

Management of a Traumatic Retrosternal Dislocation of the Clavicle

Case Report

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Abstract

The purpose of this case report was to discuss the surgical management of posterior sternoclavicular dislocations. This uncommon injury has been found to be very challenging. This report outlines the details of the anatomy of the sternoclavicular joint, and its relationship to nearby important structures. The relationship of the anatomy and how it impacts on the stability of the joint as well as the implications and potential consequences of a posteriorly dislocated joint is discussed. These factors emphasize the need for immediate recognition of this injury and the need for emergent management. The ideal surgical management has been a source of debate for decades. Various options including the ones used in the index case are discussed.

Keywords: Clavicle; Retrosternal; Dislocation; Traumatic

Abbreviation: CT: Computed Tomography

Introduction

Sternoclavicular joint instability is an uncommon and challenging clinical problem [1]. In order to achieve a good functional outcome and prevent complications, accurate diagnosis and prompt treatment is necessary [2]. The rarity of this injury has been responsible for a lack of knowledge with regards to the anatomy of the sternoclavicular joint, diagnosing the injury and its subsequent management. Consequences of a missed injury or inappropriate surgical management may prove fatal. Although it has been well established that posterior dislocations should be reduced and fixed when unstable, there remains no consensus as to the optimal surgical approach [3].

Case Presentation

A 20 year old left hand dominant male presented to the Emergency Room, with a six hour history of pain and swelling of his left shoulder. While playing football, he was pushed from behind and his left pectoral area directly hit the ground. He had no dyspnoea or dysphagia and was taken to hospital immediately afterwards. On examination, there was a tender swelling of the left sternoclavicular joint, and the medial end of the clavicle was not palpable. There was no engorgement of the veins on the left side of the chest and no neurovascular deficits in the left upper limb.

Chest x-ray and sternoclavicular views were inconclusive. A CT scan demonstrated that the left sternoclavicular joint was dislocated posteriorly, medially and superiorly (Figure 1).

Using conscious sedation, closed reduction using a sterile towel clip was attempted and failed. He was taken to the operating theatre the following day where under general anaesthesia, closed reduction failed once again. Via a parasternal L-shaped incision extending over the medial clavicle the sternoclavicular joint was exposed. The sternoclavicular and costoclavicular ligaments were found to be completely disrupted and stripped off the clavicle and thus irreparable. Open reduction was then performed and maintained with a six hole reconstruction plate.

The plate was anchored and centred on the anterior surface of the sternoclavicular joint. The wound was then closed, dressing applied and the patient was placed in a sling. Patient was discharged on day two postoperatively. He re-presented one week postoperatively with a wound dehiscence secondary to failure of the implant (Figure 2).

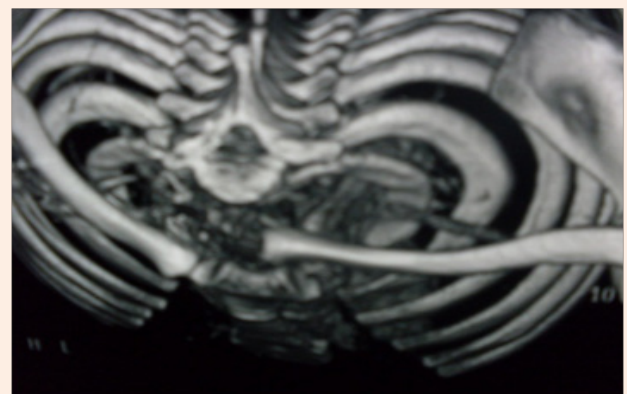


Figure 1: CT scan of left sternoclavicular joint.



Figure 2: X-Ray showed implant failure.

He was taken back to operating theatre where there was an attempt to pass mersilene tape around the clavicle and first rib, however upon dissection, it was discovered that there was disruption of the costochondral junction of the first rib. At this point, drill holes were placed in the sternum and medial clavicle, allowing mersilene tape to be passed through in a figure of eight configuration. This was reinforced with the original six hole reconstruction plate, but different sternal screw holes were used. The patient was placed in a shoulder immobilizer postoperatively. The shoulder immobiliser was maintained for six weeks and then active range of motion was commenced. At six months post surgery he was back on the job as a security guard. He had 120 degrees of flexion and abduction, full internal rotation and 25 degrees external rotation. He had grade 4 power in all directions.

Discussion

Traumatic sternoclavicular instability is an uncommon challenging clinical dilemma [1,4-8]. These cases account for 3% of all shoulder injuries and 1% of all joint dislocations [9]. Approximately 100 cases of posterior sternoclavicular dislocations have been reported in the literature and because of its rarity; this injury is often overlooked [10,11]. Due to its rarity, there is a relative lack of familiarity with the diagnosis, surgical anatomy and treatment options [12,13].

The sternoclavicular joint is formed by the articulation between the medial end of the clavicle and the manubrial part of the sternum. It is a diarthrodial joint and is the only true articulation between the upper extremity and axial skeleton [8,12,14-17]. It is known to have the least osseous congruity of the major joints in the body since the upper angle of the sternum articulates with less than 50% of the medial end of the clavicle [5,15]. This relatively incongruous joint achieves its stability via its nearby ligaments, which allow this joint to rarely dislocate [14-16]. The capsule and supporting ligaments of this saddle shaped joint allow for only minimal anteroposterior translation [1,7,15,17]. The capsular ligaments are significantly stronger posteriorly, thus making anterior dislocations more common [3,7,11,18]. The interclavicular ligament connects the superomedial aspects of both clavicles to the sternum, reinforcing the capsule superiorly [7,12,17]. The intra-articular disc ligament is a dense, fibrous structure which divides the joint into two separate spaces. It arises from the synchondral junction of the first rib to the sternum [11]. The costoclavicular ligament is extra-articular and anchors the medial clavicular metaphysis to the first rib [7]. It is short, strong and consists of anterior and posterior fibres which cross each other and provide joint stability during elevation and rotation of the clavicle [11]. Joint movement may occur passively in three planes, and is usually produced by transmitted movements of the scapula on the chest wall [8].

A traumatic dislocation usually occurs after a significant direct or indirect force applied to the shoulder [3,7,11]. This is because it requires a significant force to disrupt the strong ligamentous constraints [8]. In a posterior dislocation, there is usually complete disruption of the costoclavicular and sternoclavicular ligaments [7] which occurred in the index case. The more common causes of this injury include sports (such as the index case), motor vehicle accidents or falls [5]. The direction in which the shoulder is driven determines the direction of dislocation. A posterior dislocation

occurs when a direct force is applied to the anteromedial aspect of the clavicle or via an indirect force where the shoulder is rolled forward during lateral compression [11,17]. The indirect mechanism (such as the index case) is the more common form of injury [2,5,7,17]. The joint is most mobile in younger patients which explain the increased incidence in this age group [14].

The patients presents with severe pain increased by arm movement. The patient typically supports the injured limb across the trunk with the uninjured limb and pain is localized to the joint [11,2]. Distinguishing between anterior and posterior dislocation may be difficult to diagnose clinically or radio graphically [4,19].

A CT scan may be required for the definitive diagnosis [6,10,15]. Images of both medial ends of the clavicles must be visualized to compare the normal and abnormal sides [3]. When indicated, combined arteriography and CT scan is done to exclude vascular injury [3,7]. If associated injuries are present, then appropriate consultants are called in before reduction is performed [11] and since associated injuries are common, careful but prompt evaluation is needed [10,20].

There are several important structures in the region directly posterior to the sternoclavicular joint. Within the thoracic inlet are the trachea, oesophagus, lungs and great vessels [11]. These important structures in close proximity to the joint increase the risk of potentially catastrophic complications of injury or its surgical treatment [4,6,10,14,15,20]. Since the thoracic inlet is small compared to the medial end of the clavicle, this makes prompt reduction important [5,12-14,17,18].

Closed reduction is recommended in all cases of traumatic posterior sternoclavicular dislocation [1,8,14,19]. Immediate closed reduction should be attempted in the emergency department under conscious sedation if clinical findings suggest major airway or vascular compromise [6]. Closed reduction is usually successful under general anaesthesia, as this effectively removes the pain and muscle spasm associated with the injury [3,6]. The success rate is higher when performed within 48 hours [7,19]. Open reduction is required if closed reduction fails or if there is chronic instability, or neurovascular compromise [4,6,12-14,19]. Intra-operatively, if the reduction seems stable, isolated reduction with no additional intervention is an option [4,8]. The reduction is not usually stable because of ligamentous or capsular disruption [3]. Occasionally open reduction requires forceful traction using reduction forceps [8].

The treatment of unstable, irreducible and symptomatic cases has not been standardized [21]. A variety of surgical techniques have been described for unstable cases [1,5], however there is no consensus opinion as to which surgical technique best restores local ligamentous anatomy with the most security and the least trauma [22]. In an attempt to limit functional consequences, treatment should spare the joint surfaces, the stabilizing structures of the joint, capsules, ligaments and physis (in the young patient) [19]. Patients should be managed individually, paying attention to the severity of the initial injury, including the degree of subluxation or dislocation, presence or absence of mediastinal injury, type and stabilization procedure performed [4]. The goals of surgery are pain relief and functional improvement via restoration of the sternoclavicular joint integrity and anatomy [1].

Most articles about the surgical options are case reports or small series with a variety of fixation methods used after open reduction, including suture, pin or wire, screw, external and locking plate fixation [1,2,12,20,22,23]. Although the outcomes after all these techniques generally have been described as satisfactory or excellent, none of them had a large number of patients and each was associated with significant complications [3]. Recommendations in earlier literature included unusual materials such as kangaroo tendon xenograft and ivory pegs for stabilization [11].

Enthusiasm for the use of Kirshner wires, Steinmann pins, flexible steel wire or Hagie pins as internal fixation has lessened over time because of reports of hardware failure and migration into vital structures with devastating complications [7,24-26]. The most frequent complications are vascular [25].

Although most orthopaedic surgeons are aware of complications associated with pin migration, several pin and wire techniques remain in use [11,19]. These surgeons have attempted techniques such as using smooth pins, bending pins at 90°, avoidance of perforation of the medial cortex of the manubrium and use of supplemental external bracing [11]. Despite those measures, severe complications, including death, continue to occur [27]. Intact and broken pins have migrated into the heart, pulmonary artery, innominate artery, aorta or spinal cord [27]. One of the causes is that tremendous leverage force is applied to pins crossing the sternoclavicular joint leading to fatigue breakage [2]. Bensafi H et al. [24] noted when he reviewed the literature, that there were 15 cases of cardiac tamponade between 1960 and 2009 secondary to migration or breakage of wires. In all cases, the presentation occurred after 5 weeks post operatively and even after several years [24]. Because of these complications, those implants are now contraindicated [4,13,14,19,24]. Due to the risk of severe intra-operative complications, such as bleeding from a major vessel, a thoracic surgeon should be a part of the surgical team [8,16,19].

Rigid fixation via cerclage or Rush-pin is unphysiological and unreliable. Open reduction, removal of the intra-articular disc and repair of the joint capsule has been deemed to be unstable [28]. Barth E & Hagen R [28] recommended fixation via tendon transplant.

Open reduction and surgical stabilization include repair of the sternoclavicular and costoclavicular ligaments [7,13], reconstruction of those ligaments or combined repair and supplemental reconstruction [2,19]. Waters PM et al. [2] reported on paediatric patients who either had a Salter-Harris fracture of the medial clavicle or a posterior dislocation of the sternoclavicular repair and a figure eight suture through the sternum and medial clavicle. The patients went on to achieve excellent functional outcome. Selesnick FH et al. [13] also reported good results in an adult population using suture repair in his case series. Various reconstruction techniques have been reported including the use of

- a. Autologous tendon e.g. subclavius tendon [28,29] or palmans tendon.
- b. Suture [4,12,3] Merseline tape and allograft [1,22].

Laffosse JM et al [19] utilized suture repair of the costoclavicular

ligament combined with costoclavicular cerclage to achieve a more stable construct. They recommended that the cerclage must be transcostal instead of subcostal to decrease the likelihood of a pneumothorax [19]. The normal ligamentous stabilisers are usually irreparable following open reduction such as the index case, thus reconstruction is usually required [8].

Ligament substitution for stabilisation has been associated with mixed results. There has been a high prevalence of soft tissue complications and failure of reconstruction leading to recurrence of the deformity [8]. Waters PM et al. [2] did the first study to image the sternoclavicular joint post reduction. Scans on three patients demonstrated a recurrent displacement. He suggested that persistent instability may be due to severe ligamentous disruption, deforming muscular forces imported to the clavicle and/or soft tissue or periosteal interposition at the zone of injury. Techniques involving stabilisation to the first rib using sternomastoid, subclavius or Dacron were developed in response to complications due to other techniques including wire migration, recurrent instability, bone erosion or non-union [30]. Post soft tissue reconstruction, a period of immobilisation is required [10].

In the uncommon scenario in which open reduction cannot be achieved the medial 1-2 cm may be resected [31]. Although sufficient bone must be removed, the costoclavicular ligament must be preserved (if previously intact) or reconstructed (if injured) by stabilising the remaining clavicle to the first rib [3,31]. The recommendation of resection was based on late appearing complications after non-reduced dislocations in patients who initially had no symptoms [31,32] showed that outcome of resection is poor without adjunctive soft tissue stabilisation. Rockwood CA et al. [31] noticed those patients without stabilisation all had pain, instability and reduced activity. Battaglia TC et al. [1] described a technique involving resecting 1cm of medial clavicle creating an intraosseous tunnel and a slot in the anterior surface of the clavicle for the allograft bone plug to fit in. The tendon allograft is threaded through the sternal tunnel and doubled back. They stated that these techniques which fix the 1st rib to the medial clavicle or fuse the sternoclavicular joint, do not require exposure of the 1st rib and reduces the risk of bony erosion. They acknowledged however, that allograft is not readily available, has questionable long term strength, and carries an infectious disease transmission risk. Allograft does avoid donor site morbidity however [22]. The costochondral fracture of the first rib prevented the index case from having a procedure involving a stabilising technique utilising the first rib during the revision surgery.

Spencer EE & Kuhn J [33] reviewed the biomechanical property of three of the most popular procedures: transfer of the subclavius tendon [29], transfer of the intra-articular disk and ligament into the resected end of the clavicle [32] and reconstruction of the anterior and posterior aspects of the capsule with the use of a figure-of-eight semitendinosus auto graft. The figure-of-eight semitendinosus reconstructions were found to have significantly better mechanical properties than the reconstruction performed with other procedures [33]. Spencer EE & Kuhn J [33] reviewed the biomechanical property of three of the most popular procedures: transfer

More stable implants such as suture anchors, wire sutures and custom made plates have been advocated [34] but none have been widely tested or used [8]. These techniques still pose a substantial risk of intra thoracic migration if implant loosening or breakage occurs [8]. Arthrodesis of the sternoclavicular joint is contraindicated because it markedly decreases shoulder movement [8].

Plate fixation for sternoclavicular joint dislocation has rarely been reported [21] such as that used in the index case. Plate stabilisation for posterior sternoclavicular joint dislocation was first reported by Franck [34]. It avoids retrosternal dissection while allowing for early postoperative mobilisation [10]. Spencer EE & Kuhn J [33] reviewed the biomechanical property of three of the most popular procedures: transfer [10] stated that the plate and screw technique used by Franck WM et al. [34] put mediastinal structures at risk because of the anterior to posterior directed bicortical screws. Franck WM et al. [34] reported on ten patients, nine of whom were available at 1 year for follow-up. There were no redislocations and the only complication was a seroma which required drainage. The implant used by Franck WM et al. [34] had a hook inside the manubrium. He recommended plate removal at three months postoperatively to avoid the risk of retrosternal hook migration. Franck WM et al. [34] concluded based on their results that the Balser plate was reliable, permitted early movement and gave good postoperative results. Laffosse JM et al. [19] stated however that the Balser plate is not appropriate because the hook which is inserted into the manubrium sternum allows for some mobility but will lead to damage of the cartilage, articular meniscus and physis. Hecox SE & Wood GW [21] introduced a ledge plate which they believed prevented loss of reduction without using pins or wires and provided sufficient stability to allow early motion. He stated that one advantage of his plating system over the dual locked plating technique was that the latter required drilling holes directed towards the lungs and mediastinum. Shuler FD & Pappas N [10] pointed out however that the risk of injuring mediastinal structures by drilling was minimised by the fact that this system utilised unicortical screw fixation. Both Shuler FD & Pappas N [10] and Hecox SE & Wood GW [21] had small patient numbers with short follow up and were unable to recommend their fixation techniques as standard of care to replace soft tissue reconstruction method, but both groups felt their techniques were viable options based on their good results.

Due to the rarity of this injury, it is not surprising that the literature consists mainly of case reports and small patient series [1,2]. Because of this, comparison between studies is impossible [3]. Although rare, the surgeon with an interest in the shoulder will encounter a few cases and will need to know how to manage them appropriately [3]. With potential serious complications, which can occur at any stage of management a possibility, one must stick to the adage of doing no harm [3].

Despite the immediate gravity of this injury, if satisfactory and stable reduction is obtained, the functional outcome is excellent. Some only attempt closed reduction with no signs of mediastinal compression within 48 hours post injury. In all other cases, surgical reduction with repair of the capsular ligamentous structures especially the costoclavicular ligament must be carefully repaired and a stabilisation procedure performed.

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