e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2024; 16(5); 838-847

Original Research Article

Functional Outcome of Surgical Management of RockwoodType III-VI AC Joint Separation Repaired Using Non- Absorbable Ethibond-2

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Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 26-04-2024
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Conflict of interest: Nil

Abstract:

Background: Injuries to the acromioclavicular (AC) joint represent a spectrum of soft tissue disruptions that can result in mild, transient pain of the joint to significant displacement, chronic pain, and changes inshoulder biomechanics resulting in long term disability. These injuries most commonly occur in male patients <30 years and are associated with contact sports or athletic activity in which a direct blow to the lateral aspect of the shoulder occurs. Anatomic reconstruction of the native CC ligaments and AC ligaments represents an improved understanding of the biomechanics in this area with the attempt to improve surgical outcomes.

Aim of the study is to evaluate the clinical and radiological outcome of coraco-clavicular and acromioclavicular jointreconstruction with non-absorbable Ethibond no. 2 for treatment of Type III - VI AC Joint separation.

Study Design: Ambispective Case series.

Methodology: A total of 20 patients attending the causality and OPD of Orthopedics Department at Government Medical College, Kadapa diagnosed with Rockwood Type III-VI AC joint separation weretaken for the study after prior well informed written consent. The clinical and functional outcome was assessed with VAS Score and Constant & Murley Score while the radiological outcome was assessed using plain radiograph.

Results: Among the 20 patients who were included in the study, nine, six and three patients sustained Rockwood type V, IV and III injuries respectively. The mean age was 38.8 ± 6.569 (mean ± SD) with a mean follow-up of 12 months. At 12 months follow-up the mean VAS score was 0.65 ± 0.476 and mean Constant Murley Score was 90.75 ± 1.81. Compared to the baseline the clinical scores improved significantly ($p<0.05$). No Neurovascular complications were encountered in any of the patients who werepart of this study.

Conclusion: In this study AC joint dislocations type III-VI treated with ligament reconstruction by using 2loops of Ethibond 2 and AC ligament repaired by single loop Ethibond 2 is a reliable method for establishing Antero-posterior and superio-inferior stability of AC joint and results in excellent clinical, radiological and functional outcome.

Keywords: Acromioclavicular joint Injury, Non absorbable Ethibond-2, Antero-Posterior stability, Rockwood Classification.

Introduction

Acromioclavicular (AC) joint dislocations are frequent shoulder injuries, accounting for a significant portion of shoulder-related incidents. They make up around 9% to 12% of shoulder girdle injuries and aremore common in young adults and athletes, particularly in men. These injuries often result from a direct fall onto the shoulder's superior aspect when the arm is adducted. It is widely agreed upon that conservative management is suitable for type I and II acromioclavicular (AC) joint injuries, while types IV, V, and VI typically require surgical intervention. The optimal acute treatment for grade III injuries remains a topic of debate. Various reconstructions of the coracoclavicular (CC) ligament complex are recommended for surgically indicated acute AC dislocations. These include temporary static stabilization with pins or hook plates, fixation with a CC screw, dynamic stabilization with muscle or ligament transfers, retention of the joint using a CC loop cerclage, and direct repair of the CC ligaments. Over 150 surgical techniques for AC joint injuries have been documented, categorized mainly as AC fixation, coracoclavicular (CC) fixation, or ligament reconstruction. Non-absorbable

Ethibond-2, recognized for its strength and durability, has garnered attention in orthopedic surgery. However, there is a paucity of research examining the functional outcomes of surgical management utilizing Non-absorbable Ethibond-2 for Rockwood Type III-VI AC joint injuries.

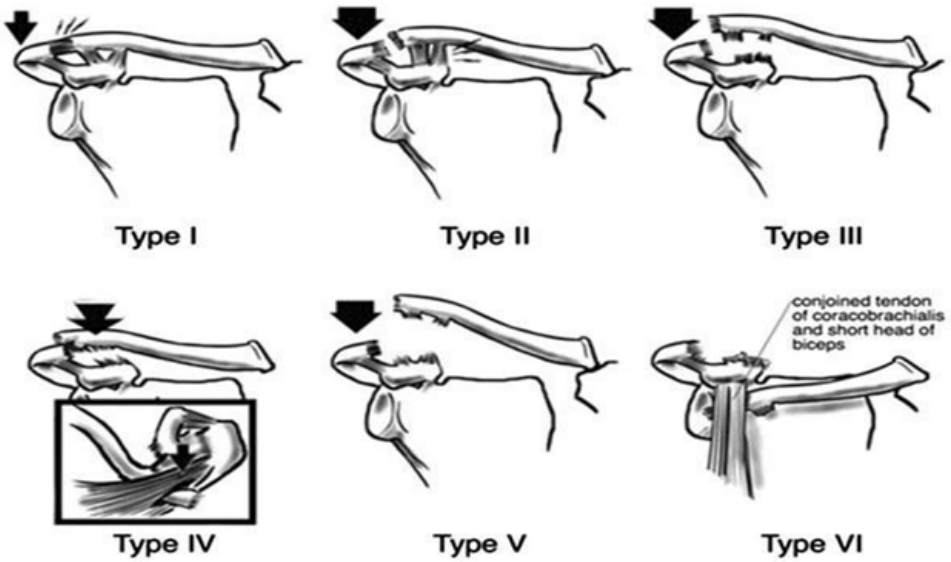

Figure 1: Rockwood's Classification of Acromioclavicular Separations Types

Review of Literature: The repair of acromioclavicular (AC) joint injuries using Ethibond-2 represents a significant advancement in orthopedic surgery. Ethibond-2, a non-absorbable suture material known for its strength and durability, has revolutionized the surgical management of AC joint injuries. Several pioneers in the field have contributed to the development and refinement of techniques utilizing Ethibond-2 for AC joint repair.

Dr. Rüedi, a renowned orthopedic surgeon, was one of the early pioneers in exploring the use of Ethibond-2 for AC joint repair. His innovative approaches to shoulder surgery laid the foundation for modern techniques in AC joint reconstruction. Through his research and clinical practice, Dr. Rüedi demonstrated the efficacy and reliability of Ethibond-2 in restoring stability to the AC joint.

Dr. Iannotti's contributions to the field of shoulder surgery have been instrumental in advancing the use ofEthibond-2 for AC joint repair. His expertise in biomechanics and surgical techniques has led to the development of novel approaches to AC joint reconstruction using Ethibond-2. Dr. Iannotti's research hasprovided valuable insights into the optimal use of Ethibond-2 sutures for achieving durable and functionaloutcomes in AC joint repair procedures.

Dr. Snyder's pioneering work in shoulder surgery has significantly influenced the use of Ethibond-2 for AC joint repair. His innovative surgical techniques and meticulous attention to detail have contributed toimproved outcomes and patient satisfaction. Dr. Snyder's research has highlighted the biomechanical advantages of Ethibond-2 in providing stability to the AC joint, particularly in cases of severe ligamentous injury. Dr. Hawkins' pioneering contributions to shoulder surgery have shaped the modern approach to AC joint reconstruction using Ethibond-2. His extensive experience and expertise in treating shoulder injuries have led to the development of refined surgical techniques that maximize the benefits of Ethibond-2 sutures.

Dr. Hawkins' research has underscored the importance of anatomical restoration and precise sutureplacement in achieving successful outcomes in AC joint repair procedures.

Dr. Getz's innovative approaches to shoulder surgery have significantly advanced the field of AC joint reconstruction using Ethibond-2. His emphasis on individualized treatment strategies and patient-centered care has led to improved functional outcomes and reduced complications in AC joint repair procedures.

Dr. Getz's research has contributed to a better understanding of the biomechanical properties of Ethibond- 2 sutures and their role in promoting healing and stability in the AC joint.

In conclusion, the pioneers mentioned above have played pivotal roles in the evolution of surgical techniques utilizing Ethibond-2 for the repair of AC joint injuries. Their contributions have not only enhanced the effectiveness of AC joint reconstruction but have also paved the way for further advancements in the field of shoulder surgery. Through their dedication and innovation, these pioneers have improved the quality of care and out-

comes for patients with AC joint injuries world-wide.

Methodology: An Ambispective analysis was conducted, encompassing 14 patients who underwent surgical management for Rockwood Type III-VI AC joint separation utilizing Non-absorbable Ethibond-2 at Government Medical College, Kadapa. Inclusion criteria comprised patients aged 15-65 years, with confirmed Rockwood Type III-VI AC joint injury. Injuries that are less than 3 weeks old were included inthe study.

Exclusion criteria included patients with Rockwood Type I and II injuries, patients below the age of 15, patients with concomitant acromion and coracoid fracture, patients with neurovascular deficit and patients with soft tissue loss and infections

Operative Technique: The Surgery is performed in beach chair position under brachial plexus block. A vertical incision was made starting below the coracoid and extending to the posterior border of clavicle & 3 cm medial to the Acromio-clavicular joint. The fascia over the deltoid is identified and incised in line with the skin incision.

The deltoid was retracted and clavipectoral fascia was exposed. Blunt dissection of the clavipectoral fascia was done to expose the acromion, clavicle and coracoid.

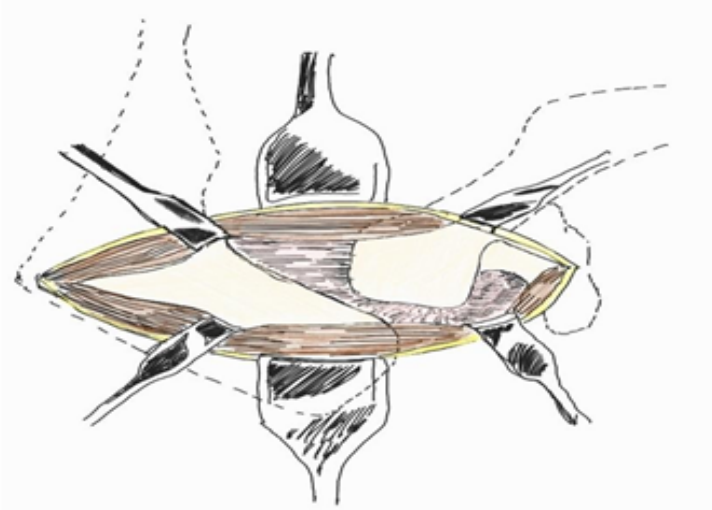

Figure 2: The Surgical Approach Which Permits Good Visualization of the Clavicle, the Coracoid Process, Ac Joint, and Acromion

Figure 3: Specific Instruments Required For the Procedure Including 2mm Drill Bit, Right Angles Forceps and Ethibond-2

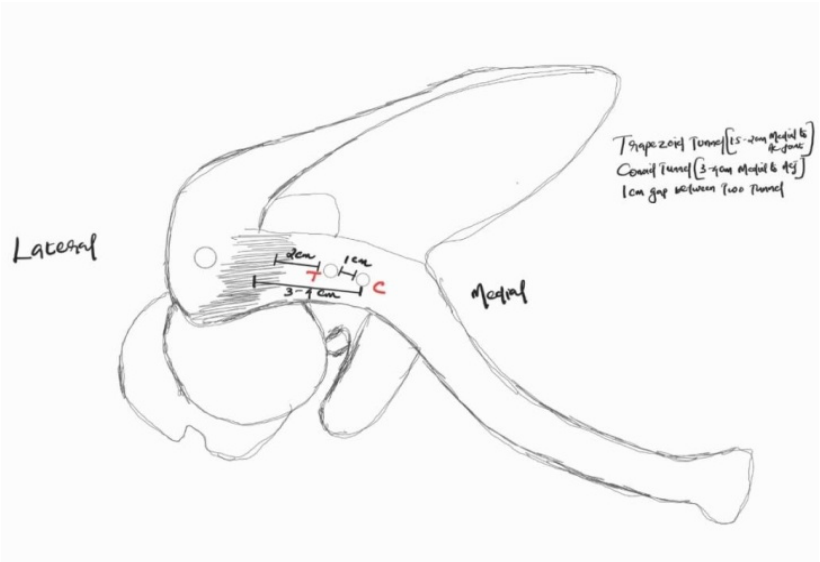

Figure 4: Diagram Depicting the Positions of Trapezoid and Conoid Tunnels on the Clavicle

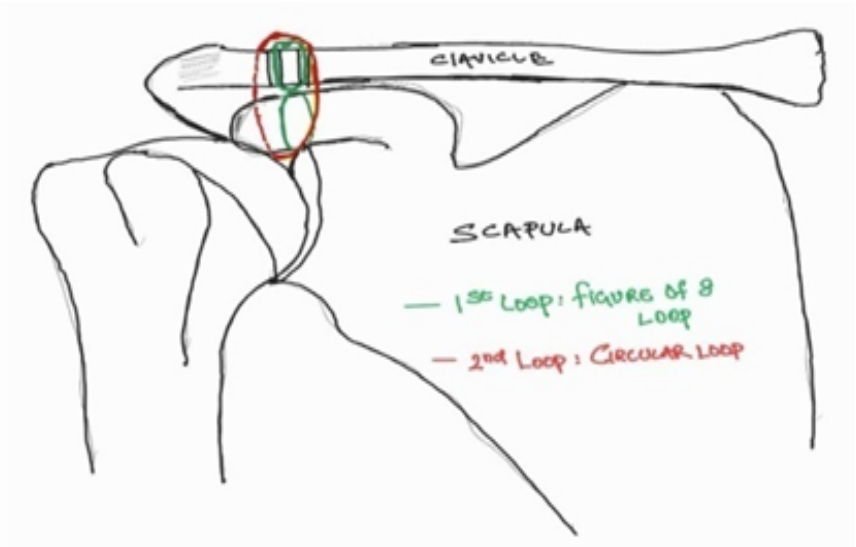

Figure 5: Diagram Showing Representing Recreation of CC Ligaments Using Ethibond-2

Two tunnels were made into the Clavicle (Trapezoid and Conoid tunnels). The trapezoid tunnel was made 1.5-2 cm medial to the AC joint and Conoid tunnel was made 3-4 cm from the AC joint respectively with a 1cm gap between the tunnels.

The Ethibond -2 was passed through the tunnels and was then looped around the base of coracoid in a figure of 8 manner to tied into place making the 1st loop. A second circular loop was then made by feeding the Ethibond-2 through the drilled holes and then looping it around the base of coracoid and tying it into place.

The loops were tightened and the reduction of the CC joint was confirmed visually and under C-Arm image intensifier. Two horizontal tunnels were drilled, one into the lateral end of Clavicle and another into medial end ofacromion. A double loop of Ethibond-2 was fed through these holes and was tied up securely. The surgical site was thoroughly cleaned followed by an antibiotic lavage before closing up the wound in layers.

Rehabilitation & Follow-up: All the patients were put on Arm slings for 4 weeks post operatively. The patients were started on passiveshoulder range of motion at 3 weeks.

Exercises against resistance were subsequently added 6-8 weeks post operatively and strengthening exercises were done starting at 3 months Post op. The patients were regularly followed for a period of ranging from 12 months to 24 months.

The clinical and functional outcome was measured using VAS score and Constant & Murley score at 3 months, 6 months and 12 months follow-up visits.

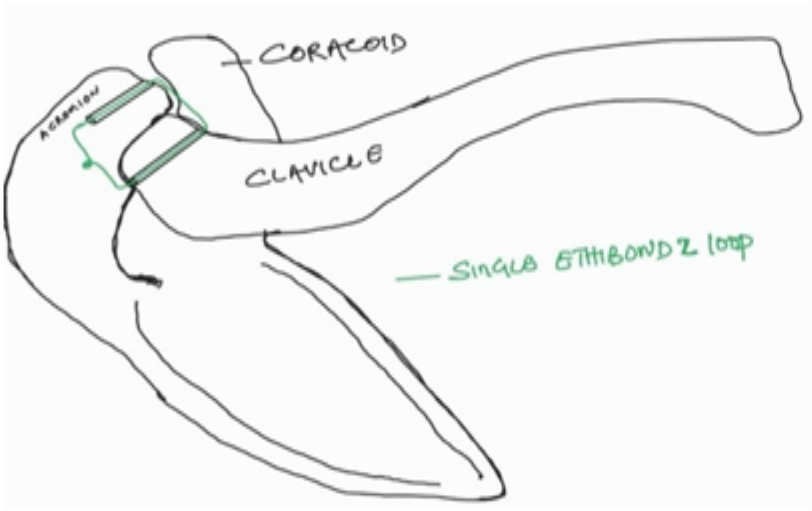

Figure 6: Diagram Showing Representing Recreation of AC Ligament Using Ethibond-2

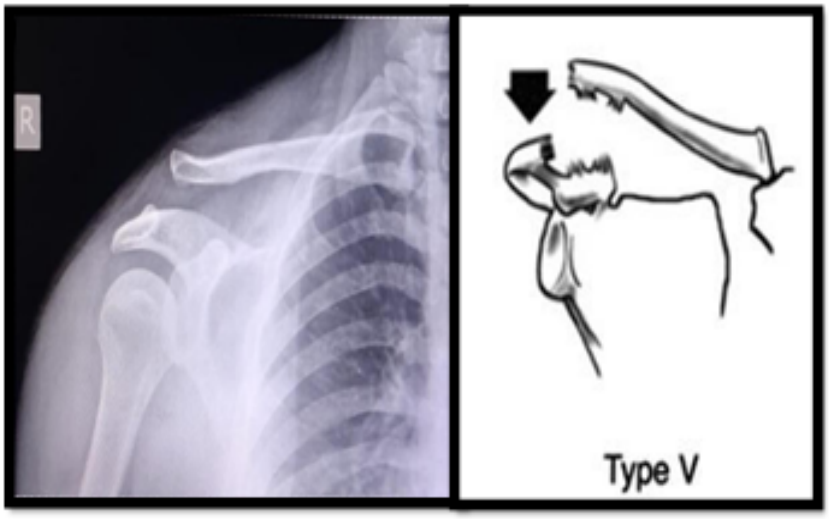

Figure 7: Pre-Op X Ray Depicting Rockwood Type V Ac Joint Injury

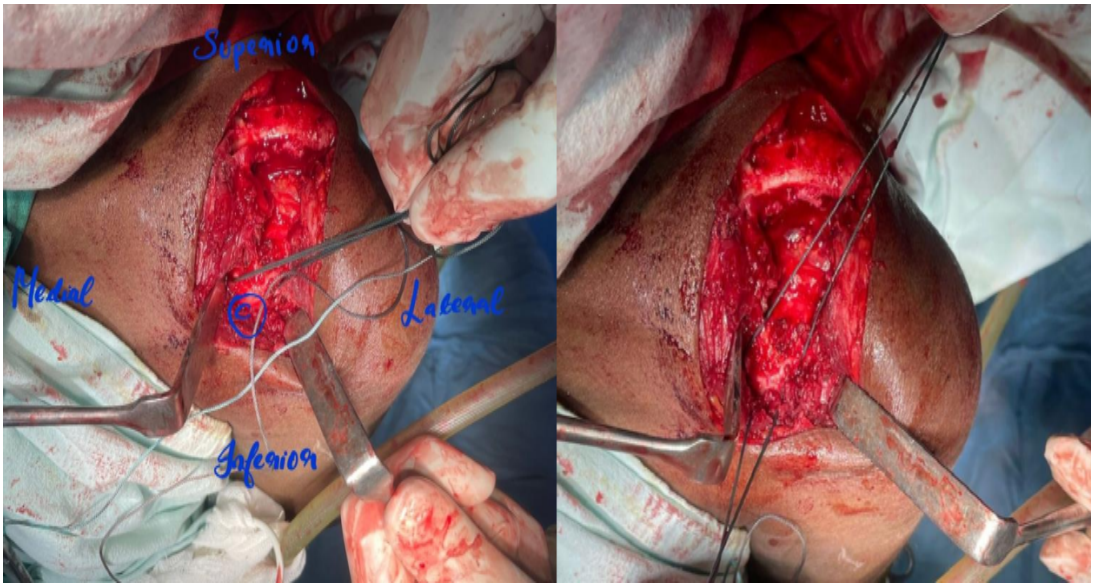

Figure 8 & 9: Intra Op Photos Depicting the Different Tunnels And Looping Of The Ethibond-2

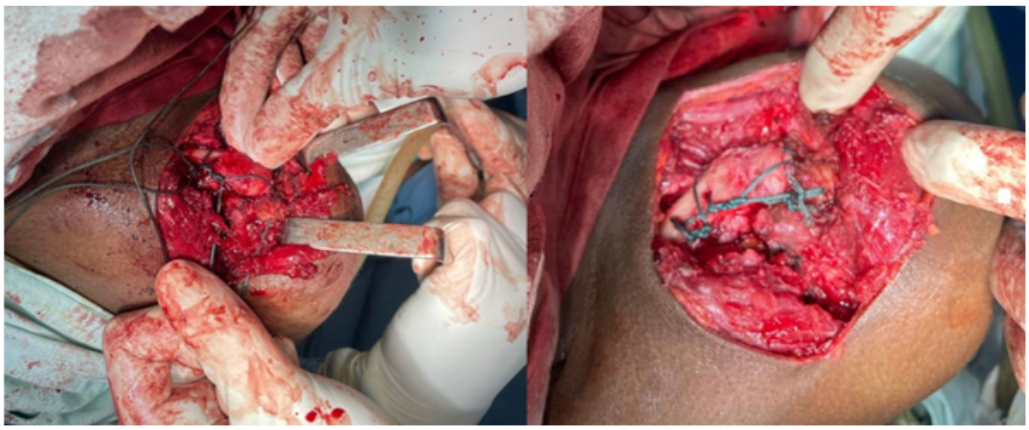

Figure 10&11: Intra-Op Photos Depicting A Repaired Ac And Cc Joints With Ethibond-2

Visual Analog Scale: The Visual Analog Scale (VAS) is frequently utilized in epidemiological and clinical research to assess subjective experiences like pain intensity, fatigue, psychological distress, itching severity, facial aesthetics, and alterations in dental and smile aesthetics. It typically ranges from 0 to 10, with clear instructions for users to assign a numerical value to the outcome. In this scale, 0 indicates the absence ofpain, while 10 signifies the highest imaginable level of pain.

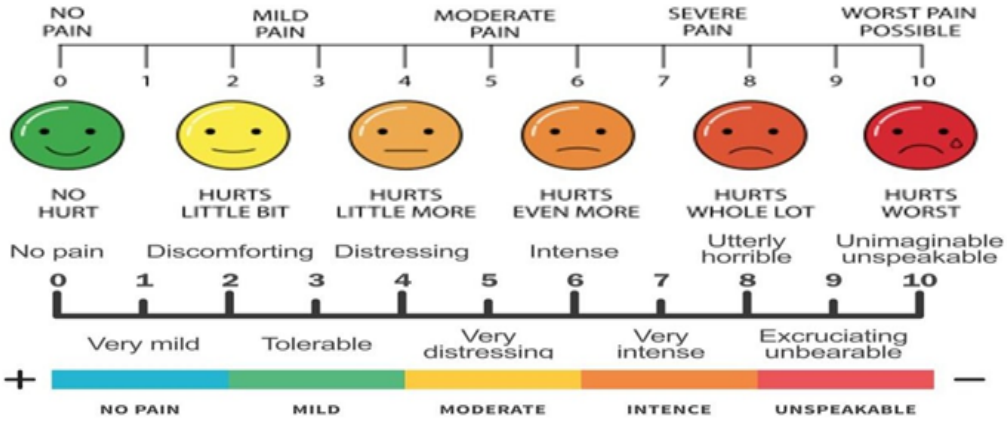

Figure 12: Visual Analog Scale

Constant–Murley Score (CMS): The CMS (Constant-Murley Score) is a comprehensive functional scale that evaluates pain, activities ofdaily living, range of motion, and strength in the affected shoulder. Scores on the CMS range from 0 to 100 points, with 0 indicating the poorest shoulder function and 100 representing the best shoulder function.

Figure 13: X Ray - 3 Months Follow-Up

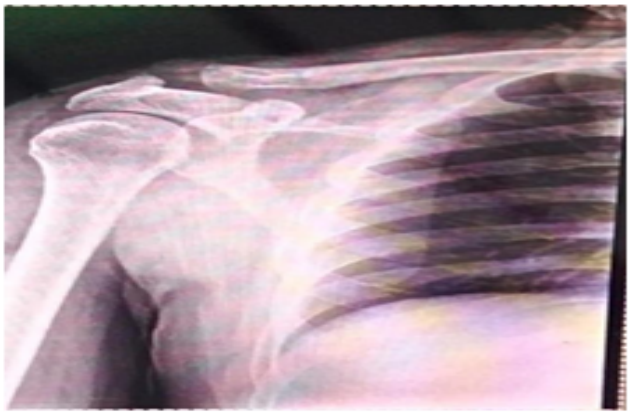

Figure 14: X Ray At 6 Months Follow-Up

Statistical Analysis: Descriptive statistics, including the mean and standard deviation (SD) for continuous variables, were calculated. The paired T-test was employed to compute the p-value for comparing functional outcomes and assess the significance of the results obtained. Comparisons among more than two groups were conducted using the Kruskal-Wallis test. A p-value less than 0.05 were considered statistically significant. The data are provided below.

Results

Patient Information: Our study cohort comprised of 12 males and 8 females (N = 20), with an average age of 38.8 ± 6.56 (Mean ± SD). Among the 20 patients who were included in the study, nine, six and three patients sustained Rockwood type V, IV and III injuries respectively.

Operative Details: The mean average blood loss was 99.3 ± 30.9 ml and the mean duration of surgery was 85.6 ± 8.2 hours. The average post-operative follow-up was for a period of 122 months.

Visual Analog Scale (VAS): The average preoperative VAS score (baseline data) was 6.75 ± 1.47. At the 3-month, 6-month, and 12- month follow-up assessments, the mean pain scores on the VAS were 4.35 ± 1.23, 2.85 ± 0.79, and 0.65 ± 0.47, respectively. The VAS score at 12 months postoperative was significantly lower than the preoperative VAS score by 5.96 points (P < 0.01).

Table 1: VAS Score

Visual Analogue Scale				
VAS Score	**Pre- Operative**	**3 Months Post Op**	**t value**	**p value**
Mean	6.75	4.35	-15.77109	0.00001
SD	1.179	1.235		
VAS Score	**Pre- Operative**	**6 Months Post Op**	**t value**	**p value**
Mean	4.35	2.85	-7.091835	<0.00001
SD	1.235	0.792		
VAS Score	**Pre- Operative**	**6 Months Post Op**	**t value**	**p value**
Mean	2.85	0.65	-9.314221	<0.00001
SD	0.792	0.476		

Constant–Murley Score (CMS): The mean preoperative, 3-month, 6-month, and 12-month postoperative CMS scores were 34.37 ± 4.32, 72.85 ± 3.94, 85.1 ± 3.72, and 90.75 ± 1.81, respectively. The CMS score at 12 months postoperative wassignificantly higher than the preoperative CMS by 56.38 points (P < 0.01).

Table 2: CMS score

Constant and Muerly Score				
CMS Score	**Pre- Operative**	**3 Months Post Op**	**t value**	**p value**
Mean	34.37	72.85	32.485636	<0.00001
SD	4.32	3.94		
CMS Score	**Pre- Operative**	**6 Months Post Op**	**t value**	**p value**
Mean	72.85	85.1	13.792668	<0.00001
SD	3.94	3.72		
CMS Score	**Pre- Operative**	**6 Months Post Op**	**t value**	**p value**
Mean	85.1	90.75	6.057894	<0.00001
SD	3.72	1.81		

Figure 15-18: Patient Feels No Pain and Has Regained Full Range of Motion and Strength of the Joint

Radiographic Outcomes: Anterior-posterior radiographs revealed no instances of partial loss of vertical reduction, additionally, no horizontal instability was observed in any of the patients based on axillary view examinations.

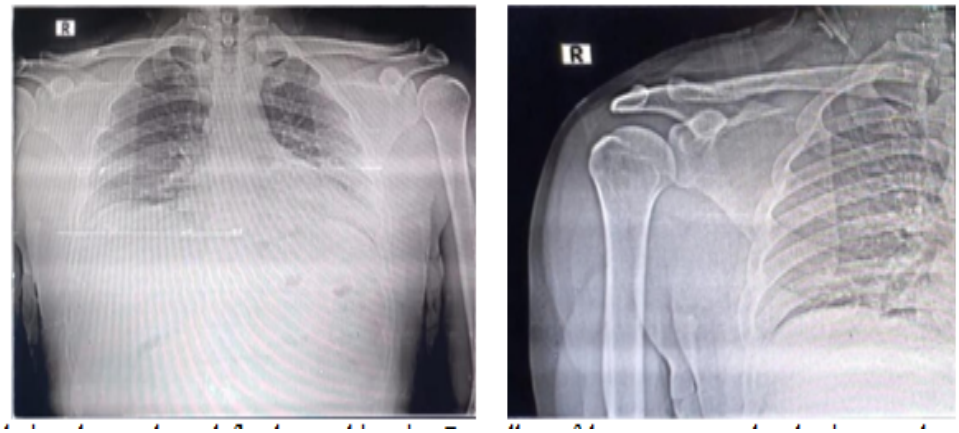

Figure 19-20: Review X ray taken on 2 years follow-up

Discussion

No consensus has been reached regarding the treatment of high-grade AC dislocation despite the prevalence of this injury [1,2,3] The choice of an adequate surgical procedure is based on various factors, such as the surgeon's preference, the patient's activity level, and biomechanical properties of the surrounding ligaments. [4] More than 150 variations have been described to treat symptomatic ACJ separations [5] ; however, the superiority of a single technique has not been defined up to this point. Regardless of the construct used, reduction must be maintained long enough for the biological healing process to occur. [6] All surgical procedures for AC dislocation can be classified into four categories: (i) fixation of the AC and/or CC with hardware including screws and K-wires; (ii) hook plates; (iii) fixation of the CC with suture buttons or anchors; (vi) reconstruction of CC ligaments with autograft or allograft tendon. [7] Anatomic reconstruction of the CC and AC ligaments using tendon grafts and endobutton CC fixation in acute ACJ dislocation have rapidly gained popularity in the past few decades [8,9] Clavicle and/or coracoid fractures resulting from bone tunnels, which are usually 6 mm in diameter, are the main reasons that restrict these techniques. Several authors recommended the use of 3 mm bone tunnels to avoid the use of large bone tunnels to reduce either clavicle or coracoid fractures. [10]

In this study we successfully maintained the ACJ in a reduced position using two suture anchors in patients with high-grade AC dislocation. This technology offers the following important features: (i) Regardless of whether 3.5 (295 N) or 5.0 mm (331N) was used, two suture anchors provided comparable biomechanical strength compared with the native CC ligament complex of 589 N and had sufficient strength to withstand physiological loads and restore stability [11]; (ii) Suture anchor implantation in the base of the coracoid process was easier and less dangerous for the neurovascular structures

than passing a loop underneath the coracoid process4; (iii) Jerosch et al. [12] evaluated eight different AC reconstruction techniques in a biomechanical study, observing the best restoration of anatomy with suture anchor fixation in the base of the coracoid process; (vi) When 3.5 mm suture anchors were used, both coracoid and clavicle tunnels were created by 2.0 mm drill bit or Kirschner wire, which needed smaller clavicle holes than those required for the tendon graft or endobutton procedure, thus minimizing the possibility of intraoperative and postoperative fractures; (v) Hardware removal was unnecessary, and implant-related complication was avoided, indirectly reducing the cost for family members and the national healthcare system. Numerous studies have confirmed the feasibility and effectiveness of suture anchor fixation to repair ACJ separation. [13]

Nevertheless, all shoulders were immobilized in a sling for 6 weeks to ensure native CC ligament healing and prevent reduction loss. Distal clavicle resection (Mumford procedure) may represent an effective solution to a painful old ACJ injury. [14] Various modified Weaver–Dunn procedures which include distal clavicle excision have been widely used. [4]

However, for acute AC injuries, a great controversy remains about whether distal clavicle resection should be conducted. [1,2] Aliberti et al. [15] reported that horizontal instability injuries are often neglected or poorly understood, resulting in difficult diagnosis, which may lead to high complication rates and failure after surgical stabilization. Consistent evidence indicates that stability of horizontal plane plays a decisive role over the clinical outcome. Other studies considered that the remaining horizontal instability is the only factor that may lead to an adverse effect on final clinical outcome. Several scholars explored stabilization methods in the horizontal plane to address this important issue. In this study, we exposed the ACJ, debrided and removed the damaged cartilage disc, reduced the dislocated joint under direct vision, and performed reliable fixation by two strands of heavy nonabsorbable sutures. On one hand, horizontal stability was obtained. On the other hand, this condition further augmented and protected the vertical stability of CC fixation.

Conclusion

Currently, no single surgical technique has demonstrated superior results over other forms of fixation. The two-suture anchor fixation method for CC ligament and suture augmentation for ACJ demonstrates a reliable alternative for the surgical treatment of acute AC dislocation. This technique restores the stable ACJ both vertically and horizontally and provides sufficient strength to hold the distal clavicle to the coracoid process for CC and AC ligament healing. Nevertheless, other factors require attention during the surgical procedure.

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