ijlpr 2022; doi 10.22376/ijpbs/lpr.2022.12.6.L95-106

International Journal of Life science and Pharma Research

ISSN 2250-0480

Research Article

Manipulation and Thermotherapy For Adhesive Capsulitis

Immediate Effect of Thoracic Spine and Shoulder Joint Manipulation and Thermotherapy on Glenohumeral Range of Motions in Patients with Adhesive Capsulitis

Abhijit Kalita[1], Pratap Chandra Sarma[2*], Jayanta Madhab Saikia[3], Abhijit Dutta[4] and Santosh K Rajak[5]

[1]*Assistant Professor, PhD scholar, Programme of Physiotherapy, Faculty of Paramedical Sciences, Assam down town University, Panikhaiti, Guwahati, Assam, India.*

[2]*Chairperson, Faculty of Sciences and Paramedical Sciences, Assam down town University, Panikhaiti, Guwahati, Assam, India.*

[3]*Consultant Orthopaedic Surgeon, Apollo Hospitals, Guwahati, Assam.*

[4]*Associate Professor and Associate Dean, Faculty of Sciences and Paramedical Sciences, Assam down town University, Panikhaiti, Guwahati, Assam, India.*

[5]*Teaching Associate, Assam Woman's University, Jorhat, Assam, India.*

Abstract: Adhesive capsulitis (AC) is a common shoulder condition that leads to progressive loss of shoulder joint mobility leading to functional limitations. Many treatment protocols are in practice however there is no consensus on which is the best. Much literature reflects clinicians using thoracic spine and shoulder joint manipulations in different studies but a lack of evidence was found studying their effect when applied together and their immediate effect, for the management of patients with AC. Therefore, the objective of this study was to statistically analyse and report the immediate effect of thoracic spine and shoulder joint manipulations on subjects with AC assessing their pain and joint Range of motion. In this study, purposive sampling of 20 pre diagnosed subjects of AC were included and VAS conducted a pre-intervention assessment for assessing pain, and a goniometer for assessing the glenohumeral active Range of motion. All the subjects received a single session of high-velocity thrust manipulative therapy to the cervicothoracic junction, upper/mid-thoracic spine, and the glenohumeral joint of the affected shoulder. Everyone received thermotherapy (moist heat) before and after the manual therapy session, after which the data were documented and analyzed statistically. It was observed that there was a significant difference between pre and post-VAS and pre and post-range of motion scores in the samples ($p<0.001$). It is essential to mention that compared to VAS, goniometry results were more promising. To conclude, it can be stated that thoracic spine and shoulder joint manipulation adjunct with thermotherapy, in general, has an immediate positive effect on the management of patients with adhesive capsulitis.

Keywords: Adhesive capsulitis; periarthritis; thoracic spine manipulation, shoulder joint manipulation, high-velocity thrust manipulative therapy; VAS; Goniometry and thermotherapy.

***Corresponding Author**

Pratap Chandra Sarma , Chairperson, Faculty of Sciences and Paramedical Sciences, Assam down town University, Panikhaiti, Guwahati, Assam, India.

Received On 19 May, 2022

Revised On 12 September, 2022

Accepted On 21 September, 2022

Published On 1 November, 2022

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors.

Citation Abhijit Kalita, Pratap Chandra Sarma, Jayanta Madhab Saikia, Abhijit Dutta and Santosh K Rajak , Immediate Effect of Thoracic Spine and Shoulder Joint Manipulation and Thermotherapy on Glenohumeral Range of Motions in Patients with Adhesive Capsulitis.(2022).Int. J. Life Sci. Pharma Res.12(6), L95-106 http://dx.doi.org/10.22376/ijpbs/lpr.2022.12.6.L95-106

1. INTRODUCTION

Adhesive capsulitis (AC) or Frozen Shoulder is a widespread shoulder condition that leads to progressive loss of mobility of the shoulder joint with significant functional limitations[1] and forms 5.3% of the general population and is the main cause of shoulder pain and dysfunction in individuals aged 40 to 70 years.[2] Both active and passive joint movements get affected, predominantly the external rotation, as a result of progressive fibrosis and contracture of the glenohumeral joint capsule[3,4,5].AC is generally classified as primary, which occurs with an insidious onset, and secondary, associated with a predisposing condition. AC follows a three-stage pattern of progression, where stage 1 is characterized by severe pain, stage 2 has a significant loss of Range of motion but is less painful, followed by stage 3, which is the recovery phase where there is a slow increase in the joint Range of motion.[6] It is considered a "self-limiting" disease that has a spontaneous recovery within 3 years[4,6,7]. Many treatment protocols have been in practice for the management of AC. However, there is no consensus on which is the best [8,9]. The physiotherapist's various treatments include modalities to provide thermotherapy or cryotherapy, Ultrasound, Electrical stimulation[10], joint mobilizations, PNF techniques[11], mobility exercises, specific ligament stretching [12,] and soft tissue mobilization techniques.[13] Although studies claim that the above tools are effective in treating AC, neither alone nor in combination gives relief or rehabilitates the patients early, at least for achieving their functional joint Range of motions for which their cost of treatment rises as well their quality of life gets affected. Clinicians are still in pursuit to find out the optimum management of this disabling musculoskeletal condition. Regional interdependence (RI) is an area that is being studied as it deals with the concept that impairments in a distant anatomical region may be associated with the primary complaint of the patient[14]. Regarding this treatment model, various studies have been carried out which reflect the involvement of distant dysfunctions, which when addressed relieve the patient from their conditions[15-17]. This concept is likely to be a complex phenomenon and perhaps is driven by a neurophysiological response related to the peripheral, spinal cord and supraspinal mechanisms[18]. Neurophysiological effects can work by peripheral, spinal, and supraspinal mechanisms.[18] Musculoskeletal system injuries may result in an inflammatory cascade and may impact multiple body systems by biochemical alterations in the periphery. Preliminary literature suggests that manual therapy techniques may influence biochemical activity and even mediate the inflammatory process. Clinicians have demonstrated that manual therapy resulted in the production of endogenous cannabinoids compared with a placebo[19]. Teodorczyk-Injeyan JA et al (2003), in their study "spinal manipulative therapy reduces inflammatory cytokines but not substance P production in normal subjects," concluded that thoracic manipulation reduced inflammatory cytokines in the short term. Plaza-Manzano et al. (2014)[20] in a study randomly assigned individuals to either cervical manipulation, thoracic manipulation or a control group. The cervical and thoracic spine manipulation groups experienced higher levels in neurotensin, and the cervical manipulation group also experienced significantly greater increases in cortisol, suggesting that manipulation may positively influence biochemical processes. Recent evidence suggests that manipulation of the thoracic spine results in changes in the neurophysiological response, which may decrease pain thereby improving the outcomes in patients with musculoskeletal disorders. In a case study of AC, the effect of thoracic manipulation was examined, which showed promising results in decreasing pain and overall outcome of the patient.[21] Strunce JB, Walker MJ, Boyles RE, Young BA (2009) in their study, the immediate effects of the thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain reported that thoracic and rib manipulation therapy is associated with the decrease of shoulder pain and increased the joint Range of motion of the shoulder joint[13,] Various pieces of evidence can be found about RI in regards to thoracic manipulation and its effect in shoulder conditions but very little could be found where thoracic manipulation is adjunct with other joint manipulations like the manipulations of the shoulder joint itself. Mohsen Kazemi in the year 2000 in his study got positive results in AC patients by applying shoulder manipulation along with other treatment tools[22]. Likewise, shoulder manipulations show effective results in AC but here, too little evidence is present in conjugation with the thoracic spine manipulations. Therefore, this preliminary study was carried out to report the immediate effect of thoracic spine and shoulder joint manipulations on subjects with AC assessing their pain and Range of motion.

2. METHODOLOGY

A total of 24 pre-diagnosed patients with AC were referred to physiotherapy by their Orthopedicians with a primary complaint of shoulder pain and ROM restrictions. Of these, 20 fulfilled the inclusion criteria and were recruited for the study.

2.1 Inclusion Criteria

a) Both male and female patients have a primary complaint of unilateral/bilateral shoulder pain for at least 3 to 4 months with decreased shoulder range of motion (external shoulder rotation, abduction, internal rotation, flexion, and extension).
b) Age between 40 and 65 years and stage 2nd or 3rd of the disease.

2.2 Exclusion Criteria

a) Patients if they had any shoulder pain resulting from systemic disease like rheumatoid arthritis, infection, tumors, etc,
b) Recent shoulder joint fractures,
c) A rotator cuff injury,
d) Tendon calcification confirmed by MRI
e) The presence of moderate or severe osteoarthritis or
f) Patients on calcium supplements for the treatment of osteoporosis
g) Uncooperative patients

Subjects that met all criteria provided written informed consent before participation. The samples were collected from Assam Down Town University OPD and Physiotherapy department, Down Town Hospital. 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).

2.3 *Outcome Measures*

Visual Analogue Scale (VAS)[23] and goniometry[24] were used for assessing pain, and passive ROM for the shoulder joint (shoulder external rotation, abduction, internal rotation, flexion, and extension)

2.4 *Procedure*

The purposive sampling method was used for the study. Patients diagnosed with 2nd or 3rd stage of AC by their Physicians and orthopedics were referred to physiotherapy. Out of 24 referred patients, 20 patients fulfilled the inclusion criteria and were included in the study. The primary investigator, a trained orthopedic manual physiotherapist, performed a preliminary physical examination for the shoulder joint, thoracic and cervical spine range of motions, and other probable orthopaedic conditions documented and treated all subjects. During the physical examination, it was found that most patients sat with a forward head posture. Visual inspection of cervical ROM highlighted slight limitations with side flexion and rotation with pain over the upper trapezius (n=7). All other patient's cervical movements were found to be normal and pain-free. Although visual assessment of cervical ROM's reliability is poor[25], further detailed measurements were thought unnecessary as physical tests like Spurling's test and cervical distraction test were all negative. The dermatomes myotomes and reflexes were all intact. Passive intervertebral movements (PIMs) were done on the cervical spine with lateral glides[26].The movements did not reproduce any pain in the patient's shoulder nor was it painful locally. These techniques' reliability for assessing mobility is poor, while it is moderate when they are used for symptom reproduction[26,27]. The thoracic spine examination of the patients revealed that they experienced pain when they were tested with posterior to anterior glides(n=12). Limited thoracic extension and rotation were found when tested with the occiput-to-wall test and the seated rotation test respectively. PA mobility testing has been found to have moderate inter-tester reliability, while visual assessment of Range of motion has poor reliability for cervical spine[25]. VAS conducted a pre-intervention assessment for assessing pain, a goniometer for considering the glenohumeral passive Range of movement followed by post-intervention evaluations for the same. The interventions were applied to the patients following a thorough physical examination and a proper explanation of the treatment protocol and manipulation techniques. The results were recorded and analyzed statistically. Informed consent was taken accordingly.

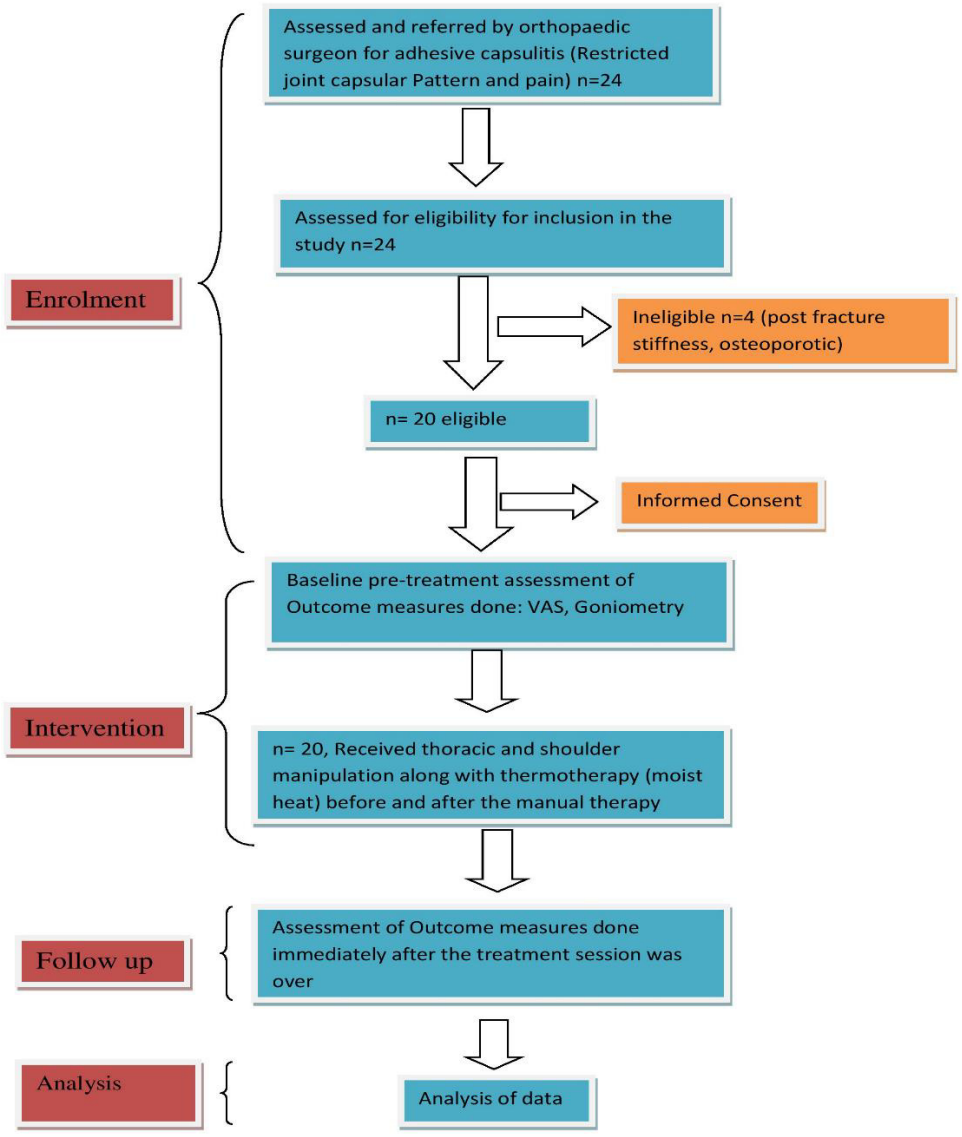

Fig :1 Consort diagram

All subjects received a single session of high-velocity thrust manipulative therapy to the cervicothoracic junction, upper/mid-thoracic spine, and the glenohumeral joint of the affected shoulder. Everyone received thermotherapy (moist heat) before and after the manual therapy session for 10 minutes to mask the pain, after which data is documented and analyzed statistically. Cervico-thoracic junction of the spine is treated with a seated cervicothoracic junction distraction manipulation[28,29,30]. (Figure 1). Thoracic vertebral segments were treated with both low-velocity mid-range (grade III and IV), and high-velocity end-range (grade V), with posterior to anterior forces directed at the mid and upper thoracic spine[31] (Figure 2,3). 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 procedures were repeated 1–2 times at each level. There was no attempt to identify or treat specific segmental levels due to research suggesting an inability to localize treatment[32, 33]

Fig 1: Cervico-thoracic junction distraction manipulation

Fig 2: low-velocity mid-range and high-velocity end-range, posterior to anterior forces directed at the upper thoracic spine.

Fig 3: low-velocity mid-range and high-velocity end-range, posterior to anterior forces directed at the mid thoracic spine

Glenohumeral joint long axis distraction[22]: - (Figure 4) patient was in the supine position; clinician stabilizes the shoulder and axilla with one hand and pulls 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 downward towards the wrist joint.

Fig 4: Glenohumeral joint long axis distraction

Fig 5: Glenohumeral anteroposterior adjustment

Fig 6: Glenohumeral posteroinferior adjustment

Glenohumeral anteroposterior adjustment[22]:- (Figure 5) Patient was seated with the arm in 90 degrees forward flexion and the elbow fully flexed. The therapist stood behind the patient to stabilize 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

Glenohumeral posteroinferior adjustment[22]:- (Figure 6) Patient was in supine position with the arm in forwarding 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.

3. DATA ANALYSIS

SPSS 23.0 version was used for statistical analysis. Demographic data and baseline scores of all outcome measures were presented to evaluate baseline comparability

of the treatment group. The data were presented as mean + standard deviation (SD). Paired t-test was used for significance testing of study participants. The $p< 0.05$ was considered statistically significant.

sTable No. 1: Age and gender-wise distribution of the study participants

			Gender		Total
Age(in years)			Males	Females	
	<=50	Count	3	6	9
		%	15.0%	30.0%	45.0%
	51-55	Count	3	2	5
		%	15.0%	10.0%	25.0%
	56-60	Count	2	1	3
		%	10.0%	5.0%	15.0%
	61-65	Count	1	2	3
		%	5.0%	10.0%	15.0%
Total		Count	9	11	20
		%	45.0%	55.0%	100.0%
	N	Minimum	Maximum	Mean	Std. Deviation
Age	20	44	65	52.80	5.926

From Table no.1 it is observed that in the present study a total of 20 individuals were considered. The mean age of the study participants is 52.8 years with the standard deviation of 5.9 years and 14(70%) of the individuals are in the age group of 44-55years.

Table No. 2: Comparison and testing of the significant difference between pre and post-treatment VAS

	Mean	N	Std. Deviation	P value
Pre VAS	6.8000	20	1.00525	.001
Post VAS	6.3500	20	.93330	

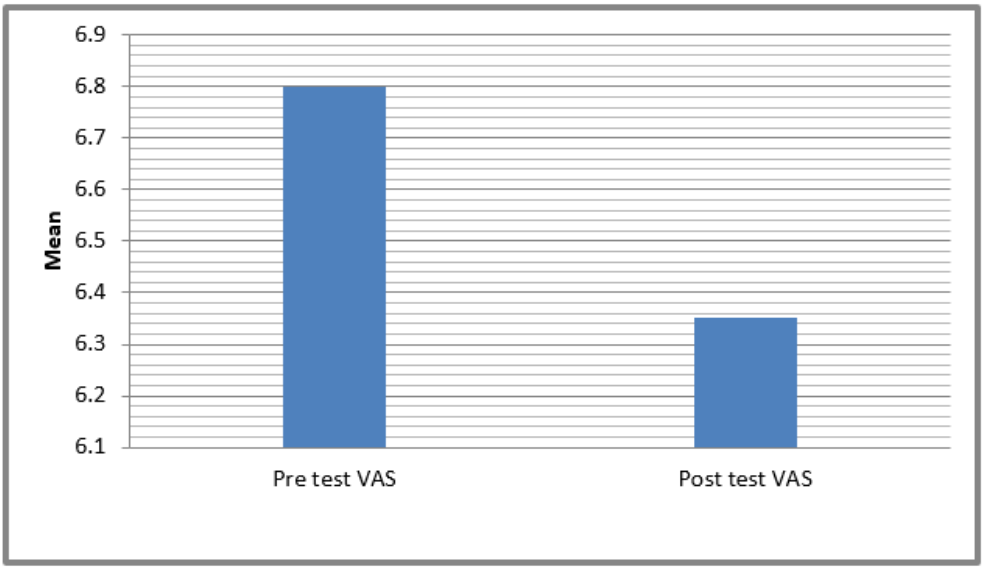

Fig 7: Comparison and testing the significant difference between pre and post treatment VAS

Table No.2 (Figure:7) indicates that the mean VAS score pre and post treatment was 6.8 ± 1.005 and 6.35 ± 0.93 respectively. Hence the statistically significant difference is observed in VAS pre and post-test scores was observed ($p<0.01$)

Table No. 3: Comparison and testing of the significant difference between pre and post-treatment passive shoulder external rotation

	Mean	N	Std. Deviation	P value
Passive shoulder External Rotation- Pre test	25.9000	20	6.57667	.000
Passive shoulder External Rotation- Post test	29.4000	20	6.65227	

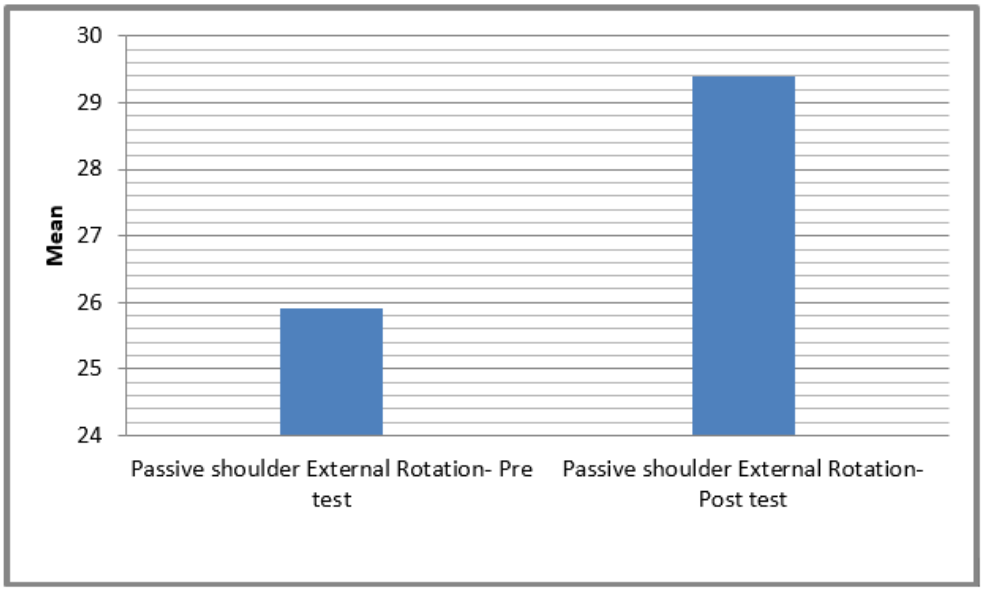

Fig 8: Comparison and testing of the significant difference between pre and post-treatment passive shoulder external rotation

It is observed from Table No.3 (Figure:8) that the mean passive shoulder external rotation pre and post-treatment scores were 25.9$\pm$6.5 and 29.4$\pm$6.6, respectively. Hence the statistically significant difference in pre and post-test passive shoulder external rotation was observed (p<0.001)

Table No. 4: Comparison and testing of the significant difference between pre and post-treatment passive shoulder internal rotation

	Mean	N	Std. Deviation	P value
Passive shoulder Internal Rotation- Pre test	25.0500	20	2.79991	.000
Passive shoulder Internal Rotation- Post-test	27.4000	20	2.43656	

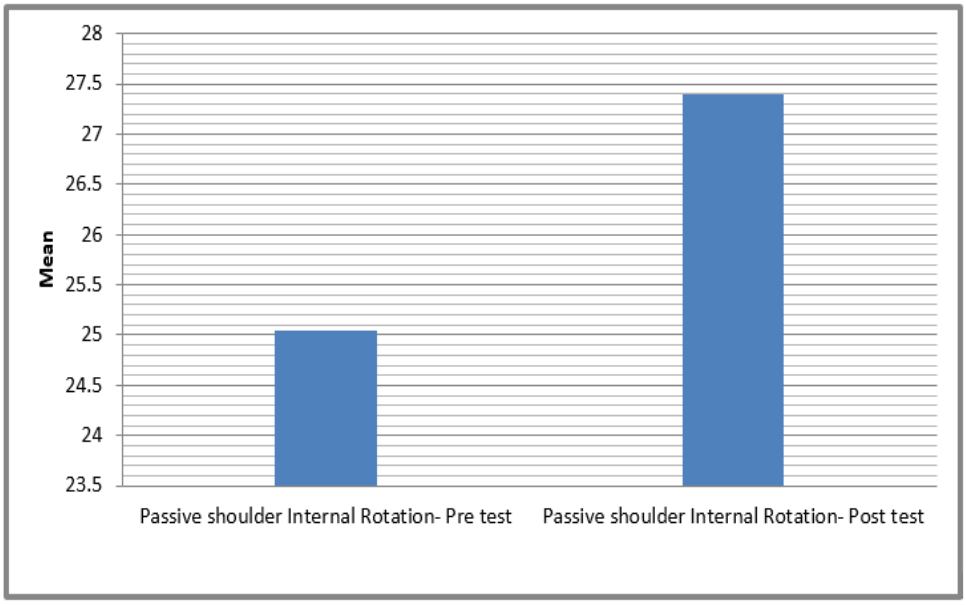

Fig 9: comparison and testing the significant difference between pre and post-treatment passive shoulder internal rotation

It is noted from Table No.4 (Figure:9) that the mean passive shoulder internal rotation pre and post-treatment scores were 25.0 $\pm$2.7 and 27.4$\pm$2.4, respectively. Therefore, a statistically significant difference in pre and post-test passive shoulder internal rotation was observed (p<0.001)

Table No. 5: Comparison and testing of the significant difference between pre and post-treatment passive shoulder flexion

	Mean	N	Std. Deviation	P value
Passive shoulder Flexion- Pre test	96.0000	20	6.32456	
Passive shoulder Flexion- Post test	104.0500	20	5.65197	.000

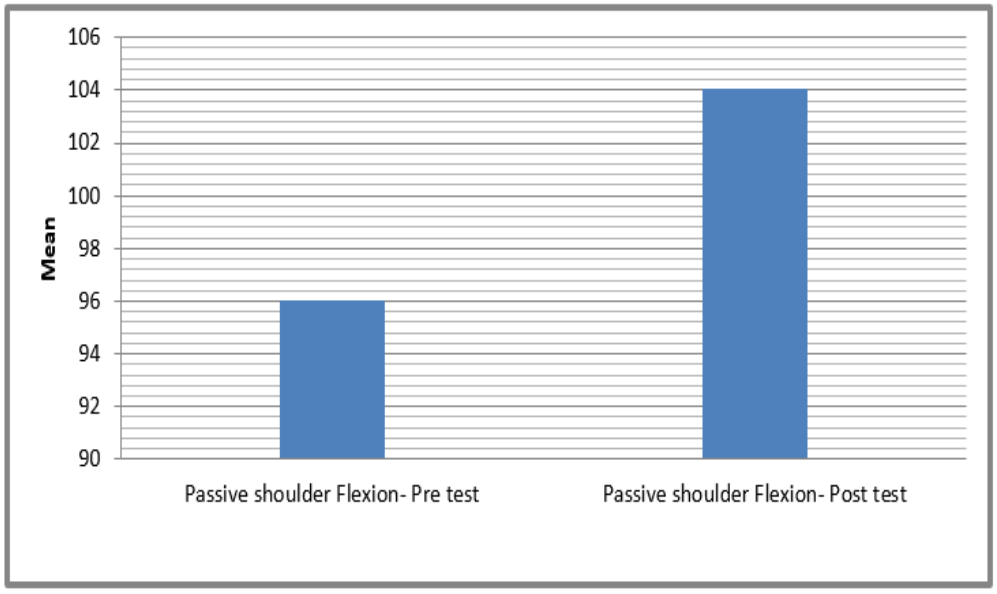

Fig 10: Comparison and testing the significant difference between pre and post treatment passive shoulder flexion

Table No.5 (Figure:10) depicts that the mean passive shoulder flexion pre and post treatment scores were 96.0 $\pm$ 6.3 and 104.0 $\pm$ 5.6 respectively. Hence the statistically significant difference in pre and post-test passive shoulder flexion was observed ($p<0.001$)

Table No. 6: Comparison and testing the significant difference between pre and post treatment passive shoulder abduction

	Mean	N	Std. Deviation	P value
Passive shoulder Abduction- Pre test	88.7000	20	9.73383	.000
Passive shoulder Abduction- Post test	94.5500	20	7.35187	

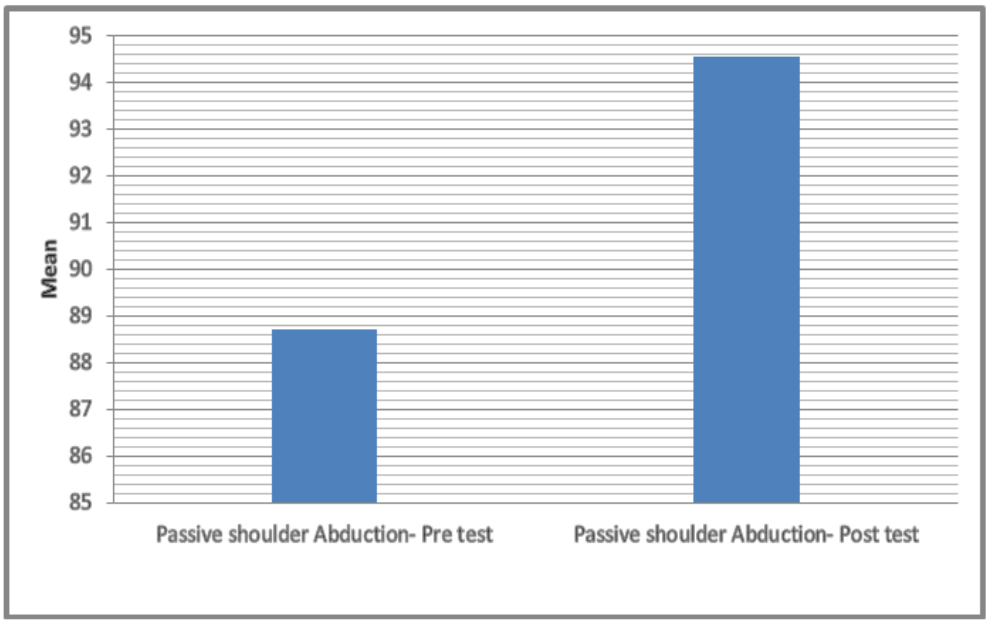

Fig 11: Comparison and testing the significant difference between pre and post treatment passive shoulder abduction

It is observed from Table No.6 (Figure:11) that that the mean passive shoulder Abduction pre and post treatment scores were 88.7±9.7 and 94.5±7.3 respectively. Statistically significant difference in pre and post-test passive shoulder abduction was observed (p<0.001)

Table No. 7: Comparison and testing the significant difference between pre and post-test passive shoulder extension

	Mean	N	Std. Deviation	P value
Passive shoulder Extension- Pre test	30.6500	20	6.40127	
Passive shoulder Extension- Post test	32.6500	20	5.65941	.000

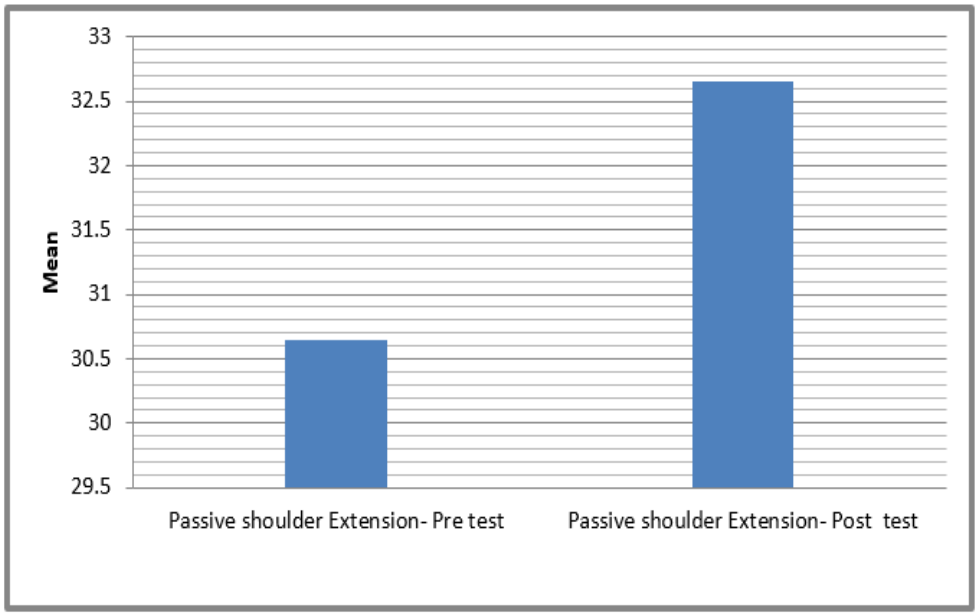

Fig12: Comparison and testing the significant difference between pre and post-test passive shoulder extension

Table No.7 (Figure:12) represents the mean passive shoulder Extension pre and post treatment scores. It is understood from the table that the pre and post treatment scores were 30.65±6.4 and 32.65±5.6 respectively. On using Paired t test, statistically significant difference was observed in the pre and post treatment passive shoulder abduction (p<0.001)

4. DISCUSSION

The primary intention of the study was to determine the immediate effect of Thoracic Spine and Shoulder Joint Manipulation and Thermotherapy on Glenohumeral Range of motions in Patients with Adhesive Capsulitis. The samples were comparable at baseline concerning age and sex (Table 1). Hence, any subsequent difference between them can be attributed to the difference in the effects of the interventions. Statistically, it is observed that there is a significant difference between pre and post-VAS (Table 2), and pre and post-range of motion scores in the samples (Table 3, 4, 5, 6, 7). This implies that Thoracic Spine and Shoulder Joint Manipulation adjunct with thermotherapy, in general, were effective in managing patients with Adhesive Capsulitis. The significant effects of the protocol of Thoracic Spine and Shoulder Joint Manipulation and Thermotherapy on pain, and Range of motion, are consistent with reports from previous studies done by various researchers like Jashua R McCormach, who did a case study of AC where he examined the effect of thoracic manipulation which showed promising results in decreasing pain and overall outcome of the patient.[21] and Mohsen Kazemi in a case study of AC got positive results by applying shoulder manipulation along with other treatment tools[22]. The human body is a kinetic chain form, an engineering concept used to describe human motion. It was introduced by Franz Reuleaux, a mechanical engineer in 1875, where he proposed that rigid, overlapping segments were connected via joints, and this created a system whereby movement at one joint produced affects movement at another joint in the kinetic link[34] In 1995, Dr. Arthur Steindler adapted Reuleaux's theory and included the analysis of human movement, sport-specific activity patterns, and exercise. He suggested that the extremities should be thought of as rigid, overlapping segments in series and defined the kinetic chain as a "combination of several successively arranged joints constituting a complex motor unit." This series, or chains, can be open or closed[34].The scapula bone which forms the foundation for the Glenohumeral joint is connected to the thoracic cage and the spine by various superficial and deep muscles. Trapezius has a major connection between the scapula and the spine as it originates on the occipital bone, the ligamentum nuchae, and the spinous process of T1 to T12 inserts on the lateral third of the clavicle, acromion, and the scapular spine of the scapula. Deep muscles like the levator scapulae and the rhomboids originate from the 1st four cervical vertebrae and the spinous process of the T2 to T5 vertebra, respectively and insert into the medial border of the scapula. Considering these anatomical connections in the context of the Reuleaux concept, any shoulder complex movement will affect the cervical and thoracic spine joints. In chronic adhesive Capsulitis patients, there is a significant loss of shoulder range of motion[1], particularly in the glenohumeral joint. It is

also seen that there is a deficit of Range of motion in the thoracic spine in this patients[21]. Therefore, the release of the stiffness of the spinal facet joints shall affect the Range of motion in the Glenohumeral joint. This is established in the present study where thoracic manipulation applied to the patients for the management of adhesive capsulitis along with other tools delivered good results. The above statements hold to the concept of regional interdependence whereby applying the concept of kinetic chain system, treatment is applied in a remote location i.e. the thoracic spine, which is connected with the diseased part, and the effect is seen in another location i.e. increase in the glenohumeral joint Range of motion. Various studies have been carried out with this treatment model, which reflect the involvement of distant dysfunctions which when addressed relieve the patient from their conditions[15-17]. This concept is likely to be a complex phenomenon and perhaps is driven by a neurophysiologic response related to the peripheral, spinal cord and supraspinal mechanisms[18]. Recent evidence has also demonstrated the effectiveness of using different manual therapy tools that incorporate the concept of RI in various diagnoses and includes spinal stenosis[35], knee osteoarthritis[36], and patellofemoral syndrome[37]. All of these studies found significantly more significant improvements in patients who received manual therapy interventions both proximal and distal to the patients' primary symptoms. However, the main body of physical therapy literature using an RI approach describes treating the thoracic spine, often for individuals with neck pain and/or shoulder pain[38,39] which is in relation to the present study.

5. CONCLUSION

From the above discussion, it may be concluded that there is an immediate effect of Thoracic Spine and Shoulder Joint Manipulation along with Thermotherapy on Glenohumeral Range of motions in Patients with Adhesive Capsulitis. From the authors viewpoint, Thoracic Spine and Shoulder Joint Manipulation adjunct with thermotherapy, in general, were effective in managing patients with Adhesive Capsulitis which was quite evident from the analysis of the data of the study. Physiotherapists are encouraged to adopt these techniques in their practice and apply for pain relief and overall improvement of the patient

6. LIMITATION

Following are some of the limitations that were experienced and seen during the study. The manipulation techniques were painful for some of the patients, therefore few of them (n=6) was not willing to continue this mode of treatment and requested to change the therapy for future sessions. The present study did not assess the probable outcome of structured consecutive therapy sessions; therefore, the effectiveness of the techniques can be further studied with tailored protocols. Long-term follow-up may be carried out to examine the effectiveness of the treatment. Medications of patients were not taken into account when the therapy was administered. The age group of the participants was restricted only to the age group of 40–65 years.

7. AUTHORS CONTRIBUTION STATEMENT

Abhijit Kalita carried out this research work as partial fulfillment for completing his structured Doctorate of Philosophy (PhD) programme under the supervision of Dr. Pratap Chandra Sarma and Dr Jayanta Madhab Saikia. Abhijit Kalita conceived and designed the study, performed the review of literature, collected and analyzed the data, and wrote the first and the final draft of the article. Dr. Pratap Chandra Sarma and Dr Jayanta Madhab Saikia supervised the entire research work, critically reviewed the article and approved the final version of the article to be published. Dr Jayanta Madhab Saikia helped with the samples taken for the study. Dr. Abhijit Dutta helped in conceptualizing the study and in reviewing literature, Santosh k Rajak contributed to data collection, discussion and organized matter in various drafts of the article.

8. ACKNOWLEDGEMENTS

The authors would like to thank all the study subjects for their participation and duly acknowledge all the orthopedic surgeons who have helped with the collection of samples.

9. CONFLICT OF INTEREST

Conflict of interest declared none.

10. REFERENCES

1. Kingston K, Curry EJ, Galvin JW, Li X. Shoulder adhesive capsulitis: epidemiology and predictors of surgery. J Shoulder Elbow Surg. 2018;27(8):1437-43. doi: 10.1016/j.jse.2018.04.004, PMID 29807717.
2. Mao CY, Jaw WC, Cheng HC. Frozen shoulder: correlation between the response to physical therapy and follow-up shoulder arthrography. Arch Phys Med Rehabil. 1997;78(8):857-9. doi: 10.1016/s0003-9993(97)90200-8, PMID 9344306.
3. D'Orsi GM, Via AG, Frizziero A, Oliva F. Treatment of adhesive capsulitis: a review. Muscles Ligaments Tendons J. 2012 September 10;2(2):70-8. PMID 23738277.
4. Plaza-Manzano G, Molina-Ortega F, Lomas-Vega R, Martínez-Amat A, Achalandabaso A, Hita-Contreras F. Changes in biochemical markers of pain perception and stress response after spinal manipulation. J Orthop Sports Phys Ther. 2014;44(4):231-9. doi: 10.2519/jospt.2014.4996, PMID 24450367.
5. Xiao RC, DeAngelis JP, Smith CC, Ramappa AJ. Evaluating nonoperative treatments for adhesive capsulitis. J Surg Orthop Adv. 2017;26(4):193-9. PMID 29461189.
6. Reeves B. The natural history of the frozen shoulder syndrome. Scand J Rheumatol. 1975;4(4):193-6. doi: 10.3109/03009747509165255, PMID 1198072.
7. Mezian K, Coffey R, Chang KV. Frozen shoulder. StatPearls [Internet]. Updated 2022 May 12:2022 Jan-.
8. Ekelund AL, Rydell N. Combination treatment for adhesive capsulitis of the shoulder. Clin Orthop Relat Res. 1992;282(282):105-9. doi: 10.1097/00003086-199209000-00013, PMID 1516300.
9. Loew M, Heichel TO, Lehner B. Intraarticular lesions in primary frozen shoulder after manipulation under general anesthesia. J Shoulder Elbow Surg. 2005;14(1):16-21. doi: 10.1016/j.jse.2004.04.004, PMID 15723009.

10. Bulgen DY, Binder AI, Hazleman BL, Dutton J, Roberts S. Frozen shoulder: a prospective clinical study with an evaluation of three treatment regimens. Ann Rheum Dis. 1984;43(3):353-60. doi: 10.1136/ard.43.3.353, PMID 6742895.
11. Kalita A, Milton A. The combined effectiveness of glenohumeral end-range mobilization and contract-relax technique for glenohumeral internal rotators in subjects with adhesive capsulitis. Int J Physiother. 2015;2(5):691-7. doi: 10.15621/ijphy/2015/v2i5/78221.
12. Walling S, Kalita A, Dutta A. Effectiveness of Kaltenborn posterior glide and coracohumeral ligament positional stretching on external rotation range of motion in patients with adhesive capsulitis. Indian J Forensic Med Toxicol. 2021;15(2):1001-9. doi: 10.37506/ijfmt.v15i2.14445.
13. Strunce JB, Walker MJ, Boyles RE, Young BA. The immediate effects of the thoracic spine and rib manipulation on subjects with primary complaints of shoulder pain. J Man Manip Ther. 2009;17(4):230-6. doi: 10.1179/106698109791352102, PMID 20140154, PMCID PMC2813499.
14. Wainner RS, Whitman JM, Cleland JA, Flynn TW. Regional interdependence: a musculoskeletal examination model whose time has come. J Orthop Sports Phys Ther. 2007;37(11):658-60. doi: 10.2519/jospt.2007.0110, PMID 18057674.
15. Bang MD, Deyle GD. Comparison of supervised exercise with and without manual physical therapy for patients with shoulder impingement syndrome. J Orthop Sports Phys Ther. 2000;30(3):126-37. doi: 10.2519/jospt.2000.30.3.126, PMID 10721508.
16. Bergman GJ, Winters JC, Groenier KH, Pool JJ, Meyboom-de Jong B, Postema K, et al. Manipulative therapy in addition to usual medical care for patients with shoulder dysfunction and pain: A randomized controlled trial. Ann Intern Med. 2004;141(6):432-9. doi: 10.7326/0003-4819-141-6-200409210-00008, PMID 15381516.
17. Winters JC, Sobel JS, Groenier KH, Arendzen HJ, Meyboom-de Jong B. Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomised, single-blind study. BMJ. 1997;314(7090):1320-5. doi: 10.1136/bmj.314.7090.1320, PMID 9158469.
18. Bialosky JE, Bishop MD, George SZ. Regional interdependence: a musculoskeletal examination model whose time has come. J Orthop Sports Phys Ther. 2008;38(3):159-60; author reply 160. doi: 10.2519/jospt.2008.38.3.159, PMID 18349496.
19. McPartland JM, Giuffrida A, King J, Skinner E, Scotter J, Musty RE. Cannabimimetic effects of osteopathic manipulative treatment. J Am Osteopath Assoc. 2005;105(6):283-91. PMID 16118355.
20. Plaza-Manzano G, Molina-Ortega F, Lomas-Vega R, Martínez-Amat A, Achalandabaso A, Hita-Contreras F. Changes in biochemical markers of pain perception and stress response after spinal manipulation. J Orthop Sports Phys Ther. 2014;44(4):231-9. doi: 10.2519/jospt.2014.4996, PMID 24450367.
21. McCormack JR. Use of thoracic spine manipulation in the treatment of adhesive capsulitis: a case report. J Man Manip Ther. 2012 February;20(1):28-34. doi: 10.1179/20426186l1Y.0000000008, PMID 23372391, PMCID PMC3267444.
22. Kazemi M. Adhesive capsulitis: a case report. J Can Chiropr Assoc. 2000;44(3):169-76.
23. Tiplady B, Jackson SH, Maskrey VM, Swift CG. Validity and sensitivity of visual analogue scales in young and older healthy subjects. Age Ageing. 1998;27(1, January):63-6. doi: 10.1093/ageing/27.1.63, PMID 9504368.
24. Riddle DL, Rothstein JM, Lamb RL. Goniometric reliability in a clinical setting. Shoulder measurements. Phys Ther. 1987 May;67(5):668-73. doi: 10.1093/ptj/67.5.668, PMID 3575423.
25. de Koning CH, van den Heuvel SP, Staal JB, Smits-Engelsman BC, Hendriks EJ. Clinimetric evaluation of active Range of motion measures in patients with non-specific neck pain: a systematic review. Eur Spine J. 2008;17(7):905-21. doi: 10.1007/s00586-008-0656-3, PMID 18427843.
26. Piva SR, Erhard RE, Childs JD, Browder DA. Inter-tester reliability of passive intervertebral and active movements of the cervical spine. Man Ther. 2006;11(4):321-30. doi: 10.1016/j.math.2005.09.001, PMID 16837235.
27. van Trijffel E, Anderegg Q, Bossuyt PM, Lucas C. Interexaminer reliability of passive assessment of intervertebral motion in the cervical and lumbar spine: a systematic review. Man Ther. 2005;10(4):256-69. doi: 10.1016/j.math.2005.04.008, PMID 15994114.
28. Flynn T. Orthopaedic manual physical TherapyManagement of the cervical-thoracic spine and rib cage. Minneapolis: OPTP, 2005.
29. Michel J, Gyer G, Davis R. Osteopathic and chiropractic Techniques for Manual therapists. London: Singing Dragon. p. 2017.139p.
30. Wise CH. Orthopaedic manual physical therapy. Philadelphia: F A Davis Company. p. 2015.795p.
31. Mintken PE, Cleland JA, Carpenter KJ, Bieniek ML, Keirns M, Whitman JM. Some factors predict successful short-term outcomes in individuals with shoulder pain receiving cervicothoracic manipulation: a single-arm trial. Phys Ther. 2010;90(1):26-42. doi: 10.2522/ptj.20090095, PMID 19959652.
32. Beffa R, Mathews R. Does the adjustment cavitate the targeted joint? An investigation into the location of cavitation sounds. J Manipulative Physiol Ther. 2004;27(2):e2. doi: 10.1016/j.jmpt.2003.12.014, PMID 14970817.
33. Ross JK, Bereznick DE, McGill SM. Determining cavitation location during lumbar and thoracic spinal manipulation: is spinal manipulation accurate and specific? Spine (Phila Pa 1976). 2004;29(13):1452-7. doi: 10.1097/01.brs.0000129024.95630.57, PMID 15223938.
34. Ellenbecker TS, Davies GJ. Closed kinetic chain exercise: a comprehensive guide to multiple joint exercises. J Hum Kinet. 2001.
35. Whitman JM, Flynn TW, Childs JD, Wainner RS, Gill HE, Ryder MG, et al. A comparison between two physical therapy treatment programs for patients with lumbar spinal stenosis: a randomized clinical trial. Spine. 2006;31(22):2541-9. doi: 10.1097/01.brs.0000241136.98159.8c, PMID 17047542.
36. Deyle GD, Henderson NE, Matekel RL, Ryder MG, Garber MB, Allison SC. Effectiveness of manual physical therapy and exercise in osteoarthritis of the knee. A randomized, controlled trial. Ann Intern Med.

2000;132(3):173-81. doi: 10.7326/0003-4819-132-3-200002010-00002, PMID 10651597.
37. Iverson CA, Sutlive TG, Crowell MS, Morrell RL, Perkins MW, Garber MB, et al. Lumbopelvic manipulation for the treatment of patients with patellofemoral pain syndrome: development of a clinical prediction rule. J Orthop Sports Phys Ther. 2008;38(6):297-309; discussion 309. doi: 10.2519/jospt.2008.2669, PMID 18515959.
38. Bergman GJ, Winters JC, Groenier KH, Pool JJ, Meyboom-de Jong B, Postema K, et al. Manipulative therapy in addition to usual medical care for patients with shoulder dysfunction and pain: a randomized, controlled trial. Ann Intern Med. 2004;141(6):432-9. doi: 10.7326/0003-4819-141-6-200409210-00008, PMID 15381516.
39. Walser RF, Meserve BB, Boucher TR. The effectiveness of thoracic spine manipulation for the management of musculoskeletal conditions: a systematic review and meta-analysis of randomized clinical trials. J Man Manip Ther. 2009;17(4):237-46. doi: 10.1179/106698109791352085, PMID 20140155.