



## Medial third clavicular fracture in combination with a posterior sternoclavicular dislocation in skeletally immature patients: 2 cases of a new proximal clavicular injury

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On one hand, medial fractures account for 2% to 3% of all clavicular fractures in children.<sup>11</sup> On the other hand, posterior fracture-dislocations of the sternoclavicular (SC) joint (SCJ) are a rare variant of pure posterior dislocation.<sup>8</sup> This uncommon injury must be identified because of its potentially life-threatening complications, which include not-uncommon injuries to thoracic structures.<sup>7</sup> Many so-called posterior fracture-dislocations of the SCJ are actually fractures through the physis (epiphysiolysis, Salter-Harris I or II). This is because the weakest link in this area in patients aged younger than 25 years is the medial clavicular physis, the last physal plate to close.<sup>1</sup>

The current report describes a new pattern of clavicular injury, in which a medial third clavicular fracture and posterior SCJ dislocation occur together in a skeletally immature patient. To our knowledge, only 1 similar case has reported, and it was in an adult.<sup>6</sup> We then review the literature on this exceptional presentation and its clinical and surgical treatment.

### Case reports

#### Patient 1

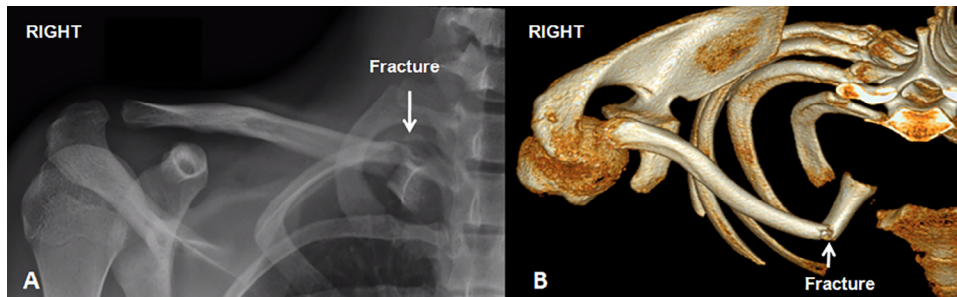
A 15-year-old, right-handed boy sustained a direct impact to his right shoulder while practicing soccer. Physical examination revealed deformity and asymmetry of the superior chest wall, with swelling and tenderness to palpation along the medial right clavicle. The result of a neurovascular examination was normal. The patient denied any shortness of breath, dysphagia, hoarseness, or numbness or tingling in any of his extremities.

Radiographs showed some asymmetry of the SCJ and a possible fracture of the medial third of the right clavicle (Fig. 1). A high level of clinical suspicion prompted us to perform computed tomography (CT) angiography of the chest, which confirmed the presence of a clavicular fracture involving the medial third of the shaft, accompanied by posterior SCJ dislocation (Fig. 1). The clavicular fracture was considered a greenstick fracture involving the medial third of the clavicle and was associated with 90° posterior angulation. No mediastinal hematoma or compression of the trachea or major mediastinal neurovascular structures was evident on CT.

After parental informed consent was obtained, the patient underwent open reduction of the posterior SCJ dislocation and internal fixation (ORIF) of the fracture, via a longitudinal SC approach, under general anesthesia. Surgical exploration confirmed that the medial clavicular physis was intact. A gentle reduction maneuver, involving

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**Figure 1** Patient 1. (A) A plain radiograph reveals subtle asymmetry of the sternoclavicular joint and a ring sign involving the right medial clavicle. (B) Volume-rendered computed tomography confirmed posterior sternoclavicular joint fracture-dislocation without medial clavicular epiphysiolsis.

shoulder extension, was performed to reduce the SCJ. Afterward, internal fixation was performed with an anterior-medial 2.8-mm 6-hole Alians Clavicle Plate (Newclip Technics Sas, PA de la Lande Saint Martin, Haute Goulaine, France). The anterior SC ligaments, found to be disrupted, were reattached using 2.0 FiberWire sutures (Arthrex, Naples, FL, USA). Sutures were placed through drill holes in the medial clavicle and the manubrium, and this was combined with anterior capsular ligament repair (Fig. 2). Stability of the reduction and fixation was evaluated intraoperatively with gentle mobilization of the ipsilateral upper extremity and loading of the SCJ.

Postoperatively, the limb was placed in a sling for 3 weeks, after which physical therapy was initiated to improve range of motion using active and gentle active-assisted exercises. All lifting and twisting restrictions were removed at 6 weeks postoperatively. Also at this time, x-ray imaging indicated bone healing (Fig. 2).

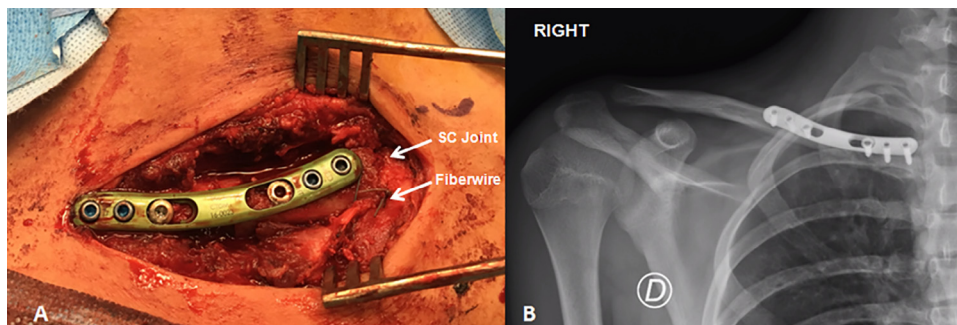
At the final follow-up, 24 months after surgery, the patient was asymptomatic. Examination revealed symmetry of both clavicles and

the SCJ, and the patient exhibited painless, complete range of motion of the right shoulder. The patient subsequently resumed full daily and athletic activities with no difficulty.

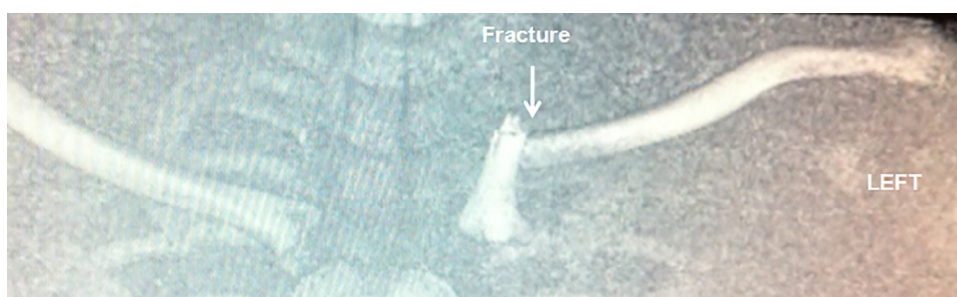
#### Patient 2

A 13-year-old, right-handed boy sustained a direct impact to his left shoulder during rugby practice. The physical examination revealed a medial left clavicular deformity. CT confirmed a midshaft clavicular fracture with displacement of the medial fragment to the apex and posterior SCJ dislocation (Fig. 3).

As with patient 1, after receiving parental informed consent, he underwent open reduction of the posterior SCJ dislocation and ORIF of the fracture using an anterior-medial 2.8-mm 6-hole Alians Clavicle Plate. Afterward the SC ligaments also were reattached, again as for patient 1. The same immobilization and rehabilitation protocol was initiated. At 13 months after surgery, the patient's shoulder was painless and exhibited complete range of motion.



**Figure 2** Patient 1. (A) Internal fixation of the medial clavicular fracture with a plate without fixation of the medial epiphysis, followed by reattachment of the anterior sternoclavicular (SC) ligaments. (B) Radiograph at the final follow-up revealed bone healing.



**Figure 3** Patient 2. Computed tomography confirmed a posterior sternoclavicular joint fracture-dislocation in the absence of medial clavicular epiphysiolsis.

## Discussion

On one hand, the clavicle is unique because it is the first long bone in the human body to ossify, usually in the fifth gestational week; on the other hand, the medial end of the clavicle is the last epiphyseal center to appear and the last to fuse, typically between the ages of 23 and 25 years.<sup>7</sup> At the clavicle's proximal extreme, in the immature skeleton, the physis is the weakest point structurally and is thus more commonly injured than ligamentous structures.<sup>2</sup> Conversely, the weakest points in adults are the SC ligaments.<sup>2</sup> For this reason, children and young adults typically sustain an epiphysiolysis Salter-Harris type I or II injury, whereas adults with full skeletal maturation characteristically present with a true SCJ dislocation.<sup>4,9</sup>

Here, we report a new injury pattern in 2 children that consisted of a medial third clavicular fracture associated with SCJ dislocation, in the absence of a physeal fracture. To our knowledge, this pattern has not been reported previously in this age range, although a similar case was reported in an adult.

The most common mechanism of SCJ injury is a direct blow to the shoulder from a fall or during a sports-related activity, as with both our patients.<sup>9</sup> We believe that this double lesion in our 2 patients might have been caused by a lateral compressive force that generated an axial vector. A direct lateral impact might have caused the clavicular fracture, with subsequent angulation of the short proximal fragment disrupting the SC ligaments through a lever mechanism at the medial clavicular head. The apex of the fracture was located anteriorly in our first patient and was placed superiorly in the second patient. In the previously reported adult case, the medial fragments lay vertically, posterior and superior to the manubrium-sternum joint, as with our first patient.<sup>6</sup> The authors of this previous report did not speculate on potential causative mechanisms.

Similar to other medial clavicular injuries, the lesion described here is difficult to detect by physical examination or through plain radiography alone. In addition, posterior dislocation of the SCJ can be life-threatening.<sup>8</sup> For these reasons, these injuries warrant a high index of suspicion, and early CT scanning is recommended.<sup>1</sup> Although chest radiographs in our first patient revealed asymmetry of the medial clavicles with a ring sign of the medial clavicle that somewhat confirmed our suspicions, we nonetheless needed a CT scan to confirm the posterior SCJ fracture-dislocation.

Closed reduction is the traditional treatment of choice for acute posterior SC dislocation and posterior SC epiphyseal fracture-dislocation, in the absence of any mediastinal injury.<sup>9</sup> In such instances, ORIF is typically reserved for patients in whom closed reduction has been unsuccessful or when subluxation persists.<sup>5,7</sup> Closed SCJ reduction was not possible in our 2 patients because there was an associated shaft fracture. Open SCJ reduction was possible; however, due to compression of the clavicle, the medial third clavicular fracture tended to bend. To obtain perfect reduction of the fracture and SC joint, we therefore treated the clavicle fracture with ORIF.

Kanoksikarin and Wearne,<sup>6</sup> in 1978, reported the first case of this combined injury in a 19-year-old man. The patient's fracture was fixed with Kirschner wires that were removed after 5 months. Because Kirschner wires or Steinmann pins used for fixation have the potential for migration toward vital structures, we preferred to plate the fracture in our 2 patients.<sup>3,10</sup> We did not use a plate to fix the SCJ or the physis. Although the SCJ was stable after reduction, we reattached the anterior SC and capsular ligaments to ensure long-

term stability. Considering that approximately 80% of clavicular growth comes from the medial physis, we recommend that any fixation with a plate does not span the physis, as in our patients.<sup>11</sup> Fixation of the medial physis could have adverse consequences for clavicular length and growth, due both to physeal compression and to presence of the plate itself.

## Conclusions

Although medial third clavicular fractures accompanied by posterior SC dislocation are rare, surgeons should be aware of ways to treat this lesion and, more importantly, to detect it, because the injury has potentially life-threatening complications. For that reason, even though not all patients with medial third clavicular fractures require a CT scan, we believe that patients with severe angulation do warrant one. In our 2 patients, this injury was successfully treated by reconstructing the SCJ and providing rigid fixation of the fracture to allow for early mobilization. We propose that this reconstructive option should be considered for this rare form of injury.

## Notes

Parental informed consent was received for both patients prior to the reporting of these cases.

## Disclaimer

The authors, their immediate families, and any research foundation with which they are affiliated have not receive any financial payments or other benefits from any commercial entity related to the subject of this article.

## References

1. Beckmann N, Crawford L. Posterior sternoclavicular Salter-Harris fracture-dislocation in a patient with unossified medial clavicle epiphysis. *Skeletal Radiol* 2016;45:1123-7. <http://dx.doi.org/10.1007/s00256-016-2399-2>
2. Beecroft M, Sherman SC. Posterior displacement of a proximal epiphysal clavicle fracture. *J Emerg Med* 2007;33:245-8. <http://dx.doi.org/10.1016/j.jemermed.2007.01.004>
3. Deren ME, Behrens SB, Vopat BG, Blaine TA. Posterior sternoclavicular dislocations: a brief review and technique for closed management of a rare but serious injury. *Orthop Rev (Pavia)* 2014;6:5245. <http://dx.doi.org/10.4081/or.2014.5245>
4. Garg S, Alshameeri ZA, Wallace WA. Posterior sternoclavicular joint dislocation in a child: a case report with review of literature. *J Shoulder Elbow Surg* 2012;1:e11-6. <http://dx.doi.org/10.1016/j.jse.2011.07.007>
5. Groh GI, Wirth MA, Rockwood CA Jr. Treatment of traumatic posterior sternoclavicular dislocations. *J Shoulder Elbow Surg* 2011;20:107-13. <http://dx.doi.org/10.1016/j.jse.2010.03.009>
6. Kanoksikarin S, Wearne WM. Fracture and retrosternal dislocation of the clavicle. *Aust N Z J Surg* 1978;48:95-6.
7. Lee JT, Nasreddine AY, Black EM, Bae DS, Kocher MS. Posterior sternoclavicular joint injuries in skeletally immature patients. *J Pediatr Orthop* 2014;34:369-75. <http://dx.doi.org/10.1097/BPO.0000000000000114>
8. Pinsky RA, Eglseider WA. Posterior sternoclavicular fracture-dislocation: a case report and novel treatment method. *J Shoulder Elbow Surg* 2010;19:e5-8. <http://dx.doi.org/10.1016/j.jse.2009.11.050>
9. Perdreaux A, Bingen B, Gossing L, Lejeune E, Beugnies A. Posterior sternoclavicular epiphysal fracture-dislocation: case report and review of literature. *Injury Extra* 2014;45:1-5. <http://dx.doi.org/10.1016/j.injury.2013.10.035>
10. Tepolt F, Carry PM, Heyn PC, Miller NH. Posterior sternoclavicular joint injuries in the adolescent population: a meta-analysis. *Am J Sports Med* 2014;42:2517-24. <http://dx.doi.org/10.1177/0363546514523386>
11. Van Der Meijden OA, Gaskill TR, Millett PJ. Treatment of clavicle fractures: current concepts review. *J Shoulder Elbow Surg* 2012;21:423-9. <http://dx.doi.org/10.1016/j.jse.2011.08.053>