CASE REPORT

Axillary Artery Injury Associated with Proximal Humerus Fracture: A Report of 6 Cases

Rinne M. Peters, MD; Mariano E. Menendez, MD; Jos J. Mellema, MD; David Ring, MD, PhD; R. Malcolm Smith, MD

Research performed at Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

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Abstract

Proximal humerus fractures are common, but associated injury of the axillary artery is uncommon. The majority of published blunt traumatic axillary artery injuries are associated with anterior glenohumeral dislocation; a few are associated with isolated proximal humerus fractures or fracture-dislocation. Experience within our institution demonstrates that axillary artery injury is often unrecognized on initial presentation owing to palpable peripheral pulses and the absence of ischemia and places the hand at risk of necrosis and amputation if there is prolonged ischemia and the forearm at risk of compartment syndrome after revascularization. Accurate physical examination in combination with a low threshold for Doppler examination or angiography can establish the diagnosis of axillary artery injury. We present 6 cases of axillary artery injury associated with proximal humerus fractures in order to highlight the potential for this vascular injury in the setting of a proximal humerus fracture.

Keywords: Axillary, Artery, Fracture, Humerus, Injury, Proximal

Introduction

Proximal humerus fractures are common, but associated injury of the axillary artery is uncommon. The majority of published blunt traumatic axillary artery injuries are associated with anterior glenohumeral dislocation; a few are associated with isolated proximal humerus fractures or fracture-dislocation (1-5). Axillary artery injury is often unrecognized on initial presentation and places the hand at risk of necrosis and amputation if there is prolonged ischemia and the forearm at risk of compartment syndrome after revascularization (3, 4, 6). We present 6 cases of axillary artery injury associated with proximal humerus fractures in order to highlight the potential for this vascular injury in the setting of a proximal humerus fracture.

Patient 1

A 57-year-old man with hypertension fractured his right proximal humerus in a fall on a boat. At initial assessment he had palpable radial pulses. Radiographs showed a displaced fracture of the proximal humerus with anterior displacement of the shaft and separation of the greater tuberosity [Figure 1A-C]. Operative repair was recommended, but the patient preferred to postpone surgery until his return to India in 3 days and he was discharged from the Emergency Department (ED) to his family's house. Two days later, the patient returned to the ED with considerable pain and inability to sleep, and a decision was made to proceed with surgery. Radial pulses were absent on the preoperative exam, and a computed tomography angiogram (CTA) revealed axillary artery thrombosis.

Through a deltopectoral approach, the fracture was reduced, supported with an allograft fibular strut graft, and secured with a proximal humeral locking plate and screws. The axillary artery thrombosis was treated with angioplasty and stenting.

Two weeks and 3 years after surgery, he had palpable brachial and radial pulses. Radiographs 3 years after trauma showed a healed fracture in good alignment with no implant problems.

Corresponding Author: Rinne Peters, Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA
Email: Rinnepeters27@hotmail.com

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Figure 1A-C. Patient 1. Displaced fracture of proximal humerus in (A) AP view, (B) lateral view and (C) 3-dimensional CT without contrast.

Patient 2

A 96-year-old woman had a comminuted open fracture-dislocation of the proximal humerus after a fall from a standing height [Figure 2A]. She had absent radial pulses. A CT angiogram revealed associated injury to the right axillary and brachial artery and vein with active extravasation of contrast material and a large hematoma [Figure 2B]. Closed reduction was perform in an attempt to restore the radial pulse and re-align the fracture at the ED, but was not successful.

Using an extended deltopectoral approach, a temporary shunt was placed in the axillary artery. After debridement and irrigation, a hemiarthroplasty was placed using cement with gentamicin. The shunt was then replaced with a 6 mm polytetrafluoroethylene (PTFE) interposition graft. Six months later, the patient demonstrated passive forward flexion of 120 degrees, active forward flexion and abduction of 30 degrees, and palpable pulses and there were no neurologic abnormalities. Radiographs showed a shoulder hemiarthroplasty in stable alignment without evidence of loosening.

Patient 3

A 56-year-old man presented with an obvious gross deformity of the shoulder with superiorly protruding bone and pain after a fall down 8 stairs. A brachial pulse was palpable but radial and ulnar pulses were absent. There was diminished sensation in the entire arm, and the hand was cooler than the contralateral hand. Radiographs showed anterior dislocation of the right humeral head with fracture of the greater

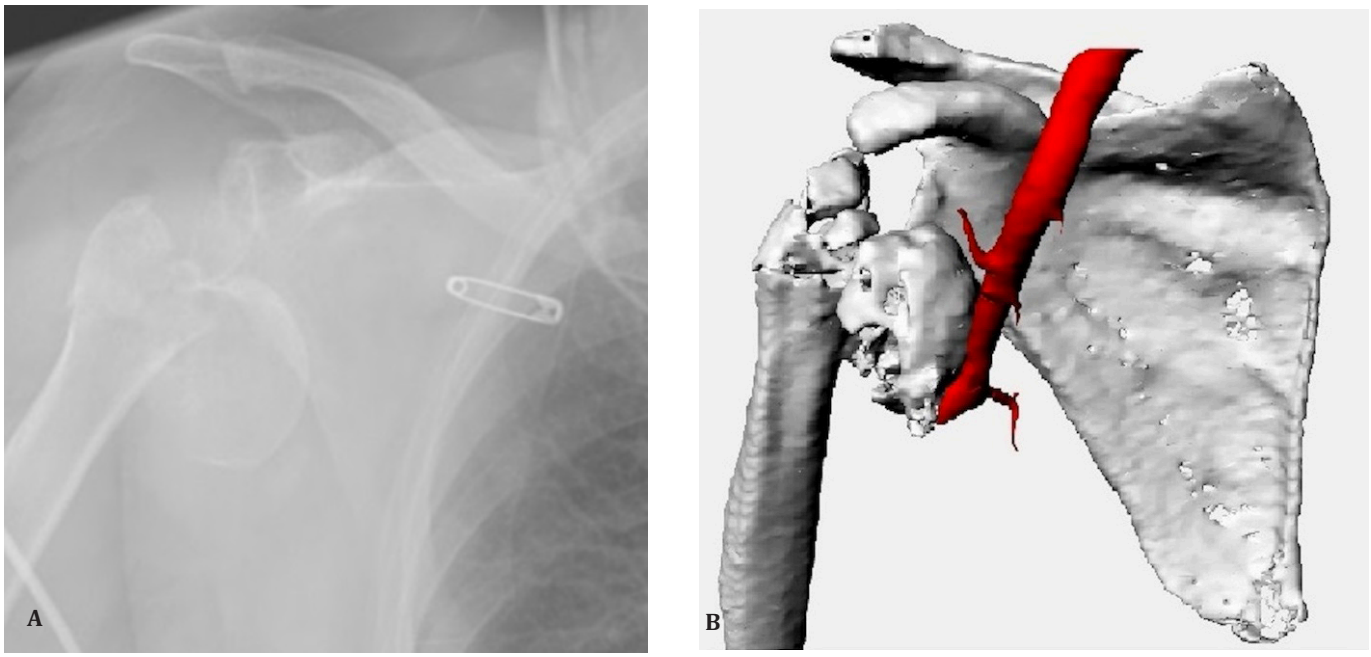

Figure 2A-B. Patient 2. Communited open fracture-dislocation of the proximal humerus with associated axillary artery injury on a (A) AP radiograph and (B) 3-dimentional CT angiogram with contrast.

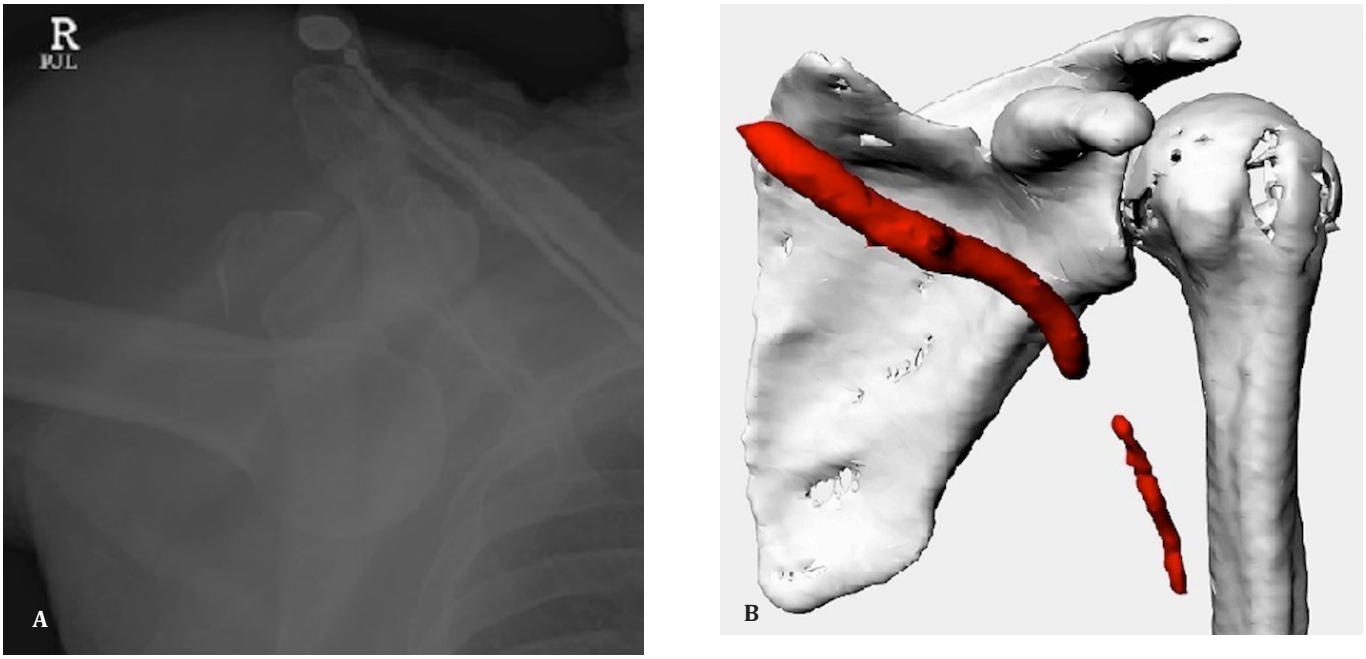

Figure 3A-B. Patient 3. Anterior dislocation of the right humeral head with a fracture of the great tuberosity of the with short segment occlussion of the axillary artery injury on a (A) AP radiograph and (B) 3-dimentional CT angiogram with contrast.

tuberosity [Figure 3A]. CT angiography revealed a short segment occlusion of the right axillary artery with distal reconstitution of the brachial artery from collaterals [Figure 3B]. Closed reduction of the shoulder dislocation was attempted unsuccessfully. During surgery for open reduction, a 4cm portion of the artery was replaced with a PTFE graft restoring good pulses. Six weeks after surgery, the patient has improved hand and shoulder function.

Patient 4

A 94-year-old woman with multiple comorbidities fractured her left proximal humerus in a fall downstairs. The radial, ulnar and brachial pulses were diminished.

Figure 4A-B. Patient 4. Displaced fracture of the left proximal humerus with acute avulsion of the axillary artery injury on a (A) AP radiograph and (B) 3-dimentional CT angiogram with contrast.

The patient was neurologically intact. Radiographs revealed a displaced fracture of the left proximal humerus with notable medial displacement of the shaft into the axilla [Figure 4A]. CT angiogram showed acute avulsion injury of the left axillary artery with reconstitution of the distal flow in the brachial artery via collateral arteries [Figure 4B]. There was adjacent hematoma with no active extravasation.

Open reduction and locking plate fixation of the proximal humerus was performed. There was no active bleeding coming from the axilla. The axillary artery was identified and noted to have a 3-cm segment of hematoma within the artery wall, which was consistent with blunt injury to the artery without transection. This section of the axillary artery was resected and replaced with a 6-mm PTFE interposition graft. Five months later, the patient had good pulses, a stiff shoulder (45 degrees of abduction), and no pain. Radiographs demonstrated adequate fixation and consolidation

Patient 5

An 81-year-old man fractured his left proximal humerus when he fell skiing. The shaft was displaced anteriorly [Figure 5A-B]. He had no radial pulse and numbness in the radial nerve distribution. A CT angiogram showed kinking of his axillary artery at the subclavian-axillary junction. There was an unsuccessful attempt to realign the fracture and operative treatment was performed. Using an extended deltopectoral incision, hemiarthroplasty was performed. The collateral circulation was sufficient and no vascular procedure was carried out. Ten months later, the patient had no pain and 85 degrees of forward flexion, 15 degrees of external flexion, and limited interal rotation to L5.

Patient 6

A 85-year-old woman with multiple comorbidities had a comminuted closed fracture-dislocation of the left proximal humerus after a fall from a standing height [Figure 6A]. She had vague hand paresthesias, but sensation was intact during physical examination. Initially she had a palpable radial pulse. It was checked again 2 hours later and her pulse was absent. A CT angiogram revealed axillary artery thrombosis [Figure 6B]. The patient was found to have elevated troponin and creatine kinase levels without chest pain, raising concern for myocardial demand ischemia. The cardiac risks and the gravity of the dysvascular arm were discussed with the patient and a shared decision was made to proceed with surgery. At surgery the proximal humerus was replaced with a hemiarthroplasty and the axillary artery was treated with angioplasty and stenting. The postoperative course was complicated by septic shock of unknown origin and acute renal failure. At the request of the patient's family, comfort measures were instituted and the patient died on hospital day 13 from multi-organ failure.

Discussion

Despite the intimate anatomical relationship between the proximal humerus and the axillary artery, vascular injury secondary to a fracture in this area is thought to be rare and its national incidence remains unclear. In this study, we report our institutional experience with these injuries.

This case series should be considered with several limitations in mind, such as: 1) limited details on pre and postoperative vascular exams, 2) 3 different surgeons with variations in operative technique and management strategies, and 3) inability to estimate the incidence of these injuries.

In all cases except for patient 3 in our series, the axillary artery occurred as a result of displaced proximal humerus fractures, which is consistent with most previously published cases (3-6). However, 2

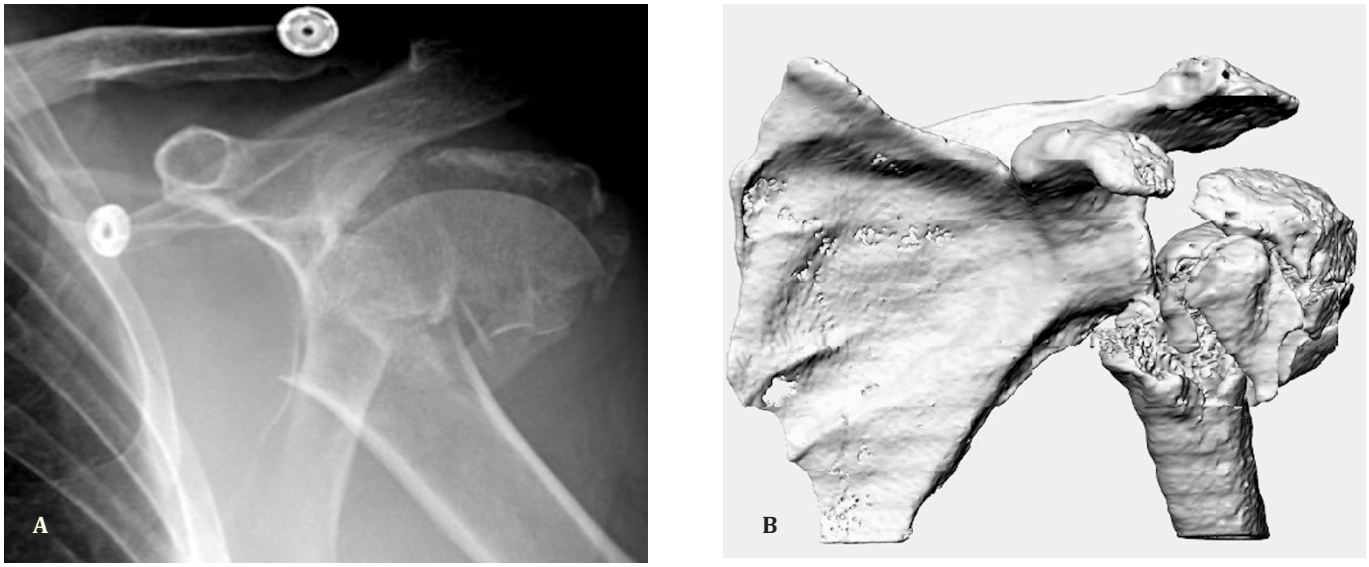

Figure 5A-B. Patient 5. Displaced fracture of proximal humerus in (A) AP view and (B) 3-dimentional CT.

single case reports described such injury following minimally displaced fractures (7, 8). Factors that are assumed to predispose to axillary artery injury include advanced age, osteoporosis and atherosclerosis (4, 9). In our sample, the average patient age was 78 years and all patients except for patient 3 had hypertension combined with other cardiovascular disorders (e.g. pulmonary hypertension, coagulopathy, history of deep venous thrombosis or lung emboli). Concomitant injuries such as brachial plexus injuries or scapula fractures are likely to occur with this arterial lesion (6, 10-12). In our series, patient 2 and 5 had concomitant a brachial plexus palsy, and patient 2 sustained injuries to both brachial artery and vein.

Various injury mechanisms of the axillary artery following proximal humerus fracture have been reported, including direct trauma by sharp fracture fragments (8), rupture or avulsion of the artery due to overstretching, and hematoma of the arterial wall and intimal disruption (5, 8). Different vascular injury mechanisms may result in acute or delayed onset of symptoms. Kelley and colleagues described the pathognomonic triad of axillary artery injury, which consists of shoulder trauma, arterial flow changes measured by a reduction in amplitude of distal pulses or Doppler ultrasound signal, and the presence of an expanding axillary mass (9). However, intimal tears can lead to delayed presentation due to secondary thrombosis, with palpable peripheral pulses on initial presentation. Effective collateral circulation at shoulder level can result in present peripheral radial artery pulses despite axillary artery damage (8, 13). In our series, both clinical scenarios were seen. Patient 1 and 6 had a palpable radial artery pulses on initial evaluation, while the other patients had absent or diminished radial pulses. Given that palpable pulses are no guarantee that axillary artery damage has not occurred, the most reliable symptom of diminished distal blood supply is probably paresthesia (6). When physical examination raises suspicion towards axillary artery injury, a Doppler ultrasonography should be performed to quantify the arterial circulation. Signs of diminished arterial perfusion can be investigated with angiography (4, 6).

Widely displaced proximal humerus fractures may merit closer observation and evaluation for associated axillary artery injury, particularly in elderly patients. If operative intervention is indicated, exposure can be obtained through a deltopectoral incision. Ideally, internal fixation is performed prior to vascular repair. Anatomical reduction and stabilization prevent redisplacement and damage to the vascular repair. In case of a severely vascular compromised limb, vascular repair should be performed first (4, 6). In our case series, patient 1 and 6 received angioplasty and stenting after open reduction of the proximal humerus and patient 5 did not undergo a vascular procedure as the collateral circulation was sufficient. The remaining patients (number 2-4) were treated using interposition grafts with PTFE prostheses.

Axillary artery injury as a result of proximal humerus fracture is uncommon, although its incidence is unclear (4, 5). As the number of inpatient admissions for proximal humerus fracture appears to be on the rise it may be that we are now detecting more axillary artery injuries than we did in the past (14-16). The increased detection rate might be driven by both an increase in ED visits and a growing tendency to manage these

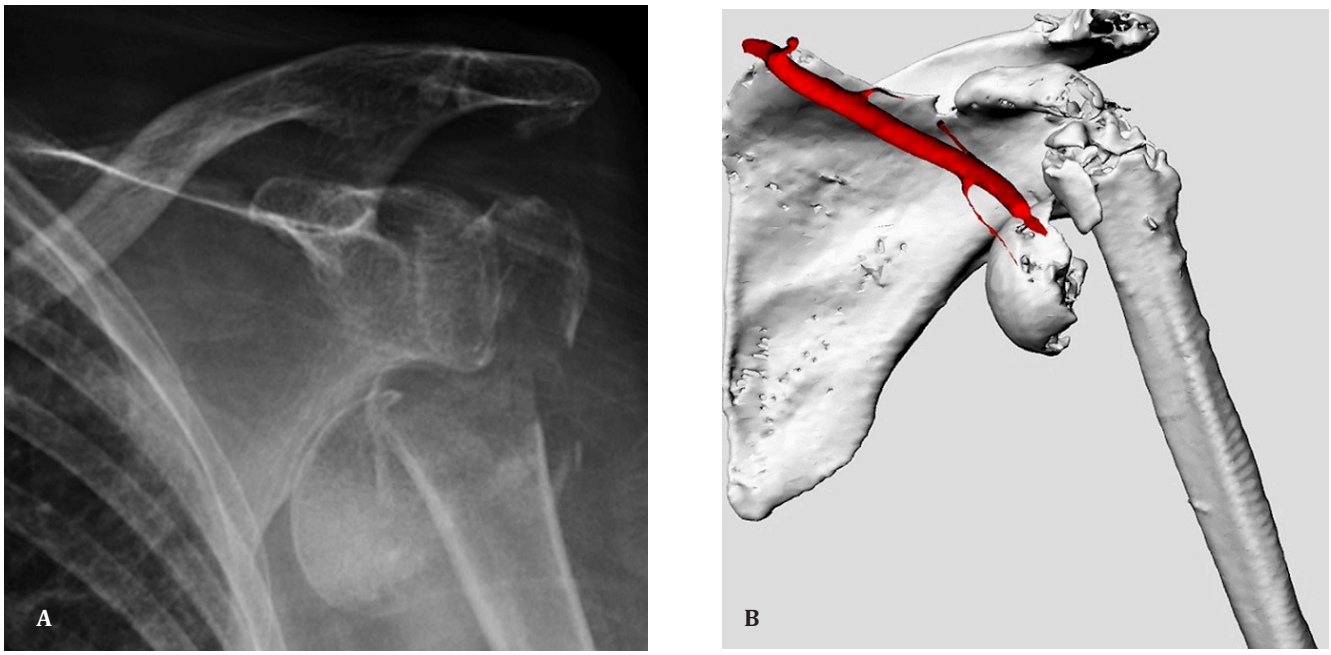

Figure 6A-B. Patient 6. Displaced proximal humerus fracture on a (A) AP radiograph with axillary artery thrombosis on a (B) CT angiogram with contrast.

fractures operatively. Experience within our institution demonstrates that recognition at initial presentation can sometimes be difficult owing to palpable peripheral pulses and the absence of ischemia. Increased awareness for this injury should be maintained in older and infirm patients, particularly when paresthesias and concomitant injuries (e.g. brachial plexus injuries or scapula fractures) are present. Accurate physical examination in combination with a low threshold for Doppler examination or angiography can establish the diagnosis of axillary artery injury. Additional research using large databases is needed to determine the prevalence and predictors of axillary artery injury secondary to proximal humerus fracture, which might lead to prompt identification of at-risk patients upon admission.

Rinne M. Peters MD
Mariano E. Menendez MD
Jos J. Mellema MD
David Ring MD PhD
R. Malcolm Smith MD
Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA, USA

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