ORTHOPAEDIC SURGERY

Anomalous external jugular vein: clinical concerns in treating clavicle fractures

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Abstract Operative treatment of clavicle fractures has seen growing acceptance, as evidence emerges to support its use over nonoperative management. Of particular popularity, more recently, is the percutaneous intramedullary techniques for fixation of these injuries. The complex neurovascular anatomy in close proximity to the clavicle requires precision with these procedures. Anatomic variations in this region pose an even greater, and often unforeseen, danger to the operating surgeon and patient. Here, we present a case report of an anomalous external jugular vein coursing anterior to the clavicle that was encountered during an open surgical approach to a clavicle fracture. The purpose of this case presentation is to serve as a caution to surgeons treating clavicle fractures by both open and percutaneous means. Inadvertent injury to anomalous neurovascular structures can be devastating to the patient and can be avoided by the careful surgical approaches recommended.

Keywords External jugular vein · Clavicle fracture · Vascular anomaly · Open reduction internal fixation · Percutaneous intramedullary nailing · Anatomic variation

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Introduction

Management of clavicle fractures is surgeon-dependent, but recently more clavicle fractures are being treated by operative means than in the past. Proponents of traditional nonoperative treatment of these fractures have indeed demonstrated excellent results in many patients [1, 2]. However, more recent reports note a higher incidence of malunion and nonunion, and worse standardized outcome scores in clavicle fractures treated nonoperatively than previously reported [3–8]. For this reason, operative management of clavicle fractures, via both elastic stable intramedullary (IM) nailing by mini-open or percutaneous methods, as well as open reduction and plate fixation, is becoming more prevalent.

The relational anatomy of the clavicle assumes great importance from both injury and treatment perspectives because of the intimate relationships the clavicle has with many neurovascular structures. This is especially important in percutaneous IM nailing of clavicle fractures, which has become more common recently. The clavicle itself appears as an S-shaped double curve when viewed from above, with a flattened lateral third and a prismatic medial third. This thicker, tubular medial third of the clavicle offers protection for the important neurovascular structures that pass beneath it [9]. The proximity of these structures places them at risk of injury from either acute clavicle fractures or fracture sequelae—namely nonunion, malunion, or excessive callus which may compress these structures and cause late symptoms.

As the brachial plexus crosses beneath the clavicle it consists of three main cords, two of which are anterior and intimately close to the clavicle [10]. The medial cord of the brachial plexus, which gives rise to the ulnar nerve, crosses the first rib directly beneath the medial third of the clavicle

and, therefore, accounts for the relatively higher frequency of ulnar nerve injuries associated with fractures of the medial third of the clavicle [11]. On the left side, the subclavian artery arises from the aortic arch and passes beneath the clavicle superior to the first rib, becoming the axillary artery at the edge of the first rib. The axillary vein lies medial to the artery, and originates at the distal margin of the teres major muscle as it is formed by the joining of the basilic vein and one or more brachial veins. The axillary vein receives the cephalic vein just distal to the clavicle, forming the subclavian vein which then runs beneath the clavicle with the artery. The external jugular vein descends from the angle of the mandible, crosses the sternocleidomastoid muscle obliquely in its superficial course to just above the middle of the clavicle, where it dives through the deep cervical fascia posterior to the clavicle and opens into the subclavian vein [12]. The internal jugular vein courses more medially in the neck, adjacent to the sternoclavicular joint and is thus, less likely to be injured by clavicle fractures.

Knowledge of the intimate relationships of the neurovascular structures to the clavicle can help ensure prompt recognition of their involvement in clavicle fractures, as well as their avoidance during operative treatment of these injuries. Even with normal anatomy the intimate relationships of these structures are responsible for their occasional iatrogenic injury in the operating room. Furthermore, many anatomical variations of the neurovascular structures near the clavicle exist, and failure to recognize an anatomic anomaly can lead to complications for the patient. Here, we present a case of a rare vascular anomaly encountered during operative treatment of a midshaft clavicle fracture as a caution to surgeons treating clavicle fractures by both percutaneous and open methods.

Case report

The patient is a 66-year-old male ski instructor who suffered a fall onto his left shoulder while skiing, sustaining a closed left midshaft, comminuted clavicle fracture (Fig. 1). Upon presentation to the office, 3 weeks following his injury, he was neurovascularly intact throughout the left upper extremity. He was indicated for open reduction internal fixation of the fracture, given that 3 weeks had already elapsed from the time of injury. He had no other notable past medical, surgical, or developmental history.

Operative method

The patient was placed supine on a radiolucent Jackson table with a bump placed under the patient between the scapulas. The entire left upper extremity was prepped and draped into the sterile field to assist in manipulation during

Fig. 1 Radiograph of displaced, comminuted, midshaft clavicle fracture in a 66-year-old male ski instructor. This radiograph is nearly 3 weeks postinjury

fracture reduction. An S-shaped incision was made over the clavicle and carried down through the subcutaneous tissue to the level of the periosteum overlying the clavicle. While performing this initial exposure a large venous vessel was encountered in the subcutaneous tissue anterior to the medial third of the clavicle (Fig. 2). During dissection to isolate and protect this vessel, a nerve was discovered coursing along with it and thought to be the medial or middle supraclavicular nerve (Fig. 3). Subcutaneous extension of the vascular structure superiorly as the external jugular vein was evident (Fig. 2). A penrose was placed around the neurovascular bundle for protection and retraction during fracture reduction and plating.

Using pointed reduction clamps the fracture fragments were reduced and then held in place with interfragmentary 2.0-mm cortical screws placed perpendicular to the fractures (Fig. 4). The fractures were then bridged with a 2.7-mm, 12-hole LCP locking plate contoured to the S-shape of the superior clavicle, and a 2.4-mm, 12-hole LCP locking plate placed on the anterior surface of the clavicle. The
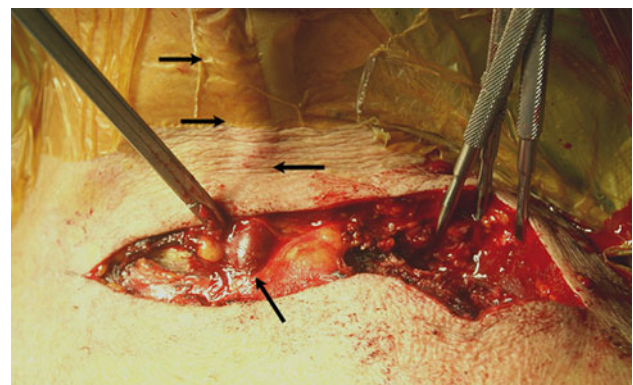

Fig. 2 Initial surgical exposure of the subcutaneous tissue overlying the left clavicle revealing an approximately 6-mm diameter venous anomaly anterior to the middle third of the clavicle. Note the subcutaneous continuation of the vessel superior to the incision (*arrows*)
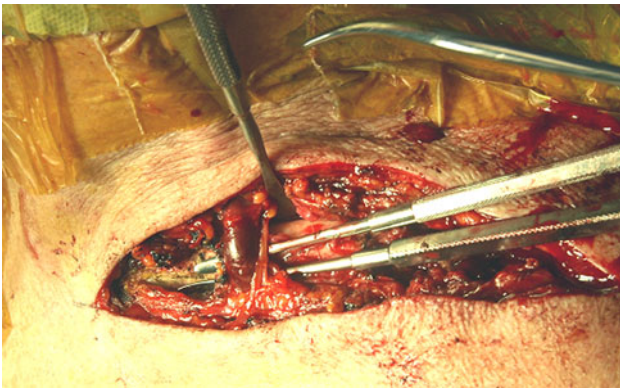
Fig. 3 Photo showing the nerve coursing along with the vessel anterior to the clavicle. Elevators are placed between the clavicle and the vascular anomaly. This may represent the middle supraclavicular nerve and external jugular vein
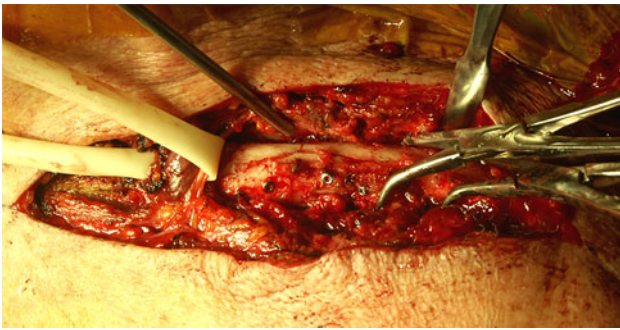

Fig. 4 Photo illustrating a penrose drain protecting the anomalous vascular bundle and middle supraclavicular nerve anterior to the clavicle after fracture reduction and interfragmentary screw placement

plates were placed carefully under the neurovascular bundle (Fig. 5), and used to gain control of the fracture fragments in a buttress fashion to assist in reduction. Plating in this way minimizes circumferential stripping from excessive clamping of fracture fragments. Small plates enable precise contouring to the anatomy of the clavicle and minimize soft tissue irritation. Enough motion of the neurovascular structures was ensured to prevent impingement on the underlying hardware. The wound was copiously irrigated and closed in layers using 0-vicryl for the fascia, 3-0 caprosyn for the subcutaneous tissue, and interrupted 4-0 nylon sutures for the skin. The patient remained in the hospital overnight for observation and was discharged on postoperative day #1 with permission to do active and passive range of motion of that shoulder, but to remain non-weight-bearing.

Follow-up

On postoperative day #4 the patient returned to the office and was noticed to have moderate serous drainage from the
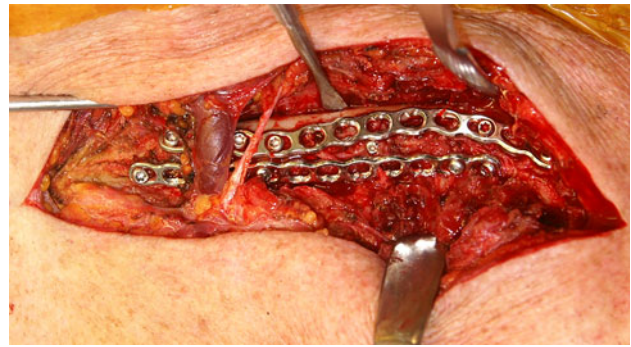

Fig. 5 Photo showing double-plate fixation of the clavicle fracture with anatomic reduction. Note the lack of tension or disruption of the neurovascular structures with the low profile plates passing posterior to them

incision without signs of infection. Despite conservation wound management for this, he returned 2 days later with incisional erythema, warmth, and purulent discharge from the wound. He was urgently admitted to the hospital and taken to the operating room the same day for irrigation and debridement. In the operating room a large amount of purulent fluid was seen within the wound and sent for culture. Again the vascular anomaly was encountered and protected. Due to the largely serous (lymphatic-appearing) nature of the drainage prior to it becoming purulent, cardiothoracic surgery was consulted, and raised the possibility of involvement of anomalous lymphatic structures, namely the thoracic duct. Two constavac drains were placed within the wound prior to closure. The postoperative course consisted of intravenous antibiotics and wound management. Analysis of the drain fluid triglyceride levels during the postoperative course was not consistent with lymphatic origin. Operative cultures grew *Propionibacterium acnes* and the patient was sent home on appropriate intravenous antibiotics for 6 weeks once the drains were removed and the incision appeared benign. On subsequent follow-up the infection resolved, his wound and fracture healed uneventfully, and the hardware has remained in place without causing the patient any irritation.

Discussion

The clavicle possesses a subcutaneous position throughout its entire length, and typically the only structures anterior to it are the supraclavicular nerves. However, anatomical variations of the neurovascular structures surrounding the clavicle have been reported in the literature. Cadaveric dissections have revealed a number of anomalies of the venous system near the clavicle including a communicating branch between the cephalic and an external jugular vein that passes anterior to the clavicle, and opens into the

subclavian vein, as well as the formation of a venous annulus around the clavicle [12–14]. The venous structure seen passing anterior to the clavicle in our patient is believed to be the external jugular vein. Postoperative CT scan images with 3D reconstructions showed a vein emptying into the subclavian vein after coursing anterior to the clavicle. Its precise continuation with the external jugular vein more superiorly could not be visualized on the CT scan because of venous compression from postsurgical edema. However, it is evident in Fig. 2 that the vein passing anterior to the clavicle is continuous with the subcutaneous course of the external jugular vein superior to the incision site. The nerve coursing along with the anomalous external jugular vein is believed to be the middle supraclavicular nerve, which typically crosses the middle third of the clavicle, and supplies sensation to the skin over the pectoralis major and deltoid muscles.

The significance of the anatomic variation seen in this patient lies in the danger it poses to the treatment of clavicle fractures, especially by percutaneous methods. Anomalous vascular structures surrounding the clavicle may be susceptible to iatrogenic injury by both percutaneous and open treatment methods of these injuries. One could imagine the relative ease with which one could incise an aberrant vascular structure in an unexpected location during superficial surgical dissection. Moreover, the placement of percutaneous reduction clamps during IM nailing of clavicle fractures places any structure anterior to the clavicle at the risk of injury.

Given the increasing number of clavicle fractures treated by percutaneous IM nailing, we encourage the treating surgeon to be cognizant of possible anatomic variations that may compromise their surgical treatment plan. Superficial surgical dissection in open treatment of clavicle fractures should be carried out carefully, and any abnormal anatomy readily identified and protected. We caution the placement of sharp reduction clamps through the skin when performing percutaneous reduction of clavicle fractures treated by IM nailing to avoid penetration of an anomalous vessel, or other anatomic anomaly. Since most anomalous structures appear to involve the medial third of the clavicle we would suggest placement of the IM nail from the medial end of the clavicle first, to use as a joystick to manipulate the medial fracture fragment, with percutaneous reduction clamps, if necessary used only on the lateral fracture fragment.

Conclusion

Anatomical variations like that presented in this case report represents a real concern and certainly an added challenge in operative treatment of clavicle fractures by both percutaneous and open methods. The potential for injury due to anatomic variability may make percutaneous treatment of clavicle fractures less appealing than previously thought, although the frequency with which these variations occur remains to be seen. Nonetheless, we caution surgeons treating clavicles to practice careful, precise dissection in the subcutaneous tissues during open exposure of the clavicle, or if using percutaneous methods, to modify their surgical technique in order to avoid potentially disastrous complications for the patient from an unnoticed anatomic variant.

Conflict of interest statement   None.

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