

CASE REPORT

Isolated first rib fracture in athletes

T Sakellaridis, A Stamatelopoulos, E Andrianopoulos, P Kormas

Br J Sports Med 2004;**38**:e5 (<http://www.bjsportmed.com/cgi/content/full/38/3/e5>). doi: 10.1136/bjism.2003.009225

Isolated fractures of the first rib are uncommon. They are caused by major blunt trauma, a violent muscular pull, or fatigue. Diagnosis is usually made by chest radiography and computed tomography. Angiography is justified when certain criteria are met. Treatment is rest and mild analgesia. Early and late complications have been reported and are treated accordingly. The purpose of this article is to report a case of first rib stress fracture in a kick boxer and review the pertinent literature.

Isolated fracture of the first rib is an uncommon and unusual entity not been previously reported in a kick boxer. It may be the result of trauma, violent muscular avulsion, or fatigue. There has been debate over the cause of isolated first rib fractures sustained without direct violent trauma. Many are located in an area of anatomical weakness (shallow depression for the subclavian artery). Powerful contraction of the scalenus anterior muscle (which inserts on the scalene tubercle adjacent to the subclavian artery), caused by coughing, sneezing, playing tennis, or baseball pitching, may result in acute fracture, with repeated insults resulting in stress fracture.

We present a case of a first rib stress fracture in a kick boxer and review the pertinent literature.

CASE REPORT

A 19 year old white male soldier presented to the accident and emergency department complaining of stabbing pain in the region of the right shoulder. It started when he was kick boxing two hours earlier but he had not sustained a direct injury to the region. He initially experienced mild discomfort over the posterior right scapula area, which gradually changed to what he described as a strong pain.

On physical examination there was tenderness over the right scapula area both at rest and with motion of the right arm, especially abduction. There was no obvious deformity or swelling. There were no neurological symptoms or findings. Radiographs taken at that time were normal. Although symptoms gradually improved with mild oral analgesics and relaxation over a period of four weeks, mild discomfort remained six months later. Radiographs taken at that time showed callus formation on the right first rib (fig 1). A computed tomography scan of the area confirmed the callus formation (fig 2), and a radionuclide bone scan with technetium 99m-DMP showed focal abnormal increased activity in the location of the lesion (fig 3). All special investigations were normal.

Follow up six months later (one year from the onset of pain) with radiographs, computed tomography scan of the area, and radionuclide bone scan showed no change compared with the ones obtained six months earlier. At that time the patient was symptom free.

DISCUSSION AND LITERATURE REVIEW

Fractures of the first rib have been reported to occur as a result of: (a) direct external trauma¹⁻⁹—for example, a kick directly to the rib; (b) indirect trauma^{1 3 6 7 10-13}—for example, falling on an outstretched arm, hyperabduction of the arm, a blow to the shoulder; (c) fatigue, stress fractures,^{2 3 6 13-24} or violent muscular contraction.^{3 13 14 21 23 25-27} First rib fractures may be isolated or occur in association with other rib fractures^{1 2 4-6 8 9 21} and are usually located in an area of anatomical weakness (a shallow depression for the subclavian artery).^{11 13 17 26 28}

All the other ribs are different from the first rib as it is deeply placed and protected on all sides by the shoulder girdle and by the regional musculature. Isolated first rib fracture is rarely the result of direct external violence. If this is the cause, there are often other associated fractures (clavicle, scapula) and great concern that there may be associated injury to the subclavian vessels, brachial plexus, or the pleura.^{2 29} The first reported isolated fracture of the first rib was due to repeated kicks sustained in a brawl and rapidly led to death from the associated rupture of the subclavian vessels.⁵

The first rib is acutely curved, usually the shortest rib, and is broad and flat.³⁰ It slopes obliquely down and forwards to its sternal end circumscribing an arc of 180°. The superior surface of the flattened shaft is crossed obliquely by two shallow grooves, for the subclavian vein and artery, separated by a slight ridge which ends at the internal border usually as a small, pointed projection, the scalene tubercle, for the attachment of the scalenus medius muscle. Anterior to the scalene muscles, the first rib serves as an attachment for the first digitation of the serratus anterior, the subclavius muscle, and the costoclavicular ligament. The intercostal muscles are attached to the convex outer margin of the first rib along the greater part of its length.

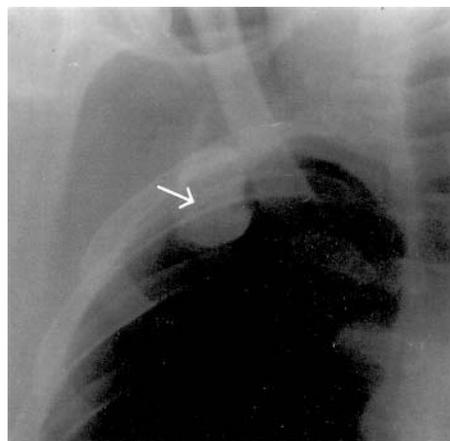


Figure 1 Posteroanterior chest radiograph showing callus formation on the right first rib (arrow).

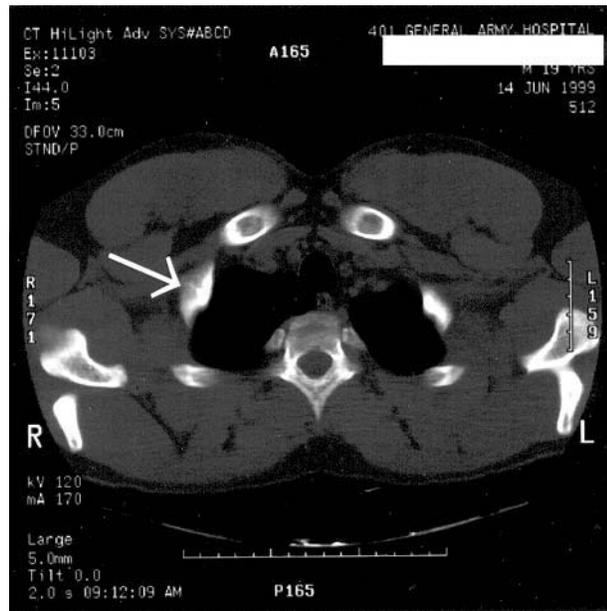


Figure 2 Computed tomography scan confirming callus formation.

Structures immobilising or providing caudal pull are the serratus anterior, intercostals, subclavius muscle, subclavian artery and vein, and the brachial plexus. It has been suggested that sudden powerful contraction of the scalene muscle may fracture the rib at its thinnest segment.^{2 11 13-15 23 25-27 31} This may occur when the head is thrown backwards or sideways. Heavy lifting, in which traction on the arm is associated with sudden and violent contraction of the scalenus anterior, may lead to fracture.^{2 14 26 27} Muscular pull may be the cause in reported cases of acute fractures after coughing, sneezing, playing tennis, or baseball pitching.^{6 14 20 22 23 25} There is a distinction between a single acute event and repetitive stresses that result in fracture of the bone.^{15 21} Repeated insults can lead to stress or fatigue fractures.

In cases of rib fractures in children, especially first rib fracture, child abuse must be considered.³² Possible mechanisms for first rib fracture include impact force, compressive



Figure 3 Radionuclide bone scan with technetium ^{99m}Tc-DMP showing focal abnormal concentrations of activity in the location of the lesion.

Information box

It is well known that rib fractures caused by stress can occur in athletes. However, they are not common. To our knowledge this is the first to be reported in a kick boxer, and our purpose is to draw attention to this clinical entity.

force, and shaking or acute axial load (slamming), which cause indirect fracture.

Many first rib fractures are found incidentally during routine screening chest radiographs of military servicemen. Alderson,¹⁴ in a series of 75 000 routine consecutive roentgenograms of servicemen, found 73 cases of fracture of the first rib. Etter³³ discovered 31 anomalies of the first rib among 40 000 consecutive chest roentgenograms. Bowie and Jacobson³⁴ reported 17 cases of first rib fracture out of 62 782 roentgenographic chest examinations.

Most patients with first rib fracture present with pain. According to the literature, as in our case, the pain is usually located under the scapula and shoulder or behind the clavicle.^{2 14 17 19 20 22 25 27} This symptom may be clinically misleading raising concern about shoulder pathology. The pain may also be located in the upper chest or the base of the neck.^{6 25-28} The pain may be acute or increase over several days.^{13 27} In some cases there has been reported pleuritic chest pain.^{13 20} Pain is noted with motion of the shoulder, especially with obvious abduction greater than 90°.^{13 27} Weakness of the upper extremity²⁷ and occasionally pain or paraesthesia radiating down the arm have also been described.^{2 13 25 28}

First rib fracture is normally visualised with chest radiographs and radiographs of the thoracic ribs as a simple linear crack. The fracture may resemble non-union or pseudoarthrosis if it has been present for some time^{14 19 21 27} or as callus formation, as in our case. When callus formation is visualised on radiographs, and the history given from the patient is unclear, a computed tomography scan of the area and a radionuclide bone scan with ^{99m}Tc-DMP are justified.

Early complications from first rib fractures, such as rupture of the apex of the lung, pneumothorax, emphysema, pleurisy, aortic arch aneurysm, tracheo-oesophageal fistula, brachial plexus injury, Horner's syndrome, ruptured subclavian artery, and abscess formation above or below the clavicle, have been reported.^{1 2 4 6 7 9 11 35} Angiography is justified in many patients when certain criteria are met—for example, in multiple traumas with a pulseless limb.^{1 4 7 9} Specific indications for arteriography of subclavian artery and aortic arch in patients with first rib fracture after trauma include widened mediastinum on chest radiography, pulse deficit in the arm, posteriorly displaced first rib fracture, subclavian groove fracture anteriorly, brachial plexus injury, and expanding haematoma.³⁶ However, in an isolated first rib fracture caused by stress or muscle pull, it is rarely indicated.^{1 7 9} Late complications such as Horner's syndrome, thoracic outlet syndrome, and non-union or pseudoarthrosis of the rib have been reported, but they are very rare.^{6 9 15 37 38} Two explanations have been proposed for pseudoarthrosis occurring without history of trauma.^{3 19 27 33 34} Firstly, in some congenital defects of ossification, the margins adjacent to the defect are smooth and show no callus formation or healing potential. Secondly, acquired fractures can show bone sclerosis in the rib adjacent to the defect and ineffective callus formation.

Treatment for isolated first rib fractures, without any complications, is mild analgesia and rest until symptoms resolve.^{2 17 20 25 27 28} If complications are present, each must be treated accordingly. Non-union of first rib fractures has been reported as asymptomatic, with no further treatment

necessary.^{17 19 27 33} If a persistently symptomatic non-union ensues, Curran and Kelly¹⁷ suggest that, if surgery is necessary, excision of the ends of the ribs at the fracture site may be required to decompress the neurovascular bundle. Proffer *et al*³⁹ suggest transaxillary resection of 90% or more of the first rib.

Authors' affiliations

T Sakellariadis, A Stamatelopoulou, E Andrianopoulos, P Kormas, Department of General Thoracic Surgery, 401 General Army Hospital of Athens, Halandri, Athens 15238, Greece

Correspondence to: Dr Sakellariadis, Department of General Thoracic Surgery, 401 General Army Hospital of Athens, 91-95 Antoniou Tritsi, Halandri, Athens 15238, Greece; sakellariadist@in.gr

Accepted 16 December 2003

REFERENCES

- Albers JE, Rath RK, Glaser RS, *et al*. Severity of intrathoracic injuries associated with first rib fractures. *Ann Thorac Surg* 1982;**33**:614-18.
- Breslin FJ. Fractures of the first rib unassociated with fractures of other ribs. *Am J Surg* 1937;**35**:384-9.
- Gershon-Cohen J, Delbridge RE. Pseudarthrosis, synchondrosis and other anomalies of the first ribs. *AJR Am J Roentgenol* 1945;**53**:49-54.
- Holmes TW, Netterville RE. Complications of first rib fracture, including one case each of tracheo-esophageal fistula and aortic arch aneurysm. *J Thorac Surg* 1956;**32**:74-91.
- Jones TE. A remarkable injury. *BMJ* 1869;ii:201.
- Lorentzen JE, Movin M. Fracture of the first rib. *Acta Orthop Scand* 1976;**47**:632-4.
- Phillips EG, Rogers WF, Gaspar MR. First rib fractures: incidence of vascular injury and indications for angiography. *Surgery* 1981;**89**:42-7.
- Woodring JH, Fried AM, Hatfield DR, *et al*. Fractures of the first and second ribs: predictive value for arterial and bronchial injury. *AJR Am J Roentgenol* 1982;**138**:211-15.
- Yee ES, Thomas AN, Goodman PC. Isolated first rib fracture: clinical significance after blunt chest trauma. *Ann Thorac Surg* 1981;**32**:278-82.
- Barrett GR, Shelton WR, Miles JW. First rib fractures in football players. A case report and literature review. *Am J Sports Med* 1988;**16**:674-6.
- Griffin EH, Minnis JF. Traumatic fracture displacement of the first rib. *NY J Med* 1957;**57**:2407-8.
- Moore RS. Fracture of the first rib: an uncommon throwing injury. *Injury* 1991;**22**:149-50.
- Powell FI. Fracture of the first rib: its occurrence and clinical diagnosis. *BMJ* 1950;**1**:282-5.
- Alderson BR. Further observations on fracture of the first rib. *Br J Radiol* 1947;**20**:237, 345-75.
- Blichert-Toft M. Fatigue fracture of the first rib. *Acta Chir Scand* 1969;**135**:675-8.
- Clement DB. Tibial stress syndrome in athletes. *J Sports Med* 1974;**2**:81-5.
- Curran JP, Kelly DA. Stress fracture of the first rib. *Am J Orthop* 1966;**8**:16-18.
- Devas MB, Sweetnam R. Stress fracture of the fibula. A review of fifty cases in athletes. *J Bone Joint Surg [Br]* 1956;**38**:774-818.
- Freiberger RH, Mayer V. Ununited bilateral fatigue fractures of the first ribs. A case report and review of the literature. *J Bone Joint Surg [Am]* 1964;**46**:615-18.
- Gartler R, Pavlor H, Targ JS. Stress fracture of the ipsilateral first rib in a pitcher. *Am J Sports Med* 1985;**13**:277-9.
- Hartley JB. Stress fracture of the first rib. *Lancet* 1945;**1**:446-7.
- Lankner PA, Micheli LJ. Stress fracture of the first rib. A case report. *J Bone Joint Surg [Am]* 1985;**67**:159-60.
- Toulos HW, Erwin WD, Woods GW, *et al*. Unusual lesions of the pitching arm. *Clin Orthop* 1972;**88**:169-82.
- Wilson EJ, Katz. Stress fractures. *Radiology* 1969;**92**:481-6.
- Brooke R. Jive fracture of the first rib. *J Bone Joint Surg [Br]* 1959;**41**:370-1.
- Hartley JB. Blind sports: first rib stresses and the B.I.R. *Br J Radiol* 1959;**32**:561-71.
- Jenkins SA. Spontaneous fractures of both first ribs. *J Bone Joint Surg [Br]* 1952;**34**:9-13.
- Aitken AP, Lincoln RE. Fracture of the first rib due to muscle pull. *N Engl J Med* 1939;**110**:1063-4.
- Weiner DS, O'Dell HW. Fractures of the first rib associated with injuries to the clavicle. *J Trauma* 1969;**9**:412-22.
- Gray's anatomy, 38th ed. Philadelphia: WB Saunders, 1995:539-41.
- McBryde AM. Stress fractures in athletes. *J Sports Med* 1976;**3**:212-17.
- Strouse PJ, Owings CL. Fractures of the first rib in child abuse. *Radiology* 1995;**197**:763-5.
- Etter LE. Osseous abnormalities of the thoracic cage seen in forty thousand consecutive chest photoroentgenograms. *AJR Am J Roentgenol* 1944;**51**:359-63.
- Bowie ER, Jacobson HG. Anomalous development of the first rib simulating isolated fracture. *AJR Am J Roentgenol* 1945;**53**:161-5.
- McAdam JG, Templeton JL, Nixon JR. Isolated fractures of the first ribs: an indication of major cervicomedastinal injury. *Injury* 1986;**17**:226.
- Gupta A, Jamshidi M, Ruben JR. Traumatic first rib fracture: is angiography necessary? A review of 730 cases. *Cardiovasc Surg* 1997;**1**:48-53.
- Aspin J. Anomalous ossification of ribs as a cause of pseudarthrosis. *Br J Radiol* 1950;**23**:16-17.
- Fordham SD. The significance of first rib fractures. *Med Times* 1977;**105**:118-19.
- Proffer DS, Patton JJ, Jackson DW. Nonunion of a first rib fracture in a gymnast. *Am J Sports Med* 1991;**19**:198-201.