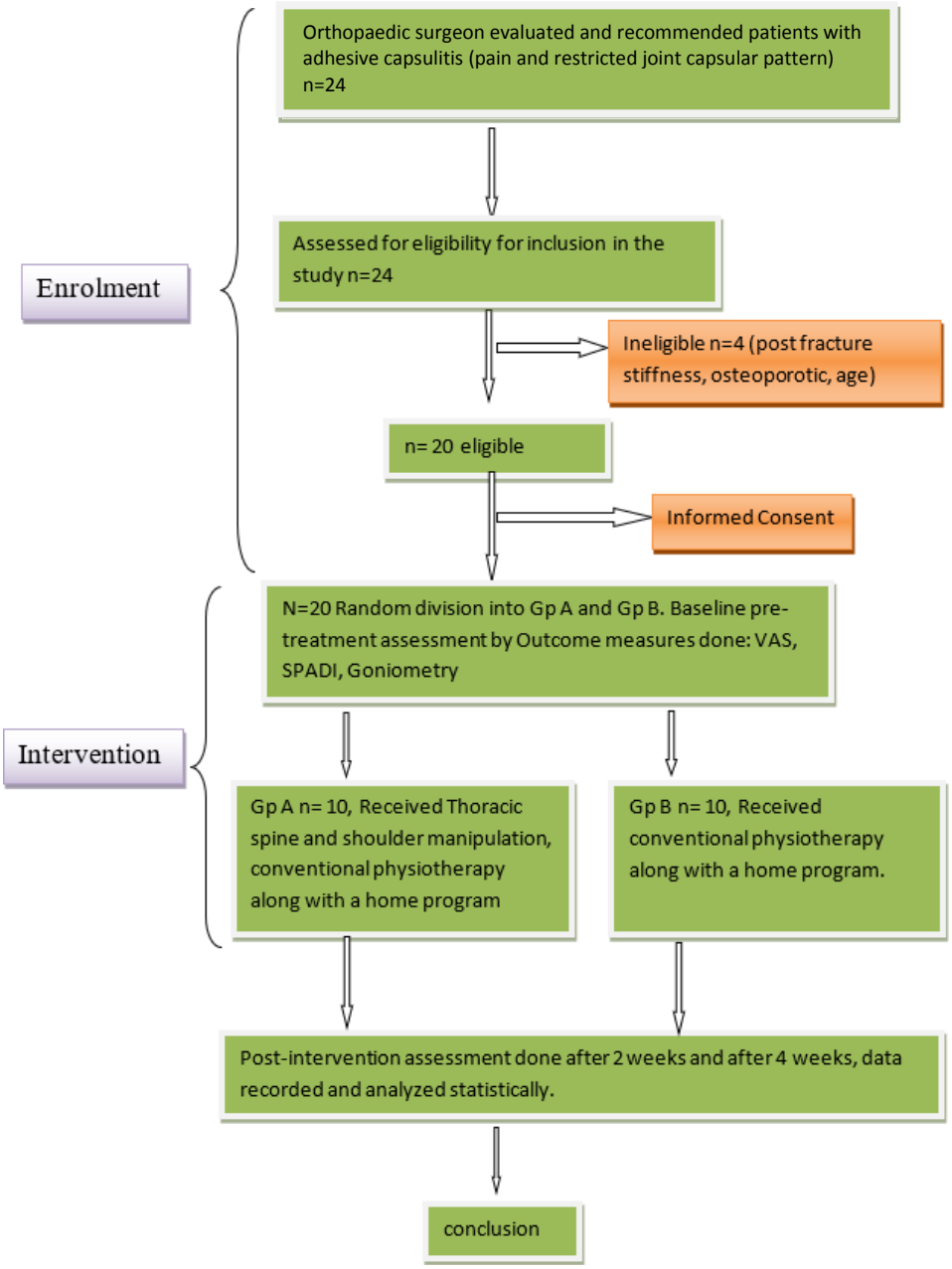
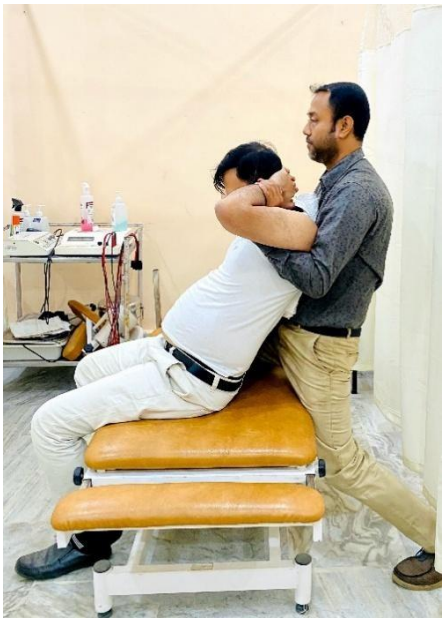


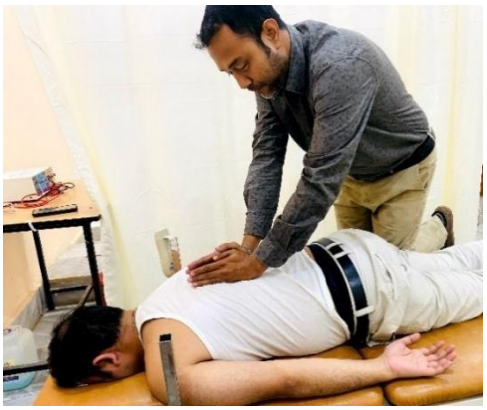
Fig: 1 Consort diagram

Treatment Techniques: -

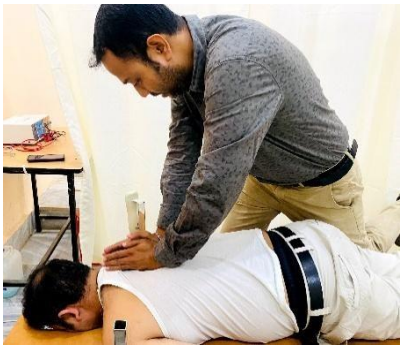
- ***Conventional physiotherapy*** in this study consisted of glenohumeral end range mobilization, scapular mobilization, contact relax proprioceptive neuromuscular facilitation technique for increasing the FROM, and thermotherapy (moist heat) treatment for managing pain with a home exercise program.
- ***Home exercise program*** consisted of Codman pendular exercises, active stretching exercises for increasing forward flexion, external rotation, extension, internal rotation, and horizontal adduction. Stretches were held from 1 to 5 seconds at the relatively pain-free range, 2 times a day[47]. Free ROM exercises for the muscles of the shoulder complex in all the planes. Strengthening exercises for the shoulder girdle and associated muscles of the neck and trunk started after 2nd week.
- ***Thoracic Spinal Manual Therapy***: A sitting cervicothoracic junction distraction manipulation was used to treat the cervico-thoracic junction defect[48,49,50]. (Picture A). Thoracic segments of the spine were treated with both low-velocity mid-range (grade III and IV), and high-velocity end-range (grade V), posterior to anterior forces directed at the mid(Picture B1) and upper thoracic spine[51](Picture B2) The low-velocity techniques were repeated for approximately 30 seconds at four non-specific levels throughout the middle and upper thoracic spine. Then the high-velocity techniques were then repeated 1–2 times at each of those levels. There was no attempt to identify or treat specific segmental levels due to research suggesting an inability to localize treatment[52,53]



Picture A: Sitting cervicothoracic junction distraction manipulation.

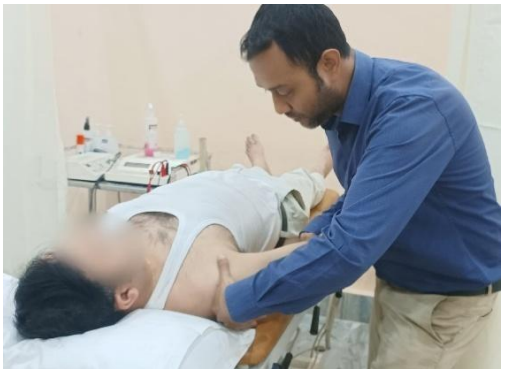


Picture B1: low-velocity mid-range (grade III and IV), and high-velocity end-range (grade V), posterior to anterior forces directed at the mid-thoracic spine.



Picture B2: low-velocity mid-range (grade III and IV), and high-velocity end-range (grade V), posterior to anterior forces directed at the upper-thoracic spine.

- ***Glenohumeral joint long axis distraction***[54]:-patient was in the supine position, the therapist stabilized the axilla with one hand and pulled on the humerus longitudinally via grasping the distal humerus at the elbow. After removing the joint slack, a low amplitude high-velocity thrust was delivered in the downward direction towards the wrist joint. (Picture C)

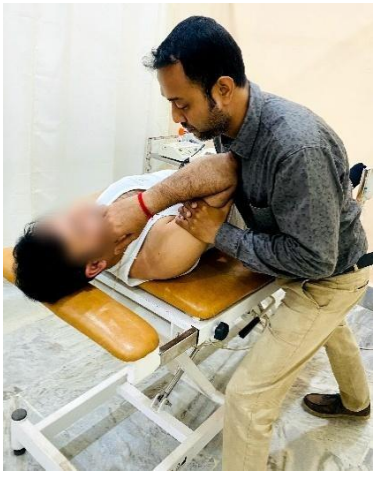


Picture C: Glenohumeral joint long-axis distraction

- ***Glenohumeral anteroposterior adjustment***[54]:-Patient was seated with the arm in 90 degrees forward flexion and the elbow fully flexed. The therapist stood behind the patient and stabilized the scapula, cupped the olecranon with both hands, removed the joint slack, and delivered a quick and shallow thrust along the axis of the humerus (Picture D).

Picture D: Glenohumeral anteroposterior adjustment

- ***Glenohumeral posteroinferior adjustment***[54] :-Patient was in a supine position with the arm in forward flexion and the elbow bent. The practitioner grasped the arm with both hands, removed the joint slack, and delivered a quick and shallow thrust inferiorly and posteriorly. (Picture E)



Picture E: Glenohumeral posteroinferior adjustment

- ***End-Range Mobilization***[55]***:-*** At the start of each intervention session, the physical therapist examined the patient's ROM in all directions to obtain information about the end-range position and the end-feel of the glenohumeral joint. The technique started with a warm-up of mid-range mobilization with the patient in supine. The therapist placed his hand on the glenohumeral joint and the humerus was brought to the position of maximal flexion in the sagittal plane.10-15 repetitions of Maitland mobilization grade 3 or 4 were given in this end-range position. Maitland mobilization included the anterior-posterior glide, posterior-anterior glide, lateral glide, and inferior glides respectively.
- ***Scapular Mobilization***[56,57]***:-*** Subjects lay on their sound side on the bed. The therapist stood before the patient's affected shoulder, placing the index finger of one hand under the medial scapular border, the other hand grasping the superior border of the scapula. The scapula was moved superiorly and inferiorly for superior and inferior glide, and then the scapula was rotated upward and downward for scapular rotation. Additionally, the physiotherapist put the ulnar fingers under the medial scapular border and distracted the scapula from the thorax. These patterns were chosen to increase scapular posterior tilt. Ten sets of 10 repetitions were applied, with rest intervals of 30 s between sets.
- ***Contract-relax PNF technique***[58]***:-***Patient was supine with the humerus abducted to approximately 45 degrees with the elbow flexed to 90 degrees, and the humerus was externally rotated to a midrange of 20 to 25 degrees. The patient was instructed to perform maximal glenohumeral internal rotation against an opposing, isometric, manual resistance applied by the treating therapist for 7 seconds. Afterward, the patient actively moved the humerus into full available external rotation. This position was maintained for 15 seconds. This 7-sec internal rotation contraction against resistance followed by full active external rotation was repeated 5 times. Subjects were then instructed to actively move through the PNF flexion-abduction external-rotation diagonal pattern for 5 repetitions with manual facilitation.

Pendular exercise.

- ***Basic Pendular Exercise***: -The patient leaned forward on a table/chair so that his back was parallel to the floor and his hands were on the back of the chair. The patient firmly gripped the chair with the nonaffected hand and slowly brought the affected arm down so that it could hang freely. Once in this position, the patient slowly started swinging his affected arm forward, backward and from side to side. These exercises were done in repetition of eight times by the affected hand.
- ***Pendular Circles*****: -** The patient got into the position from the basic pendular exercise, leaning against the back of the chair with his affected arm hanging down. Instead of the back-and-forth movement, this time the patient slowly moved his affected arm in a clockwise circle. He was advised that his circles should be as wide as they can be without pain. He made several circles with his arm, then stop and switched directions to a counterclockwise direction. These exercises were done in the repetition of 10 times in each direction.

2.3 DATA ANALYSIS

The statistical analysis was done by using SPSS 23.0. The demographic data are presented in terms of frequency, percentage, and diagrams. Descriptive statistics, like mean and SD, were used to represent the baseline scores of the outcome measures. A paired t-test was performed for within-group comparison of the baseline scores, and an independent sample t-test was done to test the comparison of baseline scores between groups.

2.3.1 Distribution of the Demographic Variables

Age

Age	N	Minimum	Maximum	Mean	SD
Experimental Group	10	44.00	65.00	52.90	7.30
Control Group	10	46.00	61.00	52.70	4.54

Table No. 1: Age-wise distribution of the study participants

Table no 1 displays the age-wise distribution of the samples. There were ten patients in the two groups. The minimum and maximum ages of the patients in the experimental group were 44 years and 65 years, the mean was 52.90 years, and the standard deviation was 7.03 years. The minimum and maximum ages of the patients in the control group were 46 years and 61 years, the mean was 52.70 years, and the standard deviation was 4.54 years.

Sex

Sex	Experimental Group		Control Group	
	Frequency	Percent	Frequency	Percent
Female	6	60.0	6	60.0
Male	4	40.0	4	40.0
Total	10	100.0	10	100.0

Table no 2: Gender-wise distribution of the study participants

The above Table 2 provides us with the gender-wise distribution of the study participants. Both experimental and control groups contained 60% females and 40% males.

2.3.2 Intra-class comparison of pain, motion of shoulder rotation, and shoulder disability within the Experimental Group (Gp-A)

	Time	Mean	N	Std. Dev	t	df	p
VAS	Day 0	6.70	10	.94	6.86**	9	.000
	After 4 weeks	4.40	10	.96			
Active Shoulder External Rotation	Day 0	24.10	10	5.21	-11.68**	9	.000
	After 4 weeks	50.40	10	3.56			
Active Shoulder Internal Rotation	Day 0	30.20	10	4.28	-14.9**	9	.000
	After 4 weeks	55.10	10	5.08			
Active Shoulder Flexion	Day 0	94.80	10	6.56	-46.50**	9	.000
	After 4 weeks	152.80	10	7.49			
Active Shoulder Extension	Day 0	32.70	10	6.58	-10.34**	9	.000
	After 4 weeks	50.10	10	2.28			
Active Shoulder Abduction	Day 0	88.30	10	10.87	-17.81**	9	.000
	After 4 weeks	148.50	10	7.36			
SPADI	Day 0	110.50	10	7.89	25.52**	9	.000
	After 4 weeks	55.50	10	9.03			

**: Significant at 1% probability level

Table no 3: Intra-class comparison of pain, motion of shoulder rotation, and shoulder disability within the Experimental Group (Gp-A)

The above Table 3 is constructed to see whether Combined Thoracic Spine and Shoulder Manipulation, along with conventional physiotherapy, could improve pain, range of motion of the shoulder, and shoulder disability of patients with frozen shoulders. A paired t-test was performed to see the significant difference on day 0 and after 4 weeks of the treatment.

To compare pain (VAS), the calculated value of t was 6.86, which is highly significant (p=.000 < .01). We can say that there has been good amount of decrease in pain, while treating the patients with combined Thoracic Spinal Manipulation along with conventional physiotherapy.

To compare Active Shoulder External Rotation (ASER) of the patients in day 0 and after 4 weeks of treatment with combined Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy, the calculated value of t was -11.68 which is highly significant (p=.000 < .01) implying that combined Thoracic Spine and Shoulder Manipulation along with

conventional physiotherapy was effective in increasing ASER of the patients with frozen shoulder.

It was found that the calculated value of t to compare Active Shoulder Internal Rotation (ASIR) before and after implementation of treatment was -14.9, which is highly significant (p=.000 < .01). We can thereby conclude that possibly combined Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy were effective in improvement in ASIR.

The calculated value of t to compare Active Shoulder Flexion (ASF) was -46.5, which was highly significant (p=.000<.01), thereby implying that perhaps combined Thoracic Spine and Shoulder Manipulation, along with conventional physiotherapy, was useful in increasing ASF.

To compare Active Shoulder Extension (ASE), the calculated value of t was -10.34, which is highly significant (p=.000 < .01). We can say that there has been a remarkable increase in ASE, while treating the patients with combined Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy.

The calculated value of t to compare Active Shoulder Abduction (ASA) before and after implementation of treatment was -17.81, which is highly significant (p=.000 < .01). We can thereby conclude that possibly combined Thoracic Spine and Shoulder Manipulation, along with conventional physiotherapy, were effective in increasing ASA.

The calculated value of t to compare SPADI of the patients was 25.52 (p = .00>.01), signifying that feasibly combined Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy was effective in improving shoulder disability of the patients in the experimental group.

The results above advocate that possibly combination of Thoracic Spine and Shoulder Manipulation, along with conventional physiotherapy, was effective in reducing pain and increasing range of shoulder motion and improving shoulder disability.

2.3.3 Intra-class comparison of pain, motion of shoulder rotation and shoulder disability Within Control Group (Gp-B)

	Time	**Mean**	**N**	**Std. Dev**	**t**	**df**	**p**
VAS	Day 0	6.90	10	1.10	6.03**	9	0.00
	After 4 weeks	4.80	10	0.63			
Active Shoulder	Day 0	24.10	10	3.07	-16.02**	9	0.00
External Rotation	After 4 weeks	44.00	10	3.56			
Active Shoulder	Day 0	27.90	10	3.54	-17.36**	9	0.00
Internal Rotation	After 4 weeks	47.30	10	4.52			
Active Shoulder	Day 0	96.20	10	4.44	-16.65**	9	0.00
Flexion	After 4 weeks	130.70	10	4.06			
Active Shoulder	Day 0	32.00	10	7.51	-10.02**	9	0.00
Extension	After 4 weeks	46.90	10	3.84			
Active Shoulder	Day 0	80.10	10	9.27	-12.54**	9	0.00
Abduction	After 4 weeks	128.50	10	6.84			
SPADI	Day 0	109.90	10	7.10	11.38**	9	0.00
	After 4 weeks	100.60	10	5.98			

**: Significant at 1% probability level

Table no 4: Intra-class comparison of pain, motion of shoulder rotation, and shoulder disability within the Control Group (Gp-B)

The above table no 4, presents the results to assess the effectiveness of conventional physiotherapy in improving VAS, ASER, ASIR, ASF, ASE, ASA, and SPADI in patients with frozen shoulder. A paired t-test was performed to see the significant difference between before and after 4 weeks of the treatment.

To compare VAS, the calculated value of t was 6.03, which is highly significant (p=.000 < .01). We can say that there has been a decrease in VAS while treating the patients with conventional physiotherapy.

To compare ASER of the patients on day 0 and after 4 weeks of treatment with conventional physiotherapy, the calculated value of t was -16.02, which is highly significant (p=.000 < .01), implying that conventional physiotherapy was effective in increasing ASER of the patients with frozen shoulder.

It was found that the calculated value of t to compare ASIR before and after implementation of treatment was -17.36, which is highly significant (p=.000 < .01). We can thereby conclude that conventional physiotherapy was effective in improving ASIR.

The calculated value of t to compare ASF was -16.65, which was highly significant (p=.000<.01), thereby implying that perhaps conventional physiotherapy was useful in increasing ASF.

To compare ASE, the calculated value of t was -10.02, which is highly significant (p=.000 < .01). We can say that there has been a remarkable increase in ASE while treating the patients with conventional physiotherapy.

The calculated value of t to compare ASA before and after implementation of treatment was -12.54, which is highly significant (p=.000 < .01). We can thereby conclude that conventional physiotherapy was effective in increasing ASA.

The calculated value of t to compare SPADI of the patients was 11.38 (p = .00>.01), indicating that perhaps conventional physiotherapy was effective in improving shoulder disability of the patients in the control group.

In summary, the results of the study indicate that conventional physiotherapy was effective in improving all measured parameters (VAS, ASER, ASIR, ASF, ASE, ASA, and SPADI). The results were proven statistically

2.3.4 Inter-class comparison of pain, motion of shoulder rotation and shoulder disability Between experimental and control group on day 0

	Groups	**N**	**Mean**	**Std. Dev**	**t**	**df**	**p**
VAS	Experimental	10	6.70	0.95	-.435	18	.669
	Control	10	6.90	1.10	NS		
Active Shoulder	Experimental	10	24.10	5.22	.000	18	1.000
External Rotation	Control	10	24.10	3.07	NS		
Active Shoulder	Experimental	10	30.20	4.29	1.307	18	.208
Internal Rotation	Control	10	27.90	3.54	NS		
Active Shoulder	Experimental	10	94.80	6.56	-.559	18	.583
Flexion	Control	10	96.20	4.44	NS		
Active Shoulder	Experimental	10	32.70	6.58	.222	18	.827
Extension	Control	10	32.00	7.51	NS		
Active Shoulder	Experimental	10	88.30	10.87	1.815	18	.086
Abduction	Control	10	80.10	9.27	NS		
SPADI	Experimental	10	110.50	7.89	.179	18	.860
	Control	10	109.90	7.10	NS		

NS: Not Significant

Table 5: Inter-class comparison of pain, motion of shoulder rotation, and shoulder disability between experimental and control groups on day 0

Table 5 above describes the results of the statistical analysis that aimed to compare various measures related to pain (VAS), range of motion of the shoulder (ASER, ASIR, ASF, ASE, ASA), and shoulder disability (SPADI) between two groups: the experimental group and the control group. The statistical method used for the comparison was an independent t-test.

No significant difference in VAS (p=.669>.05), ASER (p=1.000>.05), ASIR (p=.208>.05), ASF (p=.583>.05), ASE (p=.827>.05), ASA (p=.086>.05), SPADI (p=.860>.05) was found between the patients in the two groups implying that before starting the treatment i.e., on day 0, pain, shoulder rotation and shoulder disability of the patients' of both the groups did not differ considerably.

These results suggest that before starting the treatment (on day 0), there were no significant differences in pain (VAS), shoulder range of motion (ASER, ASIR, ASF, ASE, ASA), and shoulder disability (SPADI) between the patients in the experimental group and the control group. **This is important as it indicates that both groups were comparable at the baseline.**

2.3.5 Inter-class comparison of pain, motion of shoulder rotation, and shoulder disability between the experimental and control groups after 4th week

	Groups	N	Mean	Std. Dev	t	df	p
VAS	Experimental	10	4.40	0.97	-1.095	18	.288
	Control	10	4.80	0.63	NS		
Active Shoulder	Experimental	10	50.40	3.57	4.017**	18	.001
External Rotation	Control	10	44.00	3.56			
Active Shoulder	Experimental	10	55.10	5.09	3.624**	18	.002
Internal Rotation	Control	10	47.30	4.52			
Active Shoulder	Experimental	10	152.80	7.50	8.200**	18	.000
Flexion	Control	10	130.70	4.06			
Active Shoulder	Experimental	10	50.10	2.28	2.264*	18	.036
Extension	Control	10	46.90	3.84			
Active Shoulder	Experimental	10	148.50	7.37	6.293**	18	.000
Abduction	Control	10	128.50	6.84			
SPADI	Experimental	10	55.50	9.03	-13.161**	18	.000
	Control	10	100.60	5.98			

NS: Not Significant *: Significant at 5% probability level **: Significant at 1% probability level

Table 6: Inter-class comparison of pain, motion of shoulder rotation, and shoulder disability between experimental and control groups after the 4th week

Table 6 above is made to check if pain (VAS), range of motion of the shoulder (ASER, ASIR, ASF, ASE, ASA), and shoulder disability (SPADI) differ significantly among the patients of the experimental group and the control group after the 4th week of treatment. An independent t test was performed for the comparison statistically.

It appears that the calculated t-value for comparing pain (VAS) between the two groups was -1.095 (p=.288>.05). The finding is considered not significant. Therefore, based on the result, there is no difference in pain reduction between the experimental group (receiving Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy) and the control group (receiving conventional physiotherapy).

The calculated value of t to compare Active Shoulder External Rotation (ASER) was 4.017 (p = .001<.01), which is highly significant, implying that there was a substantial difference in ASER between the patients of the experimental group and the control group. The mean ASER shows that the improvement in the experimental group was better than the control group.

The calculated t-value for comparing Active Shoulder Internal Rotation (ASIR) between the two groups was 3.624. Since p=.002<.01, the finding is considered statistically significant. Therefore, it may be concluded that there was a substantial difference in ASIR between the two groups, and the experimental group showed better improvement compared to the control group.

The calculated t-value for comparing Active Shoulder Flexion (ASF) between the two groups was 8.20 and the p (=.000<.01)

value indicates that the result is statistically significant implying that there was a significant difference in active shoulder flexion between the experimental group (receiving Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy) and the control group (receiving conventional physiotherapy). The mean ASF values exhibited better improvement in ASF compared to the control group.

The calculated t -value to compare ASE between the experimental group and the control group was 2.264 which was significant at 5% probability level (p = .036<.05). It can be concluded that possibly Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy was more effective in improving active shoulder extension that conventional physiotherapy.

The estimated t-value for the ASA comparison between the experimental and control groups was 6.293, which was highly significant (p =.000<.01). We might conclude that Thoracic Spine and Shoulder Manipulation in combination with conventional physiotherapy was more as successful in improving active shoulder abduction than conventional physiotherapy.

There was a significant difference in SPADI between the patients in the experimental group and the control group, as indicated by the computed value of t to compare shoulder disability being -13.161 (p =.001<.01). The average SPADI values reveals that the experimental group improved more than the control group did.

3. DISCUSSION

In this randomized pilot study, our primary aim was to investigate the impact of comprehensive interventions on adhesive capsulitis. The interventions included thoracic spine and shoulder manipulation, glenohumeral end range and scapular mobilization, contact relax PNF technique with thermotherapy, and a home program.

The study assessed the effectiveness of these interventions in enhancing outcomes for individuals with adhesive capsulitis and also to compare recovery pace, enabling commentary on the time taken by the treatment protocol for the early recovery of patients as compared to conventional protocols

It was a pilot study where 20 samples were randomly selected into experimental and control groups receiving two supervised treatment protocols. Our results indicated that statistically significant improvement was seen in shoulder range of motion following the comprehensive interventions at the 4th week in both groups. But the patients of the experimental group receiving manipulations therapy along with the rest of the treatment tools showed better improvements in the different parameters of the shoulder joint (Table 6) These statements are supported by the t-values and the p values of the different range of motion parameters of the affected shoulder joint of the patients of experimental group namely ASER which was 4.017 (p = .001<.01), ASIR between the two groups was 3.624 (p=.002<.01), ASF was 8.20 and the p =.000<.01, ASE between the experimental group and the control group was 2.264, which was significant at a 5% probability level (p = .036<.05), ASA comparison between the experimental and control groups was 6.293, which was highly significant (p =.000<.01).

The calculated t-value for comparing pain (VAS) between the two groups is -1.095 (p=.288>.05), indicating non-significance. Consequently, the results suggest no discernible difference in pain reduction between the experimental group (receiving Thoracic Spine and Shoulder Manipulation along with conventional physiotherapy) and the control group (receiving conventional physiotherapy) at the end of the 4th week.

A notable disparity in SPADI scores emerged between the experimental and control groups, evident in the computed t-value of -13.161 (p =.001<.01). The average SPADI values indicate superior improvement in the experimental group at the end of the 4th week as compared to the control group.

While the interventions in this study positively impact shoulder range of motion and disability (SPADI scores) in individuals with adhesive capsulitis, they do not seem to significantly alleviate pain.

In conclusion, from the data analysis, it can be noted that even though both treatment protocols are effective, the experimental group gained better relief from the condition than the control group at the same 4th week, indicating that the administered protocol can provide faster or earlier results for the condition. For this, it can be concluded that the experimental group protocol is a better combination of treatment tools for the management of adhesive capsulitis.

4. CONCLUSION

Our randomized pilot study sheds light on the efficacy of comprehensive interventions for adhesive capsulitis. The promising results, particularly in the context of thoracic spine shoulder manipulation, warrant further investigation. Physiotherapists can consider incorporating thoracic spine shoulder manipulation as a targeted intervention for adhesive capsulitis. The comprehensive approach outlined may serve as a valuable addition to the physiotherapist's toolkit when managing individuals with this condition.

5. AUTHORS CONTRIBUTION

Abhijit Kalita conducted this research as part of his structured Doctorate of Philosophy (PhD) program, supervised by Dr.

Pratap Chandra Sarma and Dr. Jayanta Madhab Saikia. Kalita conceived and designed the study, conducted the literature review, gathered and analyzed the data, and authored the initial and final drafts. Dr. Sarma and Dr. Saikia oversaw the entire research, provided critical feedback on the article, and approved the final version for publication. Dr. Saikia and Dr Rajak assisted in obtaining study samples, played a role in organizing content in various drafts.

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