Case Report

Clavicle fixation screw impingement causing subclavian artery pseudoaneurysm

Steven D. Lewis, MD*, Felix S. Chew, MD

Department of Radiology, University of Washington, 4245 Roosevelt Way N.E., Seattle, WA 98105, USA

ARTICLE INFO

Vascular injuries are an extremely rare complication of clavicle osteosynthesis, though several cases are reported in the literature. Cadaver studies have established recommended safe lengths for clavicle screws based on precise measurements of bone thickness and distance from subjacent neurovascular structures. We present the case of a 27-year-old female who underwent orthopedic plate and screw fixation of a clavicle fracture and subsequently sustained iatrogenic vascular injury from one of the screws. This necessitated endovascular repair and orthopedic revision. This case underscores the importance of selecting appropriate screws based on available imaging.

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ABSTRACT

Introduction

A large majority, 80%, of clavicle fractures occur at the middle third of the clavicle [1]. Postoperative broken bones should be assessed for several key factors including, but not limited to, alignment, evidence of healing such as osseous bridging or callus formation, hardware fracture or loosening, and evidence of impingement. Most postoperative complications are readily identified by plain radiograph and should be correlated clinically with history and physical exam. Clavicle fractures are often repaired with plate and screw fixation, otherwise known as osteosynthesis. Indications for operative fixation rather than conservative management include those fractures which are highly comminuted, displaced more than 100%, or foreshortened more than 2 cm [2]. Sometimes iatrogenic arterial injury occurs, most often a pseudoaneurysm caused by a screw. This may be immediately symptomatic or may present years later with complications such as subcritical limb ischemia [3]. The subclavian vein and brachial plexus are also at risk from clavicle plate and screw fixations. Subclavian vein trauma can result in hemorrhage and air embolism, while nerve injury may cause immediate severe arm pain and paralysis [3]. Orthopedic screws should be tightly fixed to the plate and should extend through both the proximal and distal cortex of the bone, but they should not be so long that they endanger critical structures beyond the distal cortex.

Case report

A 27-year-old female of near average height and normal weight underwent operative plate and screw fixation of a left mid-clavicle fracture sustained in a mountain biking accident. The fracture went on to nonunion (Fig. 1). Therefore, revision

* Corresponding author.
E-mail address: stevendl@uw.edu (S.D. Lewis).
https://doi.org/10.1016/j.radcr.2019.07.002
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Radiology Case Reports 14 (2019) 1148–1150

Fig. 1 – Axial CT demonstrates left clavicle fracture nonunion (arrow).

Fig. 2 – Radiograph demonstrates clavicle plate with 2 proud screws (both arrows).

Fig. 3 – Oblique CT demonstrates pseudoaneurysm (arrow) immediately adjacent to metallic screw.

Fig. 4 – Radiograph demonstrates persistent nonunion at the fracture site (arrow).

Fig. 5 – Fluoroscopic image demonstrates vascular catheter (arrow) with tip at the pseudoaneurysm neck.

with iliac crest bone graft was performed. About 2 weeks after the revision, the patient began to develop swelling and pain along the superior side of the clavicle, as well as numbness and tingling in the left arm in an ulnar nerve distribution. Physical exam demonstrated well-healed incision over clavicle, and no significant tenderness to palpation. However, a palpable mass with an arterial pulse was appreciated near the clavicle. A bruit was auscultated with a stethoscope. Neurovascular exam of the distal extremity was normal. Labs including CRP, ESR, and WBC were normal. Review of clavicle radiographs demonstrated 2 proud screws at the middle third of the clavicle extending 10 mm and 7 mm beyond the inferior cortex, respectively (Fig. 2). Each of these 2 screws was 2.7 cm in length, measured by radiograph. A point of care Doppler ultrasound was performed, demonstrating a biphasic waveform. Vascular surgery was consulted, and the patient underwent CT angiography of the chest. This demonstrated a distal left subclavian artery pseudoaneurysm measuring 5 × 8 × 8 mm, with an immediately adjacent orthopedic screw (Fig. 3). A same-day radiograph revealed persistent nonunion of the original clavicle fracture (Fig. 4). The pseudoaneurysm was addressed by retrograde endovascular cannulation (Fig. 5) and coil embolization with 4 mm × 10 cm Azur detachable coil system, removal of the 2 proud screws, bone grafting, and placement of a second plate (Fig. 6). There has since been symptomatic improvement. Nerve conduction studies of the left upper extremity remained normal throughout.

Discussion

In this case, an inappropriately long screw, proud to the distal bone cortex, impinged on the subjacent subclavian artery and caused a symptomatic pseudoaneurysm. Subclavian vessel injury from a clavicle plate screw is an exceedingly rare
complication. A large study by Leroux et al examined 1350 cases of midshaft clavicle fracture with open reduction and internal fixation [4]. Of these, 25% underwent at least one orthopedic revision, usually performed for isolated implant removal, and more commonly performed in females [4]. Brachial plexus and subclavian vessel injuries combined were found in 5 or fewer patients, and could not be further defined due to privacy constraints [4]. Rates of nonunion or malunion combined were 3.7%, and rates of deep infection were 2.6% [4].

An anatomic study by Galley et al examined 40 dry clavicles and dissected 12 shoulders from 6 cadavers, performing statistical analysis of clavicle thickness and distance from the subclavian and axillary vessels at multiple points [1]. The subclavian artery becomes the axillary artery at the lateral border of the first rib. This study determined the closest distance between the clavicle and subjacent vessels was located between the medial quartile and the midpoint of clavicle [1]. The study established the median thickness of the clavicle over the subclavian artery at 11 mm, and over the axillary artery at 15 mm [1]. Median distance measured from the superior aspect of the clavicle to superior aspect of subclavian artery was 26 mm (range 22-35 mm), which correlates to the safe length of a screw [1]. The thickest clavicle at this danger zone one-fourth to three-fourths the clavicle length measured 17.6 mm [1]. Therefore, the Galley study advocated a drill stop of approximately 18 mm, so that the screw could penetrate superior and inferior cortices but not approach the subjacent vessels [1]. The Galley study also measured the total thickness of the subclavian muscle and the costocoracoid membrane along the inferior surface of clavicle, with thinnest specimen measuring 7.1 mm [1]. These structures also protect the neurovascular bundle [1].

Another anatomic study by Lo et al examined 4 cadavers with 8 clavicles, demonstrating a point at which the brachial plexus is in fact closer to the clavicle (average 12.76 cm) than the subclavian vessels, and thus potentially at higher risk for screw injury [5]. This area is at the lateral three-fifths point of the clavicle [5]. Lo also suggested that in the lateral two-fifths of the clavicle, there are no anatomic structures close enough to be damaged by over drilling [5].

Reported treatments for vascular pseudoaneurysms related to plate osteosynthesis are various and based on associated complications. In 1 case report [6], there was a subclavian pseudoaneurysm caused by an overlying screw, associated with subclavian artery thrombosis, critical distal limb ischemia, and clinical thoracic outlet syndrome. That patient was treated with fibrinolitics and heparinization followed by resection of the clavicle and the affected segment of subclavian artery with interposition grafting of autologus saphenous vein [6].

Our case study illustrates the rare but potentially morbid complications caused by poorly matched screw lengths in clavicle fracture fixations. Anatomic studies as described above may serve as useful guides in selecting hardware specifications, though there are limitations. The studies referenced above by Galley and Lo did not report gender-specific averages, though it seems reasonable that female clavicles are generally smaller than male clavicles and therefore may require different hardware. Further, both the Galley and Lo studies performed all measurements in standardized static positions, therefore dynamic differences in measurements to critical structures may exist. Future study of these factors may be useful.

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