Treatment of an Open Infected Type IIB Distal Clavicle Fracture

Case Report and Review of the Literature

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Abstract

Clavicle fractures are common skeletal injuries that are typically managed nonoperatively, which results in a high rate of fracture union with few or no long-term sequelae. Type II distal clavicle fractures are an exception, with reported rates of nonunion ranging from 22% to 44%. This high rate of nonunion has led to controversy regarding the appropriate treatment of type II injuries. The following case report describes a type IIB distal clavicle fracture, in which nonoperative management was complicated by the breakdown of skin over the fracture site and the subsequent development of infection. This is a rare complication of conservative management. Thorough operative debridement, fracture stabilization via external fixation, and identification of the causative organism allowed for successful outcome in the management of this complex presentation.

Fracture of the clavicle is a common skeletal injury seen in all age groups and typically occur as a consequence of a direct blow or a fall onto the shoulder.[1-3] These injuries are generally managed nonoperatively, which allows a high rate of fracture union with few or no long-term sequelae.[1,4] Type II distal clavicle fractures are an exception, with reported rates of nonunion ranging from 22% to 44%.[5-7] This high rate of nonunion has led to controversy regarding the appropriate treatment of type II injuries.[1]

Advocates of nonoperative treatment of type II clavicle fractures point to the low incidence of symptoms and shoulder disability related to the presence of nonunion, suggesting that fibrous union provides sufficient stability for painless mobility.[1,6-8] Those promoting primary operative management believe the high rate of delayed union and nonunion associated with the unstable type II injury to be unacceptable.[4,9-13]

In the acute setting, indications for operative management of clavicle fractures include neurovascular compromise, open fractures, gross displacement of fracture fragments, polytrauma, tenting of the overlying skin, and inability of a patient to tolerate prolonged conservative treatment.[4,14,15] Open clavicle fractures are rare injuries, and currently there is a paucity of information in the orthopaedic literature regarding appropriate management techniques and treatment outcomes. This report describes a rare case of a type IIB distal clavicle fracture, which was initially treated nonoperatively, but subsequently developed into an open, infected fracture. This case demonstrates a rare complication of the nonoperative management of a type II injury that was treated successfully at our institution with a multiplanar external fixation device.

Case Presentation

History

A 40-year-old, right-hand dominant male, with no significant past medical history, presented to the emergency room 5 days after a fall from the third story of an apartment building. The patient reported landing directly onto his right shoulder. He was seen in an emergency room on the day of the injury, at which time a distal clavicle fracture was diagnosed by radiographic evaluation. He was discharged from the initial emergency room visit with pain medication and instructions

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to keep his right upper extremity in a sling until his follow-up appointment.

Two days of increasing pain, progressive swelling, and erythema in the region of an ulceration over the distal clavicle prompted a return visit to the emergency room for evaluation and management. At presentation, the patient denied any sensory changes or motor weakness related to the right upper extremity.

Physical Examination

The patient was a thin, middle-aged male in minimal distress on presentation, with an oral temperature of 99.0° F. Primary survey demonstrated a distal clavicle fracture on the right side, with significant tenting of the proximal fracture fragment. Inspection of the fracture site revealed an overlying 0.5 cm ulceration that was draining gross yellow purulent material. The ulceration over the fracture site was surrounded by a 2 x2 cm raised area of edema and erythema. Palpation of this region demonstrated increased warmth and elicited significant pain. Gross purulent material was expressible from the clavicular wound. There were no obvious foreign bodies present within the wound and no evidence of anterior cervical or axillary lymphadenopathy. The right upper extremity was neurovascularly intact, with no evidence of brachial plexus pathology. Secondary survey was unremarkable for additional injury.

Evaluation

Radiographic evaluation of the right shoulder and clavicle demonstrated a displaced Neer type IIB distal clavicle fracture with 200% superior displacement of the proximal fracture fragment (Fig. 1). Samples of the draining purulent material were sent from the emergency room for a stat Gram stain, which identified Gram-positive cocci in pairs. Laboratory evaluation at the time of presentation demonstrated a white blood cell (WBC) count of 6.1 with 65.8% neutrophils, an erythrocyte sedimentation rate of 10 and a C-reactive protein (CRP) level of 1.70. The rest of the results from the admission laboratory panel fell within normal limits.

Hospital Course

In the emergency department, the patient was given a dose of intravenous ampicillin-sulbactam [Unasyn®, 3 gm IVPB, (intravenous piggyback)] and a tetanus immunization. The right clavicular wound was dressed and the right upper extremity placed in a sling for patient comfort. The patient was taken to the operating room for treatment of his open, infected clavicle fracture.

Once in the operating suite, the patient was placed supine on the operating table, and general anaesthesia was administered. The right arm and shoulder were prepped and draped in the usual sterile fashion. The ulcerated area over the distal clavicular fracture site was excised and sent as a specimen to the pathology department. Wound exploration demonstrated that the fracture site was surrounded by pus and a fibrinous exudate. Superficial and deep tissue cultures were taken, and the infected sinus and fibrinous exudate were resected. Subperiosteal dissection of the clavicle was performed, extending approximately 2 cm from the fracture site medially and a few millimeters laterally, in order to maintain the vascular supply to the small lateral fracture fragment attached to the acromioclavicular joint. Infected, necrotic bone at the fracture site was resected and a thorough debridement was performed. The wound was then copiously irrigated with several liters of saline.

Attention was next directed to reduction and fixation of the clavicle fracture. A 2.5 mm threaded pin was placed into the proximal clavicle fragment, and a 4.0 mm threaded pin was placed at a 90° angle in a multiplane fashion across the acromion. The multiplane external fixator was then utilized to manipulate and reduce the fracture fragments. The reduction was confirmed through both direct vision and intraoperative radiographs. A double-bar external fixator construct was then assembled to provide a stable fracture fixation (Figs. 2 and 3). The wound was closed in layers over a drain, and the patient's right upper extremity was placed in a sling for comfort. After reversal of anaesthesia, examination demonstrated the patient to be neurovascularly intact, and he was transferred to the recovery room in stable condition.

Postoperatively, the patient was maintained on an intravenous ampicillin-sulbactam (Unasyn® 3 g, IVPB, q6 hours) regimen until presentation and intraoperative culture results were available. External fixator pin care was provided twice daily, drain output was recorded at 8-hour intervals, and the patient's pain was controlled with an oral analgesic regimen. On postoperative day two, intraoperative cultures demonstrated growth of methicillin-sensitive *Staphylococcus aureus*

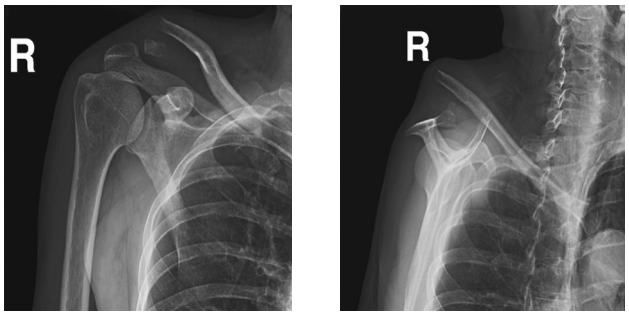

Figure 1 Injury radiographs. AP and scapular Y views demonstrating a type IIB distal clavicle fracture with approximately 200% superior displacement of the proximal fracture fragment.

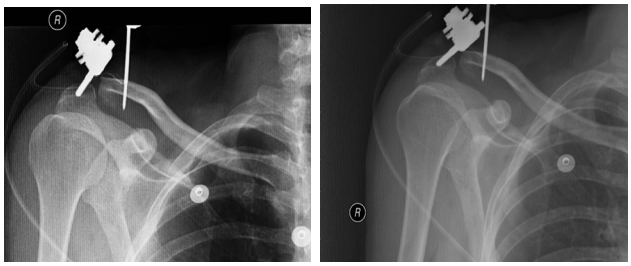

Figure 2 Intraoperative radiographs demonstrating fracture reduction and stabilization using a multiplanar external fixator device.

Figure 3 Clinical photographs demonstrating multiplanar external fixator device used for fixation of type IIB distal clavicle fractures.

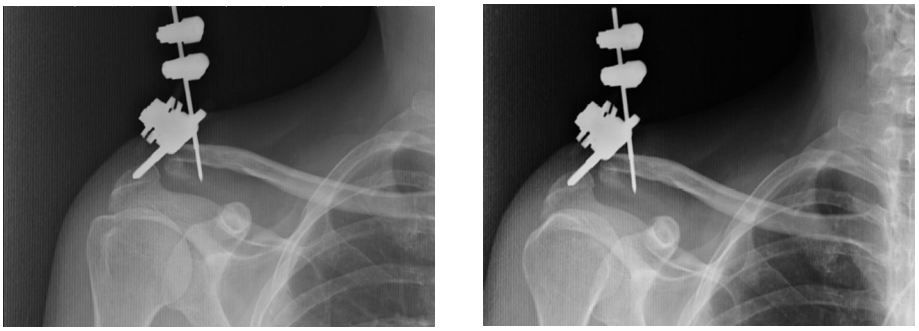

Figure 4 Radiographs taken 2 weeks postoperatively, demonstrating maintenance of fracture reduction.

and pan-sensitive *Streptococcus pyogenes* (group A). After evaluation by the infectious disease service, a peripherally inserted central catheter (PICC) line was placed in the patient's left upper extremity for administration of a 6-week course of Unasyn®. By postoperative day three, the patient reported significant improvement in regard to his right clavicular pain. He remained afebrile with stable vital signs and was progressing during physical and occupational therapy sessions, gaining both strength and mobility. The Hemovac® drain was removed on postoperative day three when minimal output (< 5 cc) was documented over an 8-hour period.

Fourteen days after the incision and drainage and application of a multiplane external fixator, the sutures were removed from the patient's surgical wounds. The incisional areas were clean, dry, and intact, with no evidence of drainage or peri-incisional erythema. Radiographs taken at this postoperative point in time demonstrated maintenance of the fracture reduction (Fig. 4). The patient denied any pain localizing to the operative site and reported nearly full return of his right shoulder strength and range of motion. The external fixator pin sites were unremarkable, with no evidence of infection.

Six weeks postoperatively, after completion of the intravenous antibiotic course and radiographs demonstrating healing of the distal clavicle fracture, the external fixator pins and the PICC line were removed without complication. The patient was without complaints related to his right shoulder and was regaining full use of the right upper extremity.

Discussion

Allman classified clavicular fractures into three main groups, based on location of the fracture site.[16] Group II fractures involve the distal third of the clavicle. They account for approximately 10% to 15% of clavicular injuries. In his review of clavicle fractures, Neer subclassified group II fractures into three types.[13,17] In type I fractures, the coracoclavicular ligaments are intact. Type II fractures are characterized by detachment of the coracoclavicular ligaments from the medial segment, but the trapezoid remains attached to the distal segment. Type III fractures demonstrate intra-articular extension into the acromioclavicular joint. As discussed in Anderson's article on distal clavicle fractures,[1] Rockwood revised the Neer type II clavicle fracture, in 1982, describing type IIA fracture as one in which both the conoid and trapezoid remain attached to the distal segment, and the type IIB fracture as one in which the conoid is torn.[1] Type IIB distal clavicle fractures are prone to significant displacement, with the sternocleidomastoid and trapezius pulling the medial fragment superiorly and posteriorly, and weight of the arm pulling on the lateral fragment through its attachment to the acromion and trapezoid ligament.[2]

Neer's original review of nonunited clavicle fractures demonstrated that, although distal fractures were much less common than those occurring in the midshaft region, they accounted for approximately 50% of cases that went on to nonunion.[5] Subsequent series have supported this finding, reporting rates of delayed union and nonunion, ranging from 22% to 44%.[12,18] Based on these findings, many investigators have advocated initial operative management of unstable type II injuries with a variety of surgical techniques described.

Fixation with transacromial Kirschner (K) wires is a commonly reported technique for the management of type II clavicle fractures. One or two wires are inserted and passed

across the acromion and lateral clavicular fragment into the reduced medial clavicle.[2] In 1963, Neer reported seven distal clavicle fractures treated in this manner. All seven patients achieved union with this technique at a mean of 6 weeks.[13] Eskola and colleagues reported similar success with operative management utilizing K-wire fixation. Twenty-three type II fractures were operatively treated in the acute setting, with 22 fractures uniting at a mean follow-up of 4.5 years. The subjective outcome in this series was good or satisfactory in 96% of cases.[19] However, successful management with wire fixation is not universal. Kona and coworkers reviewed 19 cases in which type II distal clavicle fractures underwent operative fixation.[20] Thirteen patients had their injury treated with transacromial wires and the other six were managed with a variety of other techniques (interfragmentary screws, tension band construct and Knowles pins). In this series, there were 10 satisfactory and nine unsatisfactory outcomes, with six cases developing nonunion and six cases complicated by deep infection. All six nonunions and five of the six infections occurred in patients treated with transacromial K-wires. The investigators concluded that operative management of type II fractures should be reserved only for cases in which the patient's skin is at risk, and, when required, transacromial wire fixation should be avoided.

Transacromial Knowles pins are another option for operative fixation of distal clavicle fractures. Fann and associates, reported on their experience treating 32 type II fractures with this technique.[21] All 32 cases achieved solid union at a mean of 6.8 weeks (range: 4 to 12), with no major complications reported.

Fracture fixation with cerclage techniques have been described utilizing both wires and sutures, especially for long, oblique fracture patterns.[1] Levy reported on 12 distal clavicle fractures treated with absorbable PD (polydioxanone) sutures tied in a figure-of-eight superior tension band fashion.[12] In their report, all 12 patients achieved radiographic union at a mean of 6 weeks and returned to work at a mean of 8 weeks.[12] There were no complications reported, and, at a mean follow-up of 2 years, all patients had regained full range of motion and remained asymptomatic. Bezer and coworkers described a similar technique using a single suture anchor placed vertically on the coracoid process.[22] The elevated proximal portion of the clavicle is reduced and tied down, with the suture attached to the anchor; distal fracture fragment fixation is achieved with an intramedullary K-wire. Ten patients managed with this technique resulted in nine excellent and one good outcome, with an overall mean Constant score of 96.6 at 2 years follow-up.

Other surgical options include clavicular plates and screws, transacromial Rush nails, intramedullary Steinmann pins, and coracoclavicular screw fixation.[1,2,4,11,12,15] Each technique is accompanied by its own advantages and disadvantages.

Complications associated with the operative treatment of type II clavicle fractures and the limited morbidity associated with nonoperative management have led to a number of studies comparing the results of both protocols. In a series of 30 patients, in which 15 were managed nonoperatively and 15 underwent fracture fixation with a coracoclavicular screw, Edwards and colleagues reported a high incidence of delayed union and nonunion with nonoperative treatment: results of 20 nonoperative type II fractures were compared to 23 treated with coracoclavicular screws.[10] All fractures treated operatively achieved asymptomatic union 6 to 10 weeks after surgery, whereas the nonoperative treatment arm had a delayed union rate of 45% and a nonunion rate of 30%. Rokito and coworkers reported a series of 30 type II clavicle fractures in which 16 were managed nonoperatively and 14 underwent open reduction and coracoclavicular stabilization using suture material.[7] All of the patients treated operatively achieved fracture union 6 to 10 weeks after surgery, while seven of the 16 patients managed nonoperatively (44%) had radiographic evidence of nonunion.[7] Comparison of the two treatment groups in regard to shoulder rating systems (UCLA, Constant and Murley, and American Shoulder and Elbow Surgeons scales), range of motion, and strength demonstrated no significant difference. Of the patients developing nonunion, at a mean follow-up of 53.5 months, five were asymptomatic, one had mild pain, and one had moderate pain; no patient opted for further operative treatment. These findings led the investigators to conclude that type II fractures could be managed nonoperatively, with no impact on clinical and functional outcome, even in the presence of a high rate of nonunion.[7]

Successful nonoperative management of type II distal clavicle fractures has similarly been described. Of the 110 lateral clavicle fractures treated with figure-of-eight immobilization reported by Nordqvist and associates, 23 were classified as Neer type II injuries.[23] Although there was a 22% incidence of nonunion, none of the patients demonstrated significant pain or residual shoulder disability.[23] There was, however, clavicular deformity present in eight of the 23 cases at 15 years follow-up. Robinson and Cairns reported their experience managing 101 displaced lateral clavicle fractures (90 type II injuries) with sling immobilization and early physical therapy.[8] Overall, there was a 21% incidence of nonunion, but comparison of SF-36 and Constant scores showed no significant difference between nonunion cases and those that went on to union.[8]

Reported complications of nonoperative management of type II distal clavicle fractures typically include the development of malunion or nonunion with accompanying pain and shoulder disability. In the case reported, initial nonoperative management of a type IIB fracture led to the breakdown of skin overlying the fracture site and the development of subsequent infection. This is a rare potential complication of unstable distal clavicle fractures managed nonoperatively. In this case, a multiplanar external fixator was utilized to provide stable osteosynthesis of the open distal clavicle fracture. The cortical nature of the clavicle

allowed for strong anchorage of the fixator pins,[14] creating a stable reduction while allowing access to the infected wound for continued observation and treatment. Additional advantages of this technique include the ability to institute early active mobilization of the shoulder and avoidance of internal hardware in an infected site.

In 1988, Schuind and colleagues reported on their experience in treating 20 patients with clavicular fractures and nonunions using external fixation devices.[14] Seven of the 20 patients presented with either open or impending open clavicle fractures. After a mean of 51 days (range: 32 to 90 days), all of the fractures treated united without secondary refracture.[14] There were two superficial pin tract infections reported that responded to oral antibiotics and local wound care.[14] Device removal was performed without complication in an outpatient setting, and recovery of shoulder motion was complete in all patients.[14]

Conclusion

The case described reports a type IIB distal clavicle fracture in which nonoperative management was complicated by the breakdown of skin over the fracture site and the subsequent development of infection. This is a rare complication of nonoperative management. Thorough operative debridement, fracture stabilization via external fixation, and identification of the causative organism allowed for successful outcome in the management of this complex presentation.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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