8-18-2023 12:00 PM

# Evaluation of Conservative and Operative Treatments in Active Patients with Acromioclavicular (AC) and Rotator Cuff (RC) Injuries

Jesse Singh, *Western University*

Supervisor: Dr. Joy C. Macdermid, *The University of Western Ontario*

A thesis submitted in partial fulfillment of the requirements for the Master of Science degree in Health and Rehabilitation Sciences

# Abstract

**Introduction**: Shoulder pain and disability, particularly acromioclavicular joint (ACJ) and rotator cuff (RC) injuries, are common in a physically active population. Determining operative or rehabilitative treatment plans involve multiple treatment choices influenced by the injury grade and treatment goals, such as return to sport. This thesis investigates the management of treatment for AC and RC injuries

**Method:** The first study is a scoping review that uses the Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) to synthesize 32 studies involving athletes who have undergone conservative or operative treatment for their Rockwood grade III ACJ injuries by evaluating shoulder function outcomes and return to sport (RTS). The second study is a secondary data analysis from a prospective cohort of 343 patients with RC injuries and examines the differences in shoulder function, using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, based on sex and age within a one year follow up.

**Results:** Study One indicates a slight preference for conservative treatments for ACJ injuries from patient reported outcomes, with surgical treatment preferred for younger athletes. However, they both had similar function scores and RTS for surgical and conservative treatments. Study Two determined that males and older adults had lower disability scores post-surgery.

**Discussion:** The studies provide insight into the complexities of patient care, patient goals, and the importance of evidence-based clinical practices. Patient-centric

experiences is paramount into understanding how to deliver the best rehabilitation protocol.

## Keywords and Abbreviations

**Keywords**: Shoulder, Athletic Injury, Sport Injury, Athlete, Rehabilitation, Conservative Treatment, Surgery, Instability, Acromioclavicular, Rotator Cuff.

**Abbreviations:**

AC = acromioclavicular

ACCR = anatomic coracoclavicular reconstruction

ACJ = acromioclavicular joint

ACJI = Acromioclavicular Joint Instability Scoring System

ANOVA = one-way analysis of variance

ASOSS = Age and American Society of Anaesthesiologist Score

ASES = American Shoulder and Elbow Surgeons score

CC = coracoclavicular

CS = constant score

DASH = disabilities of the arm, shoulder, and hand

DF = degrees of freedom

DV = dependent variable

ES = effect size

IV = independent variable

KT = Knowledge Translation

LARS = Ligament Augmentation and Reconstruction Systems

MINORS = Methodological Index for Non-Randomised-Control Trials

NAS = Numerical Analog Scales

N = number (of sample population)

PRISMA-ScR = Preferred Reporting Items for Systematic Reviews and Meta-Analysis for Scoping Reviews

PT = physical therapy

OR4KT = Organizational Readiness for Knowledge Translation tool

OSS = Oxford Shoulder Score

RC = rotator cuff

RCT = randomized control trial

RICE = rest, ice, compression, and elevation

ROM = range of motion

RTS = return to sport

SANE= Self-Assessment Numeric Evaluation

SC = sternoclavicular

SD = standard deviation

SIG = significance

SIRSI = Shoulder Instability Return to Sport after Injury Scale

SPADI = Shoulder Pain and Disability Index

SPORTS = Subject patient outcome for return to sports

SPSS = Statistical Package for the Social Sciences

SSAS = Somatosensory Amplification Scale

SSS = Subjective Shoulder Score

SST = Simple Shoulder Test

UCLA shoulder scale = University of California – Los Angeles Shoulder Scale

VAS = visual analogue scale

XSMFA-D = Extra Short Musculoskeletal Function Assessment questionnaire

NHL= National Hockey League

# Summary for Lay Audience

Shoulder joint injuries in athletes are a common occurrence due to the activities in which they are involved. To determine the severity of the injury, x-ray and ultrasound testing is used to see the displacement of the bone and joints. The acromioclavicular joint (ACJ) is a shoulder joint that is susceptible to injury and can tear or fracture. Rockwood is a scale from 1-6 that determines how severe the ACJ injury is. Type/grade III on the Rockwood scale is a controversial area as determining whether the conservative approach or surgical approach is more warranted is still an ongoing debate. Treatment options are given to the patient and are ultimately determined through collaboration between the patient and healthcare professional. The first approach is conservative treatment, which includes physical therapy (PT) using exercises, slings, and muscle therapy. The second approach is surgical, which encompasses a variety of techniques such as reconstruction, transferring neighbouring ligaments, and the use of pins and wires for support. When deciding which treatment approach to take, it is important for patients to be educated on the pros and cons of each approach, known as knowledge translation (KT), and should consider Return to sport (RTS) as an important factor. Patients who have undergone either approach will report on how their shoulders work after their treatment – how fast they can RTS is an important indicator of the treatment's success. Through this research, it was determined that both surgical/operative and conservative methods are successful and that RTS is determined on a case-by-case basis. Sex and age effect shoulder surgery recovery time concerning rotator cuff (RC) injuries. It was determined that older men had the highest function post-operation after 1 year from analysing the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire scores, evaluating basic functions of their shoulders post-surgery from 3-12 months.

# Acknowledgements

I would like to acknowledge Dr. Joy C. Macdermid, PT, PhD, FCAHS, FRSC, who acted as my supervisor and helped oversee this project and supply the used data sets from the Roth McFarlane Hand & Upper Limb Centre in London, Ontario.

I would like to acknowledge Greg Alcock, MSc.PT, BHSc.PT, BAHons.P.E., FCAMPT, and Dr. Pulak Parikh, PT, DPT, PhD, FCAMPT, for acting as co-supervisors and helping to provide guidance and edits when applicable.

Lastly, I would like to acknowledge Adriana Skaljin, B.A. for acting as a co-researcher by helping complete quality assessment and sort through screening of articles on Covidence based-off eligibility criteria.

# Table of Contents

# List of Tables

# List of Figures

# List of Graphs

Chapter 3 – The Effects of Age and Sex on DASH Results in Rotator Cuff Injuries Following Successful Rotator Cuff Surgery Determining Shoulder Disability Outcomes

# Preface

My name is Jesse Singh, and I am the primary author of this paper. I am a Master of Science (MSc) student at Western University within the department of Health and Rehabilitation Sciences. My work focuses on shoulder injuries within athletes and active populations as they are the most susceptible to musculoskeletal injuries, especially in the field of sport. The motivation behind my research focus was to create of a document that could be an aid to medical professionals, as an update to shoulder injury data. I wanted to create a project that contributes to shoulder instability research and provides clarity around controversies related to conservative versus surgical treatments for Rockwood Level III ACJ injuries. My goal is to eventually create a KT decision-making aid for athletes, regarding treatment options for their shoulder injuries, that highlights treatment pros and cons, expectations, and brief explanations of each major procedure. This thesis is the first steppingstone in understanding shoulder injuries by synthesizing literature and analyzing prospective surgical data. Dr. Joy Macdermid was a supervisor and editor throughout this project. Mr. Greg Alcock and Dr. Pulak Parikh were secondary editors. Adriana Skaljin was a secondary reviewer for chapter 2 and editor.

# 1.0 Introduction to Shoulder Anatomy and Injuries

This chapter provides a contextual foundation for the two studies that have been conducted in this paper. These studies outline current PT and surgical practices pertaining to the shoulder's acromioclavicular joint (ACJ) and rotator cuff (RC). The first study sought to answer the research question of what the gold standard for treatment is concerning the ACJ injuries within athlete populations. The main objective was to perform a scoping review to synthesize literature for current surgical and conservative treatments to determine if there is a gold standard to ACJ Rockwood grade III injury treatment and what the best return to sport (RTS) approach is in terms of conservative or surgical treatments. The second study is a secondary data analysis that looks at a sample population of 343 patients who received treatments for RC injuries. The objective was to observe any differences in upper body disability post RC surgery for sex and age, by analysing patient reported outcomes at a baseline, 3 months, 6 months, and 1-year timeline.

Controversy Concerning Treatment Approach for Grade III ACJ

Study one's context is based on the controversy situated with treatment for ACJ pathology.[1] Clinicians and researchers have had a historic debate on whether ACJ injuries, specifically Rockwood grade III injuries, should be treated surgically or conservatively in order to provide the best healthcare for patients in order for them to return to their activities.[2] Other factors such as timing of surgery, open or arthroscopic, and method of stabilization, are also important questions needing answers for a standardized way of treatment.[3] There has been evidence that supports

[1] Suezie, et al (2014)
[2] Modi, et al (2013)
[3] Phadke, et al (2019)

both approaches in the past, but recent literature has shown a shift in treatment preference, especially considering patient goals.[4]

Brief ACJ Anatomy

The shoulder is located laterally from the chest and consists of three major bones. Those include the humerus, scapula, and clavicle.[5] Four joints are situated in the shoulder: sternoclavicular (SC), acromioclavicular (AC), scapulothoracic and glenohumeral.[6] The ACJ is comprised up of the two bones, the scapula and clavicle.[7] It functions as a contributor to the maximum internal and external rotational range of the scapula on the thorax.[8] The ACJ is on a synovial plane joint, since there are no muscles that act directly on the joint. Ligaments neighbouring the acromioclavicular joint is the CC ligament, comprised up of the conoid and trapezoid ligaments.[9] The blood supply effected by this joint comprise of the thoracoacromial artery and suprascapular nerve.[10] Typically, ACJ injuries occur when the joint is torn or strained, with adjacent tendons being affected. The clavicle is usually suspectable to fracture from anterior dislocation from direct trauma, causing vulnerability and pain.[11] Muscles located surrounding the ACJ include the deltoid, trapezius and pectoralis major, all attaching to the clavicle. The deltoid is inserted into the anterior surface of the clavicle at the lateral third, the trapezius into the posterior clavicle, and pectoralis major inserts into the anterior surface of the two thirds medially.[12]

Brief RC Anatomy

[4] Sirin, et al. (2018)
[5] Miniato, et al. (2021)
[6] Miniato, et al. (2021)
[7] Tran, et al. (2019).
[8] Levangie, et al. (2006)
[9] Vaskovic, et al. (2023)
[10] Vaskovic, et al. (2023)
[11] Miniato, et al. (2021)
[12] Saccomano, et al. (2014)

The rotator cuff consists of the muscles and tendons that are located around the shoulder joint with the purpose of providing stability for the humeral head and the shoulder socket. The rotator cuff comprises up of four muscles, the Supraspinatus, Infraspinatus, Teres minor, and Subscapularis. The Supraspinatus muscle is not a rotator but adds stability through resisting gravitational forces.[13] The Infraspinatus is a powerful lateral rotator of the humerus. The Teres Minor is a narrow long muscle covered by the deltoid which stabilizes the glenohumeral joint. The Subscapularis, the largest component of the axilla, prevents anterior dislocation of humerus during rotation. Muscles start at the shoulder blade and tendons wrap around humeral head to form the cuff to keep the arm in the shoulder socket.[14] The purpose of the RC is to stabilize the shoulder joint to function appropriately. Movement of the humerus within the Glenoid cavity through the glenohumeral joint, enables movement.[15] Since the shoulder is classified as a ball and socket joint, the placement of the ball lies within the pocket of the shoulder blade. This is where the RC tendons form around the humerus head to provide function for motion of the arm. Common shoulder injuries include frozen shoulder, osteoarthritis, rheumatoid arthritis, gout, RC tear, shoulder impingement, shoulder dislocation, shoulder tendonitis, long head biceps tendon tendinopathies, shoulder bursitis, and labral tear.[16]

## 1.1 **Shoulder Injury Epidemiology in Sports**

Sports

Athletes and active populations have several reported shoulder injuries due to the stress and repetitive usage of their shoulder muscles. Shoulder injuries account for

[13] Maruvada, et al. (2023)
[14] Sangeeta, et al. (2015)
[15] Maruvada, et al. (2023)
[16] Pogorzelski, et al. (2018)

41% of injuries situated in contact-based sports.[17] Head-on collisions and full speed contact contribute to the increase of risk of injury, in sports such as ice hockey, American football, rugby, and various forms of wrestling. For instance, the National Hockey League (NHL)'s shoulder injury occurrences account for ~25.5% of publicly reported injuries sustained within the NHL seasons of 2013-2020, where acromioclavicular sprains and shoulder dislocations were the most common injuries.[18] Common causes of these ice hockey injuries come from the nature of the game. Since it's a physical sport, injuries can be caused by both direct impact from other players or impact from the environment, such as the ice or boards. Specifically, these include player collision, board, stick, ice, goal posts, non-direct (skating), and direct puck impact.[19]

Throwing athletes or "overhead athletes" participate in sports with a large range of motion (ROM). Usually there is a strength requirement for the overextended arm, specifically in positions such as a baseball pitcher and football quarterback. These athletes are highly susceptible to injuring their shoulder due to the repetitive motion of the sport, not due to forms of contact. Similarly, golfers have reported shoulder pain, particularly near the ACJ, due to a potential of excessive loading of the joint.[20]

Epidemiologically, sports have been a major environment in which active shoulder injuries take place, especially in major league sports such as the National Football League (NFL), NHL, and Major League Baseball (MLB). The NFL's 2012-2017 seasons reported 355 players who had sustained 403 shoulder instability injuries,

[17] Hawthorne et al. (2022)
[18] Ornon et al (2020)
[19] Ornon et al (2020)
[20] Babenko et al (2022)

which contributed to missed time from their respective games.[21] Around 65% was reported to be on the field of play, 85% of that caused by a form of contact.[22] 2012-2017 NFL preseasons reported the highest amount of shoulder injuries, at 4.9 injuries per 100,000 players.[23] This provides information regarding the level and intensity of the sport's relationship to frequency of injury and occurrence. In other words, the more intense the game is played, the higher of a chance there is for shoulder instability injuries. Position wise, defence and quarterbacks sustained the highest frequency of injuries. Spinal vertebra is a secondary outcome from shoulder dislocations, displaying a relationship between the two injuries.

Professional baseball players produce a high percentage of overhead shoulder injuries as well, averaging around 581 shoulder surgeries for every 542 players between the seasons of 2012 and 2016.[24] Conservative treatment was preferred for MLB players, as surgical treatments were only 19% of treatment plans versus 81% for minor league players. The Labarum was the primary location for repair, having 67% of that being a labral repair.[25] RC surgery accounted for 84% debridement injuries with the reported shoulder injuries.

Other major sports include swimming and volleyball, which account for the ROM and hyper stress inflicted on the shoulder through repetitive usage. These sports require a specific technique where the arm meets resistance while in motion, opposite to throwing a ball. This is significant as pressure is added, not removed, when performing an overhead action. For example, swimmers meet the physical pressures of the water, providing more resistance to the ROM under the water while performing

[21] Anderson, et al (2021)
[22] Anderson, et al (2021)
[23] Anderson, et al (2021)
[24] Chalmers, et al. (2019).
[25] Chalmers, et al. (2019).

a stroke. For volleyball players, the ball meets the arm laterally, shifting the pressure of the shoulder and its respective muscle and bones. These are documented and academically reported within the field of biomechanics. Kinetic differences are widespread in volleyball, depending on the type of serve, volley, and spike used.[26] Different forces, torques, and velocities of the shoulder are stressed into abduction motions during play, all contributing to pressures in the muscle groups and bones surrounding the shoulder.[27] Limiting the number of specific motions, such as overhead serves for a player, can decrease the risk of overuse and overloading on the shoulder and ultimately avoid shoulder instability. Baseball and football are sports that meet resistance when catching the ball, however, these are not repetitive actions and are not required by all players, since they are position-based.

Active Environments

Physically demanding activities that require repetitive movements, lifting, and pulling from the shoulder, can often result in the tearing or spraining of tendons and ligaments found within the shoulder. A study from Larsen et al. determined that strains were a prevalent issue among miners during on-site work.[28] Repetitive motions of lifting and unloading materials, varying in size and weight, contribute to the risk of sprains that could potentially lead to tearing of muscle. Tool usage was a primary factor in determining causes for frequent shoulder injuries, which range from heavy operative tools to tools that require operational techniques. Maintenance and repair of machinery are typically around 35% of overall work reported injuries in mining according to a study by Pollard et al. in 2014.

[26] Resser et al (2010)
[27] Resser et al (2010)
[28] Larsen et al (2021)

Other labour workers, such as painters, carpenters, electricians, and construction, report a dramatic increase (36%) in older workers (age 65+) due to the demands and cost of living in the United States, as reported by a study from Alwasel, et al. This contributes to the susceptibility of shoulder injury while using machines and tools. Within the study, assessment of shoulder risk was measured using a technique involving AMR sensors, which were placed at the centre of joint rotation at the shoulder, analyzing ROM.[29] With the senor in place, much of the work older adults had participated in were of risk of injury. Although the older population is at risk of injury, PT rehabilitative exercises have proven their effectiveness.

A study by *Lowe et al*. assesses the effects of conservative exercises for shoulder musculoskeletal symptoms from overhead assembly work exposures, found a significance in Shoulder Rating Questionnaires post-conservative treatment.[30] Clinically, the meaningful relevance of PT exercises was questionable, and predictability was low, but the evidence supports a positive effect on patients' short-term health and well-being.

### 1.2 **Return to Sport (RTS)**

RTS is a term used among the sports medicine and rehabilitation community to assess an athlete's return timeline to their respective sport.[31] The term was initially created with the idea of two key factors required to be answered by a healthcare professional and their patient post-treatment – these factors are "safe" and "successful." Level of sport is a primary variable in determining RTS treatment plans, as it relates to the RTS urgency, influencing the time it takes to heal effectively. For instance, a higher-level athlete has specific dates and times for performing on a

[29] Alwasel, et al. (2012)
[30] Lowe, et al (2018)
[31] Thomee, et al. (2011)

regular basis, at the highest level of athleticism. In contrast, a recreational athlete may only perform their sport in a staggered timeframe, performing more for fun than competitively and for less times on a week-by-week basis.

Concerning the aforementioned NFL data, type of injury to the shoulder can provide an estimate to RTS, as some injuries have a shorter recovery time compared to other injuries. For instance, more players missed games due to dislocation compared to other injuries such as the spinal vertebrae (median 47 days vs 13 days).[32] This meant that missed time for players could be measured based on their injury type. Similarly in baseball, the risk of shoulder instability issues arises on a position-based case. Defence and quarterbacks miss the most amount of time due to these injuries, such as anterior dislocations, through relative microtraumas from blocking, throwing, and tackles. Concerning the previously mentioned study, the RTS rate for professional baseball players was 63%, with 86% of players returning to their level of performance in the sport.[33]

Reporting RTS can be measured and defined in different ways that would impact the accuracy of reporting an intervention outcome.[34] For example, clinically following up and reporting RTS function, post treatment at a strict 3-month follow-up meeting that was discussed with the clinician, may impact the accuracy of the RTS outcome. Comparing that follow up method to one through which a patient deems themselves ready for RTS, or if the clinical is located in the athlete's place of practice, may provide more accurate RTS times.[35] RTS was measured by the athlete by determining if they were eligible for practice.[36]

[32] Anderson, et al. (2021)
[33] Chalmers, et al. (2019)
[34] Doege, et al. (2021)
[35] Centers for Disease Control and Preventions (2023)
[36] Doege, et al. (2021)

## 1.3 **Surgical Treatments for ACJ & RC Injuries**

Surgical treatments have evolved over recent years, incorporating new methods of standardized practices that provide systematic methods with the most successful treatment rates. Some of the more common anterior shoulder stabilization surgical procedures include arthroscopic Bankart repair, open Bankart, open Latarjet, mini-invasive Latarjet, and arthroscopic Bankart with remplissage.[37] The objective of these surgeries is to pursue shoulder pain relief while restoring strength, ROM, restoration of shoulder stability, and overall quality of life for the patient. Patients are typically given antibiotics and general anaesthesia pre-operation. A marking pen and pre-planning is then used, while supplying the patient with cushions and comfort when in an operating position (positions may vary depending on incision location, surgical team preference, or due to environmental situations).[38]

Surgical Treatment for RC Injuries

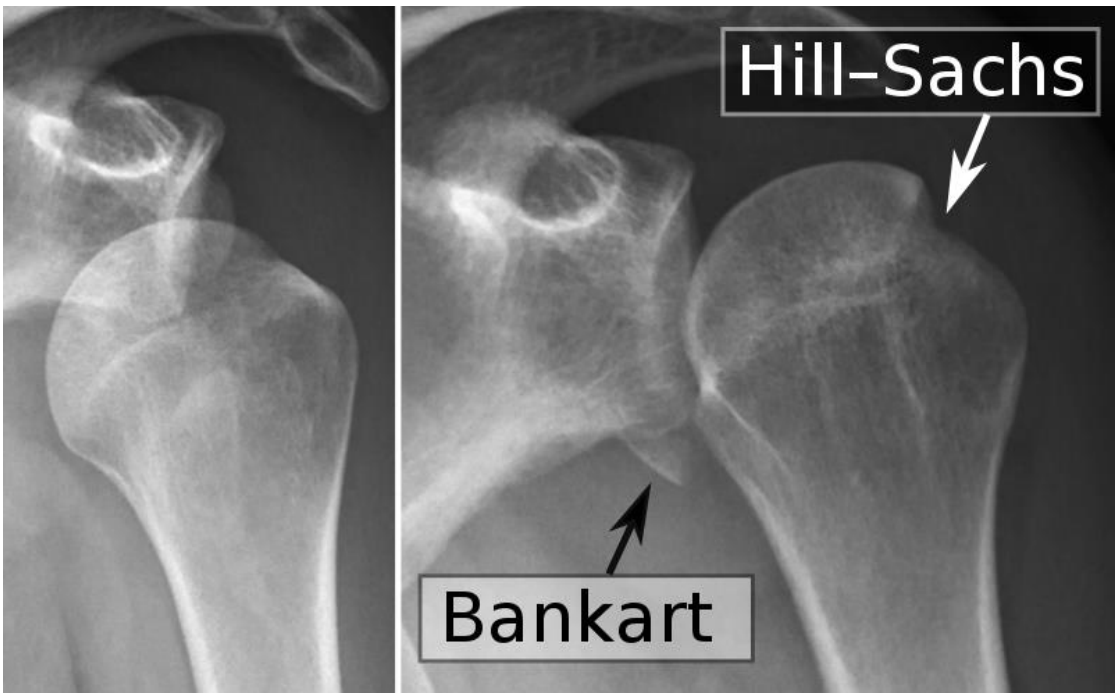
Arthroscopic Bankart repair is a common shoulder surgical procedure for shoulder instability.[39] The usage of bones and anchors are used to drill into the glenoid using bone anchors with sutures attached to them. This is tied to the torn labarum cartilage in the same location that the tear was on the glenoid. The shoulder capsule itself is sutured to the anchors to tighten the shoulder. The key difference between arthroscopic and open Bankart repair is the invasiveness of the procedure (arthroscopic is minimally invasive). The primary goal of the Bankart is to provide stabilization through the head of the humerus and the socket of the shoulder.[40]

Open Latarjet differs from the Bankart method as Latarjet typically involves bone graft muscle transfer. With an open incision in the shoulder, augmentation of the

[37] Abdul-Rassoul, et al. (2019)
[38] Coughlin, et al. (2017)
[39] Defroda, et al. (2017)
[40] Defroda, et al. (2017)

glenoid with bones is prioritized to hold the humerus head and maintain security and stability of the shoulder socket. The purpose of this procedure is to target the bones that have been damaged from the trauma of the shoulder dislocation. The mini-invasive Latarjet, similarly to the arthroscopic Bankart, is a less invasive, incision-based surgery.[41] A study done by Ebrahimzadeh, et al. explores clinical results of mini-invasive Latarjet in anterior shoulder instability. The Larajet demonstrated good/excellent short-term outcomes with low complications, making it an ideal surgery if the Larajet is considered.[42]

Arthroscopic Bankart with remplissage is a specific surgery used when a Hill Sachs is present. A Hill Sach is a deformity from a dislocated shoulder that is located at the head of the humerus.[43] This impacts movement and can cause a hindrance to the patient when attempting to restore function in surgery, as bone loss is associated with Hill Sachs. A visual of both Bankart and Hill Sachs is seen in the following image:




[41] Ebrahimzadeh, et al. (2015)
[42] Ebrahimzadeh, et al. (2015)
[43] Provencher, et al. (2012)

*(Figure 1: Bankart and Hill Sachs Visual. Haggstrom, et al. (2018), Reproduced with permission from Creative Commons under the CC0 1.0 Universal Public Domain Dedication)*

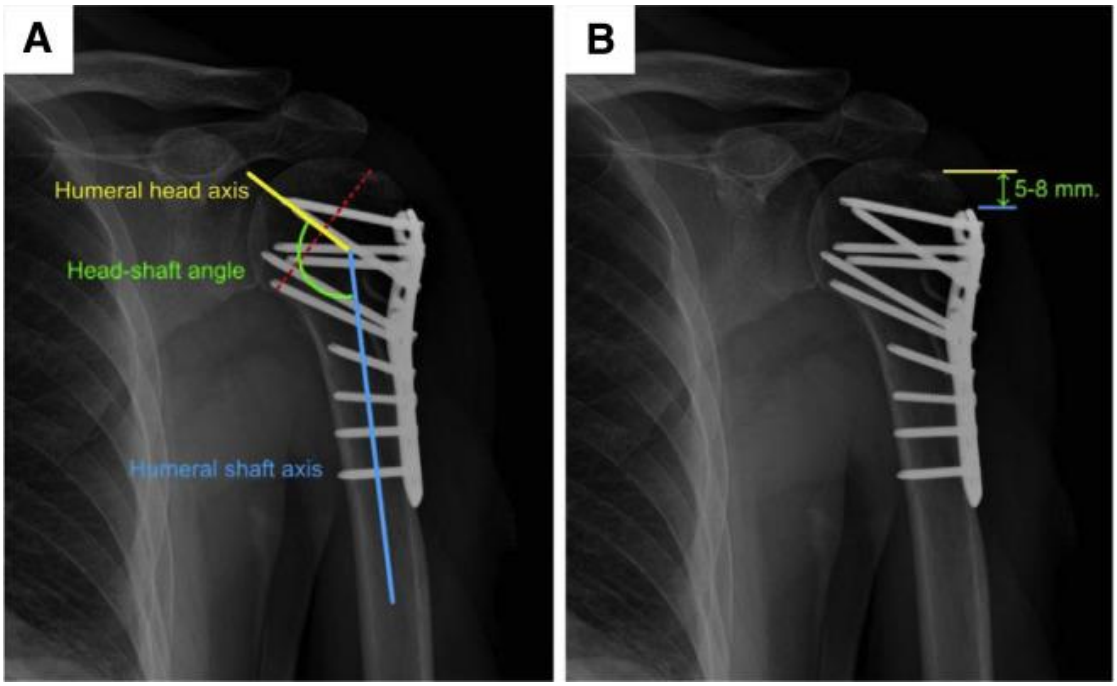
This arthroscopic Bankart with remplissage uses the posterior shoulder capsule and tendon repair into the defect itself to fill it. A study demonstrated the small, but successful impact this intervention can have, looking into patient populations with a 15% and 30% Hill Sachs defect. ROM concerning abduction increased and shoulder stability was an outcome from adding the remplissage.[44] Adding the remplissage provided effective prevention of further dislocation.

Surgical Treatments for ACJ Injuries

Acromioclavicular surgical treatments are separate from anterior shoulder instability procedures, as a smaller, precise surgical treatment is required. This is because even the slightest 2.3 mm (for women) and 2.6 mm (for men) displacement can release the AC ligament's attachment points, detaching the joint.[45] Some common ACJ treatments include open reduction and internal fixation, Weaver-Dunn (coracoacromial ligament transfer) including modified versions of a Weaver-Dunn, and anatomic coracoclavicular (CC) reconstruction.[46]

Open reduction and internal fixation require the usage of screws, pins, wires, sutures, and hook plates. Open reduction refers to the incision made on the shoulder to realign the bone, where internal fixation – the usage of hardware on the bones – is then used.[47] These tools and hardware have gained their own specializations over time, such as Kirschner wires and pins. Below is an example of internal fixation tools placed at the head of the humerus on the ball near the socket joint:

[44] Elkinson, et al. (2012)
[45] Rachel, et al (2019)
[46] Rachel, et al (2019)
[47] Greiwe, et al (2020)



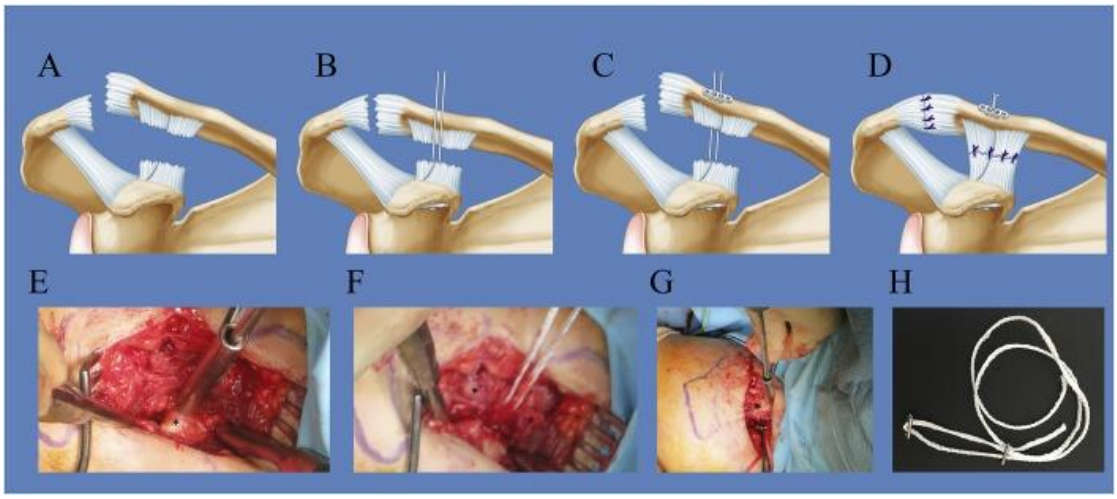

*(Figure 2: Internal fixation screws and hook plates. Kanchanatawan, et al. (2020) Reproduced with permission from Creative Commons under the Attribution-Non-commercial-No Derivatives 4.0 International (CC BY-NC-ND 4.0))*

Weaver-Dunn, on the other hand, involves the separation and transfer of the coracoacromial ligament from the acromion to the lateral end of the clavicle.[48] Modified attempts at this procedure typically aim to prioritize stability early on to decrease risks and complications for the healing process. Augmentations of suture loops, wires, screw fixations, and other aids are utilized in early stability efforts, which have been reported to significantly increase stability and sturdiness compared to ACJ reconstruction and anatomic CC reconstruction.[49]

Anatomic coracoclavicular reconstruction (ACCR) involves the reconstruction of the CC ligaments using semitendinosus allograft under the coracoid and bone tunnels within the clavicle.[50] Below is a diagram to visualize the stabilization method

[48] Glassao, et al. (2020).
[49] Rachel, et al (2019).
[50] Carofino, et al. (2010)

through the CC ligament. The acromion is used as a base while conventional tools of placement, such as screws and wires, are used to secure the bones.




*(Figure 3: ACCR Visual Diagram of Procedure. Mori, et al. (2017) reproduced with permission from JB & JS open access)*

Overall, the suggested methods of surgical approach are often determined by the medical staff, as they inform the patient during pre-op of the information associated with their chosen surgical approach. Regardless, complications in surgeries always arise at the expense of a possible shorter RTS or due to the complex nature of the surgical process, achieving similar preoperative performance levels.[51]

### 1.4 Conservative Treatments for Shoulder Injuries

Rehabilitation has been a primary treatment method for musculoskeletal injuries, particularly due to the less invasive and less risky nature of the treatment. A series of drugs and medication can be used for pain management in the initial stages of the rehabilitation process, such as anti-inflammatory, non-steroidal anti-inflammatory drugs (NSAID), painkillers, etc.[52] Exercise, as a conditional training

[51] Kang, et al (2009)
[52] Riccio, et al. (2015)

method, is a primary rehabilitation approach to restoring function to the shoulder. The science behind these exercises is related to the science of muscle healing.[53]

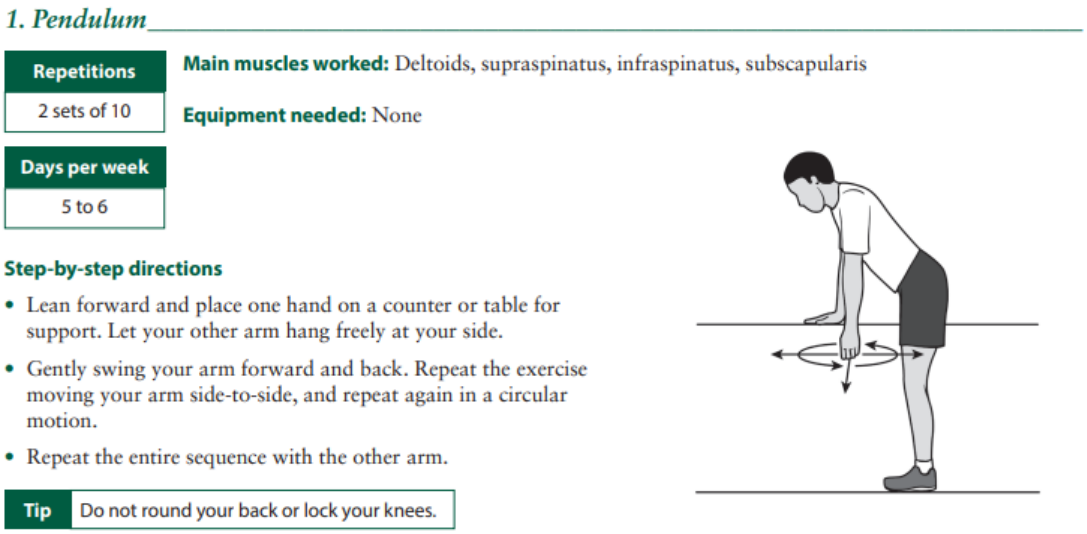
Muscle mass is around 40-45% of total body weight (subjective for each person), and has its own healing process should the muscle tear, strain, or by contusion.[54] Muscle fibres and blood vessels within the muscle are strained or damaged from force, allowing for blood containing inflammatory cells to infiltrate the wound.[55] The muscle tissue initiates a cellular repair as the body's macronutrient proteins enter the repair site. Both the lymphatic system and endocrine system contribute to neutralizing and regulating the compounds found in the muscles at the site of injury. For example, the deployment of macrophages eats dead tissue with satellite cells (myoblasts) to repair fibres. Connective tissue is then created at the injury site. Due to the sensitivity of the muscles at this point, isometric exercise and light stretching occurs. Remodelling is the next stage in rehabilitating the muscle as highlighted by physical therapists.

Conservative Treatment for RC Injuries

Rehabilitation programs contain a series of exercise drills to restore the function of the shoulder through a more comprehensive approach. Isotonic exercises targeting shoulder injuries, such as RC tears, improve the strength and flexibility of the following muscles: deltoids, trapezius, rhomboid, teres muscles, supraspinatus, infraspinatus, subscapularis, biceps, and triceps. Some example exercises include the pendulum, crossover arm stretches, passive internal and external rotations, sleeper stretches, and standing rows. Below is a visual of the some of the shoulder exercises

[53] Riccio, et al. (2015)
[54] Huard, et al. (2002)
[55] Jarvinen, et al. (2005)

used for shoulder instability from OrthoInfo – the American Academy of Orthopaedic Surgeons:



*1. Pendulum*

**Repetitions**
2 sets of 10

**Days per week**
5 to 6

**Main muscles worked:** Deltoids, supraspinatus, infraspinatus, subscapularis

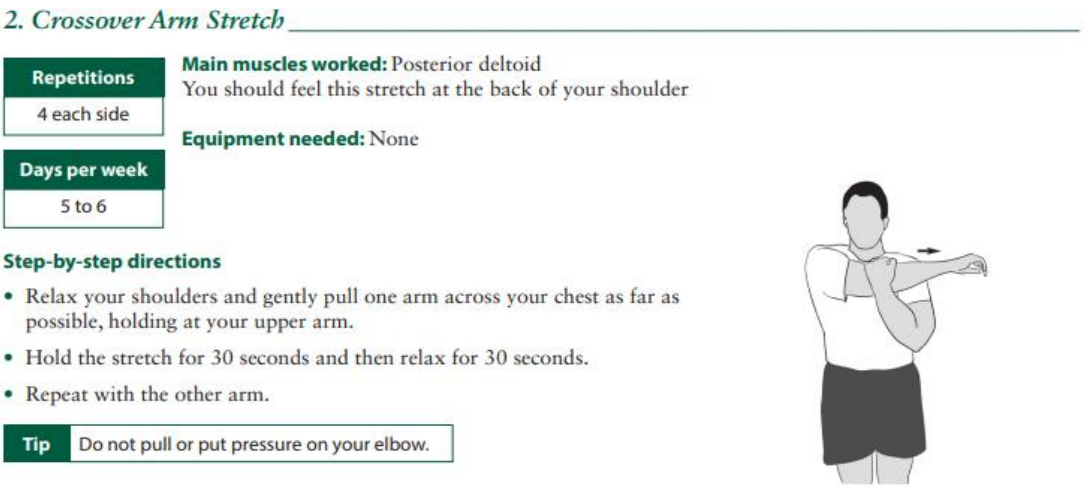
**Equipment needed:** None

**Step-by-step directions**

- Lean forward and place one hand on a counter or table for support. Let your other arm hang freely at your side.
- Gently swing your arm forward and back. Repeat the exercise moving your arm side-to-side, and repeat again in a circular motion.
- Repeat the entire sequence with the other arm.

**Tip** Do not round your back or lock your knees.

*(Figure 4: Pendulum instruction. AAOS, et al (OrthoInfo, 2021), Reproduced with permission from OrthoInfo. © American Academy of Orthopaedic Surgeons. https://orthoinfo.org/)*



*2. Crossover Arm Stretch*

**Repetitions**
4 each side

**Days per week**
5 to 6

**Main muscles worked:** Posterior deltoid
You should feel this stretch at the back of your shoulder

**Equipment needed:** None

**Step-by-step directions**

- Relax your shoulders and gently pull one arm across your chest as far as possible, holding at your upper arm.
- Hold the stretch for 30 seconds and then relax for 30 seconds.
- Repeat with the other arm.

**Tip** Do not pull or put pressure on your elbow.

*(Figure 5: Crossover Arm Stretch instruction. AAOS, et al (OrthoInfo, 2021), Reproduced with permission from OrthoInfo. © American Academy of Orthopaedic Surgeons. https://orthoinfo.org/)*

Both exercises have a series of repetitions and number of days per week assigned to a patient for rehabilitation. A program typically consists of a series of stretches, exercises, and a systematic guideline of activities to maintain muscle rehabilitation. Tools are a part of the rehabilitation process, such as the use of braces,

splints, crutches, and taping. Stabilizing the muscle helps decrease the pain and further effects of the injury on the muscle itself, such as further tearing. Muscle tissue can be treated with rest, ice, compression, and elevation (RICE).

Conservative Treatment for ACJ Injuries

Conservative treatment plans follow similar procedures to RC rehabilitation programs, however, due to the difference in injury pathologies, the ACJ is more targeted in conservative approaches to nursing the joints back to health.[56] Conservative exercises for ACJ particularly consist of the aforementioned drills in the RC exercises, however, combining a sling with rest while receiving prescriptions for anti-inflammatory medication is usually a standardized treatment model.

Conservative treatment can provide an effective, non-invasive treatment option for ACJ injuries.[57] This can be measured by a short form 12 Physical Component Score, the American Shoulder and Elbow Surgeons score, the Quick Disabilities for the Arm, and the Shoulder and Hand score, during follow up meetings with patients who had undergone conservative treatment for ACJ injuries, as found in a study by Perti, et al.[58] Conservative treatment was a successful approach to patient rehabilitation and psychology. Even for patients opting for surgery, there was still an effort to adhere to conservative treatment due to frequent success in pain management.

## 1.5 Introduction References

1. Abdul-Rassoul, et al. (2019). *Return to Sport After Surgical Treatment for Anterior Shoulder Instability*. Clinical Sports Medicine Update. Vol 47 (6), pp 1507-1515.

[56] Saltychev, et al (2015)
[57] Saltychev, et al (2015)
[58] Perti, et al (2016)

2. Alwasel, et al. (2012). *Reducing shoulder injuries among construction workers*. University of Waterloo. Vol 11(2), pp 242-246.
3. American Academy of Orthopaedic Surgeons. (2021). *Rotator Cuff and Shoulder Conditioning Program*. OrthoInfo. Retrieved from: https://orthoinfo.org/globalassets/pdfs/2022-rotator-cuff-and-shoulder-conditioning-program.pdf.
4. Anderson, et al. (2021). *Epidemiology of Shoulder Instability in the National Football League*. Orthop J Sports Med. Vol 9(5).
5. Babenko, et al. (2022). *Therapeutic Exercises for Prevention and Rehabilitation of Sports Shoulder Injuries*.
6. Carofino, et al. (2010). *The anatomic coracoclavicular ligament reconstruction: surgical technique and indications.* J Shoulder Elbow Surg. Vol 26(4), pp 679-686.
7. Centres for Disease Control and Prevention. (2023). *Managing Return to Activities*. CDC, Information for Health Care Professionals. Retrieved from: https://www.cdc.gov/headsup/providers/return_to_activities.html#print
8. Chalmers, et al. (2019). *Epidemiology of Shoulder Surgery Among Professional Baseball Players*. Am J Sports Med. Vol 47(5).
9. Coughlin, et al. (2017). *Open Bankart Revisited*. Arthrosc Tech. Vol 6(1), pp 233-237.
10. Defroda, et al. (2017). *Arthroscopic Bankart Repair for the Management of Anterior Shoulder Instability: Indications and Outcomes*. Current Reviews in Musculoskeletal Medicine. Vol 10, pp 442-451.
11. Doege, et al. (2021). *Defining Return to Sport, A Systematic Review.* Orthop J Sports Med. Vol 9(7).

12. Ebrahimzadeh, et al. (2015). *Minimally Invasive Modified Latarjet Procedure in Patients with Traumatic Anterior Shoulder Instability*. Asian J Sports Med. Vol 6(1).
13. Elkinson, et al. (2012). *The Effect of the Remplissage Procedure on Shoulder Stability and Range of Motion*. Vol 94 (11), pp 1003-1012.
14. Galasso, et al. (2020). *Modified Weaver-Dunn Procedure for Type 3 Acromioclavicular Joint Dislocation: Functional and Radiological Outcomes.* Vol 8(3).
15. Greiwe, et al. (2020). *Open reduction internal fixation vs. reverese shoulder arthroplasty for the treatment of acute displaced proximal humerus fractures.* Seminars in Arthroplasty: JSES. Vol 30 (3), pp 250-257.
16. Haggstomr, et al. (2018). *Shoulder dislocation with Bankart and Hill-Sachs lesions, before and after reduction*. Wikiversity Journal of Medicine.
17. Hawthrone, et al. (2022). *Acromioclavicular joint pathology in athletes*. Obere Extremität. Vol 17, pp 12–20.
18. Huard, et al. (2002). *Muscle Injuries and Repair: Current Trends in Research*. The Journal of Bone and Joint Surgery.Vol 84(5), pp 822-832.
19. Jarvinen, et al. (2005). *Muscle Injuries: Biology and Treatment*. American Journal of Sports Medicine. Vol 33(5), pp 745-764.
20. Jin et al. (2022). *Risk Factors Based on Analysis of Injury Mechanism and Protective Equipment for Ice Hockey Amateur Players*. International Journal of Environmental Research and Public Health. Vol 19(7), pp 4232.
21. Kanchanatawan et al. (2017). *Fluoroscopic Technique for Open Reduction and Internal Fixation of Proximal Humeral Fracture Using the Proximal Humeral*

*Locking Plate: Proposal of "Plate" and "Screw" Views*. Vol 6(4), pp1009-1014.

22. Kang, et al. (2009). *Complications Associated With Anterior Shoulder Instability Repair*. Journal of Arthroscopic Related Surgery. Vol 25(8), pp 909-920.
23. Larsen, et al. (2021). *Analysis of Shoulder Sprains and Strains in Mining*. National Institute for Occupational Safety and Health. Vol 65(1), pp 1371-1375.
24. Levangie, et al. (2006). *Joint Structure and Function: A Comprehensive Analysis*. JAYPEE, 4th ed.
25. Lowe, et al. (2018). *Evaluation of a Workplace Exercise Program for Control of Shoulder Disorders in Overhead Assembly Work*. J Occup Envrion Med. Vol 59(6), pp 563.
26. Maruvada, et al. (2023). *Anatomy, Rotator Cuff.* StatPearls. Retrieved from: https://www.ncbi.nlm.nih.gov/books/NBK441844/
27. Miniato, et al. (2021). *Anatomy, Shoulder, Upper Limb, Shoulder*. National Centre for Biotechnology Information, StatPearls.
28. Modi, et al. (2013). *Controversies relating to the management of acromioclavicular joint dislocations.* The Bone and Joint Journal. Vol 12, pp 1595-1602.
29. Mori, et al. (2017). *Anatomic Coracoclavicular Ligament Reconstruction for the Treatment of Acute Acromioclavicular Joint Dislocation.* JB JS open acess. Vol 2(8), pp 7.

30. Ornon, Gregory, et al. (2020). *Epidemiology of injuries in professional ice hockey: a prospective study over seven years*. Journal of Experimental Orthopaedics. Vol 7, 87.
31. Perti, et al. (2016). *Clinical Results After Conservative Management for Grade III Acromioclavicular Joint Injuries: Does Eventual Surgery Affect Overall Outcomes?* Journal of Arthroscopic and Related Surgery. Vol 32 (5), pp 740-746.
32. Phadke, et al. (2019). *Current concepts in management of ACJ injuries*. J Clinic Orthop Trauma. Vol 10(3), pp 480-485.
33. Pogorzelski, et al. (2018). *Nonoperative Treatment of Five Common Shoulder Injuries*. National Centre for Biotechnology Information. Vol 13(2), pp 89-97.
34. Provencher, et al (2009). *Avoiding and Managing Complications of Surgery of the Acromioclavicular Joint*. Complications in Knee and Shoulder Surgery. Pp 245-264.
35. Provencher, et al. (2012). *The Hill-Sachs lesion: diagnosis, classification, and management*. Am Acad Orthop Surg. Vol 20 (4), pp 242-252.
36. Rachel, et al. (2019). *Acromioclavicular Joint Injuries: Evidence-based Treatment.* Journal of the American Academy of Orthopaedic Surgeons. Vol 27 (17), pp 775-788.
37. Resser, et al. (2010). *Upper Limb Biomechanics During the Volleyball Serve and Spike*. Sports Health. Vol 2(5), pp 368-374.
38. Ricco, et al. (2015). *Conservative treatment of traumatic shoulder instability: a case series study.* Musculoskeletal Surgery. Vol 99, pp 133-137.
39. Saccomanno, et al. (2014). *Acromioclavicular joint instability: anatomy, biomechanics and evaluation*. Joints. Vol 2(2), pp 87-92.

40. Saltychev, et al. (2015). *Conservative treatment or surgery for shoulder impingement: systematic review and meta-analysis*. Disability and Rehabilitation. Vol 37(1), pp 1-8.
41. Sangeeta, et al. (2015). *Stabilising characteristics of rotator cuff muscles: a systematic review*. Disability and Rehabilitation. Vol 37 (12), pp 1033-1043.
42. Sirin, et al. (2018). *Acromioclavicular joint injuries: diagnosis, classification and ligamentoplasty procedures*. EFFORT Open Rev. Vol 3(7), pp 426-433.
43. Suezie, et al. (2014). *Management of Type 3 Acromioclavicular Joint Dislocations: Current Controversies.* Bulletin of the NYU Hospital for Joint Diseases. Vol 72(1), pp 53-60.
44. Trans, et al. (2019). *Anatomical study of the innervation of glenohumeral and acromioclavicular joint capsules: implications for image-guided intervention.* Regional Anesthesia and Pain Medicine. Vol 44( 2), pp 452-458.
45. Thomee, et al. (2011). *Return to Sport*. Knee Surg Traumatol Arthosc. Vol 19, pp 1795-1797.
46. Vaskovic, et al. (2023). *Acromioclavicular (AC) Joint*. KenHub. Retrieved from: https://www.kenhub.com/en/library/anatomy/acromioclavicular-ac-joint

# 2.0 Evaluation of Return-to-Sport Conservative vs Operative Treatment for Mid-Level Rockwood Type III Acromioclavicular Joint Injuries in Athletic Populations, a Scoping Review.

**Abstract**

**Rationale**: The purpose of this study is to synthesize current academic literature involving athletic and active populations who have received Rockwood type III acromioclavicular joint (ACJ) injuries. This is done by comparing the effectiveness of conservative versus surgical treatments clinical outcomes and to determine the current preference for the best return to sport (RTS) performance. Grade III was selected specifically due to the ongoing debate of conservative versus surgical treatment preferences in ACJ recovery. The research question is "*What is the state of the literature on clinical and RTS outcomes of athletes and active populations, who have had Rockwood grade III ACJ injuries, differ in conservative and surgical treatment?"*

**Methods**: The PRISMA-ScR approach was utilized in synthesising literature through a scoping review, following the PRISMA-ScR 2020 checklist formatting for the structure. The Covidence program was used for the PRISMA-ScR process. Findings include several randomized control trials (RCT), clinical case studies, and literature reviews. The Covidence Quality Assessment Tool and Methodological Index for Non-Randomized Studies (MINORS) were used to assess bias and quality.

**Results**: Thirty-two studies were identified assessing conservative and operative treatment of grade III AC injuries. Based on the Covidence Quality Assessment Tool and MINORS, all studies provided moderate to low risk of bias. Results indicate that similar outcome measures are found within studies between conservative and surgical approaches, indicating that there is no clear general standard in treating grade III ACJ injuries. Majority of the treatment preferences, after analyzing the results of both RCT's and literature, indicated that conservative

treatment was the patient's slightly more preferred treatment option. Both conservative and operative treatment yielded near equal results in terms of recovery and for RTS.

**Conclusion**: Literature reviews and case studies indicate specific requirements for the rehabilitation and surgical objectives in restoring the patient's function. Although both conservative and surgical options are equal in terms of effectiveness, there is a slight patient preference towards the conservative treatment as surgical interventions have potential for complications and discomfort. Sub classification of type III injuries through ISAKOS IIIA and IIIB may provide guidance when deciding on treatment approach. More RCTs are required to examine the variance in patient-reported outcomes and in determining the best RTS.

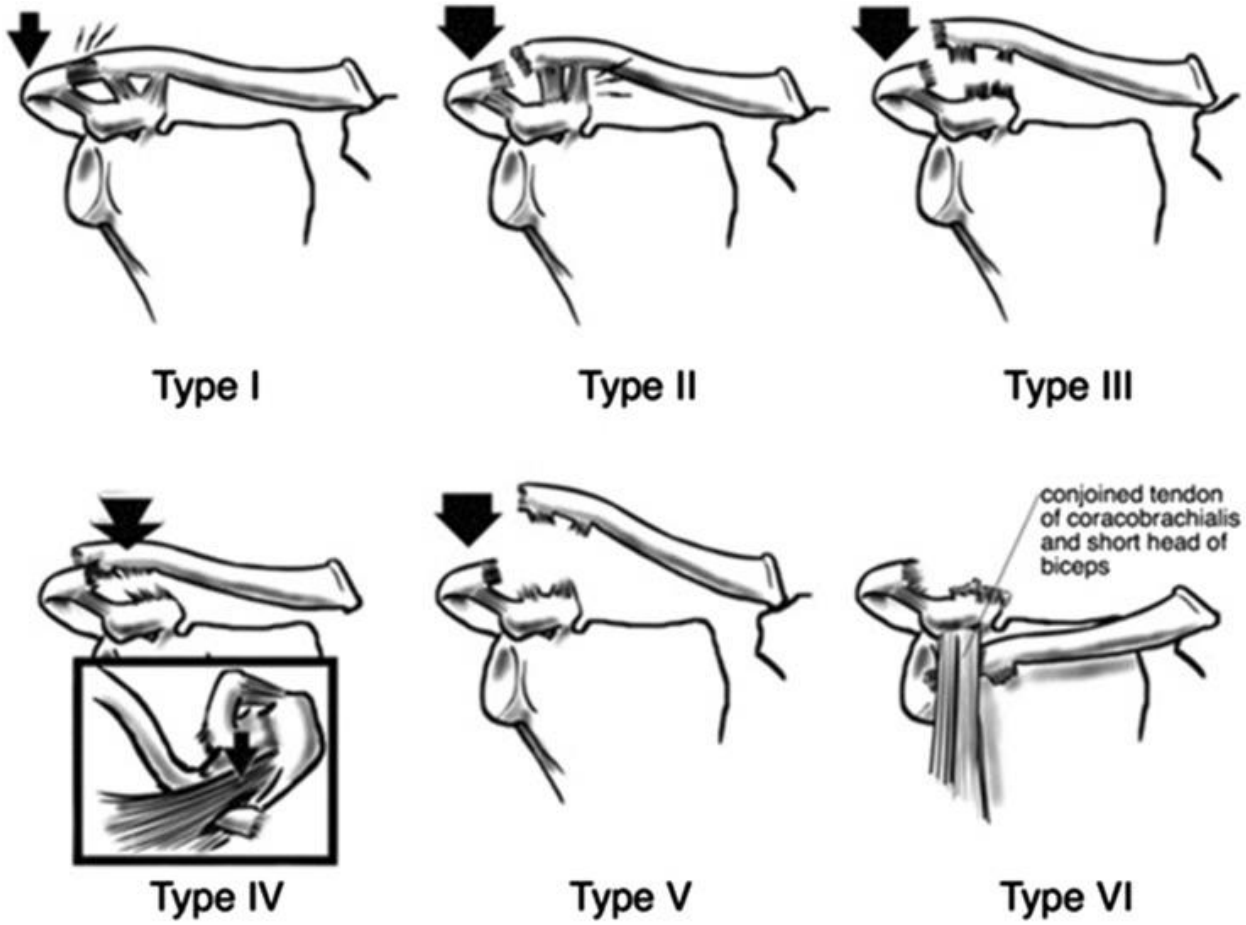
**DATA SOURCES**: PubMed, Cochrane, Embase, CINAHL, SCOPUS

## 2.1 Introduction – Rational & Background

Conservative methods, in the context of North America, typically include rehabilitation exercises that target muscles to increase range of motion, strength, and to ease pain. Bracing, slings, and taping are used as secondary tools to support the bone structure and provide relief to targeted area. Surgically, there have been many new adaptations of surgical interventions that are used to treat ACJ dislocations, especially in more surgical treatment-favoured locations, such as the United States of America. Surgery is a typically invasive procedure but has yielded relative success as modified surgical approaches are becoming more frequent. Some common examples of surgical practices in include the Tightrope, Weaver-Dunn, and K-wire,

Rockwood classification has been used for many years to distinguish the range of dislocation and separation regarding the ACJ. The classification of Rockwood is as follows: Type I refers to a mild sprain with the clavicle not elevated; Type II is a rupture in the AC ligament and joint capsule that is assessed through evaluating soft tissues; Type III is a rupture of

less than 25mm, and includes a AC/CC ligament and joint capsule rupture; Type IV is a rupture in both AC/CC ligaments and joint capsule with the clavicle displaced posterior to trapezius; Type V is a rupture of all aforementioned components including an elevation of a CC ligament tear of more than 25mm; Type VI is a clavicle displacement behind bicep tendons.[59] There are limitations to this, however, primarily due to the reliance on evaluating tissues. Other conventional methods of testing, such as x-rays, would prove ineffective at providing enough information to assign a type on the Rockwood scale. Another limitation is that treatments need to be individualized based considerations such as a patient's activity level, functional and occupational demands, and the type and level of sport.[60]




[59] Botz, et al. (2021)
[60] Gorbaty, et al. (2017)

*(Figure 6: Acromioclavicular Dislocations by Rockwood Classification. Gorbaty, et al. (2017) Reproduced with permission from the National Library of Medicine Disclaimer (https://www.ncbi.nlm.nih.gov/pmc/about/disclaimer/))*

The spraining and dislocation of the ACJ account for 12% of shoulder injuries and are more prevalent in active populations.[61] Athletic populations are vulnerable to ACJ injuries – this is due to the nature and extent of their profession, being the highly intense and demanding strains that can occur on the biomechanical functions of their body. This study will target athletic and active populations specifically to add a layer of complexity to a sample population where shoulder movement and stress is commonplace. RTS and functional outcomes will be measured when determining treatment results to provide measurements that can be used to determine full function when returning to an activity.

The primary objective of this study is to synthesize data from literature concerning Rockwood type III ACJ injuries in athletic populations, by analyzing conservative and surgical treatment outcomes. The aim is to understand active and athletic patient-reported post-treatment functional outcomes from their respective treatment plans and provide an understanding of the current practices being used for Rockwood type III ACJ injuries. This is then used to determine if modern surgical practices are more successful at RTS over conservative methods. A breakdown of literature will complete this objective by outlining the effectiveness of conservative versus operative treatment for most ACJ Rockwood type III injuries. Studies included meta-analysis, systematic reviews, case studies, RCTs, and literature reviews regarding the epidemiology of positive reported outcomes of both surgical and conservative treatments. Positive patient-reported outcomes include patient satisfaction post-treatment within the

[61] Balke, et al. (2022)

allocated estimated time for recovery and RTS. When looking at RTS, focus is placed on if they can go back to their regular function rather than on how well they performed. Radiological outcomes were briefly discussed during the study results. To determine if there is a gold standard for ACJ injuries between conservative and surgical treatments, it is crucial to understand both methods and the current state of literature to determine strengths and advantages of both approaches.

## 2.2 Methods

Protocol and Search Strategy

Covidence's data extraction template was used throughout this scoping review while following the PRISMA-ScR format. Planned dates for this study's search include 1980-2022. Databases used for data extraction included PubMed, Embase, Cochrane, Scopus, and CINAHL. All searches included any study, including to and prior to 2022. (MH = mesh terms, quotations are keywords, dashes representing AND or OR of the search i.e., S1 AND S2).

1. Keyword search PUBMED (326 imported results): "acromioclavicular"[All Fields]) (OR) "shoulder"[All Fields] (AND) "sport"[All Fields] (AND) "rehabilitation"[All Fields] (AND), "surgery"[All Fields].
2. Keywords search EMBASE (424 results): MH Shoulder injury (AND), MH Conservative (AND), MH Surgery (AND) AND MH Sport Injury/Return to sport/Sport - OR - MH Acromioclavicular (AND), MH Conservative (AND), MH Surgery (AND).
3. Keywords search CINAHL (127 results): MH surgery, operative (OR), "Surgery" (OR), "Operative" (OR) - AND - MH conservative treatment (OR), "conservative" (OR), MH Rehabilitation (OR), "rehabilitation" (OR) - AND - MH Shoulder Injuries (OR), "Shoulder" (OR) AND MH Acromioclavicular Joint (OR), MH Acromioclavicular Joint

Separation (OR), “acromioclavicular” (OR), “acromio” (OR), “clavicular” - AND - MH Athletic Injuries (OR), “Sport Injuries” (OR), “Sport” (OR), “Athlete” (OR).

4. Keywords search SCOPUS (100 results): Shoulder (OR), Acromioclavicular (OR), AC Joint (OR), Acromio (OR), Clavicular (OR) - AND - Sport (OR), Athlete (OR), Sport Injury (OR) - AND - Operative (OR), Surgery (OR) - AND - Conservative (OR), Rehabilitation (OR).
5. Keywords search COCHRANE (6 results): “Acromioclavicular” (AND) - AND - Rehabilitation (OR), - AND - Surgery (OR).

The search criteria had to include type III ACJ injury data but could not use it as a key search word. This is because some studies included type III ACJ injuries but did not use it as a keyword in identifying their study as a search result. By not including type III ACJ injury as a key search word, the search results showed all studies containing this information regardless of if they added it as one of their own search words.

Study Selection & Eligibility Criteria

The study selection is shown through the PRISMA-ScR flow chart (figure 7). The number of overall studies screened within the first phase was 1072 and the duplicated search results that were removed was 90. In total, 982 studies were screened, and 923 studies were irrelevant. 59 studies were extracted for full text assessment eligibility and 27 studies were excluded due to wrong study design, outcomes, interventions, and non-English text. The final number of studies included was 32. For study design within the database search, there were a total of 18 systematic/literature reviews, commentaries, and case studies that were comprised of ~6368+ patients and 14 trials (RCT, etc.), totalling around ~548+ patients.

Primary inclusion search criteria must include themes of **acromioclavicular** or **shoulder** for target area, **sport,** or **athlete** for target population, and **conservative** or **rehabilitation** and **surgery** or **operative** for articles comparing operative and conservative treatment. Age, level of sport, and sex were not filtered. Acromioclavicular arthritis and radiographic themes were included in the screening. For the studies to remain eligible, an outcome measure must be associated with patient responses to their treatments. Some of the outcome measures include American Shoulder and Elbow Surgeons score (ASES), University of California – Los Angeles Shoulder Scale (UCLA shoulder scale), the Constant Score (CS), and DASH scores to determine the severity of the athlete's injury. English was a language requirement for eligible studies being included in the scoping review process.

For the exclusion criteria, the rationale behind excluding non-active and non-athletic populations came from the low susceptibility of injury and the infrequent physical demand of the shoulder and not aligning with the secondary objective of RTS. Articles excluded within the screening process were non-acromioclavicular joint targeted shoulder area (for example, Latarjet procedure for bone injuries and non-joint injuries will be excluded), qualitative studies which highlighted patient experiences instead of measurable patient outcome measures (such as DASH scores), does not include any classification of a particular grade/scale of the ACJ injury (For example, the study does not highlight specifications of a type III injury), non-therapeutic, and does not include any English (Non-English)

The selection process was conducted through Covidence through a screening, full-text review, and extraction format by the primary author, Jesse Singh. Articles were imported from selected databases and screened with two independent reviewers, Jesse Singh (J.S.) and Adriana Skaljin (A.S.), who analyzed relevant criteria which was then synthesized and discussed.

Methodologies used during the extraction process of the PRISMA-ScR scoping review method included a screening process, a full text review process, and final extraction. The two reviewers for this study reviewed the initial number of studies listed above. The primary investigator J.S reviewed all 1072 studies, resolving conflicts for any discrepancies and disagreements found during study inclusion voting within the screening process. Each reviewer worked independently and referred to the inclusion and exclusion criteria stated above.

Data Charting Process

There were several data parameters used in determining extraction. Those included publication year, study design, patient population, patient outcomes, Rockwood classification level, acute injuries, operative techniques, conservative techniques, and RTS. Primarily, the goal was to determine a statistical difference in patient outcomes when comparing conservative and surgical treatments for type III ACJ dislocations. Types of literature included the RTS.

Critical Appraisal Through Quality Assessment and Selection of Sources of Evidence

All the studies were screen by two reviewers (J.S., A.S.) who independently screened the titles, abstracts, and full text articles, with disagreements being resolved through discussion between them to avoid bias. Any final vote of contention was conducted by J.S through the Covidence PRISMA-ScR process. The same two reviewers participated in the quality assessment and data extraction step. For RCT's, the Covidence Quality Assessment Risk of Bias Tool (RoB-2) was considered for quality of outcomes and risk of bias.[62] This tool consisted of 7 items: sequence generation, allocation of concealment, binding of participants and personnel, binding of outcome assessment, incomplete outcome data, selective reporting, and other sources of bias.

[62] Covidence. (2022)

The Methodological Index for Non-Randomised-Control Trials' (MINORS) 12 items ultimately was used to determine the quality and eligibility of studies that were not RCT's.[63] Those included clearly stating the aim of the study, inclusion of conservative patients, prospective data collection, endpoints to the study appropriateness, unbiased assessment of study endpoints, follow-up period appropriates, percentage lost to follow up, and the calculation of the study size.

The rational for using these two tools for quality and bias to critically appraise the studies extracted from the search were due to the reliability and transparency of each tool. Synthesizing the evidence into items of significance investigating bias and quality helps eliminate and acknowledge bias in the studies.

Data Items

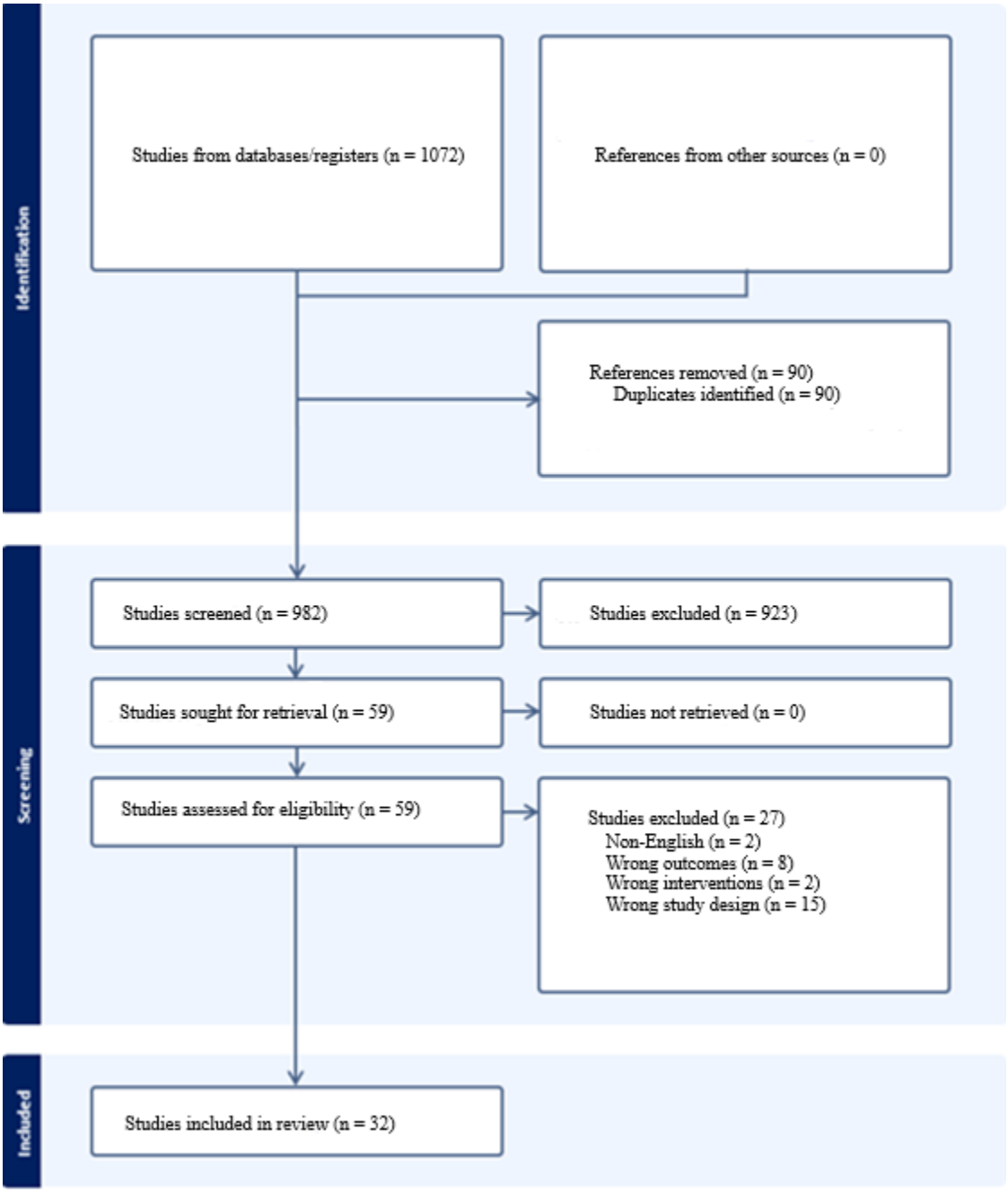
To tabulate and display desired study intervention characteristics, the article summaries within the screening process were compared to the previously mentioned eligibility criteria. These studies were then synthesized into results that analyze reported outcomes by noting the preferences of surgical or conservative treatment interventions and successful RTS rates. Clinical outcomes, types of surgical and conservative treatment interventions, and level of evidence were also items involved in the interpretation of relevant charted data.

## 2.3 Results

After the inclusion criteria in the latter stages of article screening process was completed, RTS studies through conservative or operative treatment of Rockwood III ACJ injuries passed the first screening process. They were then analyzed in the eligibility section of the PRISMA-ScR. Different methods of surgical success were included to provide variety to the operative

[63] Sundemo, et al. (2019)

comparison of the review. The PRISMA-ScR diagram shows 2 non-English, 8 wrong outcomes, 2 wrong interventions, and 15 wrong study design (total 27).




*(Figure 7: PRISMA-ScR Flow Diagram)*

There was a multitude of studies that included conservative and surgical interventions concerning type III ACJ injuries, however, they did not specify outcome measures that included

post-treatment performance. Some studies originating from Asia were excluded due to the full text accessibility hosted on a foreign, non-English site and the mention of treatment processes that were different from those in North America.

Critical Appraisal of Quality and Bias Assessment Results

Quality was assessed through the Covidence Quality Assessment Form, rating each of the previously mentioned 7-items from High (green), Low (orange/red) and Unsure (grey).[64] The full risk of bias results is found below for both Covidence Quality Assessment Tool for Risk of Bias (RoB) and MINORS. MINORS score was determined through reported adequately (green), reported but not adequately (grey), and not reported (orange/red).[65] The MINORS additional criteria for comparative studies that include adequate control group, contemporary groups, baseline equivalence groups, and adequate statistical analyses. These were all reported not adequately (grey).

Table 1: Risk of Bias for Each Study - MINORS Bias

| Study | Study aim | Consecutive patients | Prospective data collection | Endpoints appropriate to study aim | Unbiased study endpoints | Follow up appropriate | <5% lost to follow up | Calculation of study size |
|---|---|---|---|---|---|---|---|---|
| Figueiredo, et al. | | | | | | | | |
| Gibbs, et al. | | | | | | | | |
| Boffano et al. | | | | | | | | |
| Mahajan, et al. | | | | | | | | |

[64] Covidence. (2022)
[65] Sundemo, et al (2019)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Roberson, et al. | | | | | | | | |
| Xinning, et al. | | | | | | | | |
| Deans, et al. | | | | | | | | |
| Jang, et al. | | | | | | | | |
| Verstift, et al. | | | | | | | | |
| Watson, et al. | | | | | | | | |
| Kay, et al. | | | | | | | | |
| Longo, et al. | | | | | | | | |
| Broos et al. | | | | | | | | |
| Calvo et al. | | | | | | | | |
| Ceccarelli et al. | | | | | | | | |
| Giai et al. | | | | | | | | |
| Korsten et al. | | | | | | | | |
| Hootman et al. | | | | | | | | |

Table 2: Risk of Bias for Each Study – Covidence Quality Assessment Tool for RoB

| Study | Sequence Generation | Allocation Concealment | Blinding of Participants and Personnel | Blinding of Outcome Assessment | Incomplete Outcome Data | Selective Reporting | Other Sources of Bias |
|---|---|---|---|---|---|---|---|
| DeCarli, et al. | | | | | | | |
| Muench, et al. | | | | | | | |
| Windhamre, et al. | | | | | | | |
| Tamaoki, et al. | | | | | | | |
| Faggiani, et al. | | | | | | | |
| Feichtinger, et al. | | | | | | | |
| White, et al. | | | | | | | |
| Muller, et al. | | | | | | | |
| Saade, et al. | | | | | | | |
| Cardone et al. | | | | | | | |
| Esen et al. | | | | | | | |
| Feichtinger et al. | | | | | | | |
| Galpin et al. | | | | | | | |
| Gstettner et al. | | | | | | | |

Data Charting of Conservative Versus Operative Findings

A total of 32 studies were eligible for extraction and met the inclusion criteria. Below are the characteristics for each study that highlight its methods, outcomes, treatment characteristics, and patient population.

Table 3: Charting Characteristics of Each Study

| **Author and Year of Publication** | **Study Design and Methods** | **Results & Key Findings** | **Conservative and Surgical Interventions** | **Population** | **Highest Level of Evidence** |
|---|---|---|---|---|---|
| 1 DeCarli, et al. (2015) | RCT, a retrospective study of patients with acute Rockwood type III AC dislocation.[66] Scores include the UCLA shoulder rating scale, ASES, The Constant Score, the Acromioclavicular Joint Instability Scoring System (ACJI). Statistical analysis performed in SPSS, using student's t-test. | Group A (n=25) - Conservative treatment. No complications, 80% of the patient population RTS with equal ROM and performance prior injury. UCLA: 33.5 Constant: 98% ASES 98.5 ACJI 72.4<br><br>Group B (n=30) Surgical treatment. Minor complications, 83% RTS. UCLA: 34 Constant: 98% ASES 100 ACJI 87.9 | Conservative Bracing, accompanied by closed and open chain exercises.<br><br>Surgical intervention included the TightRope method. | All male, mean age was 28.7. Follow up time was 3.5 years. All patients were athletes within various sports. N= 55. | I |
| 2 Figueiredo, | Perspective case study from three | RTS after 6 months from | ACJ was repainted using a modified | A 26-year-old Olympic | II |

[66] DeCarli, et al (2015)

| | | | | | |
|---|---|---|---|---|---|
| et al. (2014) | separate surgical interventions on an athlete patient. | post op. 18 months, asymptomatic. | Weaver-Dunn with an anchor and Kirschner wire. | wrestling athlete. N = 1 | |
| 3 Bradley, et al. (2003) | Retrospective review on ACJ injury interventions from 1985-98, 4 studies. | 3-year follow up conservative treated patients had less pain and weakness, 12-month similar outcomes. | Surgical CC fixation using Bosworth screw and pins (158 patients).<br><br>Conservative rehabilitation (118 patients). | 276 patients with type III ACJ injuries. | I |
| 4 Boffano, et al. (2017) | Systematic review using PUBMED. | Non-statistical difference in patient outcomes between surgical and conservative interventions. However, surgical management is recommended only if the sport or activity is a high demanding one. | Surgical: Weaver Dunn + Hook Plate. Mini open surgery. | 69 patients with at least a Rockwood type III, and 12 with a type V.<br><br>Conservative: N = 17.<br><br>Surgical N = 24. | I |
| 5 Mahajan, et al. (2019) | Case controlled series of custom created questionnaire: Grade 3 ACJ disruption: Survey of opinion of shoulder consultants in the United Kingdom, including randomised control trials from select surgeons. | No consensus for surgeons on a single ideal treatment for type III. Most favoured surgery but not first choice, only by the demands of their shoulder, which in athletes, was high. Society of sports medicine physicians had an 81% preference rate for conservative. | Surgery within 3 weeks, reconstruction of CC ligaments. | N= 577 American Orthopaedic Society for Sports Medicine Members, an additional 42 orthopaedic surgeons for MLB athletes. | VII |

| | | | | | |
|---|---|---|---|---|---|
| | | Major league baseball orthopaedic state 69% conservative preference. 80% RTS with no pain, 90% RTS with some form of pain but normal range of motion. | | | |
| 6<br>Roberson, et al. (2016) | Analysis of multiple reconstructive type III surgeries, literature search. | Anatomical reconstruction has successful outcomes, with limitations of short term follow ups. High complication rates versus a potential conservative treatment approach. | Conservative: Anaesthetic and corticosteroid injection, bracing, laser therapy, kinesiology taping.<br><br>Surgical: Weaver Dunn, Tightrope, anatomical reconstruction. | N/A | I |
| 7<br>Muench, et al. (2021) | Control trial cohort, Patients with chronic III-IV, ASES, 20 points, 13 patients per group for 80% power for directions of a 17-point difference in ASES, alpha 0.05 and Simple Shoulder Test (SST) score, collected preoperatively and at final visit for the ACCR group. Self-Assessment Numeric Evaluation (SANE). Minimum 5-year follow-up. | Patients with III ACJ injuries had similar clinical outcomes compared to surgical ACCR surgery. Conservative management can lead to quicker recovery for RTS.<br><br>Successful conservative treatment for type III-V ACJ injuries achieved similar ASES | 22 patients with conservative treatment, scored using ACCR.<br><br>21 patients with surgical treatment, scored using ACCR.<br><br>Sling, closed/open chain exercises, band tubing/cable resistance. | N = 175 ACJ patients initially.<br><br>65 surgical measured with ACCR, and 74 conservative. | IV |

| | | | | | |
|---|---|---|---|---|---|
| | Independent t-test, SATA software. | (93.0 ± 12.0NonOP vs 86.1 ± 16.8ACCR), SST (11.2 ± 1.4NonOP vs. 10.7 ± 2.0ACCR) and SANE scores (80.9 ± 19.7NonOP vs. 90.5 ± 14.7ACCR) compared to those who were converted to ACCR. Additionally, patients who underwent conversion to ACCR showed significant improvement in ASES (49.8 ± 18.1pre vs. 86.1 ± 16.8post; Δ36.3 ± 19.7) and SST scores (6.5 ± 3.2pre vs. 10.7 ± 2.0post; Δ4.2 ± 4.0) from pre- to post-surgical. | | | |
| 8 Xinning, et al. (2014) | Clinical and radiographic evaluation, surgical indications, complications, outcomes of common treatment options. | Shoulder scoring scale - Conservative: 58%/98%/88%/100%. Surgical: =45%/98%/77%/44%. | Conservative: Broad sling, Velpeau bandage, and swathe.<br><br>Surgical: fixation of the clavicle to the coracoid with an Arbeitsgemeinschaft für Osteosynthesefragen cancellous or | N=461 Surgical: 174 Conservative: 287. | I |

| | | | | | |
|---|---|---|---|---|---|
| | | | malleolar screws, and the use of Kirschner wires. | | |
| 9<br>Windhame, et al. (2022) | Control Trial, comparing outcomes for surgical hook plate type III ACJ injury and conservative management. QuickDASH, CS, SSV, EQ-5D. | Conservative management ( was preferred over surgical hook plate interventions for RTS. However similar results | Hook plate + conservative therapy. | Total N = 124, 91% male, age ranged 18-64.<br><br>Conservative: N=33.<br><br>Surgical: N= 30. | III |
| 10<br>Deans, et al. (2019) | Literature review of three studies surrounding type III ACJ injuries. | A separation of the classification of type III ACJ injury is needed to evaluate accordingly. Type IIIA (stable AC, no overriding clavicle) and Type IIIB (unstable with therapy resistant scapular dysfunction). Clinical outcomes included 88% for surgical and 86% for conservative. RTS was higher in study 1. Other studies noted a conservative approach was superior in CC ligament calcification and lateral clavicle osteolysis, built | Conservative treatment included bracing and exercising.<br><br>Surgical treatment included hook plate, LockDown technique, and Ligament Augmentation and Reconstruction Systems (LARS). Weaver Dunn and AC resection were used. | Study 1 - 706 patients both surgical and conservative patients. Study 2: 646 patients. Study 3: 137 patients. | I |

| | | | | | |
|---|---|---|---|---|---|
| | | operative as superior for maintaining anatomic reduction. | | | |
| 11 Tamaoki, et al. (2019) | Intervention review. Cochrane Bone, Joint & Muscle Group, CENTRAL, MEDLINE, EMBASE, LILACS. 19467/1980/1982 - 2019. Included randomized control trials and quasi-randomized control trials. | Surgical interventions versus conservative treatment may not be superior for shoulder function in RTS. Conservative is better at 6 weeks as there were more complications within the surgical group. | Conservative and surgical treatments including hook plate, tunnelled suspension devices, screws and pins, and wires. Slings were used with exercises for conservative treatment. | N= 357 patients. | I |
| 12 Faggiani, et al. (2016) | RCT. Determining functional outcome after surgery via CSS, Oxford Shoulder Score (OSS), SST and Subject Patient Outcome for Return to Sports (SPORTS). | <u>Means</u><br>CSS: 91.10<br>OSS: 46.19<br>SST: 10.50<br>SPORTS: 7.88<br><br>SD showed statistical differences. MINAR mini-open surgery had significantly better outcomes. | 8 patients were treated with mini-open surgery with MINAR system, other 8 patients were treated with Dog Bone technique. | N= 16 patients. | II |
| 13 Feichtinger, et al. (2021) | RCT. Constant score (CS), ASES score, the ACJI score, visual analogue scale (VAS), bilateral force measurements, and posttraumatic/postsurgical sequelae. | Conservative treatment is recommended for type III ACJ due to operative risks and clinical results.<br><br>Surgical:<br>No difference in | Conservative: Sling and standardised conservative methods.<br><br>Surgical: Suture button and open repair technique. | N = 226<br>Post follow up = 56.<br><br>Surgical: N = 10.<br><br>Conservative: N = 19. | II |

| | | | | | |
|---|---|---|---|---|---|
| | | arthroscopic or open procedures, risks of future complications is always prevalent.<br><br>4.8 years for the operative group and 5.9 years for the conservative. Both follow ups reported similar results. | | | |
| 14<br>Jang, et al (2020) | Clinical commentary. | 6–12-week recovery conservative management. | Conservative techniques, such as sling usage, were described as the preferred method among studies physicians and physiotherapists, however, surgical treatment, in the form of open reduction, may depend on the variable of age. Young athletes want a quicker RTS time. | N/A. | VII |
| 15<br>Verstift, et al (2019) | Systematic review PRISMA. Outcome parameters were RTS, time to RTS, level of sport, functional outcomes scores. MINOR scores. | Weighted mean constant score = 92/100.<br><br>Weighted mean RTS time = 4.0 months. | Conservative approaches were initially practised, surgery followed through the CC repair cortical buttons, Weaver Dunn, LARS, Kirschner, and hook plate. | N = 498 Athletes within N = 432.<br><br>11 articles extracted. | V |
| 16<br>Watson, et al (2015) | Case study, Keralan Jobe Orthopaedic Clinic Shoulder, and Elbow score. | Score = 97.5, 100% satisfaction. | Conservative: Figure of 8 brace, with a sling followed by various exercises, which | A minor league baseball player. N=1. | IV |

| | | | | | |
|---|---|---|---|---|---|
| | | | include:<br>Bilateral scapular retraction rows, external rotation in neutral, alternating hand taps in prone on hands position, and prone plyometric external rotation at 90 degrees. | | |
| 17<br>White, et al (2020) | Review - MRI examinations, SPSS, binomial analysis for ACJ and player shooting. Chi square for observed versus expected presence or absence of muscle injury. One way analysis of variance for RTS comparisons between grades. | Mechanism of injury, player handedness, clinical features, and return to play met satisfactory outcomes. | Conservative: Pain control support with sling and early mobilization, progressive resistance exercise, and strength and physical resistance training. | N= 23 NHL patient players, mean age 24. 5.24 were type III ACJ injuries. | IV |
| 18<br>Kay, et al (2018) | PRISMA literature review - PubMed, MEDLINE, EMBASE. Constant score, The results of additional scoring systems, such as the DASH score, QuickDASH, SST, OSS, SPORTS score, UCLA shoulder score, and ACJI score. | 12 articles after full text review. Constant score Mean = 87.3/100 from 10 studies that included constant scores. ASES mean score range = 87.30-100. | Conservative | N= 315 patients, 119 were type III ACJ injuries. | I |
| 19<br>Longo, et al (2017) | Systemic review of 22 studies using PRISMA via Medline, PubMed, Cochrane, CINAHL. | Constant Score (~>90), ASES (~27-19), Shoulder Pain and Disability Index (SPADI), DASH, UCLA, Extra Short | Surgical: Weaver Dunn, Bosworth, K-wire, and hook plate.<br><br>Conservative: exercises and slings. | Surgical: N= 633. Conservative: N= 218. | I |

| | | | | | |
|---|---|---|---|---|---|
| | | Musculoskeletal Function Assessment questionnaire (XSMFA-D) (~12-13). | | | |
| 20<br>Muller, et al (2018) | RCT, with two groups, Group A: open clavicle hook plate, Group B: arthroscopically assisted double double CC suture button. Follow up at 1 year, 2 years. Age and American Society of Anaesthesiologist Score (ASOSS), Somatosensory Amplification Scale (SSAS), Numerical Analog Scales (NAS) used for measurement. | ASOSS: open clavicle hook plate at 24 months – 75.4, double double CC suture button at 24 months – 92.8<br>SSAS: open clavicle hook plate at 24 months – 6.4, double double suture button – 7. | Surgical: Hook plate and double suture button. | N = 73 ACJ injuries. | I |
| 21<br>Saade, et al (2022) | Retrospective two-centre study. Constant score. | Operative<br>CS = 91<br>No difference in other function scores<br><br>Surgical<br>CS = 83 | Open reduction with synthetic ligament, arthroscopic assistance | N=38 | III |
| 22<br>Broos, et al (2022) | Literature review: Medline, Medscape, DynaMed. | Conservative treatment had provided very good results for type III ACJ Injuries, surgical interventions should be limited. | Reviewed ligamentous repair reinforced with PDS, hook plate, and Bosworth screw. | Total N= 193. | I |

| | | | | | |
|---|---|---|---|---|---|
| 23<br>Calvo, et al (2006) | Retrospective Review, Imatani Scale. | No statistical differences in Conservative vs Operative.<br><br>Surgical group score: 93.7<br>Conservative group score: 94.1. | Modified Phemister, Kirschner wires.<br><br>Sling, ice pack, mild analgesics. | Total N=43.<br>Conservative: N=11.<br>Surgical: N=32. | I |
| 24<br>Cardone, et al (2002) | A RCT with 14 football players. RTS was recorded and measured using the Subjective Shoulder Score (SSS). | Full recovery, with two patients failing conservative treatment and proceeding with surgical treatment.<br><br>Surgical: SSS: 87.3.<br>Conservative: SSS: 72.5. | Surgical: Surgical reconstruction.<br><br>Conservative: Rest, ice, analgesia, sling Immobilization. | Total N = 14.<br>Conservative: N =6<br>Surgical: N=8 | IV |
| 25<br>Ceccarelli, et al (2008) | Literature Review with over 5 RCT's and Systematic Reviews. Cochrane, Health Technology Assessment, TRIP, MEDLINE, CINAHL, EMBASE. | Conservative treatment preferred due to low complications compared to surgical. | Surgical: Stienman pins, open reduction/stabilization,<br><br>Conservative: sling, exercises. | 5 Studies, N=144+. | I |
| 26<br>Esen, et al (2011) | A RCT with 34 patients with type III ACJ injuries from falls and accidents. | 6-week full recovery between both conservative and surgical groups. No complications and good-excellent results. | Surgical: Weaver-Dunn (modified). Surgery days varied from 5-24.<br><br>Conservative: isometric exercises, pendulum, and active-assistive exercises. | N=34 type III ACJ injuries, 24 Male, 10 Female. | II |
| 27<br>Nissen, et al | Management preference survey on | 81-86% conservative | Surgical: reconstruction of CC | N= 664 American | VII |

| | | | | | |
|---|---|---|---|---|---|
| (2007) | conservative vs operative treatment for ACJ III injuries. | preference, 57-59% surgical preference. | ligaments<br><br>Conservative: Sling and standard protocol | Orthopaedic Society for Sports Medicine members | |
| 28<br>Galpin, et al (1985) | RCT. Results based of weakness at location of injury. Scale ranges from Nil, Mild, Moderate, Severe (Strength Index). | <u>Nil (90%)</u><br>Conservative: N=16.<br>Surgical: N =12.<br><br><u>Mild (80-89%)</u><br>Conservative: N=1.<br>Surgical: =1.<br><br><u>Moderate (70-79%)</u><br>Conservative: N=1.<br>Surgical: =1.<br><br><u>Severe (70%)</u><br>Conservative: N=1.<br>Surgical: =0. | Surgical: Bosworth CC screw fixation.<br><br>Conservative: sling, exercises in physio. | Conservative: N=19.<br>Surgical: N=14. | III |
| 29<br>Giai, et al (2022) | Literature Review, PRISMA – PubMed, Scopus, Embase, and Medline.<br>Constant score (CS.) | <u>RTS at same level</u><br>Conservative: 64-80%.<br>Surgical: 66-83%.<br><br><u>CS means.</u><br>Conservative: 80-100%.<br>Surgical: 90-100%. | Conservative: Kenny Howard, sling.<br>Surgical: Phemister, hook plate, weaver dun<br>Tightrope. | Conservative: N=73.<br>Surgical: N=110. | I |
| 30<br>Gstettner, et al (2008) | RCT – Standard and stress radiograph comparison. CS, SST, OSS. | Surgical: (Mean)<br>CS: 90.4<br>SST: 11.3<br>OSS: 16<br><br>Conservative | Conservative: Sling, immobilization, and functional therapy.<br><br>Op – hook plate. | Conservative: N= 22.<br>Surgical: N=28. | III |

| | | | | | |
|---|---|---|---|---|---|
| | | (Mean):<br>CS – 80.7<br>SST – 9.9<br>OSS – 18.7 | | | |
| 31<br>Korsten, et al (2013) | Literature Review – PRISMA: PubMed, Cochrane, Embase, Scopus, Cumulative Index to Nursing and Allied Health Literature databases. | Study scoring systems:<br><br><u>Imatani score</u><br>Conservative: 94.1<br>Surgical: 93.7<br><br><u>Poigenfurst score</u><br>Conservative: 9<br>Surgical: 7<br><br>Constant score<br>Conservative: 80.7<br>Surgical: 90.4<br><br>Taft score<br>Conservative: 10.3<br>Surgical: 10.7 | Surgical:<br>Modified Phemister, Weaver-Dunn, PDS banding, Hook Plate, Bosworth Screw.<br><br>Conservative:<br>Sling, Physiotherapy exercises, Gilchrist bandage, AC-bandage | 8 articles | I |
| 32<br>Hootman, et al (2004) | Literature review – Medline.<br>Commentary. | Similar functional outcomes (pain, complications for return to work/activities).<br><br>88% surgical and 87% conservative treatment patient satisfaction.<br>93% surgical and 96% conservative little to no pain reported. | Surgical: Standard surgical ACJ treatments.<br><br>Conservative: Physiotherapy. | 24 articles:<br>Total N=1172<br><br>Conservative: N=339<br>Surgical: N=833 | I |

Table 4 – Charting Preferred Treatment for Return to Sport from Outcomes

| **Author and Year of Publication** | **Other Statistical Highlights** | **Time for RTS or Return to Function** | **Preferred Treatment** |
|---|---|---|---|
| 1<br>DeCarli, et al (2015) | Subject evaluation: Conservative: good = 85%, excellent = 15%<br>Surgical: good = 12%, excellent = 88%.<br><br>Satisfaction<br>Conservative: unsatisfied = 20%, poorly = 30%, satisfied = 50%.<br>Surgical: satisfied 22%, very satisfied = 78%. | Conservative mean = 60 days.<br>Surgical mean = 120 days. | Conservative preferred. |
| 2<br>Figueiredo, et al (2014) | 30% complication rate. | 6 months – surgically. | Indifferent. |
| 3<br>Bradley, et al (2003) | N/A | 12 months. | Indifferent. |
| 4<br>Boffano, et al (2017) | Surgical population: (1) 29 month follow up - 94%maintained reduction with no pain. (2) 84% from n = 224 | N = 9/10 in one study RTS with equal performance, 3 months RTS. | Surgery preferred. |
| 5<br>Mahajan, et al (2019) | 8/29 Surgeons preferred surgical method. | Majority - 3 months. | Conservative preferred. |
| 6<br>Roberson, et al (2016) | Satisfaction scores from reconstruction = 90-100%.<br>Constant avg = ~95<br>ASES avg = 93 | 3-5 months. | Surgery preferred. |
| 7<br>Muench, et al (2021) | Twenty-two patients (mean age: 40.1 ± 15.6 years) with successful conservative treatment and twenty-one patients (mean age: 43.6 ± 12.0 years) who required conversion to ACCR were included in the study (Fig. 1). There was no significant difference in patient age at injury between the two | 3-5 months.<br>Conservative: 6 months, Surgical: 86% RTS rate. | Indifferent. |

| | | | |
|---|---|---|---|
| | study groups (n.s.). Mean follow-up of the patients treated conservatively was 117.6 ± 29.7 months (range 60–174 months) and 84.2 ± 24.0 months (range 60–138 months) for the ACCR group. Median time from injury to conversion to ACCR was 24.1 ± 52.9 months | | |
| 8<br>Xinning, et al (2014) | Good-excellent results in conservative (91%). 12-point radiographic system, NS = 8.4, S =9.4. Constant score NS = 80.7, S = 90.4. | ~2 months for conservative. Surgical not evaluated. | Indifferent. |
| 9<br>Windhamre, et al (2022) | 24-month follow up:<br>conservative mean using CS, SSV, QuickDASH scores - 88.<br>Op Mean CS, SSV, QuickDASH scores - 91.<br>mean age, 40 years [range, 18-64 years]; 91% male patients) were randomised, nonoperative treatment (type III, n = 33; type V, n = 30) operative treatment with a hook plate (type III, n = 30; type V, n = 31) | ~6 months. | Conservative preferred. |
| 10<br>Deans, et al (2019) | N/A | ~7 months. | Conservative preferred. |
| 11<br>Tamaoki, et al (2019) | 88% ROM, 90% full strength<br>At 6 months<br>CS = MD 11.31, CI 17.19<br>UCLA = MD -2.00, CI -5.11 | 6 months. | Indifference. |
| 12<br>Faggiani, et al (2016) | Constant = 91.10<br>Oxford Shoulder = 46.19<br>Simple shoulder = 10.50<br>SPORTS = 7.88 | 3-5 months. | Surgery preferred. |
| 13<br>Feichtinger, et al (2021) | VAS/CS/ASES scores<br>Conservative<br>ACJI – 91<br>CS – 91<br>ASES - 90<br>VAS – 1 | 3-5 months. | Conservative preferred |

| | | | |
|---|---|---|---|
| | Surgical<br>ACJI – 79<br>CS - 90<br>ASES - 87<br>VAS – 1.5<br>No mean significant difference. | | |
| 14<br>Jang, et al (2020) | N/A | 12 weeks. | Conservative preferred. |
| 15<br>Verstift, et al (2019) | Mean constant score = 92 | RTS mean = 3-4 months, 84% RTS. | Surgery preferred. |
| 16<br>Watson, et al (2015) | 97.5 Kerlan Jobe Orthopaedic Clinic Shoulder and Elbow score<br>8/12 throwing athletes ability considered normal from conservative treatment. 80% return to pre-injury ability. | RTS = 12 weeks. | Conservative preferred. |
| 17<br>White, et al (2020) | ACJ width = 5mm<br>Clavicular offset = 2.1 | Mean RTS = 21 days, grade III mean = .7 compared to grade I, II of 6.1. | Conservative preferred. |
| 18<br>Kay, et al (2018) | N/A | Mean 2.6 months for missed time. 89.6% RTS pre-injury ability. | Conservative preferred. |
| 19<br>Longo, et al (2017) | N/A | 3-4 weeks. | Conservative preferred. |
| 20<br>Muller, et al (2018) | Group B = higher level of RTS and success rate. NAS | 12-24 months (late follow up). | Surgical preferred. |
| 21<br>Saade, et al (2022) | No complication found in non-op patients, 9 found in op patients. | 9.5 months | Conservative preferred. |
| 22<br>Broos, et al (2022) | Review highlighted 4.5 year follow up provided:<br>Hook plate – 53% success, 70 for Bosworth screw. | 40 months (varied on follow up). | Conservative preferred. |
| 23 | N/A | 12 month follow up, | Conservative |

| | | | |
|---|---|---|---|
| Calvo, et al (2006) | | RTS good. | preferred. |
| 24<br>Cardone, et al (2002) | SST scores as follows:<br>Surgical: 87.3 (MEAN), SD 10.61, range 75-100<br>Conservative: 72.5 (MEAN), SD 24.9, range 20-100. | Non-contact<br>2.4 weeks for non-op group, 6.3 weeks for operative.<br><br>Contact<br>26.2 weeks non operative, 18.8 operative treatment. | Indifferent. |
| 25<br>Ceccarelli, et al (2008) | N/A | 5-12 months. | Conservative preferred. |
| 26<br>Esen, et al (2011) | N/A | 12-49 months. | Indifferent. |
| 27<br>Nissen, et al (2007) | 91% prefer sling for conservative immobilization and initial rehab treatment. 61% prefer CC ligament reconstruction vs 33% AC and CC reconstruction. | 3 months | Conservative |
| 28<br>Galpin, et al (1985) | Pain Assessment<br>Nil – Cons N=15, Op N=12<br>Mild – Cons N=5, Op N=4<br>Moderate – Cons N=1, Op N=0<br>Severe – Cons N=0. Op N=0 | Conservative<br>2.6 weeks RTS<br><br>Surgical<br>6.8 weeks RTS. | Indifferent. |
| 29<br>Giai, et al (2022) | N/A | RTS 4-6 months (based off includes studies RTS). | Surgical preference |
| 30<br>Gstettner, et al (2008) | Cons VAS score –77.6%<br>Surg VAS score – 89.2% | 12 month follow up | Surgical preferred. |
| 31<br>Korsten, et al (2013) | N/A | 5.7 months – 6.5 years | Surgical preferred. |
| 32<br>Hootman, et al (2004) | N/A | 43-60 months | Indifferent. |

Synthesis of Results

The 32 studies reflected the inclusion criteria of discussing Rockwood grade III ACJ injuries while investigating RTS outcomes. Inclusion criteria aided in identifying studies that provided relevant data to the research question. Emphasis on no gold standard, with conservative outcomes providing slightly better results, and surgical complications hindering the advocation of surgical intervention over conservative treatment were also present in the findings, as indicated in some of the studies such as Figueiredo, et al (2014), Tamaoki, et al (2019), and Cardone, et al (2002)'s discussions.[67][68][69] The chart findings indicate a RTS was slightly better for conservative interventions, but surgical treatment was preferred for younger athletes due to personal preference and long-term stability in the joints, as reported by Jang, et al (2020).[70] Based off other key findings from the literature, specifically from the most common scoring, the Constant Score, from outcomes in table 3 for Saade, et al (2022), Longo, et al (2017), Kay, et al (2018), conservative proved to be slightly better than surgical.[71][72][73] Conservative treatment as outlined in the treatment preferences column in table 4, indicated that conservative treatment was overall preferred.

## 2.4 Discussion & Summary of Evidence

The primary focus of this surgical versus conservative treatment comparison paper is on Rockwood grade III ACJ injuries. This is due to the ongoing controversy in the healthcare

[67] Figueiredo, et al (2014)
[68] Tamaoki, et al (2019)
[69] Cardone, et al (2002)
[70] Jang, et al (2020)
[71] Saade, et al (2022)
[72] Longo, et al (2017)
[73] Kay, et al (2018)

community in determining a standardized treatment procedure. The research question was to determine if there was a gold standard to treating Rockwood type III ACJ injuries in athletes by examining current academic literature that use the Rockwood ACJ scale as their preferred method of classification. Variability in using Rockwood scaling for type III ACJ injuries include determining what constitutes a superior dislocation for the ACJ with a rupture in the AC ligament. There still isn't a standard approach for treating the injury due to the subjectivity of RTSs, professional opinions, and patient preferences. There are multiple mixed conclusions around whether a conservative or surgical treatment approach is preferred, as it was subjective to the authors of the studies. The results highlight an overall slight preference towards conservative treatments, however there are still numerous studies that emphasize surgical success. There was a preference for surgery found for younger adults as opposed to older adult athletes. Generally, indications for select surgical methods, such as TightRope and hook plate fixation, result in a less risky surgical treatment. Risk was the number one reason as to why patients opted for conservative treatments, as there is a lower chance of deformities or development of other conditions. Patient-centric experiences should be prioritized for treatment decisions to maintain a firm line of communication regarding advantages and disadvantages in choosing a treatment plan.

Surgeries that are less invasive typically are desirable because of low complication rates. Rehabilitation techniques typical have a variety of approaches that are more comfortable and less invasive, all the while presenting an attainable RTS goal for the athlete. The Rockwood scaling for ACJ injuries presented a persistent dilemma for conservative rehabilitation versus surgical treatment, especially with time-sensitive cases regarding athletic populations. Surgeries tend to open patients to new trauma, physically and or mentally, post-operation.

Interventions and Outcomes- Surgical

A focus of this review is on evaluating surgical treatment interventions that include a variety of successful interventions that have a higher chance of returning the patient to their original function. These approaches included hook plate, TightRope, CC ligament reconstruction, and secondary techniques of bone bracing. Surgical management has been on the rise in popularity among athletes, as new innovative techniques and procedures concerning AC and CC ligaments provide less risk and invasiveness. For instance, *Figueiredo, et al s, Complex shoulder injuries in sports,* highlights surgical success using the Weaver-Dunn with a mid-aged athlete, as the patient made a full recovery in RTS. RTS played a role in the decision for a surgical treatment due to the statement of high functional demand and competitive nature of sport as the patient is an Olympian. This case study is an example of an athlete routinely benefitting from a surgical procedure and restoring their function for RTS. This demonstrates how young athletes may opt for surgery since there is a biomechanical functional demand of the shoulder at such a high level of sport and will therefore provide a faster RTS.[74] Similarly, studies such as *Xinning et al.'s,* have shown surgical reduction and CC ligament reconstruction as favourable for functional outcome measures.[75] However, conservative management was still determined to be adequate for a more typical athlete case.

*Daniels, et al*, refers to the football players' surgical procedures to avoid drilling in the clavicle due to susceptibility of fracture. It is recommended to have only a 5-10 mm resection of the bone due to the instability of the joint.[76] These cautionary requests of surgical practices affect the studies that promote active drilling during surgical treatment. This is important to the

[74] Figueiredo, et al. (2014)
[75] Xinning et al. (2014)
[76] Gibbs, et al. (2015)

research question as other literatures address drilling to provide as much room for implanting screws and nails for bracing. Modern surgical techniques are advancing in terms of lowering complication rates. However, the contribution of this scoping review is its description on how complications, even after an initially perceived successful surgery with no immediate risks, may still arise >24 months after the surgery (i.e., TightRope), deeming the surgery unsuccessful with the complication rate increasing.[77]

*Boffano, et al.*'s systematic review study relates to the multiple case studies determining functional outcomes. The surgical interventions ranged from the years 2001-2010 and showed the evolution of techniques. The Weaver-Dunn procedure was heavily modified throughout the years; some examples include delta trapezial imbrication over the top, intramedullary tensioning, the use of titanium buttons, and heavy suture.[78] Artificial ligaments from braided polyester was another example of the uniqueness of surgical approaches to a type III ACJ injury. Respectively, the complications decreased over time, potentially due to the time it takes to perform surgical management, which included screw loosening, fracture of coracoid, recurrent dislocation, and superficial infection of superior clavicle.[79] CC ligament repair is a popular choice among surgeons as described within *Mahajan, et al's* questionnaire study. 83% of the surveyed surgeons reported a preference for conservative treatment but of the 63% that preferred surgical repair, the majority opted for CC ligament repair as a fixation method.[80]

Interventions and Outcomes - Conservative

A secondary objective for this review is the conservative, non-surgical, and conditioning intervention that is perceived to usually have a longer RTS time but safer results with less

[77] Gibbs, et al. (2015)
[78] Boffano, et al. (2015)
[79] Boffano, et al. (2017)
[80] Mahajan, et al. (2019)

complications. The study used for discussing range from literature synthesis or outcomes from non-surgical management interventions, including a series of case studies, RCT's, and systematic reviews. A conditioning program for rehabilitation treatment was followed in all the patients from the reported studies who had undergone conservative treatments.

*Watson, et al*, discussed how their baseball throwing pitcher suffered a clavicle dislocation of near 100% separation (9mm and 17.5mm).[81] However, the team recommended a conservative approach for 2-4 months before any surgical discussion regarding type III ACJ injuries because in their personal research, they found literature describing the complication rates of surgical interventions.[82] Conservative treatment has a significantly lower complication rate and naturally restores shoulder function over time. *Robertson et al*. recommends a RTS protocol post-surgery if the athlete decides to proceed with surgery. The protocol is primarily based around a conservative treatment that is divided into 4 phases that looks to restore ROM, strength, and relieve pain. The patient must continue muscle strengthening which include shoulder flexion, abduction, shrugs, and bench press. Patients will advance to phase 4 when they have painless ROM, including nontender, normal strength (near 100%) movement and pass an isokinetic test.[83] The effectiveness of this protocol is yet to be evaluated, however, the theory behind it is to maximize biomechanical output (performance) through stages of recommended exercises and prioritization of muscles. The ability to adapt, create, and provide new protocols for patients from a conservative approach is a key highlight to understanding the slight preference for conservative treatment.

<u>Comparing Outcomes of Surgical Versus Non-Surgical Management</u>

[81] Watson et al. (2015)
[82] Watson et al. (2015)
[83] Robertson et al. (2016)

Majority of the outcomes from the 32 studies extracted, when examining variables from the studies comparing conservative versus surgical, lean towards conservative treatments for type III ACJ injuries. However, surgeries may provide more immediate pain relief due to hard fixing the dislocation and perceived faster RTS. Within the scoping review, however, an estimated average of 6 months for RTS with surgical treatments and an estimated average of 8-12 months for RTS for conservative treatments was reported. A study done by *Kay, et al.* looking into the evaluation of RTS after surgical treatment through a systematic review in PubMed, MEDLINE, and EMBASE, reported that typically, a faster RTS time for surgical treatment over conservative treatment varies.[84] The results indicated a surgical full RTS success rate of 94%-100%, with preinjury RTS function resulting in ~89% (Confidence interval 79%). This indicates that RTS performance is similar in surgical and conservative treatment.

The consensus was that a conservative treatment provides a safe, less risky treatment option with similar RTS performance success compared to surgical treatments. However, it is important to keep in mind that there is currently still no gold standard among treatment options for type III ACJ injuries due to the nature of the dislocation and tearing of adjacent ligaments on a case-by-case basis. Surgical management has its unique positive feedback from patients regarding cosmetics and early surgical interventions impacting a faster rate of RTS. ASES, UCLA shoulder scale, and constant scores have advocated for both conservative and surgical success for achieving adequate functional outcomes for active populations.[85]

*Roberston et al.* had provided new surgical methods that could possibly increase net RTS and decrease pain.[86] A modified anatomical reconstruction was used to create a new method of

[84] Kay, et al. (2018)
[85] Kay, et al. (2018)
[86] Roberston et al. (2016)

surgery separate from the traditional widespread Weaver-Dunn procedure and other suture button techniques. The procedure included measurements on bone tunnels, passing suture medially and laterally, passing the graft, reduction, and fixation, suturing of reaming limbs, insertion of internal brace, and closure.[87] This was justified due to the toleration of unstable joints in active populations.

*Jang, et al.'s* study provided an important note of age being a factor in choosing surgical treatment over conservative, as it may be common knowledge for athletes that surgery equals faster RTS. It is important to note that is not the case as conservative methods have provided a fast RTS, hence the controversy of the treatment options for type III ACJ injuries. Specialized equipment should be used within the shoulder padding in conjunction with braces and extra kinesiology taping. Tailoring towards athlete's shoulder equipment in select sports will decrease contact forces from the clavicle.[88]

Every patient is different on a case-by-case basis, as *Deans et al.* explains, and incomplete reduction of the ACJ has no correlation to poor outcomes. However, chronic ACJ changes, such as osteolysis, distal clavicle hypertrophy, and calcification of the CC ligaments, do not correlate with a painful shoulder. Deformity does not reduce time; it reduces severity. There is a sizable portion of patient populations that cannot and will not do well with conservative treatment due to other personal barriers, whether they be physical or psychological.[89] Informing the patient, through knowledge translation (KT) methods may provide the patient with educational information on understanding how surgical methods truly work, including the effects of post-surgery.

[87] Roberston et al. (2016)
[88] Jang, et al. (2020)
[89] Deans et al. (2019)

*DeCarli, et al.* had an RCT with 72 patients who had suffered type III ACJ injuries and opted for either a conservative or surgical management within two groups.[90] Outcome measures included UCLA shoulder scale, ASES, Constant score, and SPADI, the outcome scores which determine shoulder function. Group A was conservatively treated with 30% calcification and similar scores of UCLA shoulder scale, and ASES, however Group B's surgical treatment presented a higher ACJI score.[91] However, due to the similarities in most of the outcome scores, there was no conclusion on the preferred method of treatment. This presents us with a dilemma of using scores as the only means of surgical success. Perhaps emphasizing outcomes that focus on patient satisfaction instead of functional outcomes may provide a better index in determining the best approach. Surgical treatments that are failing and opting for conservative treatment post-surgery is a sign of risk that can be dealt with. By looking at it from a patient-centric approach, we can better understand scenarios in which one option may be better for a patient's recovery over the latter.

*Xining et al.* reported that a small percentage of sample sizes, after a ~12 year follow up who were treated non-surgically, had developed some form of scapular dyskinesis and Scapular dyskinesis, known as SICK scapula syndrome.[92] This further complicates conservative treatments in relation to RTS due to a found reduction of strength that can come from these complications. Surgical complications, in comparison, are more technical as they are involved with the screws and wiring itself, misplacements reported at follow ups, etc.

Return to Sport (RTS) and Sub Classification

[90] DeCarli, et al. (2015)
[91] DeCarli, et al. (2015)
[92] Xining et al. (2014)

The studies reported generally high RTS in both conservative and surgical interventions. The outcomes were similar, with surgical interventions providing slightly faster RTS and higher complications compared to non-surgical approaches. Pain could be managed appropriately with both intervention methods. *Deans, et al.* had reported two studies concerning overhead athletes with a 62% & 95% RTS to baseline prior to treatment, an example of some of the RTS rates found in the comparison literature.[93]

*Roberston et al.* included an RTS protocol, separated into 4 phases. Those include pain relief and begin motion, restore full painless ROM, increase of strength, restoring strength to shoulder girdle, and finally an RTS.[94] This is done by methods of icing, immobilization, analgesics, ROM, strengthening of shoulder flexion, abduction, shrugs, and various strength based exercises.[95] This context can provide a clear picture of how RTS needs to be systematically monitored and guided in conjunction with the treatment option the patient may decide to work with. Concerning sport, due to the various levels of sport, accuracy of RTS function may differ. The most popular and frequently recurring sports included baseball (overthrowing athletes), football (impact), hockey (impact), and rugby (impact).

Individual characteristics of patients play a key role in ACJ rehabilitation and surgical management for RTS. One of which is age, as described by *Xinning, et al.'s study*, where optimal treatments are based on individual bodies. Older athletic populations differ in treatment options, depending on the sport's (i.e., overhead athletes) functional demand.

*DeCarli*'s RTS data provides a display of similarity among conservative (~80%) and surgical (~83%) RTS for performance, like what they had before the ACJ injury.[96] This is

[93] Deans, et al. (2019)
[94] Roberston et al. (2016)
[95] Roberston et al. (2016)
[96] DeCarli, et al. (2015)

enforced by *Muench et al.'s* study which investigates complication rates and RTS. One study they reviewed alluded to conservative management leading to quicker recovery for RTS, ranging from 6-8 weeks for a conservative program. Closed and open exercises for scapula control and stabilization, via kinetic chain strength, were techniques used for conservative treatment.[97] However, non-operative reconstruction can provide better RTS performance if there is a failure in non-operative treatment – it did not provide any significant outcome measures. RTS may be dependent on the type of grade III ACJ injury. Grade/type IIIA refers to ACJ injuries that are stable without overriding of the clavicle and without significant scapular dysfunction. Type IIIB refers to instability scapular dysfunction. This was discussed in *Deans, et al.'s review* as the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine (ISAKOS) upper hand committee created this classification.[98] A key takeaway is the procedure for this subclass classification, in which all type III injuries should be treated conservatively. At the 3–6-month mark, a type IIIA or IIIB injury, based on the classification criteria, should merit either a continuation of conservative treatment, or the start of a surgical intervention. These two types offer a clearer line in treatment decisions but help identify those failing conservative management and in need of ACCR surgery to minimize time missed for RTS. The average mean RTS for conservative management from the studies was ~3 months and the average mean RTS for surgical was ~6 months. This included only the type III ACJ injuries.

The analysis of the literature provided an understanding that there is still a grey area in which treatment is preferred over the other, and that both conservative and surgical treatment show similar clinical outcomes from pain to outcome scores.[99] A clearly defined method of

[97] Muench et al. (2021)
[98] Deans, et al. (2019)
[99] Muench, et al. (2021)

subclassification, depending on the pain, function, and patient objectives, can be used to determine the best approach to treatment. However, it is important to note that although both surgical and conservative methods may provide similar outcomes, they differ in RTS times. The questionnaires delivered to surgeons in the UK by *Mahajan, et al.'s Grade 3 AC joint injury: A survey of current practice in the UK*, stated the controversy is still very much active. A consensus for one ideal treatment choice for functional outcomes for type III ACJ surgeries is still controversial and more RTCs are required.

Implications of results for practice, policy, and future research include the continuation of debate regarding conservative versus surgical preference for grade III ACJ injuries. KT is needed for consultation practices, as treatment options are on a case-by-case basis. Due to the lack of standardized procedure when comparing treatments, active communication, and access to the effectiveness of conservative and surgical treatment plans with synthesized research documents can create possible positive patient experiences and outcomes in athletes and active populations. Surgical treatments are dependent on a sport-by-sport basis, as ROM and overall function is dependent on the sport.

RTS success rates rely on functional outcomes, ranging from pain, ROM, and strength. A patient-centric experience should be of primary importance when dealing with patients who have ACJ type III injuries. A qualitative approach, with a form of KT, should be emphasized for future practices. Some patients must understand the complications of an early surgical intervention if a shorter RTS is desired. This is a very important point as RTS can be coined as the driving factor for surgical preference as a treatment over conservative. The driving controversy that was studied was not patient outcomes – as they were similar but not the same in both surgical and conservative treatment approaches – but rather what approach should be the

first by-the-book treatment when given a situation where a grade III ACJ injury needs to be treated. The next goals should be to develop a deliverable to active populations and discuss with their healthcare provider for the best understanding of the most readily available type III ACJ injury treatments. Educating patients on the best treatment option should factor in looking for a standard for type III injuries, as a case-by-case basis should be analyzed and treated with from a qualitative level looking into patient satisfaction, since what's driving the controversy lies in successful RTO only.

Limitations

Limitations of evidence included in the review are heterogeneity and treatment variation among the patient populations. Limitations of the review process include studies that were not available for full text review. For the studies that were selected, limitations included low quality assessment due to failure of stating number of patients, comparison group bias, and details regarding patient characteristics. Many of the cross sectional and prevalence studies did not specify ACJ injuries outside of clavicle separation (mm) relating to the type ACJ III injury.

## 2.5 Conclusion

The research question investigated clinical outcomes from a surgical and conservative treatment perspective concerning type III ACJ injuries in athletes to determine a gold standard for treatment. The secondary objective was to factor in RTS to analyse functional outcomes in post-treatment, which was determined to have averaged 3-6 months, with conservative treatment providing slightly faster recovery. After analysing the results from several studies, there is no gold standard for grade III ACJ injuries, however, the scale in which type III ACJ injuries are treated is beyond a simple standardized approach for treatment, as results indicate a subjective

and biased favour of either treatment (moderate bias results). Overall, there was moderate to low evidence of bias as depicted by the Covidence assessment of bias tool and MINORS. More RCT's are needed if a gold standard is to be found for treating grade III ACJ injuries.

## 2.6 Other Information

Registration and Protocol

N/A

Support

N/A

Competing Interests

N/A

Availability of Data, Code, and Other Materials

All available data can be retrieved and accessed through Western University Databases, via Western Libraries.

## 2.7 Chapter 2 References


47. Balke, et al. (2022). *Minimally invasive reconstruction of acute acromioclavicular joint injuries using the TwinBridge button system.* European Journal of Othethopediuc Surgery & Traumatology.
48. Boffano, et al. (2017). *The Surgical Treatment of Acromioclavicular Joint Injuries*. EFORT open reviews. Vol 2 (10), pp 432-437.
49. Botz, et al. (2021). *Rockwood classification of acromioclavicular joint injury*. Radiopaedia Organization. Retrieved from: https://radiopaedia.org/articles/rockwood-classification-of-acromioclavicular-joint-injury.

50. Bradley, et al. (2003). *Decision making: Operative versus nonoperative treatment of acromioclavicular joint injuries*. Clinics in Sport Medicine. Vol 22(2), pp 277-290.
51. Broos, et al. (2022). *Acromioclavicular dislocations type III*. European Journal of Trauma. Vol 28 (1), pp 11-15.
52. Calvo, et al. (2006). *Clinical and radiologic outcomes of surgical and conservative treatment of type III acromioclavicular joint injury*. Journal of Shoulder and Elbow Surgery. Vol 15(3), pp 300-305
53. Cardone, et al. (2002). *Grade III acromioclavicular joint injury in Australian Rules Football.* Journal of Science and Medicine in Sport. Vol 5(2), pp 143-148.
54. Ceccarelli, et al. (2008). *Treatment of acute grade III acromioclavicular dislocation: A lack of evidence*. Journal of Orthopaedics and Traumatology. Vol 9(2), pp 105-108.
55. Covidence. (2022). *Quality and extraction template*. Retrieved from: https://www.covidence.org/.
56. DeCarli, et al. (2015). *Acromioclavicular third-degree dislocation: surgical treatment in acute cases*. J Orthop Surg Res. 10, 13.
57. Deans, et al. (2019). *Acromioclavicular joint injuries in overhead athletes: a concise review of injury mechanisms, treatment options, and outcomes.* Current Reviews in Musculoskeletal Medicine. Vol 12, pp 80-86.
58. Esen, et al. (2011). *Comparison of surgical treatment and conservative approach for type III acromioclavicular dislocations*. Turkiye Klinikleri Journal of Medical Sciences. Vol 31(1), pp 109-114.
59. Faggiani, et al. (2016). *Comparing mini-open and arthroscopic acromioclavicular joint repair: functional results and return to sport*. Musculoskeletal Surgery. Vol 100, pp 187-

191.

60. Feichtinger, et al. (2021). *Surgery improves the clinical and radiological outcome in Rockwood type IV dislocations, whereas Rockwood type III dislocations benefit from conservative treatment*. Knee Surg Sports Traumatol Arthosc. Vol 29, pp 2143-2151.
61. Figueiredo, et al. (2014). *Complex shoulder injuries in sports*. National Library of Medicine, BMJ case report.
62. Galpin, et al. (1985). *A comparative analysis of operative versus nonoperative treatment of Grade III acromioclavicular separations*. Pp 150-155.
63. Giai Via, et al. (2022). *Acute Rockwood type III ACJ dislocation: Conservative vs surgical approach, A systematic review and meta-analysis of current concepts in literature*. Injury. Vol 53(10), pp 3094-3101.
64. Gibbs, et al. (2015). *Common Shoulder Injuries in American Football Athletes*. Current Sports Medicine Reports. Vol 14(5), pp 413-419.
65. Gorbaty, et al. (2017). *Classifications in Brief: Rockwood Classification of Acromioclavicular Joint Separations*. Clinical Orthopaedics and Related Research. 475, 283-287.
66. Gstettner, et al. (2008). *Rockwood type III acromioclavicular dislocation: Surgical versus conservative treatment*. Journal of Shoulder and Elbow Surgery. Vol 17 (2), pp 220-225.
67. Hootman, J.M. (2004). *Acromioclavicular Dislocation: Conservative or Surgical Therapy*. Journal of Athletic Training. Vol 39(1), pp 10-11.
68. Jang, et al. (2020). *A Current Concepts Review of Clavicle Injuries in Ice Hockey from Sternoclavicular Acromioclavicular Joint.* Orthopaedic Journal of Sports Medicine. Vol 8(9).

69. Kay, et al. (2018). *Return to Sport and Clinical Outcomes After Surgical Management of Acromioclavicular Joint Dislocation: A Systematic Review.* Arthroscopy: Journal of Arthroscopic and Related Surgery. Vol 34 (10), pp 2910-2924.

70. Kane WJ, et al. (1981). *Current orthopaedic management*. New York: Churchill Living Stone. Pp 290-311.

71. Korsten, et al. (2013). *Operative or conservative treatment in patients with Rockwood type III acromioclavicular dislocation: a systematic review and update of current literature*. International Orthopaedics. Vol 38, pp 831-838.

72. Longo, et al. (2017). *Surgical versus conservative management of Type III acromioclavicular dislocation: a systematic review*. Oxford University Press. Pp 1-19.

73. Mahajan, et al. (2019). *Grade 3 AC joint injury: A survey of current practice in the United Kingdom*. Journal of Orthopaedic Surgery.

74. Muench, et al. (2021). *Conversion to anatomic coracoclavicular ligament reconstruction (ACCR) shows similar clinical outcomes compared to successful non-operative treatment in chronic primary type III to V acromioclavicular joint injuries*. Knee Surg Sports Traumatol. Vol 29, pp 2264-2271.

75. Muller, et al. (2018). *Return to sport after acute acromioclavicular stabilisation: a randomised control of double-suture-button system versus clavicular hook plate compared to uninjured shoulder sport athletes.* Knee Surg Sports Traumatol Arthrosc. Vol 26 (12), pp 3832-3847.

76. Nissen, et al. (2007). *Type III Acromioclavicular Separation: Results of a Recent Survey on its Management*. Aspects of Trauma. Vol 36(2), pp 89-93.

77. Roberson, et al. (2016). *Acromioclavicular Joint Injuries in the?>Contact Athlete.*

Operative Techniques in Sports Medicine. Vol 24 (4), pp 254-261.

78. Saade, et al. (2022). *Acromioclavicular joint separation: Retrospective study of non-operative and surgical treatment in 38 patients with grade III or higher injuries and a minimum follow-up of 1 year*. Vol 109 (4).
79. Schneider, et al. (2016). *Inter- and intraobserver reliability of the Rockwood classification in acute acromioclavicular joint dislocations*. Knee Surgery, Sports Traumatology, Arthroscopy. 24, 2192-2196.
80. Sundemo, et al. (2019). *Scoring Methods-MINORS*. BMJ Open Sp Ex Med.
81. Tamaoki, et al. (2019). *Surgical versus conservative interventions for treating acromioclavicular dislocation of the shoulder in adults*. Cochrane Database of Systematic Reviews. Vol 10.
82. Verstift, et al. (2019). *Return to sport after surgical treatment for high-grade (Rockwood III–VI) acromioclavicular dislocation.* Knee Surg Sports Traumatol. Vol 27, pp 3803-3812.
83. Watson, et al. (2015). *Return to play after nonoperative management for a severe type III acromioclavicular separation in the throwing shoulder of a collegiate pitcher*. British Journal of Sports Medicine. Vol 52 (4), pp 231-237.
84. White, et al. (2020). *Acromioclavicular Joint Injuries in Professional Ice Hockey Players: Epidemiologic and MRI Findings and Association with Return to Play*. Orthopaedic Journal of Sports Medicine. Vol 8 (11).
85. Windhamre, et al. (2022). *No difference in clinical outcome at 2-year follow-up in patients with type III and V acromioclavicular joint dislocation treated with hook plate or physiotherapy: a randomised controlled trial.* Journal of Shoulder and Elbow Injury. Vol

31 (6), pp 1122-1136.

86. Xinning, et al. (2014). *Management of Acromioclavicular Joint Injuries*. The Journal of Bone & Joint Surgery. Vol 96 (1), pp 73-84.

# 3.0 The Effects of Age and Sex on DASH Results in Rotator Cuff Injuries Following Successful Rotator Cuff Surgery in Determining Shoulder Disability Outcomes

**Abstract**

**Aim**: To determine if age and/or sex have any differences in upper body disabilities in Rotator Cuff recovery post-surgery/treatment over time– does *sex and age differences have an impact on RC injury recovery and function over time?*

**Methods**: A repeated measures ANOVA and general linear model (GLM) analysis using Statistical Package for the Social Sciences (SPSS) software is used for both sex and age group variables (independent) and DASH scores over time (dependant). The variables are subdivided into male and female and ages <35, 35-50, 51-65, >65 at baseline, 3 months, 6 months, and 12 months for follow up time points.

**Results**: Total sample was 343, with 104 female and 233 male patients. 130 patients reported missing data that needed to be imputed. After a carry-over imputation method was used for missing data, there is a significance found between DASH scores in sex at function at 3 months, 6 months, and 1 year, particularly with males having a faster recovery rate of function compared to females with mean scores of 32 for males and 39 for females at the final follow up at 1 year. Age had a large difference in mean with younger populations (ages 19-35) having the highest score 48 and older populations (ages 51-84) having the lowest score 30 at the 12 month follow up timepoint.

**Conclusion:** Older males reported to have less disability, with younger ages and females reporting the highest disability DASH scores. Clinicians may consider altering rehabilitative protocol post RC surgery to better accommodate younger ages and females. Researchers can investigate the reasonings to why there was a reported sex difference, and why older populations scored lower on DASH.

## 3.1 Introduction

Glenohumeral instability (shoulder instability) is a blanket term regarding the various injuries and dislocations that can occur in the shoulder. A common result of this is pain coming from the various joints, tendons, and muscles that fall within the shoulder. Rotator cuff (RC) injuries contribute to shoulder instability, as dislocations and repeated episodes occurring can cause frequent instability with a loose connection between the tendons and glenoid cavity. Tears range from partial to full thickness tears, which dictates the severity of the injury and affects the time to recover function. To determine this, the type of injury and how the patient received the injury will be recorded. The purpose of this study is to determine if there are any sex and age differences in upper extremity disability in the year following RC repair. Are there differences in patient-reported upper body function outcomes, from successful surgical interventions for RC tears, between sexes and age groups of <35, 35-50, 51-65, >65 within a one-year follow-up?

## 3.2 Methods

### Research Design

Retrospective cohort design with secondary data. A general linear model (GLM) and ANOVA use to analyze means of the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire scores was used.

### Participants

Patient data was extracted from the Hand and Upper Limb Clinic (HULC) in London, Ontario, Canada. Characteristics include ages ranging from patients in their 20's, which is the lowest, and 65+, which is the highest. There was a predominantly male sample size, with 233 being male and only 104 being female. Much of the patient population is older adults, so the sample population is heavily weighted towards the older aged populations (groups 2-4). Younger adults and teens are a small sample size (n=10).

Outcome Measures

The DASH questionnaire is a standardized method of determining shoulder function through various questions regarding symptoms of shoulder pain post-surgery. The symptom score is based on the sum of the number of responses minus 1 and multiplied by 25, over the number of responses (a score of 0 is no disability and a score of 100 is severe disability). Each question has a scale from 0-5. The utilization of the DASH for this paper is to revisit prospective data to determine if age and sex contribute to function outcomes at specific points in time after treatment for RC injuries. DASH Scores over time points of baseline, 3 months, 6 months, and 1 year.

Analysis

Missing data for males, females, and some ages needed to be imputed for a more accurate analysis. Missing data includes data that were left blank within the data sheets, recorded as 0, and values marked 999 by the data collection team. The impact of missing data hindered the ability to create fully successful GLMs to create a graph on SPSS to visually depict differences within groups. Compensation for these missing variables include imputation of the missing data by informing SPSS software of the missing data and using a carry carry-over method. Type of

injury was extracted from the data to understand and present the cause of injury in relation to the age groups.

Repeated measures GLM to test differences between men and women and different age groups in using a one-way ANOVA analysing means differences and variances were calculated. This was used to test the differences in scores and report statistically significantly differences between the sexes and age groups. DASH scores over time had been compared to the sex and age groups and will be variables for a between-subject analysis. The GLM has investigated sex and controlled for age to create a visualization of a GLM means graph to display a more accurate representation of the means distribution and variances between sex and age. This visualization includes the means of DASH scores related to sex and mean variance between age groups for DASH across the above time points.

For the independent variable of age, it was measured in four categories 65< years [1] 51-65 years [2] 35-50 years [3] <35 years [4]. The independent variable of Sex was measured in two variables: Male (0), Female (1). The age subgroups were determined due to common types of injuries, with <35 work related, 35-50 sport related, 51-65 vehicle related, and 65+ injuries associated with falls. The Dependant variable is the DASH outcome measure.

## 3.3 Results

Imputation of Missing Data

Due to the influx of missing data, a regression must be used to predict the DASH scores for 1-year (as this follow-up time presented the most missing data) and for 6-month DASH scores. Regression R indicated a .960 (R squared = .966), which was used in the formula .960 x (DASH score). 7.7 was derived from the B coefficient (-6.906). Since the regression was not significant and not a good predictor, a carry-over method was used from DASH at 6 months to

12 months. Multiple imputation was used for the remaining data entries within 12 months and was used to fill out the majority of 3-month and 6-month data. This approach was used to provide a standard estimate realistic enough – with the direction of effect steadily increasing over time) – to perform a semi-accurate analysis.

Table 5: Missing Score Data at Follow Up Times

| **Missing Scores** | **Number of Missing or Non-Completed Data** |
|---|---|
| Baseline | 66 |
| 3 Months | 250 |
| 6 months | 157 |
| 12 months | 294 |

Table 6: Missing Independent Variable Data

| | |
|---|---|
| **Age** | 7 |
| **Sex** | 5 |

There was missing patient data (N= 335/343 (8 missing)), which had recorded all variables (including age, type of injury, sex) expect for DASH scores. This did not impact the data analysis.

Types of Injury

The data provides a unique question, asking what specific event caused the RC injury. In total, ~n= 214, with these common "types" of occurrences for injury. Other unique single types of occurrences were not included in the table, as well as missing data. A breakdown of patients opting for post therapy were also presented within the data, with 73 females and 153 males.

Table 7: Type of Injury by Age and its Frequency

| Type of Injury | Age Range (Years) | Frequency (N) |
|---|---|---|
| Fall | 31-82 | 69 |
| Work | 19-75 | 49 |
| Sport-related | 35-65 | 21 |
| Vehicle accident | 41-75 | 14 |
| Repetition of lifting and pulling in daily activities | 28-81 | 33 |

One-Way ANOVA Descriptives for Sex and Age

For sex, the mean DASH scores for men at all 4 time points in order of baseline to 12 months are 46.77 (SD 20.17), 41.14 (SD 22.94), 22.93 (SD 20.77), 32.48 (SD 20.66). The mean DASH scores for women are 55.03 (SD 18.08), 43.87 (SD 22.58), 39.40 (SD 23.74), 38.51 (SD 23.45). Analysing the age groups in contrast to sex, men tend to get injured earlier, as majority of the youngest age groups (<35-50) consists of males (21% female, 79% male).

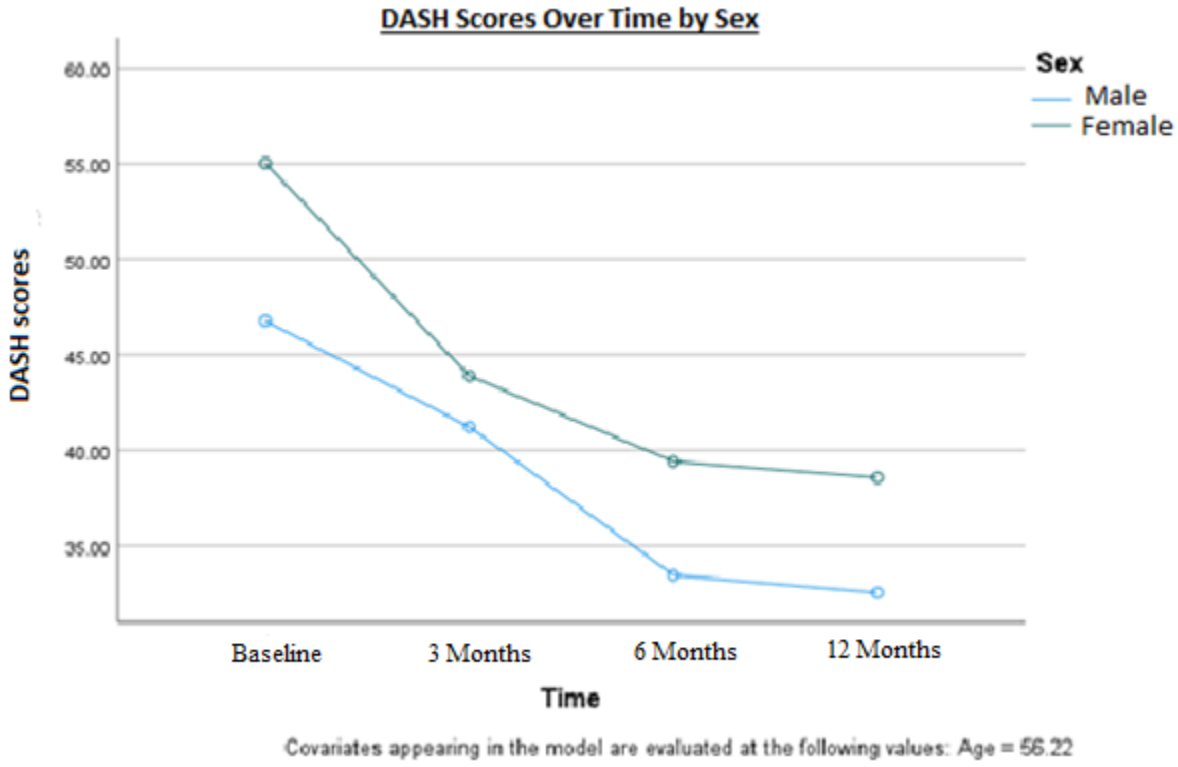
For age, the DASH score means were 30.64 for >65 years old, 35.07 for 51-65 years old, 31.09 for 35-50 years old, and 48.75 for <35 years old at the 12 month follow up. This states that older populations had the lowest DASH score, meaning higher function in the upper body, compared to the highest DASH score of younger populations resulting in low function in their upper body. However, the p values proved non-significance as they are .570, .275, .619, .492 for between groups at baseline, 3 months, 6 months, and 12 months respectively.

GLM Differences in Means and Visuals for Sex and Age

Conducting a GLM analysis helps discover any common means between two unrelated groups. In this instance, those groups are separated by sex (men and women), and age groups (65+, 51-65, 35-50, <35). The mean score for men is ~32 and for women is ~39 at the end of the follow up (12 months), presenting a ~7 difference in means which was the last follow up time

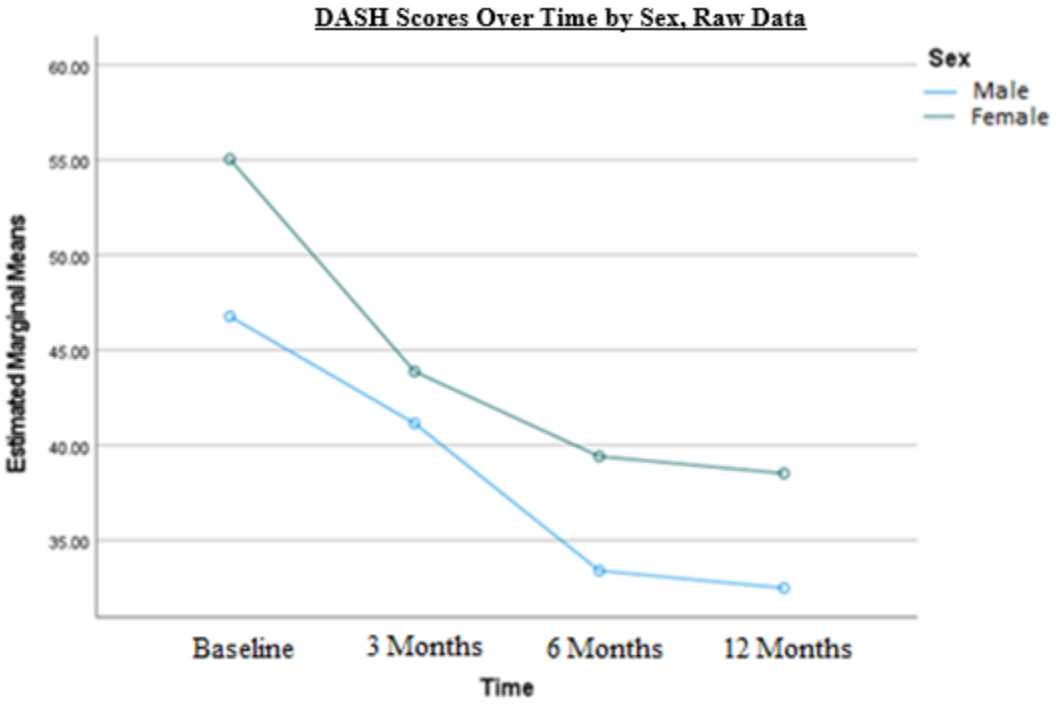
point. For age, the means of the youngest age group (<35) and the oldest age group (>65) are 48.7 and 30.6, with a ~18 difference in DASH score means. A corrected means adjusting or age as a covariant provides a visual of the direction of DASH scores.

Graph 1: GLM - Estimated Marginal Means by Sex for DASH Scoring, Corrected Means Adjusting for AGE (Covariant) (Imputed)



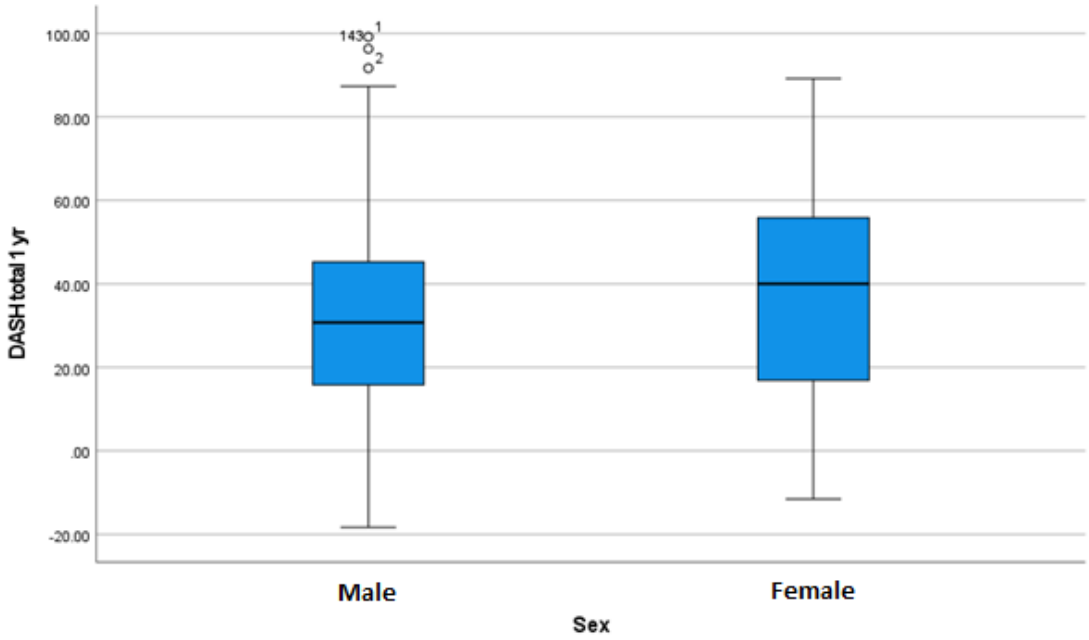

Graph one's line graph provides a visual of the trend of DASH scores over time by male (blue) and female (green) The GLM visual provides context of the means and differences between them for sex adjusting for age as a covariate.

Graph 2: GLM - Estimated Marginal Means by Sex for DASH Scoring, Raw Data (Imputed)



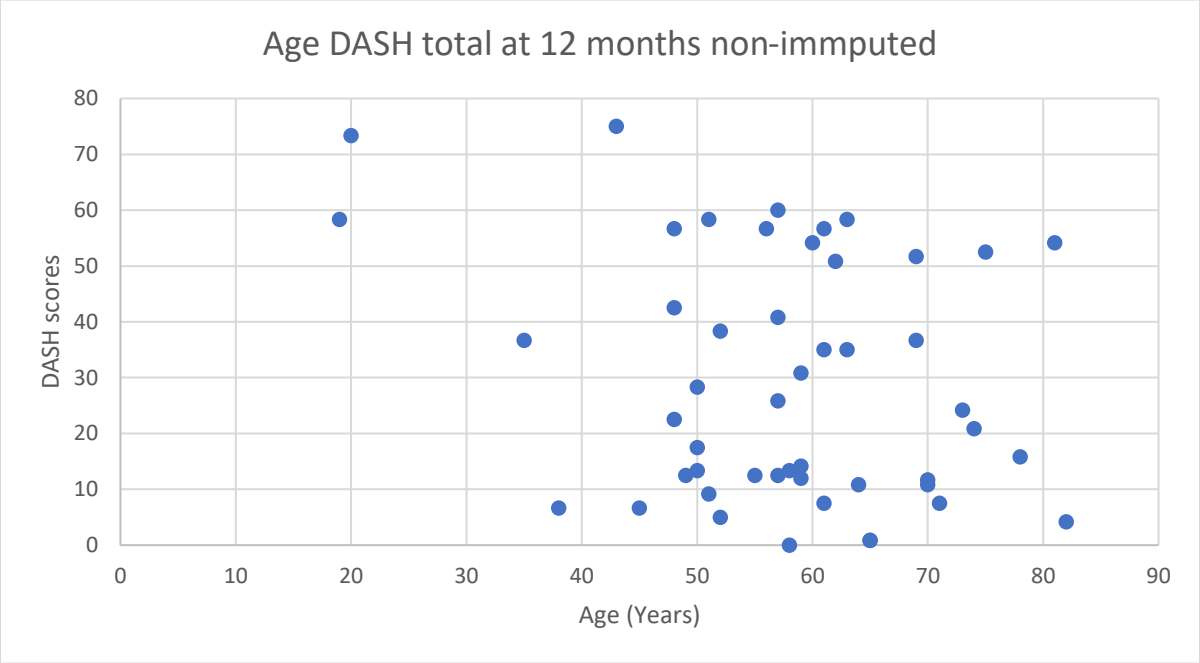

Graph twos line graph provides a visual of the trend of DASH scores over time that is uncorrected, displaying raw data, by male (blue) and female (green). This provides context in analysing and predicting the direction of DASH function outcomes. The results are near identical to graph one.

Graph 3**:** Box Plot of DASH Score Means Total at 1-Year Between Male and Female, Uncorrected

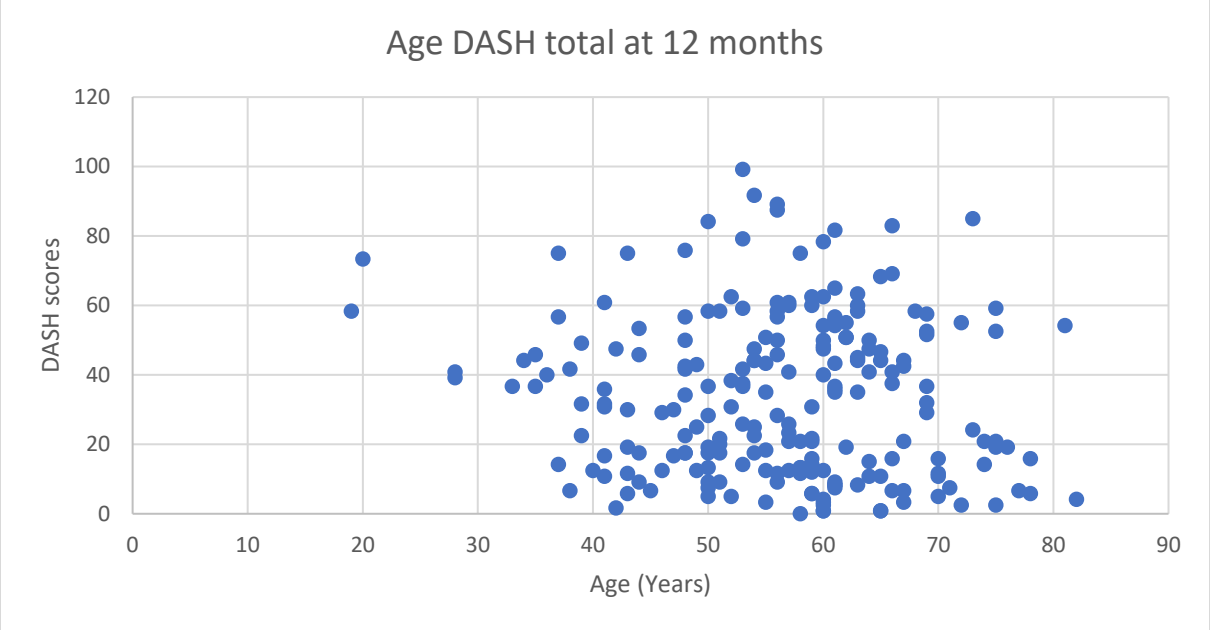



Graph three's uncorrected variance of DASH score means total representation for data at a 1 year final follow up mark. Men had a better recovery than women (due to lower DASH scores) displayed by the box plot mean line with a p value of .006.

Graph 4: Scatter Plot for Imputed DASH score for Age at 1-Year Non-Imputed Original




Graph 5: Scatter Plot for Imputed DASH score for Age at 1-Year Imputed




This graph represents the imputed values on a scatter plot to provide a visual of the clustering of scores. An observation can be made with the lowest DASH score plots within the x-

axis range of 40-80 years old. Compared to graph four, the imputed data provides a more complete understanding of the concentration of DASH scores with each age range.

Overall, the statistical analysis provides an understanding of the changes between groups concerning age and sex. Looking at the age adjusted means graph compared to the non-adjusted data, there are similarities in responses to surgical RC treatment. When analysing an ANOVA one way under the GLM to determine statistical significance, The p value between sexes was significant at baseline, 6 months, and 12 months with a score of <.001, .010, and .006 respectively.

A GLM visual was conducted to better understand the relationship these significances have, incorporating both time and sex as factors and controlling for age, those variables can act as a predictor for the mean score of the DASH. The line graph (graph 2) provides a visual representation of the direction of effect that sex has on functional outcomes. In the first time point (baseline), the range of mean DASH scores is between ~47 and ~56, with a ~10 score difference male and female. Contrary to the DASH ~7 score difference between the sexes. Due to the significance of the between group changes in the analysis, it appears that females tend to have lower function in DASH scores versus the males. The GLM shows a difference between the sexes for recovery in performance post RC treatment and can predict males having a higher recovery then females continuing with the trend of graph two.

### 3.4 Discussion

Overall findings state that older men have the lower DASH score means compared to females and younger ages The differences in DASH scores for upper body function from the results indicate that the difference between younger populations and older populations is larger than the difference between men and women.

Why Did Women Have Higher DASH Scores?

. Looking into the anatomy and other external factors may provide a level of understanding as to why this was the case A reasoning for the differences in sex may stem from the muscle mass difference, where males have more muscle mass, but more muscle fatigue than women, which may have a direct impact on RC recovery.[100] Surgical treatments in literature indicate different therapeutic rehabilitative approaches can yield differing results in men and women. For example, in a study by *Pellegrino et al,* the team investigated post-surgical rehab extracorporeal shockwave therapy outcome differences in a population of 53 men and women by looking into medical records.[101] It resulted in men having higher pain relief post therapy than women, and highlighted the possibility that this may have been due to pain tolerance in men being higher.[102] In the context of the study, shockwave therapy was not reported being used, but the take away that pain tolerance may differ in the sexes may provide an understanding why men answered the DASH with low difficulties.

This would indicate that there are factors to consider when clinicians discuss rehabilitation post RC surgery for both men and women. Clinicians may have to treat men earlier with more intensity, as it has been reported in literature that women have more pain and slower recovery of shoulder motion than men in the first three months post-surgery.[103] However, the imputed data depicted a significant difference compared to the original data, and therefore introducing an increasing level of subjectivity.

Another reason may stem from unpaid work roles and inability to afford the time to recover compared to men. A study by *Seedat, et al,* highlights that women have carried a

[100] Albert, et al. (2006)
[101] Pellegrino, et al. (2022)
[102] Pellegrino, et al. (2022)
[103] Cho, et al. (2015)

disproportionate amount of unpaid domestic and home care responsibilities which hider their well being.[104] Recovering from a shoulder injury requires rest, and women are reported to carry out three quarters of the worlds unpaid work (11 billion hours a day)[105] This translates into the inability to dedicate a significant mount of time for rehabilitation post-surgery.

Missing Data and the Follow Up Adherence

Concerning the hypothesis for why there is missing data was formed around two possibilities. The first is due to a event that may have hindered the patient's ability to come into the clinic and/or provide any new DASH data, for example difficulty getting time away from work.[106] The second may be due to the patient being healed to full function and not needing to come in for a follow-up. Due to the significant lack of reported DASH scores at the 12-month mark, it may be of interest to reduce the patient follow up times to increase adherence to the follow up times.[107]

Regarding those patient types of injuries, they typically included falling down a flight of stairs, on ice, or off objects such as a ladder. Work-related incidences are vague and inconclusive. Sports-related injuries can result from a select number of sports which include hockey, baseball, throwing, snowmobiling, and biking.[108] The age range presents a key observation in susceptibility to RC injuries. The first observation relates work, as a 19-year-old and 75-year-old from the sample both reported work-related accidents. This may be due to physical demanding jobs that put the shoulder at risk, such as factory or construction work.[109]

[104] Seedat, et al. (2021)
[105] Seedat, et al. (2021)
[106] Thompson, et al. (2015)
[107] Thompson, et al. (2015)
[108] Enger, et al. (2019
[109] Bhole, et al. (2016)

Falling is the more frequently reported type of occurrence and tends to occur to those in the higher age range.[110]

Due to the uniqueness of each case, DASH scores are a more generalized function method of testing, there are questions regarding difficulty levels of performing daily tasks such as making a bed or putting on a sweater. However, the optional parts of the DASH test include both work and sports, located at the back of the test. Taking type of injury into account, an overwhelming number of work/sports related injuries were reported in comparison to vehicle accidents or repetition of movement. A key limitation of the study is situated here as there is no documentation of use of the optional sports and work scores incorporated into calculating the overall formula for final DASH score.

The data provided information pertaining to the involvement of conservative treatment, such as PT, as post-surgical measures to aid in the healing process. The female and male breakdown of therapy per patient from the data as depicted in the results was as follows—females: 73; males: 153. This is important as it provides an understanding of the number of patients that had received both treatments, influencing the overall DASH scores from surgical treatments over time.

## 3.5 Conclusion

The purpose of this study was to determine if there was a difference in sex and age for RC injury surgical treatment success by measuring patient DASH scores. Overall, it was determined that older males have a higher recovery rate with a less disability score. A clear limitation to this study was the missing data found between both sexes and age groups. It was

[110] Banerjee, et al. (2023)

difficult to compare variances with resources going into correcting the means and stabilizing the variances for a more accurate comparison of means.

## 3.7 Chapter 3 References


87. Albert, et al. (2006). *Sex differences in the rate of fatigue development and recovery. Dynamic Medicine*. Vol 5(2).
88. Banerjee, et al. (2023). *Common Injuries of the Shoulder*. University of Rochester Medical Center. Retrieved from: https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=1&contentid=832
89. Bhole, et al. (2016). *Safety problems and injuries on construction site: a review*. International Journal of Engineering and Techniques. Vol 2(4), pp 24-35.
90. Cho, et al. (2015). G*ender Affects Early Postoperative Outcomes of Rotator Cuff Repair*. Clin Orthop Surg. Vol 7(2), pp 234-240.
91. Enger, et al. (2019). *Sports-related acute shoulder injuries in an urban population.* BMJ Open Sport and Exercise Medicine. Vol 5(1).
92. Pellegrino, et al. (2022). *Effectiveness of combined extracorporeal shock-wave therapy and hyaluronic acid injections for patients with shoulder pain due to rotator cuff tendinopathy: a person-centred approach with a focus on gender differences to treatment response*. BMC Musculoskeletal Disorders. Vol 23, pp 863.
93. Seedat, et al. (2021). *Women's wellbeing and the burden of unpaid work.* BMJ.
94. Thompson, et al. (2015). *Barriers to Follow-Up and Strategies to Improve Adherence to Appointments for Care of Chronic Eye Diseases*. Investigative Ophthalmology and Visual Science. Vol 56, pp 4324-4331.

# 4.0 Discussion

This section discusses the results from both studies in this paper and to answer the primary research question: in active athletic populations, what intervention of surgical or conservative treatment is more preferred for positive patient outcomes. What are the key takeaways from reviewing and synthesizing current academic literature, and are there any differences between sexes and age groups concerning function form shoulder injuries?

## 4.1 Discussing the Results of Studies and Treatment Plans

Review of Outcomes from Systemic Review

Shoulder instability encompasses a variety of injuries, each with their own preferred method of treatment, conducted by their respective healthcare professional. Comparing both conservative and surgical treatments provide an understanding that there still is no one gold standard of treatment, and that each patient should have their needs met on a case-by-case basis. The review provided information of updated literature regarding this statement of no standard method of treatment. Rehabilitation programs and increasingly common surgical practices are used in practice today and will primarily be based around the healthcare professionals' judgement on which surgical method or conditioning treatment will take place.

Many of the reported outcomes from the results of scores, through the numerous studies, alluded to a more conservative approach with surgical inventions still having a risk of complications, depending on the severity of the injury and complexity of the surgical process. The scoping review has provided insight to updated literature and with cases studies describing personal situations situated to their outcome measure scores. This presented a key takeaway that every individual is unique in their own case due to level of sport work, sex, age, and other external factors not researched, including as socioeconomic status, which may provide some

information on environmental factors that could influence potential of injury. Aside from a patient centric approach, sub classification of Rockwood grade III ACJ injuries into ISAKO IIIA and IIIB may be necessary to help direct the decision-making process regarding treatment.

Shoulder instability can lead to complex pathologies that require these insightful findings in order to provide the best care through evidence-based research.

RTS is essential to those who claim sport as a profession, dedicating their body's health and well-being to performance. There have been tools to analyze this performance and score methods to better understand where the patient lies post-recover from shoulder ACJ injuries. *Gerometta et al.'s* study *The Shoulder Instability-Return to Sport after Injury (SIRSI): a valid and reproducible scale to quantify psychological readiness to return to sport after traumatic shoulder instability,* helps evaluate not only the physical readiness of the athlete, but the psychological readiness as well.[111] The study reflects the psychological aspects of treatment post-conservative or surgical intervention, via Shoulder Instability Return to Sport after Injury Scale (SIRSI). 60 professional athletes, who were treated for their shoulder instability – 30 of which underwent surgical treatment – had reported a strong correlation with SIRSI and reference questionnaires, providing the most accurate method of communication for patient performance analysis. Tools, like the SIRSI, should be utilized for athletes when being treated for shoulder injuries to better assess secondary objectives of RTS, and to monitor both daily function (including pain) and performance. This was discussed in chapter 2, where a more patient centric approach to treatment may be more viable than resorting to a standard of treatment concerning ACJ injuries.

<u>Review of outcomes from secondary data analysis</u>

[111] Geometta, et al. (2018).

Using the one-way analysis of variance (ANOVA) for the GLM analysis, the primary objective was to compare the means of DASH scores at four follow-up times between sexes and between age groups, which provided results of meaningfully differences between recovery of function over time for females and males. Older adults had a steady decrease of DASH scores; the older they were the lower the score. This is an interesting takeaway, as this possible reasoning for a higher DASH score for younger adults may be due to the non-familiarity of the injury or lack of care.

Detail specifications of injury occurrence and severity were included in the data and discussion, which provided knowledge of the source of where most shoulder injuries take place. Since falls were a primary cause of injury, emphasis on a form of fall protection, whether in sport or work, should be priority, to minimize risk of injury. Studies have shown there are methods and strategies for active older adults (majority of the population of study 2) can partake in, such as the study by *Sun, et al*. focusing on exercise interventions for reducing fall risk.[112] From 648 subjects and 0 randomized control trials, exercise interventions with integrated training impacted reducing the risk of falls.[113] This was due to the teachings of balance and stability, in conjunction with techniques that offer more control of your body. Interventions such as this is an example of ways to eliminate the risk of shoulder instability injuries (particularly in the RC) via falls.

Implications of both studies for Clinicians and Researchers

Both research questions concluded that shoulder instability pathology is unique and that evidence-based practices are paramount to successful treatments of both ACJ and RC injuries. Study one added more background for clinical practice as there is no standardized clinical

[112] Sun, et al. (2021).
[113] Sun, et al. (2021).

treatment for ACJ grade III injuries and concluded that conservative approaches had a slightly better RTS result, with surgical interventions being used on a case-by-case basis. Emphasizing the complexity of deciding on the best treatment plan for a patient in the context of sport is dependent on shoulder demand, with sub classification of grade IIIA and IIIB Rockwood scaling having an influence on decision making process. Clinicians can utilize this literature to understand that the overall clinical outcomes for conservative and operative treatment is dependant on several factors based on the patients needs. Conservative treatment offers less complications and a slightly shorter RTS time, however surgical treatment is best for young athletes with a high demand for shoulder function. Since it was reported that younger females responded with more disability post surgery in their RC rehabilitation period than older men, clinicians could implement that knowledge when determining their protocols for post surgical treatment. Researchers can utilize the findings from the first study and implement it into action by creating a deliverable for KT, depicting pros and cons of both treatment approaches. Study two could provide some insight into research that investigates differences in sex and age concerning recovery form shoulder instability surgery. There is a plethora of research projects that study differences in the sexes and ages in the context of sport recovery and RTS performance. With both studies advancing knowledge of patient complexity in deciding protocols and treatment for shoulder instability, from both a clinical and research perspective, there is evidence that clinicians and researchers alike are providing the best care that they can deliver.

### 4.2 Future Considerations – Knowledge Translation and Patient-Centric Practices

Surgical and conservative treatment for shoulder injuries have been well reported in cases of sports injuries. Seeking consultation for treatment plans needs to adapt into a more patient-

first approach. Patient-centric pre-operative communication must be paramount when dealing with the bodies of athletes, due to the physical demands their bodies go through. Both study one and two endorse the practices of patient-centric approaches in order to understand the needs of patients post-treatment. For instance, in study one, a patient-centric approach could help influence the decision for a Rockwood grade III treatment. If the athletic demand is low, conservative treatment may be the best approach; however, due to similarly reported clinical outcomes, and a higher preference of surgical options for younger and more active and physically demanding patients, the surgical arthroscopic surgeries may be a better option. Building off of patient-centric approaches and leading into study two, older men were reported to have the lowest disability scores post-RC surgery. Altering a post-surgical rehabilitation protocol to better fit the patient's rehabilitation process may be a option to create more effective outcomes for all ages and both males and females.

Historically, KT has been very effective in the healthcare setting. *Dal Mas et al.* conducted a recent systematic review investigating the translation of concepts from a healthcare professional to a patient. KT is a set of tools used to deliver existing and new knowledge to stakeholders. Providing an abundance of knowledge may be difficult due complexities and external factors. Several implications had been reported from this study's findings as *Dal Mas et al.* discuss these major takeaways: practitioners should be involved in the dialogue, some areas of the world are more investigated than others, the private sector deserves more attention, several healthcare services are investigated, there's a lack of dominant framework, there is no common definition of KT, and there an open list of KT tools. [114]

[114] Dal Mas, et al. (2021)

Acknowledging these points is essential to improving treatment pathways for shoulder injuries, however, the emphasis on a lack of dominant framework when approaching a treatment pathway from a KT is concerning. This is evident in the study by *Gagnon et al.'s Development and Content Validation of a Transcultural Instrument to Assess Organizational Readiness for Knowledge Translation in Healthcare Organizations: The OR4KT*. This was a systematic review from 2018 that investigated the validity of the Organizational Readiness for Knowledge Translation tool (OR4KT). However, study findings presented a high face validity for the OR4KT, including across English, Spanish, and French versions, further expanding the practice of KT in the healthcare setting.[115] Due to the commonality of shoulder instability and shoulder injuries, KT's emergence via tools, like OR4KT into PT practices and surgical interventions, would have a positive effect on patient-reported outcomes through their patient-centric experiences, leading to more communication and better met needs.

## 4.3 Chapter 4 References


95. Dal Mas, et al. (2021). *Knowledge Translation in the Healthcare Sector. A Structured Literature Review*. The Electronic Journal of Knowledge Management. Vol 18 (3), pp 198-211.
96. Gagnon, et al. (*2018). Development and Content Validation of a Transcultural Instrument to Assess Organizational Readiness for Knowledge Translation in Healthcare Organizations: The OR4KT.* International Journal of Health Policy and Management. Vol 7(9), pp 791-797.
97. Geometta, et al. (2018). *The Shoulder Instability-Return to Sport after Injury (SIRSI): a valid and reproducible scale to quantify psychological readiness to return to sport after*


[115] Gagnon, et al. (2018)

*traumatic shoulder instability*. Knee Surgery, Sports Traumatology, Arthroscopy. Vol 26, pp 203-211.

98. Sun, et al. (2021). *The Effect of Exercise Intervention on Reducing the Fall Risk in Older Adults: A Meta-Analysis of Randomized Controlled Trials*. International Journal of Environmental Research and Public Health. Vol 18(23).

# Curriculum Vitae

| | |
|---|---|
| **Name:** | Jesse Singh |
| **Post-Secondary Education and Degrees:** | Master of Science (MSc.) in Health and Rehabilitation Sciences in Physical Therapy – *University of Western Ontario,* London, Ontario, Canada \| 2020 – 2023<br><br>Honours Bachelor of Arts (B.A.) in Geography and Environmental Studies – *McMaster University*, Hamilton, Ontario, Canada \| 2015-2020 |
| **Honours and Awards:** | Iroquois Ridge Scholarship \| 2014<br><br>Ridge Staff Award \| 2013 |
| **Related Work and Volunteer Experience:** | Teaching Assistant – *The University of Western Ontario* \| 2021 – 2022<br><br>Physiotherapist Volunteer – *Physio Med Oakville* \| 2020<br><br>Student Graduate Council Executive Member – *The University of Western Ontario* \| 2021 – 2022 |