Case Report

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Critical ischemia and myonecrotic sepsis following scapulothoracic dissociation in the setting of apparent hand perfusion

A case report

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Abstract

Scapulothoracic dissociation is a rare and devastating injury to the shoulder girdle. It is often caused by traction or severe blunt trauma injury to the upper extremity and is associated with both neurologic and vascular injuries. Scapulothoracic dissociation is a highly morbid and rare injury pattern that is often seen in conjunction with other traumatic injuries. The authors describe a case of scapulothoracic dissociation with associated complete brachial plexus injury and subclavian artery injury that was complicated by hypoperfusion, myonecrosis, and subsequent polymicrobial infection of the affected limb in the setting of a warm hand with brisk capillary refill. While capillary refill and hand warmth in the setting of a pulseless extremity have been used in previous cases of scapulothoracic dissociation as an indication for limb perfusion and nonoperative management, these markers cannot reliably be used to evaluate collateral circulation as exemplified in this case report. This case highlights multiple important aspects of the evaluation and management of scapulothoracic dissociation that orthopaedic surgeons and vascular surgeons should be familiar with and utilize when dealing with these challenging injuries.

Level of Evidence: V

Keywords: flail extremity, ischemia, scapulothoracic dissociation, subclavian artery, upper-extremity

1. Introduction

Scapulothoracic dissociation (SD) is a traumatic injury to the upper extremity in which the shoulder girdle is distracted from the axial skeleton.[1,2] This injury pattern is seen in patients undergoing high-energy traumatic mechanisms and is often found in the setting of other serious traumatic injuries. For this reason, SD is extremely morbid and rarely encountered.[3] Disruption of the musculoskeletal anchors of the shoulder girdle allows the scapula to displace from the thoracic wall, which places tension on the neurovascular structures innervating the affected extremity.[3] In severe presentations of SD, this tension can cause associated vascular and brachial plexus injuries and result in traumatic internal forequarter amputation.[3] As such, the care of these patients requires a concerted multidisciplinary effort. This case highlights multiple important aspects of the evaluation and management of scapulothoracic dissociation that orthopaedic surgeons, vascular surgeons, and trauma surgeons should be familiar with and utilize when dealing with these challenging injuries.

2. Case report

2.1. Presentation

A 28-year-old right-hand dominant male presented as a level-two trauma after a motorcycle crash in which he was the helmeted driver. He was thrown from his vehicle, struck a guardrail and sustained an injury to the left upper extremity. He complained of left upper extremity pain and weakness upon arrival. He had a Glasgow Coma Scale of 15 and stable vital signs (blood pressure 140/89 mmHg, heart rate 80 beats/min, respiratory rate 16/min, O2 saturation 99% on room air) on admission. He had no relevant past medical history.

2.2. Physical examination

Physical examination revealed abrasions and superficial lacerations to the left upper extremity, as well as substantial swelling about the left shoulder. The patient was noted to have nonpalpable and nondopplerable brachial, radial and ulnar pulses. Motor examination revealed 0/5 strength in the entire left upper extremity with no sensation in the axillary, median, radial, and ulnar nerve distributions. Further examination revealed a pink, warm left hand with brisk capillary refill less than 2 seconds in all digits. Remainder of neurologic examination and secondary survey showed no other abnormality.

2.3. Imaging/labs

Chest x-ray during initial trauma bay evaluation (Fig. 1) revealed a laterally displaced scapula on the left. No chest x-rays were

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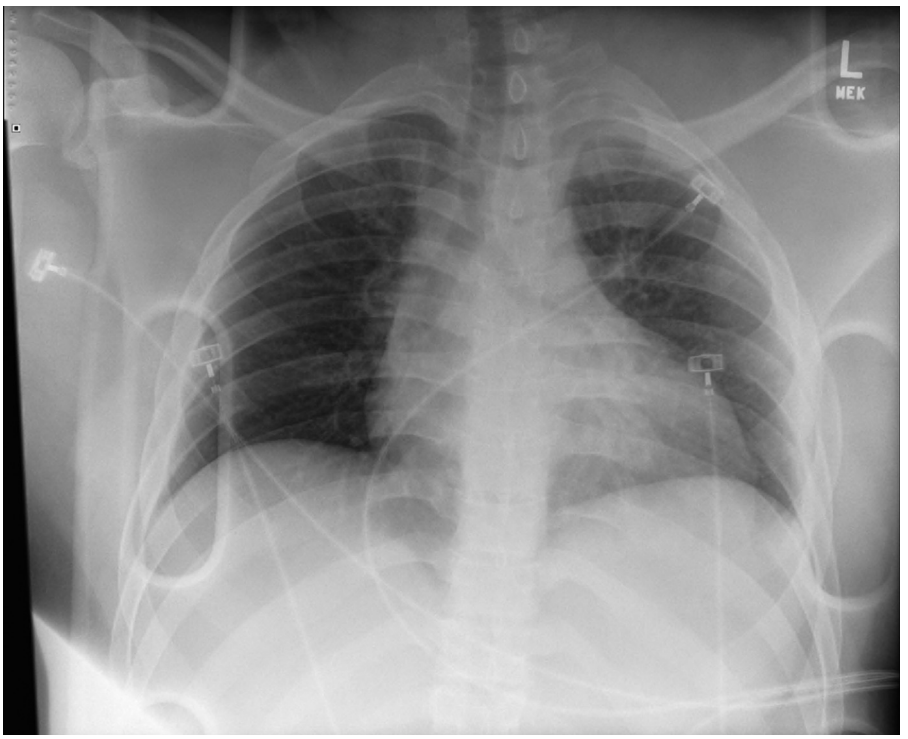

Figure 1. Anteroposterior chest radiograph of patient carried out upon initial trauma evaluation showing lateral displacement of the left scapula. The radiograph is slightly rotated, which precludes use of scapular index described by Kelbel et al.[2]

taken that were truly nonrotated as required for the evaluation of a scapular index.[2] He was subsequently taken for computed tomography (CT) of the chest, abdomen, pelvis, and spine, which was notable for a Type V acromioclavicular (AC) joint dislocation, coracoid avulsion fracture, left greater tuberosity fracture, and apparent lateralization of the left scapula which can be seen on injury radiographs (Fig. 2A–C) provided. Additional injuries included a left C7 transverse process fracture, left vertebral artery injury, and a left pleural effusion. The patient then underwent CT angiogram which revealed occlusion of the left subclavian artery at the level of the first rib (Fig. 3) as well as left vertebral artery dissection at the level of C7. Labs upon admission were notable for a hematocrit of 37, a lactate of 1.4, and a white blood cell count of 17.5k which normalized to 11k on hospital day 1.

2.4. Hospital course

Orthopaedic surgery and vascular surgery were consulted following initial trauma evaluation to further evaluate and manage these injuries in conjunction with the general surgery trauma team. Vascular surgery evaluated the patient, noting that brisk capillary refill and hand warmth signified adequate left upper extremity perfusion despite subclavian artery injury and thrombosis. Given the risks associated with revascularization, vascular surgery determined that no revascularization intervention was warranted secondary to the patient's hemodynamic stability and presumed upper extremity viability. The vascular surgery team recommended serial vascular examination via digital and Doppler ultrasound pulse checks, as well as close monitoring of hand appearance and capillary refill. Orthopaedics placed the patient in a sling and swath on the left upper extremity and elected to manage the orthopaedic injuries nonoperatively. He was educated on the poor prognosis of his injury and the low likelihood of neurologic recovery. The patient was taken to the trauma intensive care unit for resuscitation and observation of his traumatic injuries. Following admission, the patient suffered an embolic stroke with subsequent binocular vision loss likely secondary to emboli from a left vertebral artery dissection. A therapeutic heparin drip was started on hospital day 1 despite potential for development of subclavian artery hemorrhage. He was evaluated on a daily basis by the orthopaedic surgery, vascular surgery, and general surgery trauma services. Initiation and maintenance of a therapeutic heparin drip through hospital day (HD) 6 prompted no change in upper extremity vascular examination. Of note, heparin anticoagulation did not result in delayed onset hemorrhage. Overnight on HD 6 into HD 7, the patient was noted to have new onset fever, hypotension, declining urine output, hyponatremia, and a rising white blood cell count of 21k. This prompted an infectious workup, which included a C-reactive protein of 407, a Creatine Phosphokinase level of 32,559, as well as CT and magnetic resonance (MR) imaging of the chest and left upper extremity which revealed intramuscular and perifascial gas concerning for deep infection versus necrotizing fasciitis. Repeat examination at this time revealed an unchanged vascular examination, with a warm hand and brisk capillary refill.

The patient was taken for an emergent irrigation and debridement and wound exploration on hospital day 7 with orthopaedic and vascular surgery. Intraoperatively, the left upper extremity musculature was found to be noncontractile and nonviable distal to the level of the deltoid with surrounding purulent, foul-smelling fluid. The patient underwent trans-humeral guillotine amputation with loose closure and wound vacuum placement. Intraoperative cultures revealed gram-negative rods with subsequent speciation revealing polymicrobial

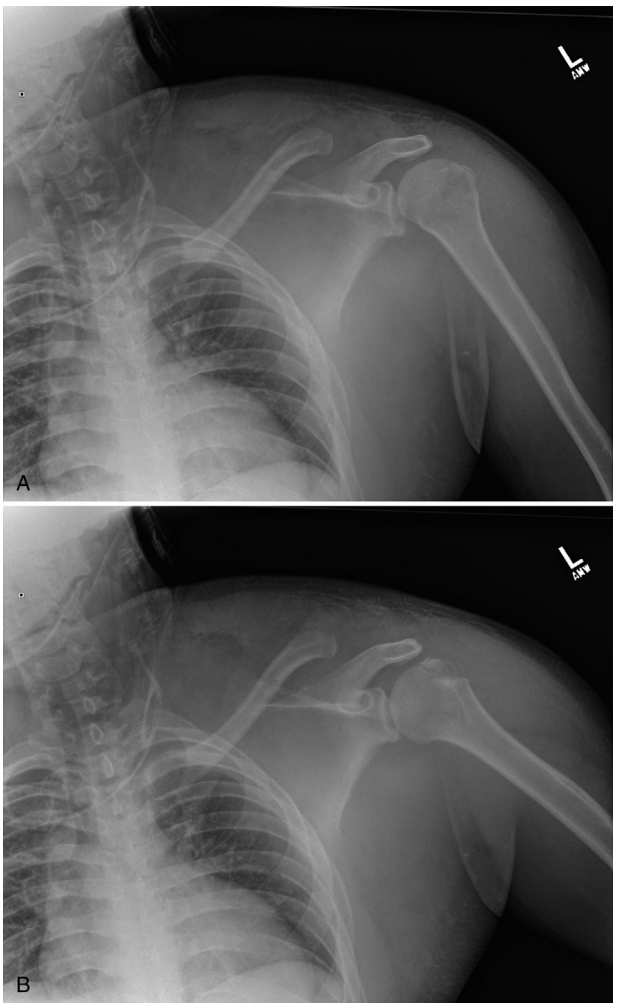

Figure 2. (A–C) Anteroposterior and scapular Y views of the left shoulder demonstrating a Type V acromioclavicular dislocation and apparent displacement of the left scapula laterally and posteriorly.

Figure 2. (Continued).

infection with citrobacter youngae and bacillus bacteria. The patient remained intubated postoperatively and was taken for repeat irrigation and debridement of the left upper extremity with orthopaedic surgery on hospital day 8 with purulence and nonviable musculature observed to the mid-deltoid level. The patient returned to the operating room on hospital day 10 with purulence and necrosis of the deltoid and pectoralis musculature requiring debridement and subsequent trans-glenohumeral amputation of the left arm with wound vacuum application. On hospital day 12, orthopaedic surgery carried out the final irrigation and debridement of the glenohumeral amputation site with primary wound closure. He was discharged on hospital day 30 to inpatient rehabilitation on IV antibiotics. The remainder of his postoperative course was uneventful. He is now over 4 years out from the date of injury. He still suffers from severe phantom limb pain but has adjusted to life with a glenohumeral amputation. His Disabilities of the Arm, Shoulder, and Hand (DASH) Score is 86.6.

3. Discussion

Scapulothoracic dissociation represents a devastating injury to the shoulder girdle. It is often caused by traction or severe blunt trauma injury to the upper extremity and is associated with both neurologic and vascular injuries.[1–3] SD is a rare and highly morbid injury pattern that is often seen in conjunction with other traumatic injuries.[3] This case report describes a case of SD with complete subclavian artery injury and subacute critical limb ischemia that was obscured in the setting of a warm hand with brisk capillary refill. This unique presentation highlights many important aspects of the complex, multidisciplinary management required in the successful treatment of scapulothoracic dissociation.

SD represents a traumatic division of the shoulder girdle from the axial skeleton. The degree of shoulder girdle distraction at the time of injury dictates the spectrum of severity of this injury pattern. As musculoskeletal anchors of the shoulder girdle are disrupted, the neurovascular structures innervating the affected arm are tensioned and placed at risk of injury or complete disruption. Subclavian artery injuries have been found to have a statistically significant association with complete brachial plexus injuries and represent the most severe presentation of scapulothoracic dissociation.[4–6]

Initial evaluation should include a trauma ATLS evaluation, a thorough vascular examination, and a neurologic examination of the affected extremity if possible. Vascular examination of the affected extremity must be thorough, as extensive collateral blood flow in the upper extremity can prevent obvious signs of ischemia.[7] Additionally, polytrauma patients often present with peripheral constriction and cool skin from hypovolemia and shock, which can further obscure examination of limb vascular status.[8]

As highlighted by this case, obtaining a truly nonrotated chest x-ray of a polytrauma patient can be very challenging. This case

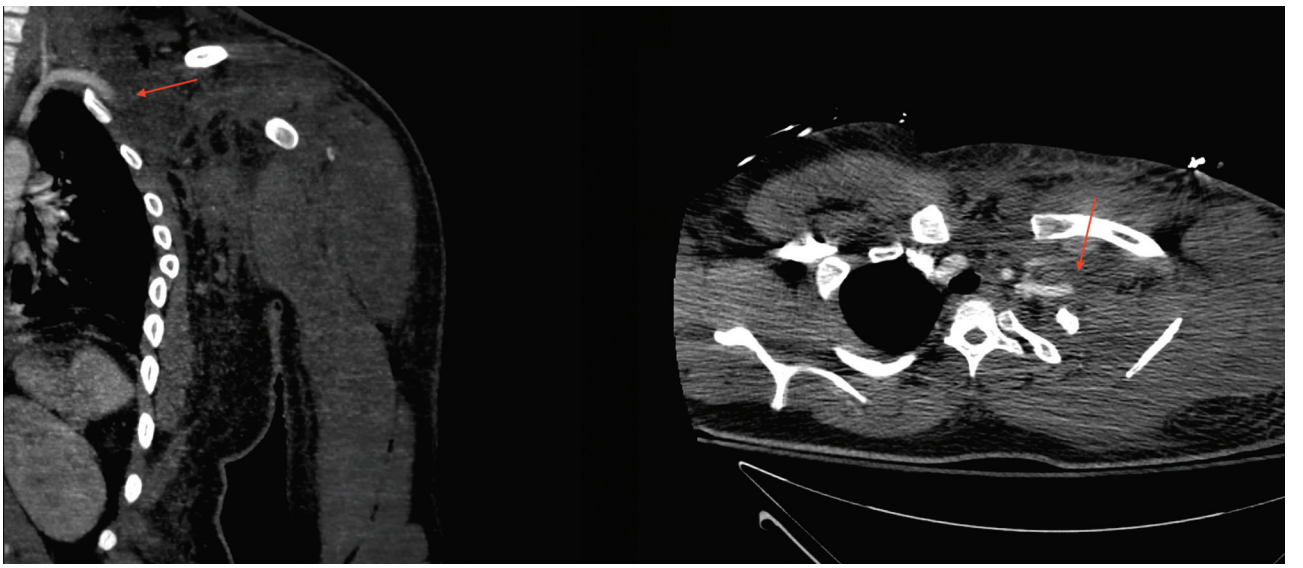

Figure 3. Axial and coronal views of left upper extremity computed tomography angiogram revealing a complete left subclavian artery injury (red arrows) at the level of the first rib with no sign of active extravasation.

demonstrates the poor applicability of this metric in the acute evaluation of scapulothoracic dissociation. Other metrics proposed for radiographic diagnosis of scapulothoracic dissociation suffer from the same flaws.[5,9,10] Any concern for SD should therefore prompt computed tomography angiogram of the affected extremity and immediate evaluation by both orthopaedic surgery and vascular surgery.

In this case of a Type IV SD with complete subclavian artery injury and complete brachial plexus avulsion, hand warmth and brisk capillary refill in the injured extremity were utilized as proxies for limb perfusion in the setting of a pulseless extremity. The continued presence of capillary refill and hand warmth following the injury were perceived as indicators of adequate collateral perfusion of the entire upper extremity.[6,8] In this case, it is likely that the severe blunt trauma to the left forequarter caused substantial soft tissue injury and disrupted zones of collateral flow, rendering it more susceptible to subacute ischemia and infection from superficial skin lacerations. Tissue necrosis likely evolved as the local tissue demands for nutrients outstripped poor collateral vascular supply. Distal collateral pathways remained adequate for perfusion of superficial tissues. Once myositis was established, it easily progressed through injured and hypoperfused tissues resulting in eventual limb loss.

Current literature on scapulothoracic dissociation has been derived from small case series and current management recommendations remain poorly defined.[3,11] The lack of current treatment guidelines for scapulothoracic dissociation is in part due to the complex nature of the injury pattern, its rare occurrence, and the wide variation of injury severity encountered.[11] While there are no universal treatment recommendations in place for the management of scapulothoracic dissociation, prevention of acute ischemic or hemorrhagic complications is of utmost importance.[3,11] In the setting of hemorrhagic shock or overt critical limb ischemia, which presents as a white or blue mottled, cool, pulseless upper extremity, these injuries should be taken for operative intervention by vascular surgery and orthopaedic surgery emergently.[8,11,12]

If acute limb ischemia and hemorrhage are absent, management guidelines surrounding vascular repair are ambiguous at best.[3,8,11] The necessity of acute vascular intervention in this setting was brought into question by Sampson et al; the authors carried out a retrospective review of 11 patients with scapulothoracic dissociation with associated axillary or subclavian arterial occlusions and pulseless upper extremities. All patients had stable hemodynamics on presentation and underwent angiography, which showed no active extravasation.[13] While only 1 patient had acute, limb-threatening ischemia (cold hand with mottled, blue appearance), 6 patients in total underwent revascularization, while the other 5 patients underwent nonoperative management. All 5 nonrevascularized limbs remained viable with no delayed-onset hemorrhage observed. There was no difference in functional outcome between the revascularized and nonoperative groups as all 11 patients continued to have an asensate, flail extremity. Sampson et al carried out a review of literature and observed that acute hemorrhagic shock from blunt subclavian injury is extremely rare while delayed hemorrhage has never been reported and poses minimal risk following SD.[8] As a result of these findings, the authors recommend that these patients can be managed nonoperatively with respect to their vascular injuries with appropriate monitoring and resuscitation in an intensive care unit setting.[8,11] There are no current recommendations surrounding anticoagulation in the setting of scapulothoracic dissociation with an associated vascular injury.[3,11] Therapeutic anticoagulation is ideal in the setting of arterial injury and repair, although it is often precluded secondary to other traumatic injuries in patients with SD.[12,14] Repeat computed tomography angiogram provides no value in the ongoing observation of vascular status of an injured limb following SD. The authors are unaware of any additional imaging that can be carried out for improved ongoing monitoring of vascular status. Lactate levels can be trended but are often nonspecific in the setting of a polytrauma patient with multiple injuries.

While capillary refill and hand warmth in the setting of a pulseless extremity have been used in previous cases of scapulothoracic dissociation as an indication for limb viability and nonoperative management, these markers cannot reliably be used to evaluate collateral circulation and perfusion as exempli-

fied in this patient.[8,13] Collateral circulation at the shoulder maintains limb viability in these injuries but represents a tenuous blood supply that can be jeopardized by many factors.[14,15] Tissue hypoperfusion combined with infection, as seen in this case, can result in increased complications, prolonged hospital stay, more proximal amputation, and poor patient outcome.[8] A flail extremity poses substantial risk to the patient, as protective sensation is absent and risk of pressure sores, burns, and infection is significantly increased.[8] As such, preventative care should be taken to thoroughly clean and debride any superficial wounds, protect against pressure sore formation, and carry out daily dressing changes as indicated.

The complication seen in this case was likely the result of multiple factors. Although ischemia played a large role, improved local wound care may have prevented the need for eventual glenohumeral amputation. No research to date has evaluated the effect of above elbow amputation on collateral perfusion to the shoulder and brachium but early amputation may have decreased local soft tissue ischemia and decreased susceptibility to infection. Preservation of the glenohumeral joint and proximal humerus in the treatment of a flail extremity remains ideal as it allows for the possibility of subsequent prosthetic fitting following above elbow amputation. Previous case reports of acute above elbow amputation in the setting of a flail extremity have resulted in successful return to work.[5]

Patients should be counseled on the liabilities that a flail extremity poses and the risks of amputation versus nonoperative management. In cases of complete brachial plexus injury where acute or delayed amputation is indicated, above elbow amputation is the preferred surgical intervention.[3,6,11] Early above elbow amputation in the setting of a flail extremity may reduce complications and result in quicker recovery.[5,6,8]

Each presentation of scapulothoracic dissociation represents a unique and complex injury within a broad spectrum of pathology. As such, orthopaedic surgeons should approach each case on a unique, patient-specific basis and maintain clear lines of communication with vascular and trauma surgery. All patients treated nonoperatively should be monitored closely for the development of life-threatening complications related to their traumatic injury.

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