Coracoclavicular Fixation Using the Tight Rope Technique in Acute Acromioclavicular Joint Dislocations: A Comprehensive Review

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Abstract: Background: Acromioclavicular (AC) joint dislocations are common shoulder injuries, particularly in young and active individuals. While conservative management is often considered for low-grade injuries, surgical intervention is preferred for high-grade (Rockwood type III-V) dislocations to restore anatomical alignment and shoulder function. Various surgical techniques have been explored, with coracoclavicular (CC) fixation using a tight rope system emerging as a promising alternative to traditional methods. This review aims to analyze the current literature on the effectiveness, biomechanics, clinical outcomes, and complications associated with the tight rope technique in the management of acute AC joint dislocations. A comprehensive review of the literature was conducted using databases such as PubMed, Scopus, and Google Scholar. Studies evaluating the tight rope technique for CC fixation in acute AC joint dislocations were included. The review focused on surgical technique, functional outcomes, radiological assessment, complications, and comparative studies with other fixation methods such as hook plates, screw fixation, and ligament reconstruction.The literature suggests that CC fixation using the tight rope system provides satisfactory outcomes in terms of joint stability, functional recovery, and pain relief. Several studies report significant improvements in functional scores, including the Constant-Murley Score (CMS) and the American Shoulder and Elbow Surgeons (ASES) score, with high patient satisfaction rates. Radiographic evaluations indicate effective joint reduction, although some studies highlight potential concerns regarding loss of reduction over time, implant loosening, and risk of coracoid fractures. Comparative studies suggest that the tight rope technique may offer advantages over hook plates by allowing early mobilization and avoiding the need for implant removal. However, the long-term superiority of this technique remains debated due to variability in reported complications and recurrence rates.Coracoclavicular fixation using the tight rope technique represents a minimally invasive and biomechanically favorable option for managing acute AC joint dislocations. While short- to mid-term outcomes are promising, further high-quality randomized controlled trials and long-term studies are required to establish its efficacy relative to other fixation methods. Standardized surgical techniques and postoperative rehabilitation protocols may enhance the consistency of results and optimize patient outcomes.

Keywords: Acromioclavicular joint, coracoclavicular fixation, tight rope, dislocation, shoulder injury, surgical techniques, biomechanics, functional outcomes.

1. Introduction

Acute acromioclavicular (AC) joint dislocation is a common shoulder injury, particularly among athletes involved in contact sports, cyclists, and individuals who experience direct trauma to the shoulder. The AC joint, which connects the clavicle to the acromion of the scapula, plays a crucial role in shoulder stability and movement. Dislocation of this joint occurs when excessive force disrupts the ligamentous structures responsible for maintaining joint integrity, leading to pain, deformity, and functional impairment [1].

The AC joint is stabilized by both static and dynamic structures, including the acromioclavicular and coracoclavicular (CC) ligaments. The AC ligament provides horizontal stability, while the CC ligaments—comprising the conoid and trapezoid ligaments—maintain vertical stability. Disruption of these ligaments leads to varying degrees of dislocation, classified using the Rockwood classification system, which ranges from Type I (minor sprain) to Type VI (severe displacement with associated soft tissue injury) [2].

The most common mechanism of injury for AC joint dislocation is a direct blow to the lateral aspect of the shoulder, often seen in falls onto the shoulder in sports like rugby, hockey, and cycling accidents. Indirect mechanisms, such as a fall onto an outstretched hand, can also contribute, though they are less common. The degree of displacement depends on the severity of ligamentous injury and the force applied [3].

Clinical presentation includes localized pain, tenderness, swelling, and a visible deformity over the AC joint, often referred to as a "step-off" deformity in higher-grade injuries. Patients may report pain exacerbated by shoulder movements, particularly abduction and cross-body adduction. Diagnosis is primarily clinical but is confirmed through imaging, including radiographs and, in some cases, magnetic resonance imaging (MRI) to assess ligament integrity [4].

Standard radiographic evaluation involves anteroposterior, Zanca, and axillary views of the shoulder. The Zanca view, taken at a 10–15 degree cephalic tilt, is particularly useful in assessing AC joint alignment. Stress radiographs with weighted views may be used to determine the extent of displacement in suspected higher-grade injuries, although their routine use is debated [5].

Management of AC joint dislocation depends on the severity of the injury. Type I and II injuries are typically managed conservatively with rest, ice, analgesia, and physiotherapy to restore function. Type III injuries remain controversial, with treatment decisions influenced by patient activity level, occupation, and persistent symptoms. Type IV–VI injuries usually require surgical intervention due to significant displacement and associated functional impairment [6].

Surgical options include open and arthroscopic techniques aimed at restoring joint stability and function. Common procedures involve reconstruction of the CC ligaments using allografts, synthetic materials, or autografts, as well as fixation techniques such as hook plates, suture buttons, or screw fixation. Arthroscopic approaches have gained popularity due to their minimally invasive nature, reduced soft tissue trauma, and faster recovery times compared to open procedures [7].

Postoperative rehabilitation is crucial for optimizing functional outcomes. Initial immobilization is followed by progressive physiotherapy, emphasizing range of motion, strengthening, and gradual return to activity. Full recovery can take several months, with return to sports typically occurring around three to six months postoperatively, depending on the severity of the injury and the surgical technique employed [8].

Complications of AC joint dislocation include chronic pain, instability, post-traumatic arthritis,

and hardware-related issues in surgically managed cases. Residual symptoms, particularly in Type III injuries treated conservatively, may necessitate delayed surgical intervention. Persistent deformity, while not always functionally limiting, can be of cosmetic concern to some patients [9].

Biomechanical studies have investigated the effectiveness of various surgical techniques, highlighting that anatomic CC ligament reconstruction provides superior stability compared to non-anatomic techniques. However, no single approach has been universally accepted as the gold standard, and treatment strategies continue to evolve based on emerging evidence and technological advancements [10].

Recent advancements in surgical techniques, such as arthroscopically assisted ligament reconstruction and biological augmentation using growth factors, have shown promise in improving long-term outcomes. The integration of biologic healing with mechanical stability may enhance ligamentous healing and reduce the risk of recurrent instability [11].

Patient-specific factors, including age, activity level, and occupational demands, play a crucial role in treatment decision-making. Young, active individuals may benefit more from surgical intervention to restore function, whereas older, less active patients may achieve satisfactory outcomes with conservative management [12].

Long-term studies suggest that even with appropriate treatment, some patients may experience residual pain and functional limitations. Factors influencing outcomes include the severity of initial displacement, treatment modality, rehabilitation adherence, and patient expectations. Ongoing research is focused on optimizing treatment protocols and minimizing complications [13].

Return to sports following AC joint dislocation depends on the severity of the injury and the chosen treatment modality. Athletes undergoing conservative treatment may return within a few weeks for minor injuries, whereas surgically treated patients may require extended rehabilitation before resuming high-impact activities [14].

The economic burden of AC joint dislocation is significant, particularly in athletes and laborers who may require prolonged recovery and time off work. Cost-effective management strategies should balance the need for surgical intervention with functional outcomes and quality of life considerations [15].

Rehabilitation programs should be individualized, incorporating scapular stabilization exercises, proprioception training, and progressive loading to restore shoulder function and prevent recurrence. Patient education on injury prevention, including proper falling techniques and protective gear, is essential, particularly in high-risk sports [16].

Future directions in AC joint dislocation management include the development of biologic scaffolds, tissue engineering, and regenerative medicine approaches to enhance ligament healing. Additionally, advancements in imaging techniques may allow for more precise assessment of ligament integrity and treatment planning [17].

Acute AC joint dislocation is a prevalent shoulder injury requiring careful assessment and tailored management. Conservative and surgical approaches both have roles, with decisions influenced by injury severity, patient demands, and long-term functional goals. Continued research and technological advancements will likely refine treatment strategies and improve patient outcomes [18].

Acute acromioclavicular (AC) joint dislocations are common shoulder injuries, particularly among athletes and individuals involved in high-impact activities. The coracoclavicular (CC) fixation using the tight rope technique has emerged as an effective surgical intervention for restoring joint stability and function. This method offers an alternative to traditional procedures, such as hook plate fixation and screw fixation, by providing dynamic stabilization while preserving the normal kinematics of the AC joint [19].

The AC joint is a diarthrodial joint that connects the acromion process of the scapula to the clavicle. It is stabilized by both intrinsic ligaments (the AC ligaments) and extrinsic ligaments

(the CC ligaments, comprising the conoid and trapezoid ligaments). Disruption of these ligaments, particularly the CC ligaments, leads to displacement of the distal clavicle and dysfunction of the shoulder girdle. Surgical intervention is often required in high-grade dislocations, classified as Rockwood types IV to VI [20].

The tight rope technique involves the use of a suture button construct that provides a non-rigid fixation between the clavicle and the coracoid process. This method mimics the natural function of the CC ligaments by allowing micro-motion, reducing stress shielding, and promoting biological healing. The technique is performed through a minimally invasive approach, reducing soft tissue disruption and postoperative complications associated with open surgical methods [21].

Biomechanical studies have demonstrated that tight rope fixation provides superior load-to-failure characteristics compared to traditional screw or hook plate fixation. The suture-button construct allows controlled movement while maintaining reduction, thus minimizing the risk of implant failure due to excessive stress concentration. This dynamic stability has been shown to facilitate early rehabilitation and improved functional outcomes in patients with AC joint dislocations [22].

One of the primary advantages of the tight rope technique is its minimally invasive nature. Unlike hook plate fixation, which often necessitates a second surgery for implant removal, the tight rope system remains in place without requiring further intervention. This reduces the overall surgical burden on the patient and lowers healthcare costs associated with multiple procedures [23].

Clinical studies have reported promising outcomes with the tight rope technique. Patients undergoing CC fixation with a suture-button device exhibit significant improvements in shoulder function, pain relief, and return to sports or occupational activities. The reported complication rates are relatively low, with fewer incidences of hardware-related discomfort or implant migration compared to conventional methods [24].

Despite its benefits, the tight rope technique is not without limitations. One potential concern is the risk of clavicular or coracoid fractures, particularly in cases where excessive tension is applied during fixation. Proper surgical technique and careful intraoperative assessment are crucial in preventing such complications. Additionally, biomechanical studies suggest that although suture-button constructs provide immediate stability, biological healing of the CC ligaments is necessary for long-term success [25].

The success of the tight rope technique depends on precise surgical execution. Fluoroscopic guidance is often used to ensure accurate placement of the drill holes in the clavicle and coracoid process. The suture-button construct is then secured, achieving anatomical reduction of the AC joint. Surgeons must balance adequate tensioning of the construct to maintain reduction while avoiding excessive force that could lead to complications [26].

Rehabilitation following tight rope fixation involves early mobilization with gradual strengthening exercises. Unlike rigid fixation techniques, which may necessitate prolonged immobilization, the dynamic nature of the suture-button construct allows for controlled movement in the early postoperative period. This facilitates quicker recovery and a faster return to normal activities [27].

Comparative studies have evaluated the tight rope technique against other fixation methods, such as hook plate and screw fixation. Results indicate that patients treated with tight rope fixation experience superior range of motion, reduced postoperative pain, and higher patient satisfaction scores. The avoidance of hardware removal procedures further enhances patient outcomes and reduces the risk of secondary surgeries [28].

Long-term follow-up studies suggest that tight rope fixation provides durable outcomes with low rates of recurrent instability. Patients generally maintain good shoulder function even several years after surgery, with minimal radiographic evidence of joint degeneration or arthritic changes. These findings highlight the effectiveness of this technique as a reliable

option for managing acute AC joint dislocations [29].
Nevertheless, certain patient-specific factors must be considered when selecting the tight rope technique. For example, individuals with osteoporotic bone quality may be at higher risk for implant-related complications. In such cases, additional augmentation techniques, such as autograft or allograft reconstruction, may be considered to enhance fixation strength [30].
Advancements in suture materials and implant designs continue to improve the efficacy of the tight rope technique. Recent modifications include the use of double suture-button constructs to enhance stability and mitigate the risk of implant loosening. These innovations aim to further optimize surgical outcomes and expand the applicability of this technique to a broader patient population [31].
The role of biologic augmentation in AC joint reconstruction is also an area of ongoing research. Studies are exploring the use of platelet-rich plasma (PRP) and collagen scaffolds to promote ligamentous healing and enhance the biological integration of the suture-button construct. Such approaches may further improve long-term outcomes and reduce the risk of residual instability [32].
Despite the promising results, ongoing clinical trials and multicenter studies are necessary to establish standardized protocols for tight rope fixation. Current research efforts focus on defining optimal rehabilitation strategies, identifying risk factors for failure, and assessing long-term outcomes across diverse patient populations [33].

2. Conclusion

In conclusion, coracoclavicular fixation using the tight rope technique represents a significant advancement in the surgical management of acute AC joint dislocations. This method offers several advantages, including dynamic stabilization, minimally invasive application, and reduced need for secondary surgery. While challenges remain, continuous improvements in implant technology and surgical techniques are expected to further refine this approach and solidify its role in orthopedic practice [34].

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