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Post-surgical Functional Assessment Following Three Different Types of Surgical Repair in Type III to VI Acromioclavicular Joint Disruption

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Abstract

This study assesses the functional outcomes and associated risks of various surgical procedures for types III to VI acromioclavicular (AC) joint injuries, including Endo button flipping, hamstring grafting, and the suture anchor & eight plate method. Conducted at Saveetha Medical College Hospitals from June 2021 to June 2022, the study involved 21 patients aged 25 to 60 with AC joint injuries, excluding types I and II injuries and those with medical ineligibility. Surgical correction included reconstructing the coracoclavicular ligaments using various techniques, followed by at least one year of follow-up. Functional outcomes were measured using the Constant Murley Score, and radiographic evaluations were performed at set intervals. The mean Constant scores were 92.54, 90.85, and 91.42 for the suture anchor, Endo button flip, and hamstring graft methods, respectively. Although the suture anchor technique had a slightly higher score, the difference was not statistically significant. All methods maintained coracoclavicular distance and provided a good range of motion. Patients treated with suture anchors showed notably fewer complications during the one-year follow-up. In conclusion, all surgical methods resulted in successful outcomes for AC joint injuries of types III to VI, with the suture anchor technique showing a trend toward better functional scores, though without significant differences. Further long-term monitoring is recommended to determine the optimal treatment approach.

Keywords: *Acromioclavicular Joint, Endo Button, Hamstring Graft, Suture Anchor.*

Introduction

Acromioclavicular joint injuries, commonly referred to as ACJ injuries can occur at any age but are most common in the 20 - 50-year age group. Young male athletes, especially those involved in contact sports, are at higher risk [1]. Acromioclavicular joint injuries, which commonly occur in contact sports, make up 40% to 50% of all athletic shoulder injuries. They account for around 12% of shoulder girdle injuries [2]. Low-grade injuries are usually not associated with significant long-term morbidity [3], but other grades can lead to significant loss of strength and function of the shoulder [4]. These injuries are typically traumatic and can range in severity from mild sprains to complete disruptions [1]. Osteoarthritis (OA) is commonly attributed to increased biomechanical stress on a joint caused by repetitive or sudden excessive loading [27]. Frozen Shoulder is another common condition that occurs due to trauma Any condition where shoulder motion, including passive and active, is restricted in all directions without apparent cause is referred to as frozen shoulder [28]. The primary goals of evaluating a patient with ACJ damage are to determine the extent of the injuries, identify

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relevant criteria that can guide therapy decisions, and select the most effective treatment approach to restore pain-free shoulder function. The ACJ's main job is to provide the scapula with an extra range of scapulothoracic rotation as well as to let the scapula adjust so that it can follow the shape of the thorax when the arm moves [5]. Additionally, it permits the forces to be transferred to the clavicle from the upper extremity. A force applied medially to the lateral shoulder, pushing the acromion into and beneath the distal clavicle, leads to more severe injuries and greater displacement [19].

The capsular ligaments provide stability in the anteroposterior direction in addition to vertical stability under physiological forces. Additionally, injuries to the capsular ligaments, particularly to the anterior segments, have a significant impact on rotational stability [5]. When the normal anatomy or stability of the ACJ is compromised, normal biomechanics may be impacted [6]. The capsular ligaments provide stability in the anteroposterior direction as well as vertical stability with physiological loads. Also, rotational stability is greatly affected when the capsular ligaments are injured, especially the anterior segments [5]. Biomechanically, motion at the ACJ is a combination of translation, elevation, and rotational motions influenced by the complex interaction of scapulothoracic motion and guided by ligamentous restraints and dynamic muscular support. Normal biomechanics can be affected when the normal ACJ anatomy or stability is disrupted [6]. Fukuda et al. conducted load displacement tests with a set displacement after progressively sectioning the ligaments to evaluate the specific roles of each ligament in maintaining AC joint stability. This method allowed them to identify how each ligament individually contributes to the overall stability of the AC joint [17]. At small displacements, the acromioclavicular (AC) ligaments were the main stabilizers against posterior (89%) and superior (68%) clavicle translation, which are the most frequently observed failure patterns in clinical settings. For larger displacements, the conoid ligament predominantly restrained superior translation (62%), while the AC ligaments continued to be the primary stabilizer against posterior translation (90%) [18].

Lee et al determined that the conoid ligament is the main factor responsible for preventing the upward movement of the clavicle [6]. MRI provides a more accurate technique of assessing AC joint injuries, with grade 1 injuries upgraded in up to 50% of instances and grade 2 injuries upgraded in up to 20% of cases 27, Classification: Various systems are used to classify ACJ injuries: The Rockwood system is the most commonly used [Figure1], Rockwood et al. developed the most widely accepted classification system, building on the foundational work of Tossy et al. [20]. categorizing injuries into six types and the features are set out in.

Structure	I	II	III
Acromioclavicular ligament	Sprained	Complete tear	Complete tear*
Acromioclavicular Joint	Intact	Disrupted; widened in the transverse plane	Dislocated; clavicle displaced superiorly relative to the acromion
Coracoclavicular ligaments	Intact	Sprained; slight widening of interval	Disrupted; interval widened up to 100%*
Deltoid and trapezius muscles	Intact	Possible partial detachment	High probability of detachment from distal clavicle

*In a Type III variant, the clavicle ruptures through the periosteal sleeve superiorly, leaving behind, inferiorly, a periosteal tube attached to the cartilaginous epiphysis that maintains the integrity of the AC joint. The CC ligaments are intact and remain attached to the periosteal sleeve.

Structure	IV	V	VI
Acromioclavicular ligaments	Complete disruption	Complete disruption	Complete disruption
Acromioclavicular joint	Dislocated; clavicle displaced posteriorly into or through the trapezius muscle	Dislocated; extreme vertical incongruity between lateral clavicle and acromion.	Dislocated; clavicle displaced inferior relative to the acromion*
Coracoclavicular ligaments	Partial or complete disruption with change in interval orientation	Complete disruption; interval widened 100% to 300%	Intact; interval is decreased or reversed*
Deltoid and trapezius muscles	High probability of detachment from distal clavicle	High probability of detachment from distal clavicle	Intact, partial, or complete detachment

*In a continuation of Type VI, the clavicle is displaced inferior to the coracoid process. In this case the coracoclavicular ligaments are completely torn, and the coracoclavicular interval no longer anatomically exists.

Figure 1. Rockwood Classification of Acromioclavicular Joint Injury[16].

The Tossy system and Allman grading system are other alternatives Type 1 and 2 injuries are managed non-surgically with a shoulder immobilizer. However, the treatment approach for Type 3 injuries is still a subject of debate. In young and active patients, a surgical intervention strategy is employed, while in older and less demanding patients, a conservative approach is taken. Type 4 to 6 cases typically necessitate surgical intervention [10, 11]. The non-operative treatment has the disadvantage of prolonged immobilization which sometimes may be required as long as a few months resulting in significant morbidity[29]. Proper diagnosis and management are crucial for optimal outcomes in ACJ injuries. Treatment options range from non-operative approaches to surgical interventions, depending on the specific injury type surgical intervention, and are typically treated using Kirschner wires or Hook Plates. A review of the literature showed that a comparative assessment of the various surgical approaches concerning Type 3 to 6 were few, especially in a South Indian setting where lifestyles are unique and hence the present study.

Materials and Methods

This study involved 24 patients, aged 25–60, hospitalized at Saveetha Medical College Hospital between March 2021 and August 2023 with acromioclavicular (AC) joint disruptions (types III-VI). All patients underwent surgery followed by a minimum 12-month postoperative follow-up, evaluated using the Constant Murley score and radiological assessments at 6, 12, 24 weeks, and 1 year post-surgery. The treatment protocol started within 24 hours to 30 days after injury. Exclusion criteria included type I or II AC joint disruptions, medical unfitness for surgery, associated fractures, ligament laxity, and patients over 60 years.

Patients were divided into three groups:

1. Group A underwent CC ligament reconstruction with double-loaded 5mm suture anchors and a 2-holed recon plate, fixed with K-wires from the acromion to the clavicle.
2. Group B received CC ligament reconstruction using the Endo button Flip Technique with a 5.0 Ethibond suture over a recon plate, also fixed with K-wires.
3. Group C had CC ligament reconstruction using a Hamstring Autograft.

Post-surgery, sutures were removed after 12 days, K-wires within 4 weeks, and a brace was worn for 6 weeks. Strengthening exercises began at 12 weeks, and athletic activities resumed after 6 months. Functional outcomes were evaluated through the Constant score and radiological assessments at 1, 3, 6, and 12 months. Data analysis was performed using IBM SPSS Version 22, revealing a statistically significant P value of 0.005.

Results

In the present study, twenty-one treated instances formed the sample of the study using three different surgical procedures. Nineteen patients were male and two were female among all groups, each group had seven patients, predominantly male, [Figure 2] with motor vehicle accidents being the primary cause of injury [Figure 3]. 12 Patients had a Type 3 injury, whereas 6 suffered a Type 4 injury and the remaining were diagnosed to have a Type 5 injury [Figure 4].

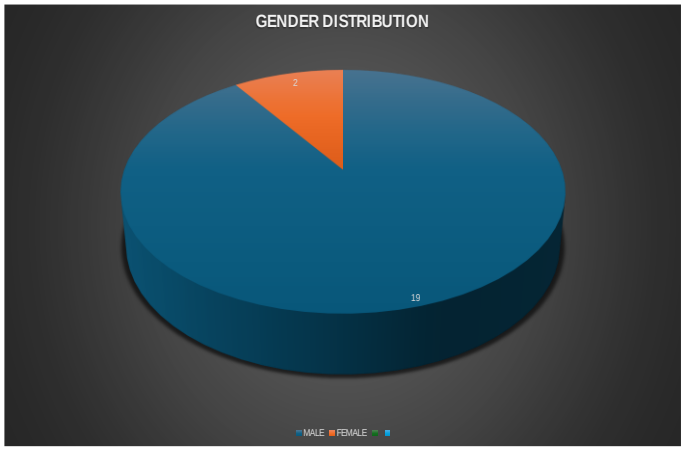

Figure 2. Gender Distribution

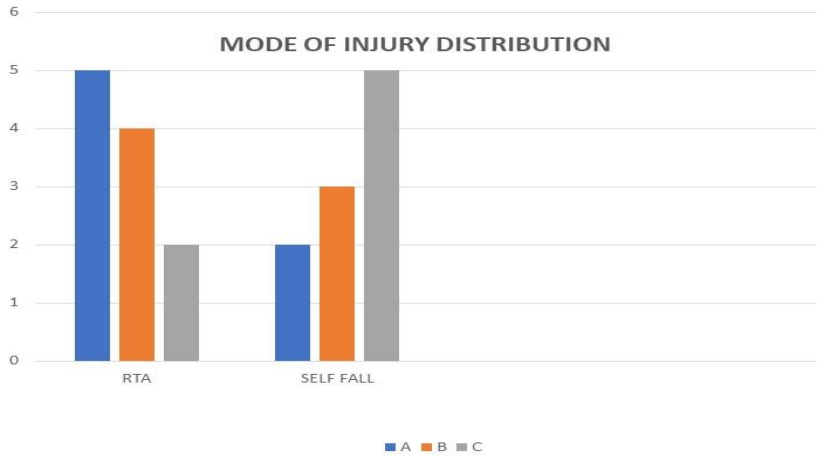

Figure 3. Graphical Representation of Mode of Injury

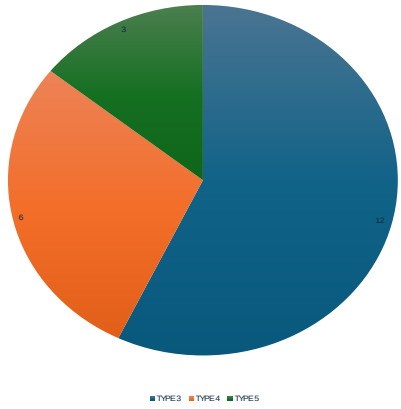

Figure 4. Types of AC Joint Disruption

We assessed the outcomes using the constant score. Each instance was monitored at intervals of 3 months, 6 months, and 12 months. The average was computed for pain, range of motion (specifically abduction), radiographic decrease, and the Constant Score. The average radiographic value at 3 months was 4 for all three groups. The average abduction value at 3

months was 3 for all three groups. The average pain value at 3 months was 3 for all groups. The average radiographic value at 6 months was 4 for all three groups. The average pain score at 6 months for Group A (Suture Anchor) was 3.71, for Group B (Endo button) was 3.85, and for Group C (Hamstring) was 3.5. The average radiographic value for all three groups at 12 months was 4. The average pain value at 12 months was 3.71 for Group A (Suture Anchor), 3.85 for Group B (Endo button), and 3.7 for Group C (Hamstring). The average abduction was 3 for all groups after 3 months, 4 after 6 months, and 4 after 12 months. The mean constant score for Group A (with suture anchor) [Table 1].

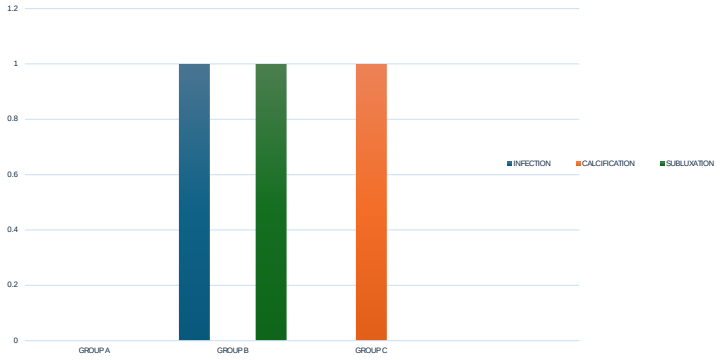

Figure 5. Complications.

Table 1. Suture Anchors

Group A			
	3 months	6months	12 months
X ray scoring mean	4	4	4
Mean subjective pain	3	3.71	3.71
Mean abduction	3	4	4
Mean constant score	85.14	89.14	92.54

At 3 months was 85.14, for Group B it was 83.14, and for Group C it was also 85.14. The mean constant score at 6 months for Group A (using the Hamstring technique) was 89.14, for Group B (using the Endo button technique) was 87.4, and for Group C (also using the Hamstring technique) was 88 (Table 3). The mean constant score for Group A at 1 year was 92.54 (using the Suture Anchor technique), 90.85 (using the Endo button technique [Table 2], and 91.42 (using the Hamstring technique). Group A had 0 complications, In Group B 1 Patient had subluxation and another had an Infection, and in Group C 1 patient had calcification [Figure 5].

Table 2. Endobutton

Group B			
	3 months	6months	12 months
Xray scoring mean	4	4	4
Mean subjective pain	3	3.85	3.85
Mean abduction	3	4	4
Mean constant score	83.14	87.4	90.85

Table 3. Hamstring Autograft

Group C			
	3 months	6months	12 months
Xray scoring mean	4	4	4
Mean subjective pain	2.85	3.5	3.7
Mean abduction	3	4	4
Mean constant score	85.14	88	91.42

This study found that all three methods produced positive functional results in the treatment of acromioclavicular joint disruptions ranging from type III to type VI. However, the suture anchor method had a consistently higher score at both the 6-month and 1-year follow-up periods (**Table 4**) Despite this, all three methods were found to be comparable, with no statistically significant differences between them.

Discussion

Operative Management of the AC Joint: Surgical methods are employed to treat Type 4 and 5 AC joint injuries, as well as the few known instances of Type 6 injuries. Although many different surgical methods have been reported, none have proven to be demonstrably better, and minimally invasive arthroscopic procedures are becoming more and more popular. Operative therapy is based on reducing the AC joint in both the coronal as well as sagittal planes and then reconstructing or repairing the damaged CC ligaments to restore AC joint stability. The AC joint may be momentarily stabilized by a hard implant. After the repair has healed, it needs to be taken out to prevent the construct from fracturing or causing stiffness in the shoulder. The principal goals of surgical treatment for acromioclavicular joint dislocations are to achieve a stable realignment of the joint, restore the coracoclavicular and acromioclavicular ligaments to their proper anatomical positions, and preserve the integrity of the deltotrapezial complex. During the first two weeks after the accident, the ruptured CC and AC ligaments can be directly repaired through an open operation before any significant scar tissue forms. A high rate of osteoarthritis is one drawback, and the open incision requires invasive surgery. Suture material shouldn't be apparent on postoperative radiographs, which should confirm a good reduction of the AC joint [5]. While there have been individual studies describing different surgical approaches to reduce acromioclavicular joint dislocations, there is a paucity of comparative data on treatments such as hamstring graft versus fibre-wire-loaded suture anchor or Endo button flip technique.

This study involved randomly assigning patients diagnosed with acromioclavicular joint disruptions ranging from Type III to Type VI into three groups. Group A received treatment with 5mm double-loaded suture anchors, Group B underwent the Endo button flip technique, and Group C underwent the hamstring graft technique. Each group had seven patients, predominantly male, with motor vehicle accidents being the primary cause of injury.

Most patients underwent surgical intervention within a timeframe of 5-7 days following the accident, whereas a small number of patients originally received non-surgical care. After the surgery, all patients were given standard care for the period after the operation. This included first keeping the shoulder still and gradually increasing the range of motion with passive exercises. The K-wires were extracted after 4 weeks, and concurrent commencement of active shoulder exercises and strengthening took place. Traditionally, contact sports were permitted following 6 months of recuperation.

For this study, we included 7 patients in Group A who received coracoclavicular (CC) ligament restoration. This procedure involved utilizing suture anchors positioned across the base of the coracoid. The selection of this approach was based on its decreased probability of producing neurovascular damage and shorter time of the surgical procedure. Our objective was to mimic the higher tensile strength of the natural coracoclavicular ligament by aligning the CC ligaments in two separate strands. Furthermore, by avoiding the placement of any instruments or fixation materials beneath the coracoid, the potential for neurovascular damage was significantly reduced. The sutures were secured over a plate, strengthening the repair by enhancing the clavicular cortex and aiding in the prevention of osteolysis of the distal clavicle. All seven instances exhibited a reasonable range of motion, and the average constant shoulder score for this technique was 92.54. In another study of a total of 29 patients (20 men and nine women) A total of seven, six, and 16 patients had Rockwood type III, type IV, and type V ACJ dislocations treated with Suture Anchors with a mean Constant–Murley score of 93.02 showing excellent results [24], another similar study conducted a 2-year study involving 15 patients. Out of these, 14 patients achieved a good range of movement, with a mean constant score of 92.9. One patient experienced subluxation as a complication. Darren and his colleagues conducted a comparable study, following 22 patients for 2 years. They discovered that 18 of these patients exhibited a satisfactory range of mobility, with an average constant score of 92.3. One patient experienced a problem in which the anchor became dislodged. In our study, there were however no complications found with repair using a suture anchor, in another similar study of 20 patients who underwent Acromioclavicular joint reconstruction using anchor sutures. The results showed a Constant Murley score used to evaluate the functional outcome to be excellent in 75% of patients, good in 15% of patients, fair in 5% of patients and poor in 5% of patients[25].

In our study in Group B where we treated a total of 7 patients by performing a procedure to reduce the acromioclavicular (AC) joint and reconstruct the coracoclavicular (CC) ligament using the Endo button flip technique. This technique facilitated more accurate anatomical reproduction of the coracoclavicular ligament and enhanced realignment of the AC joint. Moreover, the Endo button serves as a cost-efficient substitute for suture anchors. Improper horizontal placement of the Endo button beneath the coracoid can result in subluxation, which raises the likelihood of neurovascular damage. During our investigation, our study had a mean Constant Murrley Score of 83.14. A study conducted [13], on a group of 21 patients found that 18 individuals had a satisfactory range of motions, with an average constant score of 91. However, one patient experienced complications in the form of infection and stitch granuloma. In our study in Group B a single patient experienced an infection, which was effectively treated using intravenous (IV) antibiotics and skin grafting to close the lesion. In another separate study conducted [14], 10 out of 10 patients demonstrated a favourable range of motion, achieving a mean constant score of 89 without experiencing any problems. A study consisting of Eight patients with an acute unstable Neer type IIB distal clavicle fracture were treated with a closed-loop double endobutton implant. Mean follow-up averaged 3.4 years, and they found that there was definitive fracture healing among all patients with a constant score of 97 with no complications [21], In Another study where four strand, single tunnel, double endobutton repair had been performed entirely percutaneously, without any arthroscopic guidance or deep surgical dissection, had found . There was no restriction of movement in any of the patients post-operatively and their average QuickDASH scores at final follow-up

were 4.2 [22], Another study in a total of 35 patients (31 men, 4 women) were surgically treated for a Rockwood type III with Endobutton, the results were excellent with mean American Shoulder and Elbow Surgeons Shoulder Score of 98, and with no complications [23].

A study [15] found that out of 30 patients, 25 had good ROM and a mean constant score of 83. The study included a total of 5 patients with fractures of the clavicle and 4 patients with fractures of the coracoid.

In our study, a total of 7 patients in Group C received treatment that involved the reduction of the acromioclavicular (AC) joint and the rebuilding of the coracoclavicular (CC) and AC ligaments using the hamstring graft technique. As a result of this method, the coracoclavicular distance decreased when subjected to stress loading, resulting in increased stability and enhanced replication of both the coracoclavicular and acromioclavicular ligaments.

Nevertheless, there are disadvantages associated with this method, such as the possibility of complications at the location where the graft is taken from and the requirement for the patient to undergo surgery while under general anaesthesia (GA), regional anaesthesia (RA), or spinal anaesthesia (SA). Furthermore, the time of the procedure is often more extended in comparison to alternative techniques. One patient experienced the formation of calcification, which occurred later and was discovered during the follow-up examination which was treated conservatively. Notwithstanding this consequence, all seven patients successfully acquired a favourable range of motion, and their constant scores remained adequate during the 6- and 12-month follow-up periods. In addition, one patient experienced calcification at the site where the graft was applied, but their continuous score remained positive. Subsequent evaluations were carried out at intervals of 6 weeks, 3 months, 6 months, and beyond. The average constant score achieved utilizing the hamstring transplant procedure was 91.4, in a similar study [26] conducted with 39 patients, 25 patients had a good outcome with a mean constant Murley Score of 83, In another study of 8 patients, all 8 had a good range of movements with a mean Constant Murley Score of 92, Calcification and Infection were the complications faced in the study comparing to our study which had 1 patient having calcification as a complication.

Conclusion

Successful functional outcomes were achieved through surgical correction of AC joint disturbances of categories III to VI employing a variety of procedures, such as suture anchor & eight plate, endobutton flip, and hamstring graft. A year after the initial treatment, Suture Anchor had a higher Constant Score than the other two treatment techniques, despite the fact that there was no discernible difference in the treatments' results. Additional long-term monitoring is necessary to identify the best course of action.

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Conflict of Interests

The authors declare that they have no conflicts of interest.

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