CASE REPORT

Extensive Posterior–Inferior Heterotopic Ossification in Chronic Grade V Acromioclavicular Injury Blocking Reduction During Surgical Repair: A Report of Two Cases

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Introduction

Acromioclavicular (AC) joint dislocations are among the most common shoulder injuries [7, 14]. Heterotopic ossification (HO) of the structures adjacent to the AC is recognized to occur after injury; however, the incidence and location of the HO is poorly defined [4]. In general, formation of heterotopic bone is associated with immobilization after trauma, severe burn wounds [12], spinal cord injury [5], and head injury [6, 11]. In the setting of AC joint dislocation ossification is conventionally thought to directly involve damaged coracoclavicular and coracoacromial ligaments [4, 10]. The HO may also be seen after distal clavicle excision [2, 16]. In the two cases reported, heterotopic bone formation was found posterior–inferior to the lateral clavicle and actually blocking reduction of the clavicle during surgical reconstruction. In both cases, excision of the heterotopic bone through significant additional dissection and exposure was required for anatomic reduction of the clavicle and AC joint. These cases highlight the importance of analysis of preoperative imaging when HO is present in chronic high-grade AC injuries. Careful scrutiny of preoperative imaging will best prepare the surgeon

for optimizing the operative approach and help counsel patients to risks of surgery.

Case Report

Case 1

A 31-year-old male was referred to the University of Iowa's Sports Medicine Center for management of a chronic high-grade AC joint injury. The patient suffered an impaction injury to the apex of his shoulder 12 months prior to presentation. Over the 5 months prior to presentation, the patient had been experiencing increased pain and difficulty with overhead movements, crepitus at the AC joint, as well as muscle soreness around his scapula and periscapular muscles. He had failed a physical therapy program. On exam, the distal clavicle was minimally mobile and not reducible. The patient displayed mild scapular dyskinesis. He had near full overhead range of motion, which was very painful. Plain films demonstrated a Rockwood type V AC injury with extensive calcification inferior to the mid- and lateral clavicle near the location of the damaged coracoclavicular ligaments on standard radiographs (Fig. 1). The patient underwent surgical excision of the heterotopic calcification and AC joint reconstruction.

An 8-cm saber incision was made beginning just posterior to the distal clavicle and extending inferiorly toward the coracoid. The deltotrapezial fascia was found to be damaged from the chronic type V injury. No posterior dislocation of the clavicle was appreciated. The fascia was identified, bluntly dissected, and then elevated anteriorly and posteriorly off the lateral clavicle. The superficial clavicle, AC joint, and acromion were exposed subperiosteally. The AC joint was debrided of interposed scar and pseudojoint tissue. A large amount of heterotopic bone was encountered on the inferior surface of the clavicle. However, this bone was not anterior–inferior to the clavicle where the damaged coracoclavicular ligaments were located. Rather, it was located posterior–inferior and tracking into the supraspinatus fossa of the scapula, impinging into the rotator cuff musculature. The heterotopic ossification was so extensive it was

Level of Evidence: Level IV: Prospective Case Series.

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Fig. 1. A preoperative AP radiograph of the left shoulder for the patient in case 1. Note the extensive heterotopic ossification in the region of the coracoclavicular ligament. Also, note the Rockwood grade V AC joint injury.

blocking reduction of the clavicle to the acromion by heterotopic bone abutting the scapula and rotator cuff.

Attempts were made to excise the bone from the standard anterior–inferior exposure of the clavicle routinely used for coracoclavicular reconstruction. However, visualization was difficult, and the HO could not be fully removed. There was also risk of injury to the subclavian neurovascular bundle (SCNVB) with the limited access from an anterior approach. Therefore, the remaining trapezius was elevated off the posterior clavicle, and the heterotopic bone was fully exposed measuring 3 cm×3 cm×4 cm in size. The large spike of the HO was confluent with the inferior surface of the clavicle and was impinging postero-inferiorly into the supraspinatus muscle. It could then be excised through both the anterior and posterior windows. The HO was removed until the inferior surface of the clavicle was flat and confluent with the uninvolved lateral clavicle. No attempt to locate the SCNVB was made, and the SCNVB was not visualized. Following heterotopic bone excision, the AC joint was reducible, and coracoclavicular ligaments were reconstructed with autologous semitendinosis in an anatomic fashion as previously described [17] using a technique similar to that described by Mazzocca et al. [9]. The autogenous graft was wrapped around the coracoid and passed through transclavicular tunnels. In addition, two separate #2 non-absorbable Fiberwire (Arthrex, Naples, FL, USA) sutures were passed around the base of the coracoid and through the clavicular tunnels and tied over a 12-mm titanium four-hole button. Postoperative plain films at final follow-up displayed

appropriate AC joint reduction and heterotopic bone resection. The patient had an uneventful recovery and was discharged from care at 6 months postoperatively (Fig. 2).

Case 2

A 26-year-old male was referred to the University of Iowa's Sports Medicine center 10 months after a grade V AC joint injury from a bicycle accident. He had persistent shoulder pain, deformity, pain with overhead activities, and he had failed physical therapy. On exam, his left shoulder displayed deformity consistent with high-grade AC injury. The distal clavicle was not reducible to the acromion. Plain films demonstrated a Rockwood type V AC joint injury with extensive calcification adjacent to the coracoclavicular ligaments (Fig. 3). Prior to operative intervention, and due to the unexpected location of the HO in case 1, the patient underwent a left shoulder CT scan with 3D reconstruction (Figs. 4, 5 and 6). The CT scan demonstrated the HO to again be posterior–inferior to the lateral clavicle. The patient underwent surgical excision of the heterotopic ossification and AC joint reconstruction similar to case 1. No posterior dislocation of the clavicle was appreciated. Heterotopic bone was encountered adjacent to the anterior margin of the lateral clavicle but also posterior–inferior to the lateral third of the clavicle that was carefully dissected and excised through both anterior and posterior approaches to the inferior aspect of the lateral clavicle similar to case 1. Only after excision of all heterotopic ossification and adjacent fibrous tissue was the clavicle reducible to its anatomic position. The AC joint was then reconstructed using a variation of the “anatomic” technique [9, 17] with autologous

Fig. 2. Case 1. Postoperative AP radiograph taken at final follow-up (6 months) of the left shoulder following excision of heterotopic ossified structures, and AC joint reconstruction with autograft.

Fig. 3. Preoperative upright AP radiograph of the left shoulder of the patient discussed in case 2. This image is notable for grade V AC joint injury with extensive heterotopic ossification that appears to involve the coracoclavicular ligaments.

semitendinosus graft similar to case 1. Postoperative plain films obtained on the day of surgery displayed adequate AC joint reduction and HO excision (Fig. 7). No HO prophylaxis was provided in either case.

Discussion

Ossifications after AC injury are thought to occur in the anterior shoulder structures such as the damaged coracoclavicular

Fig. 4. A 3D CT scan of the patient in case 2. Note the extensive bone formation posterior and inferior to the clavicle.

Fig. 5. A 3D CT scan of the patient in case 2. Note the extensive bone formation posterior and inferior to the clavicle.

[4] and the coracoacromial ligaments [10]. We are unaware of any cases in the literature reporting heterotopic ossification posterior–inferior to the mid- to distal clavicle in the setting of AC injury. The two cases we report in this article demonstrate that dealing with heterotopic bone may be required to accomplish appropriate AC reduction, and that the operating surgeon must be prepared for dealing with heterotopic bone that is not immediately accessible in routine exposure commonly used for reconstruction of the AC joint. In addition, surgical treatment of heterotopic bone that is medial and posterior potentially brings other anatomic structures such as the subclavian neurovascular bundle (SCNVB) and the supraspinatus into danger.

In general, the SCNVB follows an oblique course from proximal to distal along the clavicle [1, 3]. Sinha et al. determined the distance between the SCNVB and the posterior–inferior boarder of the distal clavicle to be large (63.4–75.7 mm). At the middle third of the clavicle, the distance to

Fig. 6. A 3D CT scan of the patient in case 2. Note heterotopic bone posterior and inferior to the clavicle.

Fig. 7. Case 2. Postoperative AP radiograph (obtained on the day of surgery) of the left shoulder following excision of heterotopic ossified structures, and AC joint reconstruction with autograft.

the SCNVB averaged between 12.4 and 17.0 mm [15]. Qin et al. determined the average distance from the clavicle to the SCNVB in a region adjacent to the coracoid to be 36.2 mm [13]. The structure within the SCNVB closest to the clavicle is the subclavian vein [13, 15], and there has been one reported case of fatality from subclavian vein injury during elective clavicle surgery [1]. The SCNVB was not exposed or injured in either case during the subperiosteal dissection, but the operative team was aware of its proximity. Furthermore, the posterior location of the HO may be adjacent the suprascapular nerve. Mallon et al. reported two cases of suprascapular neuropathy after distal clavicle excision [8]. The authors subsequently dissected seven shoulders and determined that, in each specimen, the suprascapular nerve coursed within 1.3 cm (range, 0.6–1.3 cm) of the posterior aspect of the clavicle [8]. If there is any evidence of rotator cuff weakness or atrophy exam, an EMG could be considered to evaluate the suprascapular nerve function, and neurolysis should be considered. To our knowledge, there have been no reported cases of suprascapular nerve injury associated with AC dislocation. Caution was used during posterior dissection and HO resection in these cases. Excision of

the entirety of the HO was required to obtain an anatomic reduction of the AC joint. The authors now consider using 3D CT to fully assess unusual or significant heterotopic bone in the setting of high-grade AC injuries to guide preoperative planning.

The cause of ossification in the posterior–inferior area of the lateral clavicle is unknown. We can hypothesize an etiology. We hypothesize the presence of posterior–inferior heterotopic bone suggests ossification of the damaged and stripped inferior periosteum after the clavicle migrates superiorly with the injury. Ossification of this tissue, possibly with surrounding hematoma, could be responsible. Berg et al. reported a series of 40 patients who developed HO after open or arthroscopic acromioplasty and distal clavicle resection. They concluded that the procedure is associated with a 3.2% risk of symptomatic heterotopic ossification [2]. While periosteal injury and associated hematoma formation is plausible, this is simply a theoretical cause.

When considering surgical management of chronic high-grade AC injuries, careful study of plain radiographs is prudent. Irreducibility of the AC joint during a clinical exam (as seen in both cases) may also raise suspicion for HO. If there is indication of heterotopic ossification, we recommend having a low threshold to obtain a preoperative CT scan for further evaluation. If further imaging is not used, then the surgeon should consider that the HO present may be more posterior and difficult to access through standard exposure used for AC joint reconstruction. In these cases, excision of the heterotopic bone is likely required to achieve AC joint reduction. A complete understanding of the pathologic bony anatomy is helpful in preoperative planning and has implications in the informed consent process, a more extensile approach and dissection adjacent to large neurovascular structures may be necessary.

Disclosures

Conflict of Interest: Robert W. Westermann, MD and Brian R. Wolf, MD, MS have declared that they have no conflict of interest.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed Consent: Informed consent was waived from all patients for being included in the study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

References

1. Bain GI, Eng K, Zumstein MA. Fatal air embolus during internal fixation of the clavicle. A case report. *J Bone Joint Surg Case Connect.* 2013; 3(1):e24 1–4. doi:10.2106/JBJS.CC.L.00194

2. Berg EE, Ciullo JV. Heterotopic ossification after acromioplasty and distal clavicle resection. *J Shoulder Elbow Surg.* 1995; 4(3): 188-193.
3. Boon JM et al. Central venous catheterization—an anatomical review of a clinical skill—Part 1: subclavian vein via the infraclavicular approach. *Clin Anat.* 2007; 20(6): 602-611.
4. Chen YM, Bohrer SP. Coracoclavicular and coracoacromial ligament calcification and ossification. *Skeletal Radiol.* 1990; 19(4): 263-266.
5. Garland DE. Clinical observations on fractures and heterotopic ossification in the spinal cord and traumatic brain injured populations. *Clin Orthop Relat Res.* 1988; 233: 86-101.
6. Garland DE, Blum CE, Waters RL. Periarticular heterotopic ossification in head-injured adults. Incidence and location. *J Bone Joint Surg Am.* 1980; 62(7): 1143-1146.
7. Kaplan LD et al. Prevalence and variance of shoulder injuries in elite collegiate football players. *Am J Sports Med.* 2005; 33(8): 1142-1146.
8. Mallon WJ et al. Suprascapular neuropathy after distal clavicle excision. *Clin Orthop Relat Res.* 1996; 329: 207-211.
9. Mazzocca AD et al. A biomechanical evaluation of an anatomical coracoclavicular ligament reconstruction. *Am J Sports Med.* 2006; 34(2): 236-246.
10. Morimoto K, Mori E, Nakagawa Y. Calcification of the coracoacromial ligament. A case report of the shoulder impingement syndrome. *Am J Sports Med.* 1988; 16(1): 80-81.
11. Pansard E et al. Heterotopic ossification of the shoulder after central nervous system lesion: indications for surgery and results. *J Shoulder Elbow Surg.* 2013; 22(6): 767-774.
12. Peterson SL et al. Postburn heterotopic ossification: insights for management decision making. *J Trauma.* 1989; 29(3): 365-369.
13. Qin D et al. Safe drilling angles and depths for plate-screw fixation of the clavicle: avoidance of inadvertent iatrogenic subclavian neurovascular bundle injury. *J Trauma.* 2010; 69(1): 162-168.
14. Simovitch R et al. Acromioclavicular joint injuries: diagnosis and management. *J Am Acad Orthop Surg.* 2009; 17(4): 207-219.
15. Sinha A et al. A radiological study to define safe zones for drilling during plating of clavicle fractures. *J Bone Joint Surg (Br).* 2011; 93(9): 1247-1252.
16. Strauss EJ et al. The evaluation and management of failed distal clavicle excision. *Sports Med Arthrosc.* 2010; 18(3): 213-219.
17. Westermann RW, Martin W, Wolf BR. Double graft anatomic acromioclavicular reconstruction: surgical technique and early results. *Tech Should Elbow Surg.* 2014;(in press).