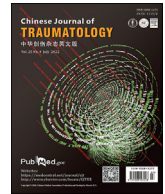




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## Case Report

# Bipolar clavicular dislocation treated with biological anatomical repair and reconstruction: A case report with a literature review of management options

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## ABSTRACT

Bipolar clavicular dislocation is rare, and therefore its management is contentious. With an increase of patient's physical demand and a near-normal shoulder function, there has been a shift in the paradigm of its management from a conservative one to a stabilized one of anatomical open reduction. Proposed methods of fixation have also evolved with the advent of more biological fixation devices, which elude implant or fixation related complications. This case report highlights the salient features of this rare case and details the management options along with the benefits of biological anatomical repair and reconstruction.

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## Introduction

Bipolar clavicular dislocation is rare. It was firstly described by Porral<sup>1</sup> in 1831 as double dislocation of the clavicle, and further reported by various names in literature, such as traumatic floating clavicle,<sup>2,3</sup> simultaneous dislocation of both ends of the clavicle,<sup>4</sup> bifocal or pan-clavicular dislocation<sup>5</sup> and bipolar clavicular dislocation.<sup>6,7</sup> These names have been used randomly by different authors over time and all of them essentially mean the same, i.e. simultaneous dislocation of acromioclavicular (AC) joint and sternoclavicular (SC) joint with intact clavicle (no fracture) following trauma.

The exact mechanism of injury leading to this simultaneous bipolar clavicular dislocation is not well understood and various hypotheses have been proposed. Cook et al.<sup>6</sup> postulated that trauma to the lateral pole of the clavicle leads to disruption of the AC ligament and posterior or superior dislocation of the lateral end of the clavicle followed by anterior dislocation of the medial end with constantly acting force on the clavicle. Later, Maruyama et al.<sup>8</sup> proposed the pivotal role of the first rib in the pathophysiology of bipolar clavicular dislocation. Meanwhile, they postulated that the

anterior SC joint dislocation is caused by posteromedial-directed force from the anterolateral surface of the shoulder or through the outstretched hand. The force pushes the clavicle onto the first rib, and the medial end of the clavicle is elevated due to this leverage motion, causing anterior SC joint dislocation. These hypotheses may explain the mechanism of injury for anterior SC joint and posterior or superior AC joint dislocations, but not for other uncommon combinations of bipolar dislocations.<sup>9</sup> Therefore, it is presumed that bipolar dislocation is not caused by a single direction of the force and may involve a combination of multiple directions of forces. Although understanding the direction of forces and injury patterns may be decisive for a management, an ideal treatment protocol is still debatable.

The present case report describes a rare acute case of posterior AC joint and anterior SC joint bipolar dislocation of the clavicle treated with a novel, biological repair and reconstruction of the bifocal joints and coracoclavicular (CC) ligament simultaneously. To the best of our knowledge, this is the first documented case where biological treatment is considered for the management of bipolar clavicular dislocation.

## Case report

A 22-year-old right-hand dominant male, a volleyball player, sustained an injury to the right shoulder following an accidental fall from stairs. He presented in the emergency department with

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swelling and deformity in the right shoulder and upper chest. On clinical examination, the patient had pain and swelling involving the right clavicular region with marked bony deformity projecting anteriorly over the medial end of the right clavicle (Fig. 1). The right shoulder movements were restricted and the patient felt painful. There was no associated neurovascular deficit, chest injury or any other solid organ/bony injury.

The radiological assessment revealed a relatively normal anteroposterior chest radiograph with increased right-sided SC joint space (Fig. 2A). Hence involvement of the SC joint was suspected, and a radiographic view was taken which revealed an anterior dislocation of the medial end of the right side clavicle (Fig. 2B). Considering the severity of deformity and diffuse pain, a CT scan was done for a better radiological evaluation which further revealed associated Rockwood type IV/complete posterior dislocation of the AC joint (Fig. 2C).<sup>10</sup> Thus, the diagnosis of bipolar clavicular dislocation with the posterior AC joint and anterior SC joint dislocation was established.

In the emergency department, closed reduction by gentle manipulation under sedation department was attempted, but failed to achieve the reduction. Therefore, open reduction was planned. The patient was positioned supine with a bolster support cushion to push the scapula forward under general anesthesia (Fig. 3A). Horizontal incision of roughly 6 cm was given centered over the SC joint to expose the anteriorly dislocated medial end of the clavicle. However, reduction could not be achieved due to the associated posterior dislocation of the lateral end of the clavicle, and hence this was followed by a 7 cm vertical incision (bra strap) centered over the coracoid and lateral third end of the clavicle.

Intraoperatively, tear of the CC ligament was found with tears of AC joint and SC joint capsule and ligaments. Both ends were simultaneously reduced to achieve anatomical reduction, which was confirmed clinically and under fluoroscopic examination. However, the outcome of reduction was unstable. Hence, the AC joint was stabilized using two percutaneous 2 mm K-wires. This was followed by the acute repair of the AC joint and SC joint capsule and ligaments with No. 2 fiber wire (Arthrex®). The torn ends of the CC ligament fibers were repaired using fiber wire to further add stability and strength; the CC ligament was also reconstructed/reinforced using autologous Gracilis tendon graft augmented with fiber tape (Arthrex®) (Fig. 3B). CC ligament reconstruction was done by passing the loop of augmented graft under the coracoid base and then passing the two ends of the graft through the two drilled holes 1 cm apart at the anatomical site of attachments of



Fig. 1. Preoperative bony deformity following the right side bipolar clavicular dislocation.

conoid and trapezoid ligaments (CC ligament) (Fig. 3C). Then, with the reduction maintained, both ends of graft were tied over the clavicle. The K-wires were left in situ to keep the AC joint stabilized till the healing of soft tissue repair and to allow an early rehabilitation (Fig. 4). No fixation other than soft tissue repair using fiber wire was used for the SC joint as it was clinically stable once the capsule was sutured and the AC joint was repaired.

Arm pouch sling support was given for the initial three weeks. Intermittent pendulum shoulder exercises were started from the first postoperative day followed by passive shoulder abduction and flexion up to 90° in the second week. Passive followed by active overhead shoulder abduction and rotation was started after K-wire removal at four weeks. The patient resumed full shoulder functions by three months and started playing volleyball after six months without any pain or motion restriction. There was no graft related complication or re-dislocation at one-year follow-up with near normal range of joint motion at the shoulder (Fig. 5).

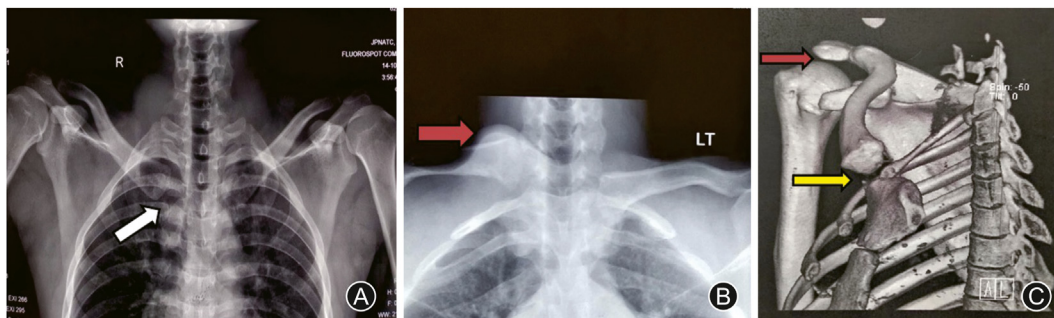
## Discussion

AC joint injuries are increasing in number with an incidence of 9.2 per 1000 person-year, which are considered to be the leading cause of chronic shoulder pain in young athletes.<sup>11</sup> AC joint injuries associated with simultaneous involvement of the SC joint are still rare. The first case reported was in 1831,<sup>1</sup> after that it took almost a century for another case series by Bekman in the year 1924,<sup>4</sup> and subsequent case was presented nearly half a century later by Gearen and Petty in 1982.<sup>5</sup> Since then nearly 30 cases of bipolar clavicular dislocation have been reported till date.<sup>9</sup> There could be various reasons for its rare and infrequent presentation. Lack of awareness of the simultaneous involvement of bifocal joints is believed to be the major causal factor.

Before the 21st century, the majority of AC joint injuries were managed conservatively with sling support irrespective of the degree of involvement.<sup>12</sup> The management of bipolar clavicular dislocation followed the same principle, in which each reported case almost were managed conservatively and reported good functional outcomes.<sup>2,5,6,13–15</sup> However, in the last two decades, some reports have shown a transition towards surgical management with better functional outcomes and rehabilitation compared to conservative treatment.<sup>9</sup> Patient factors like young age, physical demands, athletics, labor occupation, dominant side shoulder and severity of bifocal joint dislocation have also made surgeons opt for the operative treatment with uncompromised functional outcomes.

In a detailed review,<sup>9</sup> it was found that in the majority of case reports, the initial diagnosis of bipolar dislocation of the clavicle was missed or neglected and treated conservatively with sling support. All these cases were reported to have persisting symptoms like chronic pain, cosmetic deformity and restricted shoulder movements, leading to late operative intervention. Various surgical techniques and modes of fixation of AC joint and SC joint dislocation have been proposed, such as Kirschner wire,<sup>16–18</sup> cerclage wire,<sup>19</sup> compression screw,<sup>20</sup> T-plate,<sup>21</sup> and hook plate,<sup>22</sup> as well as the ligamentous reconstruction with polyester fiber tape,<sup>3</sup> polyester surgical mesh,<sup>23</sup> muscle strip<sup>24</sup> and tendon graft.<sup>25</sup> However, none of them has been found to be superior over the other and the preferred surgical technique is still debatable.

The main aim of surgical fixation is to achieve the reduction of the clavicle anatomically without compromising the AC joint and SC joint functions. This can be achieved with an early or acute operative intervention with the biological repair of the AC joint and SC joint. The CC ligament is invariably torn in Type III and IV AC joint dislocation, which is recommended to be repaired with reinforcement in acute cases for a better long term functional



**Fig. 2.** (A) Preoperative radiographic anteroposterior view showing the increased sternoclavicular joint space in the right side indicated with white arrow; (B) Serendipity view of sternoclavicular joint in the right side showing anterior dislocation of the medial end clavicle, indicated with red arrow; (C) Preoperative CT scan 3D-reconstruction showing the posterior acromioclavicular joint dislocation (red arrow) and anterior sternoclavicular joint dislocation (yellow arrow).



**Fig. 3.** (A) Intraoperative clinical picture depicting positioning of patient under general anesthesia; (B) Autologous gracilis graft augmented with fibre tape; (C) Intraoperative clinical picture depicting coracoclavicular ligament reconstruction using augmented graft looped under base of coracoid and free ends passed through two holes 1 cm apart in the clavicle.



**Fig. 4.** Postoperative radiographs with anatomical clavicular reduction and two k-wires in situ in the acromioclavicular joint: (A) anteroposterior view, (B) serendipity view.



**Fig. 5.** (A) Radiographic image showing anatomical and reduced clavicle without any complication and (B) clinical pictures depicting full shoulder range of motion, both at one-year follow-up.

outcome without failure.<sup>26</sup> Okano et al.<sup>9</sup> reviewed 26 cases of bipolar dislocation of the clavicle, and in none of them, concomitant CC ligament repair or reconstruction was considered or described by the authors. In the majority of these cases, either a lateral hook plate or other AC joint fixation methods were used which may require a second surgery due to hardware-related complications.<sup>27</sup>

Now it is well evident that the high degree of AC joint dislocations (Type IV/V/VI) need CC ligament repair and reconstruction by using various surgical techniques and modes of fixation.<sup>26</sup> The use of autologous hamstring graft is an established method for CC ligament reconstruction, however it may be modified depending upon the timing of surgery and graft size availability.<sup>28</sup> Recently, the use of allograft has been quite popular, but its widespread use is restricted depending upon an availability.<sup>29</sup>

The SC joint generally does not require any fixation devices or reconstruction in acute cases, as it promptly gets reduced following AC joint anatomical relocation.<sup>26</sup> However, the stability should be assessed intraoperatively and the torn capsule and ligaments should be repaired meticulously. Any hardware or metallic device used for an additional stabilization of the SC joint carries a significant risk of hardware displacement or migration, which leads to severe life-threatening complications, and thus should be avoided.<sup>9,30</sup>

Rockwood type III/superior AC joint dislocation has been the most common combination with the anterior SC joint dislocation. However, so far only four studies reporting Type IV/posterior AC joint dislocation with anterior SC joint dislocation are available.<sup>9</sup> The present case highlights the rarity of the combination of posterior AC joint and anterior SC joint dislocation, as well as reports novel and biological surgical treatment which aims to achieve a desired maximal functional outcome from a bipolar clavicular dislocation without any compromise or implant-related complications.

Bipolar clavicular dislocation is rare. Various combinations of bipolar dislocations are possible and have been reported. Now the surgical treatment is considered to be the gold standard in acute and neglected cases. In acute injuries, we recommend the use of biological surgical fixation techniques to avoid any implant or hardware-related complications and to prevent undesired AC or SC joint arthrosis. However, the efficacy of various biological fixation methods applicable needs to be further assessed.

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## Ethical statement

Ethical approval not required as per our institute review board. All procedures performed in this study involving human participants were in accordance with the ethical standard of the institutional and/international research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## Declaration of competing interest

On behalf of all authors, the corresponding author states that there is no conflict of interest to disclose.

## Author contributions

Hemant Bansal: manuscript designing and editing, data analysis, surgical planning and follow up and initial manuscript drafting. Aditya Jain: collection of patient's clinical and follow-up data

and initial manuscript formatting. Samarth Mittal: collection of patient's clinical and follow-up data, data analysis and surgical planning and execution. Vivek Trikha: surgical planning, and supervision and final editing of the manuscript.

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