



# MANUAL THERAPY TECHNIQUES FOR THE ACROMIOCLAVICULAR JOINT DYSFUNCTION – A NARRATIVE REVIEW

Nallapareddygari Bhavya Sree<sup>1</sup> Dr Senthil Kumar<sup>2</sup> Dr Shwetha Sashidharan<sup>3</sup>

<sup>1</sup>Mpt Student, School of Health Science, Department of Physiotherapy, Garden City University, Bengaluru, Karnataka, India,

<sup>2</sup>Research Supervisor and Professor, School of Health Science, Department of Physiotherapy, Garden City University Bengaluru, Karnataka, India,

<sup>3</sup>Assistant Professor, School of Health Science, Department of Physiotherapy, Garden City University, Bengaluru, Karnataka, India.

Article DOI: <https://doi.org/10.36713/epra16778>

DOI No: 10.36713/epra16778

## ABSTRACT

### INTRO/BACK GROUND

Ac joint dysfunction is a prevalent cause of shoulder discomfort. As far as we're aware, there are currently no published studies focused on the manual therapy management of AC joint dysfunction. However, manual physical therapy has proven successful in treating various other shoulder conditions. To address this, recent research has started to investigate whether manual techniques are more effective in treating ac joint dysfunction.

### OBJECTIVE

Aim of this study on the literature review pointing on the available evidence for the manual therapy interventions in acromioclavicular joint dysfunction patients.

### METHODS

Research involved a computerized data base used for searching articles were Science direct, Pedro, PubMed, goggle scholar search pertaining to studies that include the manual therapy among acromioclavicular joint dysfunction Patients'

### RESULTS:

These 10 studies were based on the inclusion exclusion criteria were included in this review the methods used in all these studies were strengthening exercises, transverse friction massage, joint mobilization, myofascial release techniques, active passive motion exercises, scapulothoracic exercises, peri joint muscle exercises, joint stability exercises with different sets of exercises for muscle activation and range of motion and function these manual therapy techniques aims to alleviate inflammation recover the shoulder pain free rom and restore the proper function of soft tissue and joint.

### CONCLUSION:

We conclude from this review that a variety of manual treatment procedures have been shown to be useful and effective in treating patients with AC joint dysfunction. There is, however, a dearth of data on the use of manual therapy procedures or interventions to treat ac joint dysfunction. More investigation is required to determine the precise role that manual therapy strategies may play in managing ac joint dysfunction.

**KEY WORDS:** ac joint dysfunction, manual therapy, interventions, shoulder dysfunction

## INTRODUCTION

The acromioclavicular (AC) joint connects the lateral end of the clavicle with the anteriorly projecting acromion of the scapula. This joint is essential for providing stability and facilitating movement within the shoulder complex <sup>(1)</sup> The acromioclavicular (AC) joint is a type of synovial joint characterized by the lateral clavicle connecting with the acromion process, which extends forward from the scapula. Functioning as a plane joint, its typical function involves facilitating gliding movements. <sup>(2)</sup> In its normal

state, it contributes to mobility of the scapula, aiding in actions like shoulder abduction and flexion. Additionally, it plays a crucial role in transmitting forces from the upper arm to the skeletal structure. <sup>(3)</sup>

The AC joint is encased by a capsule and features a synovial membrane. Positioned between the bony structures is an intra-articular cartilaginous disk, with fibrocartilage covering the articulating surfaces instead of hyaline cartilage. Three primary



ligaments play crucial roles in stabilizing the joint. The acromioclavicular ligament (AC) consists of superior, inferior, anterior, and posterior components, with the superior and posterior ligaments being particularly robust, providing horizontal stability. <sup>(4)</sup> The coracoclavicular ligaments (CC) complex, comprising the conoid and trapezoid ligaments, inserts onto the undersurface of the distal clavicle, contributing to vertical stability. Moreover, the coracoacromial ligament, a sturdy triangular band connecting the coracoid process to the acromion, also aids in vertical stability. <sup>(5)(6)</sup>

Acromioclavicular (AC) joint injuries are frequently encountered among athletes and young people, constituting over forty percent of shoulder injuries. While minor injuries typically don't result in significant health issues, severe cases can lead to notable decreases in shoulder strength and function. <sup>(7)</sup> Most AC joint injuries occur in young males, typically from a direct fall onto the superior aspect of the shoulder when the arm is adducted <sup>(8)</sup> Symptoms like Swelling and bruising (ecchymoses) can develop around the distal end of the clavicle due to downward displacement of the shoulder girdle. Tenderness is commonly experienced upon touching the AC joint, and discomfort frequently restricts the mobility of the shoulder <sup>(9)</sup> The approximate incidence rate stood at 1.8 cases per 10,000 individuals per year, with males disproportionately affected compared to females, with a ratio of 8.5 to 1. Around 50.5% of all dislocations were reported in individuals aged 20 to 39 years. Sports-related injuries constituted the most prevalent traumatic mechanism, with Rockwood type III dislocation being the most common type observed. <sup>(10)</sup>

This injury is frequently seen in contact athletes who sustain a fall directly onto the superolateral shoulder, causing the acromion to move inferomedial relative to the distal clavicle. With increasing impact severity, there is a progressive injury pattern affecting stabilizing structures, starting with the AC ligaments, then the CC ligaments, and potentially involving the deltotracheal fascia in more severe cases. The most common cause of AC injuries is direct trauma, but there are several indirect mechanisms as well. For example, falling onto an outstretched arm that has been abducted can cause the shoulder blade to be forced into the inferior region of the acromion and the AC joint. <sup>(11)</sup> Manual therapy, a longstanding practice employed for centuries to alleviate pain and enhance functionality, has seen a rise in the utilization of joint mobilization. This increase stems from compelling evidence demonstrating its efficacy in diminishing pain and addressing limitations in joint range-of-motion. <sup>(12)</sup> The treatment of pain, restricted motion, and posture issues frequently involves manual therapy, which encompasses a range of

techniques such as soft tissue manipulation, massage, manual traction, joint manipulation, and joint mobilization. Joint mobilization consists of gentle, slow movements within or at the edge of the joint's range of motion, while joint manipulation involves a swift, forceful thrust to temporarily surpass the restricted range. Recent trends in physical therapy education and ongoing professional development have highlighted the importance of joint mobilization techniques, leading to increased emphasis on these methods in both academic and practical settings. <sup>(13)</sup>

## METHODOLOGY

### STUDY DESIGN

#### SEARCH METHODS AND ELIGIBILITY CRITERIA

The databases utilized to look up content were science direct, Pedro, PubMed, google scholar search. The articles collected full text and screened properly. The key words used to search the relevant articles are Acromioclavicular joint dysfunction, manual therapy, interventions, shoulder dysfunctions, management of ac joint. Citation and reference of relevant articles were checked to find out availability of more articles. Every possible pertinent article was acquired along with a title, abstract, full text literature availability with proper screening of all the literature inclusion criteria.

#### SAMPLE SIZE

A sample size of 30 articles was searched with the keywords of Acromioclavicular joint dysfunction, manual therapy, management of ac joint, shoulder dysfunction. Out of these articles, papers obeying the inclusion and exclusion criteria were filtered and finally, 10 articles were obtained for the review.

#### INCLUSION CRITERIA

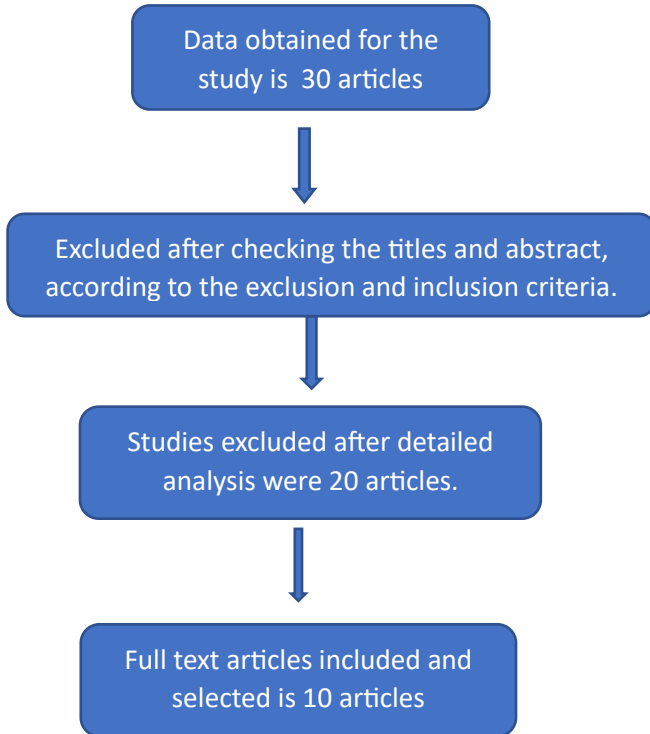
- Articles explaining ac joint dysfunction manual therapy were included
- Recent publications of articles
- Full – text articles.
- Articles written in English
- Articles from year 2010- 2024 were included.

#### EXCLUSION CRITERIA

- Articles of past 2010
- Articles explaining other than manual therapy were excluded.
- Article discussed other than shoulder dysfunction were excluded.
- Articles not containing relevant discussion were excluded



**FLOW CHART**



**RESULTS**

Out of 30 articles, only 10 articles were retrieved which fulfilled the eligibility criteria using above mentioned selection strategy.

Numerous articles were eliminated due to their duplicate content, inability to fulfill the requirements for inclusion or exclusion. Findings of these 10 articles are summarized below.

S.N O	AUTHOR YEAR	TITLE	STUDY METHOD	STUDY DESIGN	CONCLUSION
1.	Thierry Marc PT et al 2024	Effectiveness of a joint mobilizations protocol for shoulder subacromial pain syndrome: A pilot study	45 patients with SPS were divided into two groups randomly. One group received specialized mobilizations Both groups underwent the same second session with all mobilizations. Their functional activities before and after the initial two sessions using the Constant score and Quick Dash. After 11 sessions, ROM through passive and active-assisted mobilizations, stretching, and muscle strengthening	A pilot study	In this study manual therapy technique demonstrated the ability to enhance shoulder mobility in a single session. Specifically, additional joint mobilizations, such as spin correction, notably improved Glenohumeral (GH) abduction and external rotation
2.	Fatemeh Ehtesham et al 2023	Comparing the Effects of Tele-Physical therapy and Supervised Physical	prospective, assessor-blind, randomized controlled clinical trial focusing on 33 patients diagnosed with SAPS three		In this study they address the effects of tele physical therapy and supervised physical therapy



		Therapy on Pain, Range of Motion, Function, and Satisfaction in Patients with Sub Acromial Pain Syndrome: A Protocol of randomized trail	groups, each consisting of 11 individuals: a Control group receiving supervised (ET)+(MT), three groups will undergo 10 sessions of ET and MT spanning three weeks. Assessments will be conducted at VAS and SPADI	A Randomized Clinical trail	on pain range of motion function and satisfaction of individual
3.	Jordan et al 2022	A quantitative placebo-controlled study of the efficacy of manipulation of acromioclavicular joint dysfunction in weight trainers	20 patients randomly splint into 2 groups each group under went 4 treatments over 2 weeks and was assessed. Objective measures include algometer and inclinometer, Subjective results were assessed with SPADI and NRS.	A quantitative placebo-controlled study	This study stated that manipulation shows promise as an effective treatment for AC joint dysfunction when contrasted with a placebo, particularly in terms of objective outcomes. However, because of several limitations, including small sample sizes, it is imperative to approach the interpretation of these data cautiously.
4.	Anna ELIASON et al 2022	GUIDED EXERCISES WITH OR WITHOUT JOINT MOBILIZATION OR NO TREATMENT IN PATIENTS WITH SUBACROMIAL PAIN SYNDROME: A CLINICAL TRIAL	There was a controlled experiment with three arms.120 patients clinically diagnosed with shoulder dysfunction were randomized into guided exercise groups with and without additional joint mobilization, as well as a control group that received no treatment. assessed, 6 weeks, 12 weeks, and 6 months. outcome measured was the Constant-Murley score, secondary outcomes included pain levels and active range of motion.	A clinical trail	In this study Additionally, in the near future the integration of joint mobilization reduces pain and presents a potential alternative to NSAIDs or other pain-relieving medications at the beginning of the treatment course
5.	KEVIN D. HARRIS et al 2017	Manual Physical Therapy for Injection-Confirmed Nonacute Acromioclavicular Joint Pain	50% pain relief from an ACJ treatment involved manual physical therapy addressing shoulder girdle and cervicothoracic spine impairments. outcome measure was the SPADI, with American Shoulder and Elbow Surgeon scale and global rating of change scales. for 4 weeks, and 6 months, and analyzed using repeated-measures analysis of variance for the SPADI	Prospective single cohort study	In this study statistically significant and clinically There was an improvement in every outcome that was measured. after a short series of manual therapy interventions at both the 4-week and 6-month marks. While these findings suggest the effectiveness of this treatment approach within a small patient sample, further validation is necessary through a randomized controlled trial



6.	Ming Zhang, et al 2015	Clinical Effectiveness of Scapulothoracic Joint Control Training Exercises on Shoulder Joint Dysfunction	<p>Forty patients with joint dysfunction and shoulder pain were randomized to either the treatment or control group. Patients in the treatment group completed scapulothoracic joint control training activities, which included active and passive motions, peri-joint muscle workouts, and joint stability exercises, for one month. Interventions included glenohumeral joint mobilization techniques and ultrasound therapy. The Constant-Murley scale was used to evaluate the progress of the patients.</p>	Observational study	This study states that participants received one month of treatment with scapulothoracic joint control exercises, active passive motion of the scapulothoracic joint, peri-joint muscle exercises, and joint stability exercises. The improvement in range of motion and function both before and after the treatment is statistically significant.
7.	Aimie L. Peek et al 2015	Thoracic manual therapy in the management of non-specific shoulder pain: a systematic review	Prisma guidelines From 1990 to 2014, Interventions encompassed cervicothoracic junction and thoracic manipulative therapy (TMT) with or without supplementary exercises. Data extraction was performed independently by each reviewer using a standardized form.	Systemic review	This study stated that Thoracic manual therapy demonstrated accelerated recovery, decreased pain, and reduced disability compared to usual care for non-specific shoulder pain, with benefits lasting up to 52 weeks.
8.	Lennard Voogt et al 2015	Analgesic effects of manual therapy in patients with musculoskeletal pain: A systematic review	A thorough analysis was carried out in accordance with PRISMA guidelines. Manual therapy was characterized as any manual manipulation of joints aimed at eliciting analgesic effects. Pain threshold served as the primary outcome measure.	A systemic Review	In this study Based on moderate evidence, it appears that manual therapy results in a reduction of local pressure pain thresholds among individuals experiencing musculoskeletal pain immediately after the treatment. However, there were no notable changes observed in thermal pain threshold values
9.	TRACY J. BRUDVIG, et al 2011	The Effect of Therapeutic Exercise and Mobilization on Patients with Shoulder Dysfunction: A Systematic Review with Meta-analysis	six databases for randomized controlled studies looking into the efficacy of therapeutic exercise and joint mobilization in adults with confirmed shoulder dysfunction, manifested by pain, restricted range of motion (ROM), impaired function. Effect sizes were assessed using standardized mean difference and 95% confidence intervals (CI) for every parameter, those were then	A systematic review with meta-analysis	According to study meta-analysis, we cannot conclude that the combination of therapeutic exercise and joint mobilization is superior to therapeutic exercise alone for pain reduction, increase in ROM and function, and decrease in disability in patients with shoulder dysfunction and vice versa. However, we are unable to entirely rule out that one. treatment is more





			synthesized to derive weighted standardized mean differences (WSMDs) and 95% CIs.		beneficial than the other. Additional high-quality evidence is needed .
10.	Lee N. Marinko PT, ScD et al 2011	The effectiveness of therapeutic exercise for painful shoulder conditions: a meta-analysis	A thorough search was conducted using Medline via Ovid, CINAHL, and the Cochrane Central Register of Controlled Trials. from 1997 to March 2011. The objective was to identify randomized controlled trials comparing physical therapist-prescribed exercises with primary outcomes related to range of motion (ROM), pain, and function. Individual effect sizes were computed using a standard formula, and the overall effect was assessed using random- and fixed-effects models.	A Meta-analysis	In this study Therapeutic exercise has shown effectiveness in treating painful shoulder conditions, but additional research is needed to ensure its seamless integration into clinical practice.

## DISSCUSION

Manual therapy aims to alleviate inflammation recover the shoulders pain free range of motion and restore the proper function of soft tissue and joints Thierry Marc PT 2024 stated in their study Effectiveness of a joint mobilizations protocol for shoulder subacromial pain syndrome: A pilot study 45 patients diagnosed with Shoulder Pain Syndrome (SPS) were randomly assigned to two groups: an experimental group and a control group. Both groups underwent a rehabilitation program called the Shoulder Global Concept. However, a difference in the initial session between the experimental and control groups. The experimental group received all specific mobilizations, including spin correction mobilizations, while the control group received the same program but without the spin correction mobilizations. The second session was identical for both groups, involving all specific mobilizations Before and after the first two sessions, range of motion (ROM) in flexion, abduction, external and internal rotations, pain levels, and functional status were evaluated using the Constant score and Quick Dash. All ROM were improved after the first session for both groups, but significantly more in the experimental group for glenohumeral (GH) abduction and external rotation ( $p < 0.05$ ). Functional scores, pain and strength were significantly improved after 11 rehabilitation sessions. Fatemesh et al 2023 stated in his study Comparing the Effects of Tele-Physical therapy and Supervised Physical Therapy on Pain, Range of Motion, Function, and Satisfaction in Patients with Sub Acromial Pain Syndrome: A Protocol of Randomized Clinical Trial he study will include 33 patients with SAPS, divided into three groups: Control group receiving supervised Exercise Therapy (ET) + Manual Therapy (MT), Videoconferencing group receiving ET + self-release therapy, and Video-based group receiving ET + self-release therapy. Self-release therapies involve self-joint mobilization and self-myofascial release using a tennis ball, while MT includes joint mobilization techniques and transverse friction massages.

ET comprises stretching and strengthening exercises. Each group will undergo 10 sessions of therapy over three weeks. Assessments will be conducted at baseline, midterm, and post-treatment, using measures such as the VAS for pain, the SPADI for function, and flexibility evaluation. Patient satisfaction will also be assessed using the Telehealth Satisfaction Scale and Physical Therapy Patient Satisfaction Questionnaire. Data analysis will involve repeated measures ANOVA to compare outcomes among the groups over time. The experiment's goal is to contrast the efficacy of tele-physical therapy utilizing self-release techniques and exercises via videoconferencing against traditional face-to-face therapy with supervise exercises and manual therapy. The focus is on pain reduction, functional improvement, Range of Motion enhancement, and patient satisfaction.

Jardon et al stated that A quantitative, placebo-controlled investigation of the effectiveness of acromioclavicular joint dysfunction in weight trainers twenty weight trainers were randomly assigned to two groups. Each group received four treatments over two weeks Patients were evaluated at initial, one week, two weeks, and one-month follow-ups. Algometer and Inclinator readings were used. Numerical Pain Rating Scales (NRS), Shoulder Rating Questionnaire (SRQ), and (SPADI) were employed. Manipulation appears effective in treating malfunction of the AC joint, particularly with respect to the goals. Ming zangh et al In 2015, he reported that among 40 patients with traumatic shoulder discomfort, scapulothoracic joint control training activities were beneficial in treating shoulder joint dysfunction. These patients were split into two groups at random: the therapy group and the control group. Standard rehabilitation procedures, including glenohumeral joint mobilization, ultrasound therapy, interfering current therapy, and traditional Chinese medicine, were administered to both groups. The treatment group also received these conventional treatments plus one month of



scapulothoracic joint control training activities. These workouts included peri-joint muscle activities, joint stability-enhancing exercises, and both passive and dynamic scapulothoracic joint motions. The Constant-Murley scales were used to evaluate the patients' conditions both before and after the therapies. The results showed that after the recommended therapies, there were notable improvements in a number of areas, including pain levels, everyday activities, range of mobility, and overall ratings. Additionally, patients in the treatment group showed statistically significant improvements in pain management, daily activities, breadth of activities, and overall scores ( $P < 0.05$ ) in comparison to the control group. Regarding the results of the strength tests, there was, however, no discernible difference between the two groups.

### LIMITATION

- Limited articles on manual treatment for ac joint dysfunction
- Non-availability of articles in other search engines
- Difficult to find full text articles in above mention search engines

### STRENGTH

This review has shown more scope of research to analyze manual therapy procedures for ac joint dysfunction.

### CONCLUSION

We conclude from this review that a variety of manual treatment modalities have been shown to be useful and effective in treating patients with AC joint dysfunction. Further research and study are required to determine how manual therapy techniques can help manage ac joint dysfunction, as there has been little research on the use of these techniques or interventions for treating ac joint dysfunction.

### REFERENCES

1. Wong M, Kiel J. *Anatomy, Shoulder and Upper Limb, Acromioclavicular Joint*. [Updated 2023 Jul 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK499858/>.
2. Hyland S, Charlick M, Varacallo M. *Anatomy, Shoulder and Upper Limb, Clavicle*. 2023 Jul 24. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. PMID: 30252246.
3. Nakazawa M, Nimura A, Mochizuki T, Koizumi M, Sato T, Akita K. *The Orientation and Variation of the Acromioclavicular Ligament: An Anatomic Study*. *Am J Sports Med*. 2016 Oct;44(10):2690-2695. doi: 10.1177/03635465166651440. Epub 2016 Jun 17. PMID: 27315820.
4. Gottschalk HP, Browne RH, Starr AJ. *Shoulder girdle: patterns of trauma and associated injuries*. *J Orthop Trauma*. 2011 May;25(5):266-71. doi: 10.1097/BOT.0b013e3181e47975. PMID: 21464745.
5. Marsalli M, Moran N, Laso JI. *Arthroscopic Acromioclavicular Joint Reconstruction With TightRope and FiberTape Loop*. *Arthrosc Tech*. 2018 Oct 8;7(11):e1103-e1108. doi: 10.1016/j.eats.2018.07.005. PMID: 30533355; PMCID: PMC6261064.
6. Lee SJ, Yoo YS, Kim YS, Jang SW, Kim J, Kim SJ, Kim BS, Jung KH, Varshney A. *Arthroscopic Coracoclavicular Fixation Using Multiple Low-Profile Devices in Acute Acromioclavicular Joint Dislocation*. *Arthroscopy*. 2019 Jan;35(1):14-21. doi: 10.1016/j.arthro.2018.07.007. Epub 2018 Nov 16. PMID: 30455087.
7. Kiel J, Taqi M, Kaiser K. *Acromioclavicular Joint Injury*. [Updated 2022 Sep 24]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK493188/>
8. Frank, Rachel M. MD; Cotter, Eric J. MD; Leroux, Timothy S. MD; Romeo, Anthony A. MD. *Acromioclavicular Joint Injuries: Evidence-based Treatment*. *Journal of the American Academy of Orthopaedic Surgeons* 27(17):p e775-e788, September 1, 2019. | DOI: 10.5435/JAAOS-D-17-00105
9. Sirin E, Aydin N, Mert Topkar O. *Acromioclavicular joint injuries: diagnosis, classification and ligamentoplasty procedures*. *EFORT Open Rev*. 2018 Jul 17;3(7):426-433. doi: 10.1302/2058-5241.3.170027. PMID: 30233818; PMCID: PMC6129955.
10. Chillemi C, Franceschini V, Dei Giudici L, Alibardi A, Salate Santone F, Ramos Alday LJ, Osimani M. *Epidemiology of isolated acromioclavicular joint dislocation*. *Emergency medicine international*. 2013 Jan 1;2013
11. John A. Johansen, Paul W. Grutter, Edward G. McFarland, Steve A. Petersen, *Acromioclavicular joint injuries: indications for treatment and treatment options*, *Journal of Shoulder and Elbow Surgery*, Volume 20, Issue 2, Supplement, 2011, Pages S70-S82, ISSN 1058-2746, <https://doi.org/10.1016/j.jse.2010.10.030>. (<https://www.sciencedirect.com/science/article/pii/S1058274610004465>)
12. Bishop MD, Torres-Cueco R, Gay CW, Lluch-Girbés E, Beniucik JM, Bialosky JE. *What effect can manual therapy have on a patient's pain experience?* *Pain Manag*. 2015;5(6):455-64. doi: 10.2217/pmt.15.39. Epub 2015 Sep 24. PMID: 26401979; PMCID: PMC4976880.
13. Di Fabio RP. *Efficacy of manual therapy*. *Phys Ther*. 1992 Dec;72(12):853-64. doi: 10.1093/ptj/72.12.853. PMID: 1454861.
14. Marc T, Morana C. *Effectiveness of a joint mobilizations protocol for shoulder subacromial pain syndrome: A pilot study*. *Journal of Bodywork and Movement Therapies*. 2024 Mar 26.
15. Ehteshami F, Ghotbi N, Otadi K. *Comparing the Effects of Tele-Physical therapy and Supervised Physical Therapy on Pain, Range of Motion, Function, and Satisfaction in Patients with Sub Acromial Pain Syndrome: A Protocol of Randomized Clinical Trial*. *Journal of Rehabilitation Sciences & Research*. 2024 Mar 1;11(1):36-42.
16. Jordan WG. *A quantitative placebo controlled study of the efficacy of manipulation of acromioclavicular joint dysfunction in weight trainers (Doctoral dissertation)*.



17. Eliason A, Harringe M, Engström B, Werner S. Guided exercises with or without joint mobilization or no treatment in patients with subacromial pain syndrome: a clinical trial. *Journal of Rehabilitation Medicine*. 2021;53(5).
18. Harris KD, Deyle GD, Gill NW, Howes RR. Manual physical therapy for injection-confirmed nonacute acromioclavicular joint pain. *journal of orthopaedic & sports physical therapy*. 2012 Feb;42(2):66-80.
19. Zhang M, Zhou JJ, Zhang YM, Wang JH, Zhang QY, Chen W. Clinical effectiveness of scapulothoracic joint control training exercises on shoulder joint dysfunction. *Cell biochemistry and biophysics*. 2015 May;72:83-7.
20. Peek AL, Miller C, Heneghan NR. Thoracic manual therapy in the management of non-specific shoulder pain: a systematic review. *Journal of Manual & Manipulative Therapy*. 2015 Sep 1;23(4):176-87.
21. Voogt L, de Vries J, Meeus M, Struyf F, Meuffels D, Nijs J. Analgesic effects of manual therapy in patients with musculoskeletal pain: a systematic review. *Manual therapy*. 2015 Apr 1;20(2):250-6.
22. Brudvig TJ, Kulkarni H, Shah S. The effect of therapeutic exercise and mobilization on patients with shoulder dysfunction: a systematic review with meta-analysis. *journal of orthopaedic & sports physical therapy*. 2011 Oct;41(10):734-48.
23. Marinko LN, Chacko JM, Dalton D, Chacko CC. The effectiveness of therapeutic exercise for painful shoulder conditions: a meta-analysis Marinko LN, Chacko JM, Dalton D, Chacko CC. The effectiveness of therapeutic exercise for painful shoulder conditions: a meta-analysis. *Journal of shoulder and elbow surgery*. 2011 Dec 1;20(8):1351-9. is. *Journal of shoulder and elbow surgery*. 2011 Dec 1;20(8):1351-9.