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Minimally Invasive Endobutton Fixation for Acute Acromioclavicular Joint Injuries and Lateral Clavicle Fractures

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Abstract
Acute acromioclavicular joint (ACJ) dislocations and lateral clavicle fractures are common injuries that can significantly impact shoulder function, particularly in physically active individuals. The severity of ACJ dislocations is typically classified using the Rockwood classification system, ranging from Type I (mild sprains) to Type VI (severe dislocations with significant displacement and ligamentous disruption). Similarly, lateral clavicle fractures, particularly those involving the distal third of the clavicle, present challenges due to the high mobility of this region and the limited soft tissue support, often resulting in delayed healing or nonunion. The procedure employs a four-strand, single-tunnel, double-endobutton repair, which is performed entirely percutaneously without arthroscopic guidance or deep surgical dissection. The goal of this technique is to provide a stable yet minimally invasive solution for these injuries, allowing for quicker recovery while achieving results comparable to traditional surgical methods. This study included a consecutive series of six patients who underwent percutaneous endobutton fixation for acute acromioclavicular joint (ACJ) dislocations or lateral clavicle fractures with the inclusion criteria of type III to type V AC Joint injuries or Neer Type 2 Distal Clavicle fractures with the age group of 18 to 60 years. A total of six patients underwent percutaneous endobutton fixation for acute acromioclavicular joint (ACJ) dislocations or lateral clavicle fractures. The mean follow-up period was six months. The primary outcomes assessed included surgical time, radiographic correction of the coracoclavicular (CC) distance, functional recovery and postoperative complications. Percutaneous endobutton fixation for acute ACJ dislocations and distal clavicle fractures demonstrates favourable outcomes in terms of surgical efficiency, anatomical reduction, functional recovery, and low complication rates. This minimally invasive approach offers a viable alternative to traditional open surgical methods, potentially leading to faster recovery and improved patient satisfaction.

INTRODUCTION

Acute acromioclavicular joint (ACJ) dislocations and lateral clavicle fractures are common injuries that can significantly impact shoulder function, particularly in physically active individuals[1] These injuries often result from direct trauma to the shoulder, such as falls onto an outstretched arm or direct blows sustained during contact sports, motor vehicle accidents, or work-related incidents. The severity of ACJ dislocations is typically classified using the Rockwood classification system, ranging from Type I (mild sprains) to Type VI (severe dislocations with significant displacement and ligamentous disruption)[2]. Similarly, lateral clavicle fractures, particularly those involving the distal third of the clavicle, present challenges due to the high mobility of this region and the limited soft tissue support, often resulting in delayed healing or nonunion. Traditional surgical techniques for treating ACJ dislocations and lateral clavicle fractures include open reduction and internal fixation using plates, screws, hook plates and ligament reconstruction procedures[3]. While these approaches have demonstrated success in restoring joint stability, they are often associated with complications such as hardware irritation, loss of reduction, post-operative stiffness, and the need for secondary surgeries for hardware removal. Additionally, extensive soft tissue dissection in open procedures increases the risk of postoperative pain, infections and delayed rehabilitation. In recent years, minimally invasive techniques have gained popularity due to their ability to provide stable fixation while minimizing soft tissue trauma[4]. Arthroscopic-assisted techniques and percutaneous fixation methods have been introduced as alternatives to traditional open surgery. Percutaneous fixation, in particular, offers several advantages, including reduced surgical time, minimal disruption of surrounding tissues and faster post-operative recovery[5]. However, concerns remain regarding the long-term stability of such techniques and their ability to maintain anatomical reduction over time. This study describes a novel percutaneous endobutton fixation technique designed to address acute ACJ dislocations and certain distal clavicle fractures. The procedure employs a four-strand, single-tunnel, double-endobutton repair, which is performed entirely percutaneously without arthroscopic guidance or deep surgical dissection. The goal of this technique is to provide a stable yet minimally invasive solution for these injuries, allowing for quicker recovery while achieving results comparable to traditional surgical methods.

MATERIALS AND METHODS

Patient Selection: This study included a consecutive series of six patients who underwent percutaneous endobutton fixation for acute acromioclavicular joint (ACJ) dislocations or lateral clavicle fractures. The inclusion criteria were:

- Acute (<3 weeks old) Rockwood Type III–V ACJ dislocations or Neer Type II distal clavicle fractures
- Patients aged 18-60 years with no history of previous shoulder surgery
- No evidence of severe degenerative changes or chronic ACJ pathology
- No concomitant neurovascular injuries or fractures requiring additional surgical intervention

Exclusion criteria included chronic ACJ instability (>3 weeks post-injury), open fractures, polytrauma patients requiring multiple procedures and cases with significant bone loss or severe osteopenia that would impair fixation stability.

Surgical Technique: All procedures were performed under general anesthesia with the patient placed in the beach-chair position. A radiolucent arm support was used to allow unrestricted shoulder manipulation during the procedure. The surgical field was prepped and draped under sterile conditions.

Step 1: Preoperative Planning and Marking: Using fluoroscopic guidance, the anatomical landmarks of the clavicle, coracoid process, and AC joint were identified and marked on the skin. Proper visualization of the coracoid was ensured to facilitate precise tunnel placement.

Step 2: Percutaneous Tunnel Creation: A small (approximately 1 cm) skin incision was made over the lateral clavicle. A guide wire was inserted percutaneously and advanced through the clavicle into the base of the coracoid under fluoroscopic guidance. Once optimal positioning was confirmed, a cannulated drill was used to create a single bone tunnel spanning from the clavicle to the coracoid. The diameter of the tunnel was determined based on the specifications of the chosen endobutton fixation system.

Step 3: Endobutton and Suture Placement: A four-strand, double-endobutton construct was used for fixation. A looped suture passing device was introduced through the tunnel to shuttle the sutures and endobutton through the coracoid. The distal endobutton was deployed on the undersurface of the coracoid, ensuring a secure anchor point. The proximal endobutton was positioned over the clavicle, with the sutures tensioned to achieve anatomical reduction of the AC joint or fracture fragments.

Step 4: Fixation and Verification: Fluoroscopic imaging was used to confirm appropriate reduction of the coracoclavicular (CC) interval and proper seating of the endobuttons. The sutures were tied sequentially to maintain stability while avoiding over tightening, which could lead to over-reduction or restriction of shoulder motion.

Step 5: Wound Closure and Postoperative Care: The incision was irrigated and closed with absorbable sutures and a sterile dressing was applied. The patient's arm was placed in a shoulder immobilizer for initial post-operative protection.

Postoperative Rehabilitation: A standardized rehabilitation protocol was followed:

- **Weeks 0-2:** Immobilization in a sling, with passive range-of-motion (ROM) exercises for the elbow and wrist.
- **Weeks 3-6:** Gradual initiation of shoulder ROM exercises, avoiding overhead activities.
- **Weeks 6-12:** Progressive strengthening exercises, focusing on scapular stability and rotator cuff function.
- **After 12 weeks:** Return to full functional activities, with a gradual reintroduction of sports or heavy lifting.

Outcome Measures: Clinical and functional outcomes were assessed using the following parameters:

- Surgical time (measured from incision to closure)
- Reduction quality (measured as post-operative CC distance compared to the uninjured side)
- QuickDASH score (Disabilities of the Arm, Shoulder, and Hand questionnaire)
- Range of motion (measured at final follow-up)
- Complications (including hardware failure, loss of reduction, and post-operative stiffness)

Patients were followed up at 2, 6 and 12 weeks postoperatively, with final assessments conducted at 6 months. This percutaneous endobutton fixation technique aims to provide a minimally invasive yet biomechanically stable solution for acute ACJ dislocations and distal clavicle fractures, allowing for early mobilization and improved patient outcomes.

RESULTS AND DISCUSSIONS

A total of six patients underwent percutaneous endobutton fixation for acute acromioclavicular joint (ACJ) dislocations or lateral clavicle fractures. The mean follow-up period was six months. The primary outcomes assessed included surgical time, radiographic correction of the coracoclavicular (CC) distance, functional recovery and postoperative complications.

Table 1: Patient Demographics and Injury Characteristics

Patient #	Age	Sex	Injury Type	Rockwood /Neer Classification	Dominant Side Affected Surgery	Time from Injury to (days)
1	32	M	ACJ Dislocation	Rockwood V	Yes	5
2	41	F	Distal Clavicle Fracture	Neer Type II	No	7
3	29	M	ACJ Dislocation	Rockwood III	Yes	6
4	35	M	ACJ Dislocation	Rockwood IV	No	4
5	38	F	Distal Clavicle Fracture	Neer Type II	Yes	8
6	45	M	ACJ Dislocation	Rockwood V	No	5

Table 1 provides an overview of the patient cohort, including age, sex, type of injury, classification based on Rockwood (for ACJ dislocations) or Neer (for distal clavicle fractures), involvement of the dominant side, and the time interval between injury and surgery. The majority of patients sustained ACJ dislocations, with Rockwood Type V being the most common. Two patients had distal clavicle fractures classified as Neer Type II. The mean age of the patients was in the mid-30s to early 40s and both male and female patients were included. The time from injury to surgery ranged from 4 to 8 days, indicating that all cases were treated in the acute phase.

Table 2: Operative and Radiographic Outcomes

Patient #	Surgical Time (minutes)	Pre-op CC Distance (mm)	Post-op CC Distance (mm)	Reduction Achieved (mm)
1	35	15.2	2.8	12.4
2	40	13.8	3.5	10.3
3	32	16.1	4.0	12.1
4	37	14.5	3.1	11.4
5	39	15.8	4.2	11.6
6	36	14.9	3.3	11.6
Mean	36	15.1	3.5	11.6

Table 2 summarizes key intraoperative and radiographic findings, including surgical duration, preoperative and postoperative coracoclavicular (CC) distances, and the degree of reduction achieved. The mean surgical time was 36 minutes, reflecting the efficiency of the percutaneous approach. Preoperatively, patients exhibited an increased CC distance due to ligamentous disruption, with an average of 15.1 mm. Postoperatively, the CC distance was significantly reduced to a mean of 3.5 mm, indicating successful anatomical realignment. The mean reduction achieved was 11.6 mm, comparable to other surgical techniques used for ACJ stabilization.

Table 3: Functional Outcomes (QuickDASH and Range of Motion)

Patient #	Quick DASH Score (0-100)	Forward Elevation (°)	External Rotation (°)	Abduction (°)
1	5.2	170	60	160
2	3.8	175	65	165
3	4.1	172	62	162
4	6.8	168	58	158
5	2.5	176	67	166
6	4.2	171	63	161
Mean	4.4	172	62.5	162

Table 3 presents functional recovery data, including QuickDASH scores and shoulder range of motion at final follow-up. QuickDASH is a validated measure of upper limb function, with lower scores indicating better outcomes. The mean QuickDASH score in this study was 4.4, signifying minimal functional impairment. Shoulder range of motion assessments demonstrated near-normal values across all patients, with forward elevation averaging 172°, external rotation 62.5° and abduction 162°. These findings suggest that percutaneous endobutton fixation allows for excellent post-operative shoulder mobility with minimal residual disability.

Table 4: Postoperative Complications

Patient #	Complication	Management	Outcome
1	None	N/A	Full Recovery
2	None	N/A	Full Recovery
3	None	N/A	Full Recovery
4	Mild Shoulder Pain	Physical Therapy	Resolved by 12 weeks
5	None	N/A	Full Recovery
6	None	N/A	Full Recovery

Table 4 details any complications encountered during the follow-up period. Five out of six patients experienced an uneventful recovery with no reported complications. One patient reported mild shoulder pain, which was effectively managed with physical therapy and resolved within 12 weeks. Importantly, there were no cases of implant failure, loss of reduction, infection, or neurovascular injury. The absence of major complications highlights the safety and reliability of the percutaneous fixation technique. The management of acute acromioclavicular joint (ACJ) dislocations and distal clavicle fractures has evolved with the advent of minimally invasive techniques, aiming to restore joint stability while minimizing soft tissue disruption. In this study, we evaluated the outcomes of percutaneous endobutton fixation in six patients, focusing on surgical efficiency, radiographic correction, functional recovery and complication rates.

Surgical Efficiency: The mean operative time in our series was 36 minutes (range: 32-40 minutes), reflecting the efficiency of the percutaneous approach. This duration is consistent with other studies utilizing similar techniques. For instance, a study on percutaneous endobutton fixation reported a mean surgical time of 36 minutes, highlighting the procedure's efficiency[6]. The reduced operative time may contribute to decreased anesthesia-related risks and improved patient throughput.

Radiographic Correction: Anatomical reduction of the coracoclavicular (CC) distance is crucial for optimal functional outcomes. Our patients achieved a mean CC distance reduction of 11.6 mm (range: 10.3-12.4 mm), resulting in postoperative CC distances comparable to the uninjured side. These findings align with previous research demonstrating effective reduction using percutaneous techniques[6]. However, it's important to note that some studies have reported early loss of radiographic reduction, particularly with the double endobutton technique. For example, a study observed a 26% rate of early radiographic failure in patients treated with the double endobutton method, emphasizing the need for meticulous surgical technique and accurate implant placement[7].

Functional Recovery: Functional outcomes, as assessed by the QuickDASH scores, were favorable in our cohort, with a mean score of 4.4 (range: 2.5-6.8), indicating minimal disability. Patients also regained near-full shoulder range of motion, underscoring the effectiveness of the percutaneous approach in preserving shoulder function. These outcomes are consistent with existing literature. A study on minimally invasive double endobutton fixation reported significant improvements in shoulder pain and function, with excellent AC joint reduction maintained[8]. Similarly, another study concluded that percutaneous fixation for ACJ injuries is a safe and effective treatment, providing good results for function and appearance[9].

Complication Rates: Our study observed minimal complications, with only one patient experiencing mild shoulder pain that resolved with physical therapy. There were no instances of implant failure, loss of reduction, infection, or neurovascular injury. This low complication rate is encouraging and aligns with other studies reporting favorable outcomes with percutaneous techniques. For example, a study on percutaneous coracoclavicular tightrope reduction of a displaced distal clavicular fracture demonstrated appropriate reduction and healing, with the minimally invasive nature of the procedure avoiding functional impingement and the need for future hardware removal[10]. However, surgeons should remain vigilant about potential complications, such as early loss of reduction, particularly when using techniques like the double endobutton method[7].

Comparison with Other Techniques: Traditional open surgical methods for ACJ dislocations and distal clavicle fractures often involve extensive soft tissue dissection, which can lead to longer recovery times and increased morbidity. In contrast, the percutaneous endobutton technique offers a minimally invasive alternative with several advantages, including shorter operative times, reduced soft tissue disruption and expedited rehabilitation. A systematic review on arthroscopic fixation of unstable distal clavicle fractures highlighted significant improvements in clinical outcomes, further supporting the efficacy of minimally invasive approaches[11].

Limitations: While our findings are promising, the study's limitations include a small sample size and a short follow-up period. Larger, randomized controlled trials with extended follow-up are necessary to validate these results and assess the long-term durability of the percutaneous endobutton fixation technique.

CONCLUSION

Percutaneous endobutton fixation for acute ACJ dislocations and distal clavicle fractures demonstrates favorable outcomes in terms of surgical efficiency, anatomical reduction, functional recovery, and low complication rates. This minimally invasive approach offers a viable alternative to traditional open surgical methods, potentially leading to faster recovery and improved patient satisfaction. However, careful patient selection and meticulous surgical technique are essential to minimize potential complications and ensure optimal outcomes.

Recommendations: Based on our findings, percutaneous endobutton fixation is a viable and minimally invasive approach for treating acute acromioclavicular joint (ACJ) dislocations and distal clavicle fractures. However, to further improve patient outcomes, we recommend that surgeons carefully select candidates for this technique, ensuring that the procedure is performed in the acute phase (<3 weeks post-injury) for optimal reduction and healing. Future research should focus on long-term follow-up studies to assess the durability of fixation and the potential for late complications such as implant loosening or loss of reduction. Additionally, comparative studies evaluating this technique against arthroscopic and open-surgical methods would help establish standardized treatment protocols. Lastly, advancements in implant design and biomechanical studies could further refine the fixation technique, reducing complications and improving functional recovery.

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