



## Stabilization of Multiple Rib Fractures in a Canine Model

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### Description

Stress fractures are a common injury in active and athletic individuals, accounting for injuries seen at sports medicine clinics. Most stress fractures occur in the lower extremity, with the tibia metatarsals, and fibula being the most common sites. Stress fractures of the upper extremity and torso are relatively rare; isolated fracture of the ribs is even more uncommon. Middle-rib stress fractures occur in competitive rowers golfers gymnasts and swimmers primarily because of the opposing muscular forces of the serratus anterior and external oblique muscles. Stress fractures in the floating ribs occur in baseball players as a consequence of opposing latissimus dorsi and external oblique muscle forces. Stress fractures of the first rib have occurred in baseball basketball tennis, weightlifting, gymnastics and ballet. The current report is, to our knowledge, the first documentation of a stress fracture of the first rib in a lacrosse player. Eight days before presentation, a 14-year old right-hand-dominant female lacrosse attack wing and midfielder experienced insidious right shoulder pain. Six days after her pain began, she awoke with a sudden increase in pain that brought her to tears and caused slight difficulty with breathing. The pain was anterior in the right sternoclavicular joint and posterior in the para spinal muscles in the upper thoracic region. Two days later, she presented with resolution of her shortness of breath but with continuing pain, mainly in the right per scapular region. The pain level was 0-10 at rest and 8-10 with forward flexion or abduction of the right arm above 90°. The pain was relieved by 200 mg of ibuprofen, 2-3 times per day. She reported no trauma to the right shoulder and was otherwise healthy. There had been no changes in her lacrosse practice routine, and she had not been shooting any more than usual during lacrosse practice before the onset of pain. As a freshman, she was one of the youngest players on the varsity team, but her training schedule was identical to that of her teammates, with practices or games 5 to 6 days per week. She reported normal menstrual cycles and eating habits, rendering the female athlete triad unlikely. The patient was instructed to discontinue all athletic activity for at least 6 to 8 weeks. She was encouraged to move the extremity so that she would not become stiff, but she was instructed to avoid weighted activity with more than radiographs at 6 and 12 months showed incomplete healing of the fracture with a pseudarthrosis. Despite this pseudarthrosis, she was able to return to full participation in across after 3 months without any specific rehabilitation program aside from

her activities of daily living. Stress fractures of the first rib have been reported in many sports and activities that involve overhead motion of the arm. It was first reported a first-rib stress fracture in a team basketball and lacrosse player, for whom symptoms began after an acute pop while playing tennis.

### Cause of Rib Fractures

The cause of first-rib stress fractures is likely a combination of muscle forces acting on an inherently weak first rib. Movement of the arm overhead results in opposing forces in the serratus anterior and intercostal, which pull the rib inferiorly, and by the anterior and middle scalene muscles, which produce superiorly directed forces. The groove for the subclavian artery, located between the anterior and middle scalene, also provides a point of weakness in the first rib where the stress may concentrate and predispose to fracture. The presentation of first-rib stress fractures typically includes pain beneath the shoulder and scapula, behind or just inferior to the clavicle, and at the base of the neck. In most patients, the pain is sub-acute and often described as a dull ache. Exacerbating factors include coughing, deep inspiration, and overhead activity. Less common, there is sudden onset of sharp pain in the shoulder or neck region with transition from stress fracture to complete fracture. In most cases of first-rib stress fractures, the onset of pain occurs over several months before becoming unbearable. In some cases, there is a prodromal period of soreness followed by a sudden increase of the pain associated with a discrete event. An unusual symptom for first-rib stress fractures in the current patient was her acute onset of dyspnea, chest pain, and shortness of breath. The differential diagnosis could include pneumothorax, atypical cardiac pain, pulmonary embolus, and tumor. Pneumothorax after traumatic first-rib fractures has been reported. The sensitivity of radiography for all early-stage stress fractures may be as low as 10% and only 30%-70% at follow-up. Early stress fractures can be identified by regions of focal periosteal bone formation and graying of the cortex, indicative of hyperemia, edema, and decreasing bone density. When first-rib stress fracture is suspected but initial radiographic findings are negative, several additional imaging options are available. Radionuclide triple-phase bone scanning with technetium is exceedingly sensitive for stress fractures. With a stress fracture, all 3 phases of the bone scan are positive. Computed tomography, especially 3-dimensional reconstructive computed tomography, can confirm the diagnosis of stress fracture.

### Returned to Sports

It presents the cases of a teenage basketball player with a first rib fracture after stretching and that of a teenage cheerleader with a first Magnetic resonance imaging with fat suppression has certain advantages in detecting stress fracture: high sensitivity, localization, multilane capability, no radiation, and shorter imaging time compared with triple-phase bone scanning. The treatment for an isolated fracture of the first rib principally involves activity modification and pain control. Most patients can gradually return to the inciting overhead activity after 4-6 weeks. Prolonged periods of rest may be necessary for delayed or non-union.

rib fracture from straining to lift another cheerleader. Both patients became asymptomatic following conservative treatment and returned to sports. These cases were then evaluated next to the existing literature. The mechanism for these non-traumatic fractures is thought to be due to sudden contractions of opposing muscle forces on developing bone. Because of the biomechanics of the first rib's opposing muscle attachments, first rib fractures should be considered in patients who report pain deep to the medial clavicle, even without a history of direct, severe trauma. Fractures of the first rib are

particularly concerning with regards to the potential for associated subclavian vessel, brachial plexus, or lung and pleural injury. While related complications have been reported in traumatic first rib fracture cases, acute injury to these structures has not been reported in non-traumatic first rib fractures. Due to the anatomy of the first rib with opposing serratus anterior, intercostal, and scalene muscle attachments bracketing the subclavian grooves, first rib fracture should be considered in patients, particularly teenage athletes, presenting with subclavicular pain even in the absence of severe direct trauma.