

# Posterior Remodeling of Medial Clavicle Causing Superior Vena Cava Impingement

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## Abstract

Injuries involving the sternoclavicular region resulting in posterior displacement of the medial clavicle are rare, and those that occur prior to fusion of the medial epiphyseal growth plate are more often a result of physis fracture, rather than sternoclavicular joint dislocation. Medial clavicular physis fractures initially are treated by closed reduction with the expectation of normal osseous repair and remodeling. We report a case of a previously fractured medial clavicle physis that abnormally remodeled, was reinjured, and resulted in posterior displacement with superior vena cava impingement and brachiocephalopathy. Our case report describes the patient's initial injury and repair, the reinjury and discovery of abnormal remodeling, and the outcome of surgical intervention. We also include a review of recent literature on sternoclavicular joint injuries and treatment options. To our knowledge, this is the first reported case of an abnormally remodeled medial clavicle resulting in superior vena cava compression.

Injuries involving the sternoclavicular joint (SCJ) are rare, accounting for as little as 3% of shoulder girdle injuries. Among these injuries, anterior dislocations are far more common than posterior dislocations of the medial clavicle.<sup>1,2</sup> Despite being uncommon, posteriorly displaced medial clavicles should be diagnosed and treated in a timely fashion to avoid potential damage to vulnerable adjacent structures, such as the aorta, carotid arteries, superior vena cava, brachial plexus, trachea, and esophagus.

In this article, we report on an abnormally remodeled medial clavicle physis fracture that dislocated poste-

riorly. The patient presented with superior vena cava compression, dyspnea, and possible brachiocephalopathy. We describe this patient's initial injury and repair, the reinjury leading to the discovery of the lesion, and the outcome of surgical intervention. We also review the recent literature on SCJ injuries and treatment options.

To our knowledge, this is the first reported case of an abnormally remodeled medial clavicle resulting in superior vena cava compression subsequent to instability from reinjury. The patient provided written informed consent for print and electronic publication of this case report.

## CASE REPORT

An 18-year-old man in the US Navy presented with the chief report of pain over the right medial clavicle after feeling a painful pop in this region while retrieving an anchor rope. Signs and symptoms included dyspnea while lying supine; paresthesias of the dorsal and ulnar aspects of the right hand, suggesting an injury to the inferior trunk of the brachial plexus; and a palpable deformity of the SCJ.

Medical history was significant for a traumatic right medial clavicle physeal fracture, initially treated with closed reduction at age 14. At age 16, the patient underwent open reduction and internal fixation (ORIF) for painful deformity of the right SCJ.

The initial surgery included a dissection to expose the SCJ. Dissection revealed no posterior remodeling of the clavicle. After exposure, a soft-tissue flap originating from the sternum was created and passed through a drilled tunnel in the medial clavicle. The flap was then looped over the top of the clavicle and sutured to itself while the medial clavicle was secured in reduction by a towel clamp. About half of the sternocleidomastoid was isolated, tagged with a Krakow suture, and looped around the flap to supplement the reconstruction. The reconstruction remained stable through full range of motion (ROM), and the remaining capsule was closed. The postoperative course, described in this report, was uncomplicated until the reinjury 2 years later.

At time of presentation after reinjury, physical examination revealed a tender, palpable deformity over the right SCJ. The patient had a well-healed surgical scar over the right medial clavicle. There was decreased sensation diffusely over the ulnar and dorsal aspects of the right hand. Ulnar and radial pulses were normal, as

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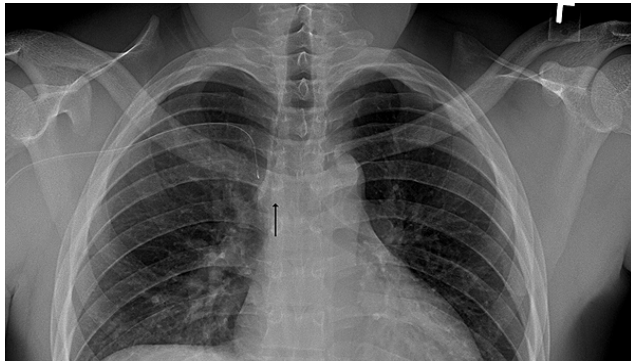
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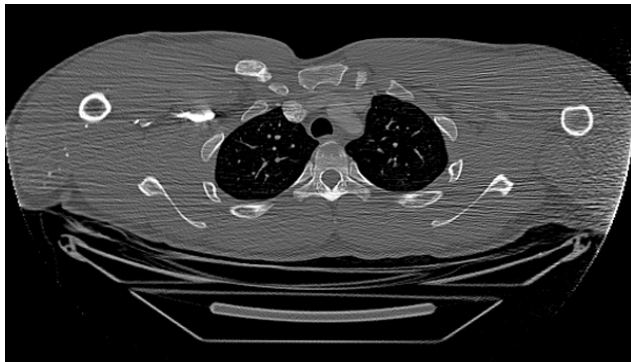
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**Figure 1.** Posteroanterior radiograph of chest shows asymmetry of medial clavicles, with right clavicle (arrow) inferior to left clavicle.



**Figure 2.** Axial computed tomography bone window shows posterior remodeling of right medial clavicle.

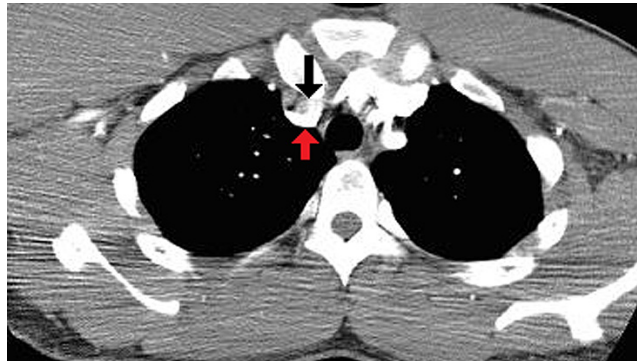
were the findings of a motor examination of the right upper extremity.

Posteroanterior (Figure 1), lateral, and 40° cephalad radiographs of the chest obtained at time of admission showed asymmetry of the medial clavicles. With use of the bone window and intravenous contrast study, axial computed tomography (CT) showed posterior growth of the right medial clavicle (Figure 2) and superior vena cava impingement (Figure 3). Three-dimensional CT reconstruction, which demonstrated asymmetric enlargement of the right clavicular head with posterior subluxation (Figure 4), was used to construct a polyethylene model to assist in preoperative planning (Figure 5).

The patient was taken to the operating room for closed reduction under anesthesia. Examination under anesthesia revealed instability of the right SCJ with anteroposterior translation of 5 mm to 7 mm. Stable reduction was unsuccessful after several attempts, and rhomboid ligament (costoclavicular ligament) reconstruction was required to maintain anatomical alignment.

### Surgical Technique

An incision was made over the previous surgical scar, extending down the length of the clavicle and over the top of the mid-manubrium. Dissection was carried down to the SCJ. The medial end of the clavicle was exposed, and a threaded pin was placed into the medial clavicle for



**Figure 3.** Axial computed tomography with contrast shows posterior angulation of right medial clavicle (black arrow) and superior vena cava impingement (red arrow).



**Figure 4.** Axial 3-dimensional computed tomography shows posterior remodeling of right medial clavicular head (red arrow).

use as a lever to facilitate removal. An oscillating saw was used to make an oblique cut in the most medial aspect of the clavicle, and the remaining approximate 1 cm of the medial segment of the clavicle was then resected.

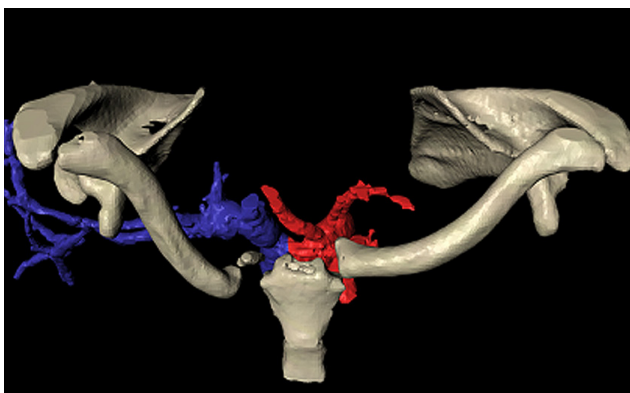
On removal of the medial clavicle segment, sutures from the previous surgery were noted to be crossing the original physis. The histology of the segment was normal; there was no evidence of neoplastic growth (Figure 6).

The superior vena cava was visible at the base of the wound. Two holes were drilled in the clavicle, and the exposed intramedullary canal was lightly curetted out. No. 2 Fiberwire was woven through the rhomboid ligament, and the ends of the sutures were placed through the drill holes. The medial clavicle was sutured back to the rhomboid ligament. The wound was closed in layers over a drain.

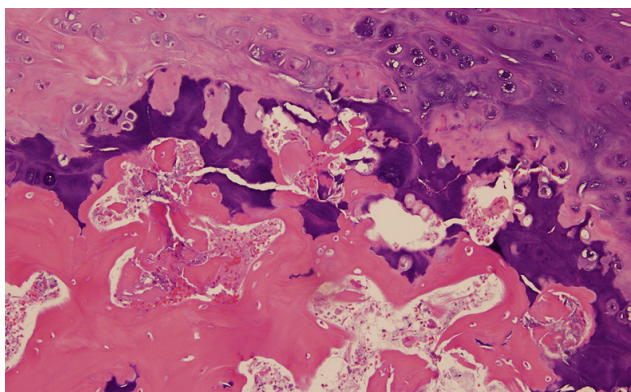
After surgery, the patient was placed in a sling and a swath and was given a shoulder abduction pillow. ROM was restricted to supported Codman exercises for 6 weeks, followed by gentle ROM for another 6 weeks. The patient was then advanced to full active ROM.

### Results

The definitive surgery had no complications. Postoperative radiographs showed a well-aligned medial clavicle (Figure 7). The dyspnea and right hand paresthesias resolved, and



**Figure 5.** Caudal-view 3-dimensional computer model created from computed tomography with contrast. Figures show posterior remodeling of right medial clavicle and superior vena cava impingement (blue vessel).



**Figure 6.** Histologic photograph of resected portion shows normal osseous architecture without evidence of neoplastic growth.

strength and function gradually returned. At 4-month follow-up, the patient demonstrated full active ROM and near full strength.

## DISCUSSION

The clavicle is the first bone to ossify, appearing at approximately 5 to 6 weeks of fetal growth.<sup>3</sup> Secondary (epiphyseal) growth plates develop in the medial and lateral clavicle at approximately 12 to 15 years, with the medial growth plate responsible for 80% of elongation. These secondary ossification centers are the last to fuse in the human body, typically in the middle of the second decade, with the outer limit at 31 years.<sup>4,5</sup>

Before fusion, the medial physis is the weakest part of the medial clavicle<sup>3</sup> and is more susceptible to fracture than the SCJ is to dislocation.<sup>6</sup> The diagnosis of posterior dislocation of the medial clavicle in patients under age 25 requires a high index of suspicion for physal fracture.<sup>6</sup> In many of these cases, the surrounding ligamentous structures remain intact, as they are significantly stronger than the physis.<sup>3</sup> The medial physis of the clavicle has significant growth potential and is likely to promote remodeling. Medial physis fractures, there-



**Figure 7.** Postoperative posteroanterior radiograph shows well-aligned proximal and distal portions of medial clavicle.

fore, are often treated conservatively with closed reduction and seldom require open reduction and repair.<sup>7</sup> It is nevertheless important to distinguish a posterior SCJ dislocation from a physal fracture, as the former, if solely a dislocation, will not remodel.<sup>2</sup>

Posterior instability categories, including traumatic, nontraumatic, congenital, developmental, and iatrogenic, were proposed by Kalandiak and colleagues.<sup>2,8</sup> Traumatic posterior dislocations are most common and are usually corrected with closed reduction. Unstable or irreducible fractures of the medial physis with posterior displacement, however, warrant ORIF. Atraumatic posterior dislocations or subluxations are rare (the more common atraumatic injuries are anterior dislocations) and most often occur in young women; these injuries are usually self-limiting and do not require imaging or surgical treatment. Congenital and developmental dislocations or subluxations, whether caused by birth trauma or congenital defects, are infrequent and usually do not require surgical intervention. Iatrogenic instability typically results from suboptimal reconstruction or excessive medial clavicle resection.<sup>2</sup>

Imaging of medial clavicle injuries requires several studies. Posteroanterior, oblique, and lateral plain radiographs are standard studies for SCJ injuries, but are of limited use because of their inability to discern the subtleties between SCJ dislocation and physal fracture. CT with 3-mm slices is the imaging modality of choice, and is better for detecting fractures, joint involvement, and osseous changes. Three-dimensional modeling can assist in further evaluation of dislocations, and of impingement of vascular structures, once intravenous contrast is added to the study.<sup>9</sup>

We speculate that the medial clavicle physal growth potential was responsible for the abnormal remodeling in our patient's case. This is supported by the histology, which showed normal osseous growth. The patient had a history of fracturing the right medial clavicle physis, which eventually required surgical repair because of subsequent deformity and SCJ pain. We cannot determine whether it was the initial injury or the surgical repair 2 years later

that influenced the posterior growth and remodeling of the medial clavicle. Regardless, this posterior remodeling resulted in impingement on the superior vena cava impingement after reinjury and subsequent instability.

Our patient's resultant symptoms are common in medial clavicle posterior dislocations and medial physal fractures with posterior displacement. These injuries should warrant immediate attention because of vital adjacent structures. Since tracheal compression after posterior clavicle dislocation was first reported in 1843, numerous cases with varying morbidities and mortalities involving damage to the airway, esophagus, and neurovascular structures have been described.<sup>8,10,11</sup>

The relative infrequency of posterior SCJ dislocations and medial physal fractures has limited the development of definitive treatment.<sup>8</sup> Persistent instability and pain, which have been observed after closed reduction, have required open reduction and repair.<sup>11</sup> In their review of the literature, Allen and Zielinski<sup>12</sup> found that all medial physis fractures of the clavicle with posterior dislocation were treated successfully with initial ORIF. In addition, it has been suggested that physal fractures should be treated separately from SCJ dislocations and that primary internal wiring be used to stabilize fractures.<sup>3</sup> Current guidelines support closed reduction whenever possible, with surgical reduction only when nonsurgical intervention fails. However, the success of closed reduction diminishes significantly when more than 48 hours has elapsed between injury and initial treatment, making early diagnosis important.<sup>8</sup>

Our patient's case of superior vena cava impingement from posterior SCJ dislocation of a dysplastic medial clavicle represents a rare occurrence within an already rare injury pattern. This case of abnormal remodeling demonstrates the growth potential after a physal injury of the medial clavicle. Given this potential, we suggest that patients with medial clavicle physal fractures and

posterior dislocation be treated on an individual basis only after careful categorization and consideration of disability. Closed reduction is the standard of care but may not always be appropriate. Open reduction initially may be required to influence proper remodeling and to relieve compression of vital structures. Long-term follow-up studies have yet to be conducted on medial clavicle physal fractures, so it is difficult to determine the incidence of this entity. However, similar symptoms and a history of medial clavicle physal injury in a skeletally immature bone raise the possibility of abnormal posterior physal remodeling.

### AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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