

CASE REPORT

Incomplete Avulsion Fractures of the Scapular Spine Caused by Violent Muscle Contraction

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Two percent of scapular fractures occur as a result of indirect trauma caused by traction of the muscles and ligaments attached to the scapula. We present two cases involving adults with incomplete avulsion fractures of the scapular spine caused by violent voluntary contraction of the deltoid muscle. These cases are the first reported avulsion fractures confined to the scapular spine medial to the spinoglenoid notch. Although the fractures were incomplete, one patient had a typical symptom of scapular fracture – pseudo-rupture of the rotator cuff characterized by clinical signs of a complete rupture of the musculotendinous cuff. Although this symptom is generally thought to be caused by massive hemorrhaging under the rotator-cuff muscle bellies, it may develop from modest bleeding through the formation of an intramuscular hematoma and a resultant elevation in intramuscular pressure. Confirming the presence of tenderness on the scapular spine and performing appropriate imaging investigation constitute a clinically effective method for preventing misdiagnosis. (doi: 10.2302/kjm.2013-0004-CR; Keio J Med 63 (1) : 13–17, March 2014)

Keywords: scapular fracture, muscle violence, deltoid muscle, incomplete fracture, pseudo-rupture of the rotator cuff

Introduction

The incidence of fractures of the scapula is low, accounting for 0.5–1% of all fractures. Because such fractures primarily develop as a result of major direct trauma, most cases (>80%) are complicated by serious injuries. On the other hand, 2% of scapula fractures are caused by indirect trauma, accounting for only 0.01% of all fractures.¹ The cause of indirect trauma is the traction of muscles and ligaments attached to the scapula.

Presented herein are two cases featuring incomplete avulsion fractures of the scapular spine caused by violent voluntary contraction of the deltoid muscle. Further discussion of this extremely rare fracture is based on information from the literature. The two patients gave informed consent for their data to be presented in this article.

Case 1

A 25-year-old male graduate school student in good health tripped while running during a softball game and elevated his right arm to almost 60° abduction and thrust his hand vigorously onto the ground to prevent his fall. He felt an intense pain in his right shoulder and visited an orthopedic clinic where a diagnosis of scapular fracture was made. Subsequently, the spontaneous pain in his upper scapular region worsened, and the patient visited our clinic 2 days after the accident. Examination revealed that active movement of the right shoulder was limited in all directions. There was localized swelling with tenderness on the scapular spine 4 cm medial to the acromial angle, and the patient complained of pain in that region on downward pressing of the acromion. Radiography demonstrated an incomplete fracture of the scapu-

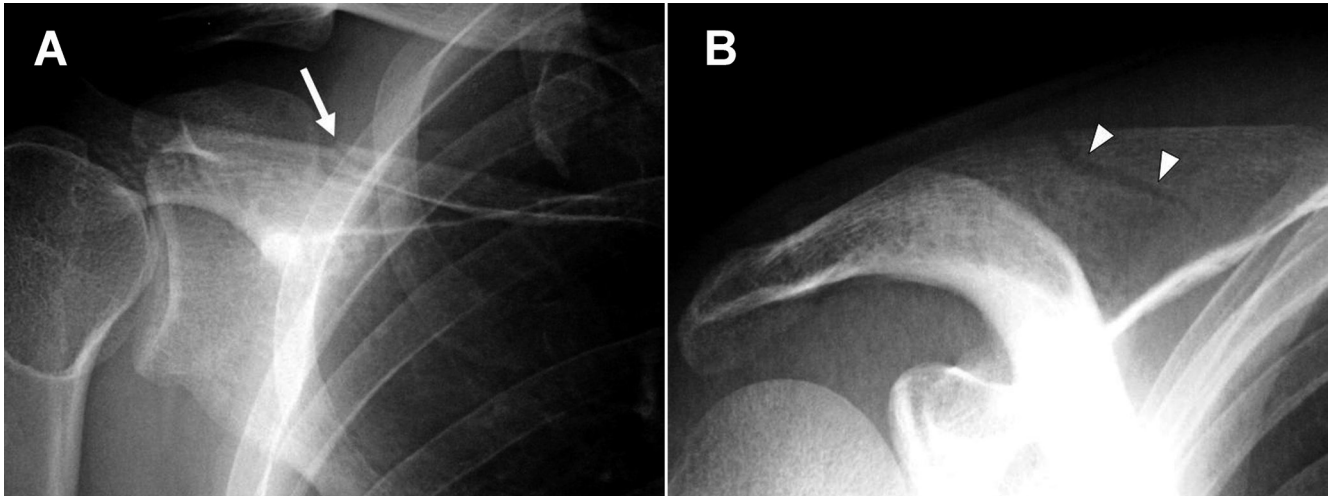


Fig. 1 Radiographic findings in case 1.

(A) Anteroposterior view at the time of the first visit revealed a minimally displaced fracture of the scapular spine (arrow). (B) Eight weeks after injury, a 45° craniocaudal view showed the widened and unclear fracture line (arrowheads) resulting from bone absorption and osteogenesis.

lar spine (**Fig. 1A**). The arm was immobilized in a sling for 1 week, after which the patient started passive range of motion exercises of the shoulder and was allowed to perform activities of daily living (ADL) within pain-free limits. The patient returned to the clinic 8 weeks after the accident and noted that pain during ADL had quickly decreased during the first week and then had completely subsided. There were no limitations in range of motion, nor were there any drop arm signs. The patient reported no pain on resistive movement in various directions. Shoulder radiograms showed concurrent resorption and osteogenic changes along the fracture line (**Fig. 1B**). The patient was advised to avoid sporting activities for the following month and was asymptomatic 10 years after the accident.

Case 2

A 30-year-old male office worker in good health slipped while washing his car. He abducted his arm to 45° and slammed the lateral aspect of his right elbow onto the door of the car to prevent his falling. At that time he heard a cracking sound and felt a slight pain in his right shoulder. About 30 min later, however, he became completely incapable of moving his upper limb because of severe pain. He visited a local hospital where radiograms were taken, and these were considered unremarkable. The pain increased the following day and he visited the orthopedic clinic of another hospital where rotator cuff injury was suspected. Magnetic resonance imaging (MRI) performed 5 days after the accident ruled out any such injury. Because intense pain had continued with any active motion of the shoulder, he was referred to our clinic

16 days after the accident. No obvious deformity, swelling, or redness was noted. Intense tenderness was evident in the center of the muscle belly of the supraspinatus and infraspinatus. There was no limitation in the passive range of shoulder motion, the drop arm sign was positive, and intense pain was induced on resistive abduction even with the arm at the patient's side. The radiograms taken at the initial local hospital showed a fracture of the scapular spine (**Fig. 2A**). The MRI taken at the orthopedic clinic of another hospital revealed a tumor-like mass within the supraspinatus muscle virtually coinciding with the fracture line (**Fig. 2B**). Because an adequate radiogram showing the whole fracture line had not been obtained, computed tomography (CT) was indicated and was carried out at our clinic 20 days after the accident (**Fig. 2C**). The CT images confirmed that the fracture was confined to the scapular spine, so the patient was allowed to use the affected upper extremity and was started on passive range-of-motion exercises 3 weeks after the accident. The patient noted that although severe pain during ADL had continued for one more week, it had gradually decreased. Because pain did not interfere with his ADL 8 weeks after the accident, isotonic muscular strength exercises of the shoulder muscles were then initiated. An examination performed 4 months after the injury demonstrated complete bone union on radiography (**Fig. 2D**), no limitation in the range of motion, and no pain during resistive movement in any direction. The patient is asymptomatic 4 years after the accident.

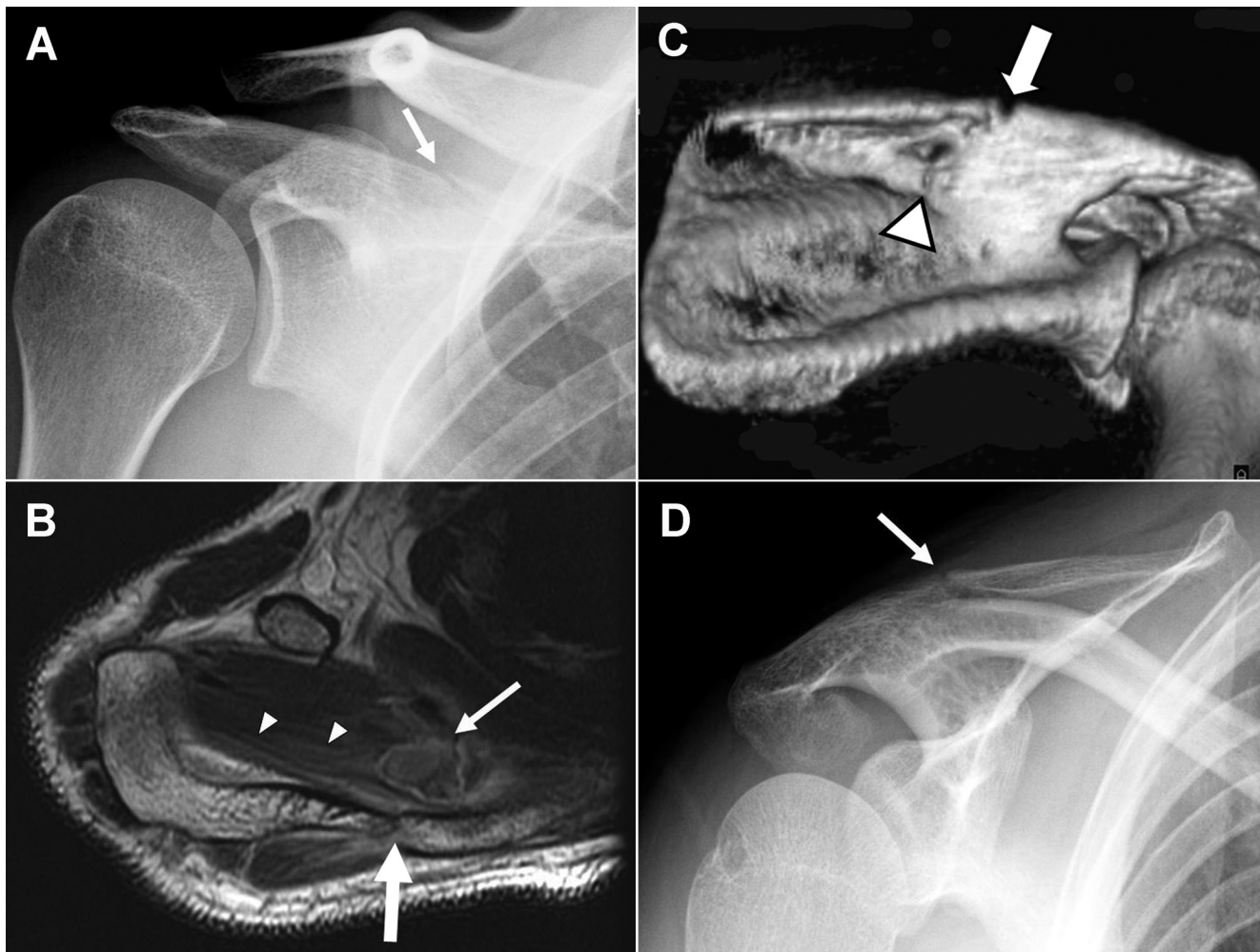


Fig. 2 Imaging of case 2.

(A) Anteroposterior radiogram taken at a local hospital revealed a minimally displaced fracture of the scapular spine (arrow). (B) Findings of magnetic resonance imaging (MRI) taken at the orthopedic clinic of another hospital. Axial T2-weighted MRI demonstrated a medium-intensity tumor-like mass with a surrounding linear high-intensity shadow (small arrow) and linear high-intensity shadows consistent with the muscle fibers (arrowheads) within the supraspinatus as well as the fracture line (large arrow). (C) Three-dimensional CT images taken 20 days after injury revealed the whole fracture line starting at the scapular spine crest with slight displacement (arrow) and disappearing at the base of the scapular spine (arrowhead). (D) Four months after injury, a 45° craniocaudal radiogram indicated bone union without any displacement (arrow).

Discussion

Many muscles are attached to the scapula, and fractures can develop as a result of contraction of these muscles. Such fractures are grossly classified as avulsion fractures (caused by a single violent muscle contraction) or stress or fatigue fractures (caused by repetitive sports- or work-related movement). Avulsion fractures are generally classified into those caused by involuntary muscle contraction and those caused by voluntary muscle contraction. Fractures of the scapula resulting from involuntary muscle contraction have been reportedly caused by uncoordinated muscle contraction associated with

electroconvulsive therapy, accidental electric shock,^{2,3} epileptic seizures,² and severe tetanus.⁴ In contrast, avulsion fractures caused by voluntary muscle contraction arise from resisted muscle pull as a result of trauma or unusual exertion.² Reported scapular fracture sites and the possible causative muscles are diverse.^{2,5–8} The coracoid, acromion, and scapular spine, which are generally referred to as scapular processes, are particularly prone to avulsion fractures because of their anatomical and structural characteristics. Fractures of the coracoid possibly occur as a result of traction of the conjoint tendon along with or without the pectoralis minor.^{9,10} Fractures of the anatomical acromion anterior to the acromial angle

were reported in two adolescents.^{2,11} Kuhn *et al*. reported avulsed-type fractures occurring in the distal or posterolateral acromial region in three patients.¹² Fractures of the scapular spine medial to the acromial angle that extended to the spinoglenoid notch also occurred in two men.^{1,13} The cause of these seven fractures occurring in the acromion and scapular spine was considered to be traction of the deltoid muscle. The fracture lines in our two cases were obvious and were slightly dilated in the crest of the scapular spine and disappeared at the junction between the scapular spine and scapular body. This fact indicates that the force generating these fractures was a downward force acting on the lateral part of the scapular spine or acromion. Therefore, the violent traction of the deltoid muscle presumably caused the fractures in our two cases because neither patient reported receiving a direct blow to their shoulder at the time of injury. The present cases are the first reported avulsion fractures confined to the scapular spine medial to the spinoglenoid notch caused by a resisted deltoid muscle pull as a result of trauma or unusual exertions.

The previously reported sites of stress or fatigue fractures of the scapula and the muscles possibly producing such fractures vary. Stress fractures of the acromion or the scapular spine were previously uncommon and were found to be related to cuff-tear arthropathy, work-related activities, or sporting activities such as baseball, golf, or football.^{14–18} Recently, the occurrence of such fractures has increased considerably as a result of complications of reverse total shoulder arthroplasty.^{19,20} Because of the worldwide application of this procedure, even stress fractures confined to the scapular spine medial to the spinoglenoid notch are becoming common.

We often encounter fractures of the scapula that on radiograms are suggested to be incomplete fractures. It is reasonable to believe that an incomplete fracture of the scapula can occur in adults because incomplete fractures of the ribs, which have the same thin cortex as the scapula, have commonly been observed.²¹ However, insufficient attention has been paid to these fractures in the literature. Although a transverse greenstick fracture of the center of the scapular body caused by direct trauma in a 12-year-old boy has been reported, and Armitage *et al*. mentioned the existence of incomplete fractures of the scapular bodies,^{22,23} our two cases are the first to feature isolated incomplete fractures confined to the scapular spine. Even though their fractures were incomplete, one of our two patients presented with a typical symptom of scapular fracture, *i.e.*, pseudo-rupture of the rotator cuff. This pseudo-rupture is characterized by the clinical signs of a complete rupture of the musculotendinous cuff including a positive drop arm test and inability to abduct the arm.²⁴ This symptom is thought to be caused by massive hemorrhaging under the bellies of the cuff muscles.²⁴ In our second case, intense pain during ADL and the inability to abduct the arm lasted 4 weeks. Because the frac-

ture was incomplete and localized in the scapular spine, severe pain during ADL should generally have subsided within 1 week in line with diminishing acute traumatic symptoms, as was seen in our first case. When the causes of prolonged severe pain and inability to abduct the arm in this case are analyzed, intramuscular hematoma is considered to be the most probable cause, rather than the incomplete fracture itself. Therefore, massive bleeding is not essential to produce this symptom of pseudo-rupture of the rotator cuff because it may develop from modest bleeding through the formation of an intramuscular hematoma and a resultant increase in intramuscular pressure. A diagnosis of these fractures is established based on imaging, and CT is preferable to radiography because radiography is much less sensitive in delineating fractures of the glenoid, coracoid process, and scapular spine.²⁵ As in our first case, however, sharply defined images may be obtained in an appropriate radiographic view in patients with an obvious injury location.

In conclusion, we presented two cases in which the patients had incomplete avulsion fractures of the scapular spine caused by violent voluntary contraction of the deltoid muscle. Confirming the presence of tenderness on the scapular spine and performing appropriate imaging investigations constitute an effective method for preventing misdiagnosis.

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