Stress Fracture of Second Rib and Scapular Spine in a Female Softball Player

Article in Current Sports Medicine Reports · September 2014
DOI: 10.1249/JSR.0000000000000084 · Source: PubMed

CITATIONS
2

READS
66

4 authors, including:

Alejandro Ignacio Marcano
Karolinska Institutet
11 PUBLICATIONS  41 CITATIONS
SEE PROFILE

Gonzalo Samitier
Hospital General de Villalba
20 PUBLICATIONS  597 CITATIONS
SEE PROFILE

Kevin Farmer
University of Florida
43 PUBLICATIONS  167 CITATIONS
SEE PROFILE

All in-text references underlined in blue are linked to publications on ResearchGate, letting you access and read them immediately.
STRESS FRACTURE OF SECOND RIB AND SCAPULAR SPINE
IN A FEMALE SOFTBALL PLAYER

Alejandro I. Marcano, MD, Gonzalo Samitier, MD PhD,
Thomas W. Wright, MD and Kevin W. Farmer, MD

Department of Orthopaedics and Rehabilitation,
University of Florida, Gainesville, FL

Running title: Stress Fracture of 2nd Rib & Scapular Spine

Corresponding author:

Kevin W. Farmer, MD
Orthopaedics and Sports Medicine Institute
3450 Hull Road, University of Florida
(352) 273-273-7456, office; (352) 273-7388, fax.
Gainesville, FL 32607
Phone: 352-273-7017
Farmekw@ortho.ufl.edu

No funding or research support of any kind has been received for this research.
None of the authors have any conflicts of interest associated with this research.
The results of the present study do not constitute endorsement by the American College of Sports Medicine.

Abstract

INTRODUCTION: Stress fractures of the upper extremity in athletes are relatively common. However, stress fractures to the second rib or the scapular spine are not common. Their rarity can present a diagnostic challenge and result in delayed diagnosis. We report the case of a female softball player with a stress fracture of the second rib and scapular spine.

METHODS: A 17-year-old, right-hand-dominant female who is a softball player in the catcher position (overhead throwing motion) presented with chronic, intermittent right shoulder pain for three years. She had been seen by several physicians without a satisfactory outcome. We describe her symptoms and our diagnosis and management of her case.

RESULTS: Three-phrase radionuclide bone imaging revealed increased uptake of tracer over the first rib and along the scapular spine. A computed tomography (CT) scan of the shoulder and upper ribs with multiplanar 3D reconstruction confirmed a fracture over the posteromedial angle of the second rib with significant old callus formation and remodeling but no scapular spine pathology. Patient was advised to stop her sports activities completely and within two months after definitive diagnosis she was completely pain free and allowed to gradually resume upper body activities.

CONCLUSION: In overloading athletes with prolonged upper extremity pain and normal x-rays, we suggest use of three-phrase radionuclide bone imaging. If any abnormality is found, MRI or CT scans of the site indicated. High-speed photographic evaluation of the athlete’s throwing or batting mechanics could aid in diagnosis and in detecting abnormal motion that
could create excessive forces in the upper extremity. A repeat motion analysis after healing could identify problems that could be addressed, preventing reinjury.

KEY WORDS: three-phase radionuclide bone imaging; upper extremity pain; overhand athlete; osseous pain
Paragraph Number 1  Stress fractures of the upper extremity in athletes are relatively common and have been well described. These include stress fractures of the first rib and scapula, specifically the acromion and body. However, stress fractures to the second rib or the scapular spine are very rare. A stress fracture can arise when repetitive mechanical loading of the bone is greater than the capacity of the bone to remodel and heal (21). Because mechanical loading is greatest in the lower extremities, this is the most common site of stress fractures, especially in the tibia. Non-weightbearing bones have stress fractures less often (28), but sites such as the upper extremity are now being recognized more frequently (20).

Paragraph Number 2  Athletes participating in sports with repetitive overhead motions or high upper extremity usage like rowing, golf, baseball, weight lifting and tennis are more likely to have stress fractures of the ribs, as is the case reported here (18). We found only three case reports of second rib stress fractures in the literature (7,15,17); another case was reported within a series of rib stress fractures due to rowing (19).

Paragraph Number 3  Even more rare are stress fractures of the scapula, although they have been described in the coracoid, the scapular spine, the acromion and the body of the scapula. Of these, only 8 occurred in athletes. Upper extremity stress fractures have been reported from upper extremity activities such as playing tennis, golf, or cricket, baseball pitching and blocking by an offensive lineman in football (9).

Paragraph Number 4  This report describes a unique case of a female softball player with a second rib stress fracture and a coexistent stress fracture of the scapular spine of the dominant arm. The very unusual etiology of her shoulder pain represented a diagnostic challenge due to its rarity. Permission was obtained from the patient for publication of this case report. To our knowledge, there are no published reports of second rib or scapular spine stress fractures,
occurring together or individually, in baseball or softball players. Our case represents an interesting novelty in the medical literature and illustrates the importance of alternative diagnostic procedures when presented with a clinically challenging case.

CASE REPORT

Paragraph Number 5  A 17-year-old, right-hand-dominant female who participates in softball at the catcher position (overhead throwing motion as opposed to the underhand motion of a softball pitcher) presented with chronic, intermittent right shoulder pain that has lasted for three years. During this period, the patient had been seen by several physicians without a satisfactory outcome. The pain was fairly diffuse in nature and localized to the posterior lateral aspect of the shoulder, primarily over the posterior surface and medial border of the scapula. It was exacerbated with a significant increase of activities, including overhead motions when throwing or weight training, and had a concomitant grinding sensation felt at the lateral inferior aspect of the scapula. The patient had normal and complete active and passive range of motion. There was a primary focus of tenderness to palpation along the medial scapular border as well as in the medial muscle belly of the supraspinatus and infraspinatus musculature directly over the posterior scapula. Two x-rays of right shoulder were obtained and revealed no evidence of fractures, dislocation, or subluxation. Magnetic resonance images (MRI) of right shoulder were ordered and revealed no evidence of any pathology.

Paragraph Number 6  After inconclusive and/or negative reports of the imaging studies, the patient was offered several treatment options such as physical therapy, specific throwing
mechanism reeducation program, anti-inflammatory medications or a trigger point injection. She elected to have the trigger point injection, and noted about a 60% improvement in her pain and continued throwing and participating in softball.

**Paragraph Number 7** Two months after the injection, the patient continued to have pain. She said, “It feels like my shoulder blade is sticking to my rib.” This impeded her follow-through motion when throwing. A second MRI of the scapulothoracic joint was obtained and revealed edema in serratus anterior insertion on inferior scapula, but no other pathology. The patient was advised to discontinue physical activity. She was seen for follow-up two months later and reported that she continued to experience right scapulothoracic pain and crepitus when the joint was positioned on forward flexion and abduction. Due to the involvement of the scapulothoracic joint, a triple-phase bone scintigraphy was sought to assess other possible osseous pathology. The bone scan revealed intense increased uptake of tracer over a point in the first rib and along the scapular spine compatible with stress fractures (Figure 1).

**Paragraph Number 8** A computed tomography (CT) scan of the shoulder and upper ribs with multiplanar 3D reconstruction confirmed a fracture over the posteromedial angle of the second rib (Figure 2) with significant old callus formation and remodeling present but no scapular spine pathology. After radiographic analysis we diagnosed a healed scapular spine stress fracture visible on CT scan with remnant uptake on bone scan. From the bone scan we mistakenly observed a stress fracture of the posteromedial angle of the first rib that later was determined to be located on the second rib. The misidentification arose from the proximity of the two ribs, possible structures superposition and the poor resolution of the scan.

**Paragraph Number 9** The patient was advised to stop her sports activities completely and within 2 months after definitive diagnosis she was completely pain free and allowed to gradually
resume upper body activities. Our recommendations also included an evaluation of her throwing and batting mechanics with the coaches. The patient agreed that her clinical data could be used anonymously in a presentation or publication. Because she was a minor, written authorization was obtained from the mother as well.

DISCUSSION AND REVIEW OF THE LITERATURE

**Paragraph Number 10** A stress fracture occurs as a consequence of an imbalance between bone resorption and bone deposition in response to stress. Tension forces promote osteoclastic resorption and compressive forces stimulate osteoblastic activity. Cortical stress usually involves tension and torsion (which consists of circumferential tensions), though promoting osteoclastic action. Bending produces tension on the convex side but compression on the concave side (21). Bone has a tendency to be weaker to tension forces. Therefore, with repeated stress as occurs with overuse, new bone formation cannot maintain the pace of bone resorption. A thinning and weakening of cortical bone develops and eventually microfractures appear alongside cement lines. These microfractures can progress to clinical stress fractures unless enough rest is ensured in order to allow osteoblasts to correct the imbalance (3). It is believed that shock absorption is lessened when muscles are fatigued and therefore more force is transmitted directly to bone, this increases the likelihood of microdamage accumulation. This is true specially for weight-bearing bones; however, in nonweight-bearing bones, repetitive contraction of muscle at its insertion may generate enough force to cause stress-induced injuries (21).
Paragraph Number 11  Risk factors for developing stress fractures include: consuming more than 10 alcoholic drinks per week, excessive physical activity with limited rest periods or a sudden increase in physical activity, female sex and the female athlete triad (eating disorders, amenorrhea, osteoporosis), low levels of 25-hydroxyvitamin D, smoking and running sports (20). Our patient presented with three of these risk factors. All of these factors other than running sports would also be applicable for stress fractures of the upper extremities.

Paragraph Number 12  Upper-extremity stress fractures are being diagnosed more frequently. Because each represents a unique entity with different mechanisms and presentations, we will discuss rib and scapular stress fractures separately.

Stress Fracture of the Rib

Paragraph Number 13  In a review of 196 stress fractures in athletes, tibia fractures were the most common (11). Second in frequency were rib fractures (11), which have been reported in athletes participating in activities such as rowing, golf, baseball, weight lifting and tennis, among others (12,18). We found only three case reports in the literature of second rib stress fractures. These occurred in a basketball and lacrosse player (15), a weightlifter (7) and a mother for carrying her child with a single arm (17). Additionally, another case was found included within a case series of 12 rowers (19).

Paragraph Number 14  Upper-extremity movements, trunk rotation, bending, and breathing all make use of muscles attached to the ribs. Stress fractures of the ribs are mostly likely to occur when the athletic activity results in excessive and repetitive forces. In an overview, Jones reported that stress fractures of the ribs are most often reported in the first rib
anterolaterally, the fourth through ninth ribs posterolaterally, and the second and third ribs posteromedially (12) which coincides with the case we described.

**Paragraph Number 15** Second rib stress fractures are rare and have not been described in the literature. First rib stress fractures, which are similar anatomically, occur where the bone is thinnest in width, at the subclavian groove between the insertion of the anterior and middle scalenus muscles (18). The second rib is much longer than the first, but has a very similar curvature. The body is not flattened horizontally like that of the first rib and it does not have such grooves. It has attachments for the serratus anterior, scalenus posterior and intercostal muscles. Superiorly directed forces from the scalene muscles stress the rib, whereas inferiorly directed forces are the product of the serratus anterior and intercostals muscles (4). The head and neck are stabilized during throwing motions by eccentric loading of the anterior neck musculature; this may contribute to the mechanism of injury. Noonan et al. performed electromyographic (EMG) analysis of specific muscles and reported that the serratus anterior muscle becomes active in the late cocking phase, is at maximum exertion during acceleration, and remains active during the follow-through (18). This agrees with our patient’s pain when performing overhead throwing motions (late cocking-acceleration).

**Paragraph Number 16** Patients with rib stress fractures usually report a dull aching pain of insidious onset in the posterior shoulder or upper back (5). Our patient initially had medial scapular pain that could have been generated by the fractured second rib underneath. This could explain the grinding sensation and, later on, the crepitation; these could have been a consequence of the callus forming underneath making contact with the scapular body. In throwing athletes, delayed union and nonunion are the most common complications (5). Fortunately, our patient did not suffer from these complications.
Stress Fractures of the Scapula

**Paragraph Number 17** Stress fractures of the scapula are even more rare than rib stress fractures. They have been described in the coracoid, the scapular spine, the acromion and the body of the scapula. The literature provides 12 previous reported cases of acromial stress fracture, of which 4 occurred in sports athletes (2, 6, 8, 10, 22-25, 27). With fractures of the base of the acromion considered as scapular spine fractures, only 5 cases were identified (8, 10, 24, 27).

**Paragraph Number 18** The scapula is highly mobile and the chest wall and relatively well protected from stress injuries. Hall and Calvert argue that the probable mechanism could be a contraction of the posterior fibers of the deltoid (8). On the other hand, EMG studies have shown that the posterior rotator cuff muscles are maximally active during the follow-through phase of throwing. The muscles that attach to the scapula in this area may, under certain conditions, produce more stress than the bone can withstand (9). Our patient had tenderness when palpating the supraspinatus and infraspinatus muscles, which could have been easily referred from their scapular spine attachments. The mechanism of injury in our patient cannot be definitively stated, as she had no formal photographic or electromyographic study of her throwing mechanics before or after the injury.

**Paragraph Number 19** High clinical suspicion is required for diagnosis of rib or scapular stress fractures because onset of pain is seldom acute and physical symptoms can be vague. Plain radiographs are often inconclusive and could be normal initially in the acute phase, but bone scans and MRIs usually help clarify the diagnosis (3). Altered metabolism associated
with stress injuries can be detected by bone scintigraphy (or bone scan) about two weeks earlier than structural findings can be seen in radiographs. Bone scintigraphy is highly sensitive (almost 100% sensitivity), but its applicability is limited by lack of specificity (16). Once unusual stress fractures have been identified by bone scan, additional studies are required for treatment or follow-up. In sports medicine, bone scintigraphy is most useful in identifying stress lesions and fractures in athletes with negative radiographs. However, when stress fractures are suspected most authors recommend using MRI for higher specificity and soft tissue detail for potential differential diagnosis (14). In addition, MRI may show earlier return to baseline or recovery compared with scintigraphy (approximately 6 months versus 8–12 months), which explains why, for our patient, there was late evidence of fracture in the scapular spine on the bone scan but not on other studies. Currently, most authors reserve MRI for the evaluation and follow-up of elite athletes or when combined assessment of clinical and scintigraphic findings are inconclusive. Yet, in our case, several MRI studies were done and reported non-specific findings. The use of CT should only be reserved for specific indications like an equivocal finding on radiograph, MRI and scintigraphy (16). The use of bone scan helped us localize the anatomic area where our patient’s stress fracture took place; CT scan with 3D reconstruction determined the exact location and confirmed the diagnosis.

**Paragraph Number 20** Lee and Worsley (13) have suggested a different diagnostic approach for osseous pain. If plain radiographs return normal, they recommend following with scintigraphy; if any abnormality is found, an anatomic imaging of the site is indicated (such as MRI or CT scans) (Figure 3). This approach would have likely avoided the delay in diagnosis that our patient experienced, because a bone scan would have been performed earlier in the diagnostic process.
Paragraph Number 21  Most upper extremity stress injuries will heal without operative treatment (3), with activity discontinuation (rest) and pain management. When symptoms have subsided (usually 4 to 6 weeks), progressive return to activity is permitted (26). As a consequence of not having an accurate diagnosis, our patient did not suspend physical activity, hence, the symptoms continued; four months of rest were required before the symptoms calmed completely. Abnormalities which could predispose an athlete to injury may be identified by evaluation of throwing or batting mechanics (26). Our patient did not have such an evaluation before her diagnosis and four months of rest; this is why we suggested a detailed evaluation of her mechanics afterwards.

Paragraph Number 22  Currently, MRI is often used to evaluate suspected stress fractures. The rationale for this approach is based primarily on studies of the lower extremity and, hence, is site-dependent. This logic does not necessarily apply to all stress fractures. Based on our experience, we recommend the diagnostic flowchart proposed by Lee and Worsley (13) (Figure 3) for cases of prolonged unusual upper extremity pain in overloading athletes with normal x-rays, in order to avoid the consequences of a delayed diagnosis. High speed photographic analysis of the athlete’s throwing or batting mechanics may also be useful in detecting abnormal motion that could create excessive forces in the upper extremity. Identification of excessive forces would elevate the clinical suspicion and drive the diagnosis process towards stress injuries.
REFERENCES


Figure Legends

**FIGURE 1** - Triple-phase bone scintigraphy showing increased uptake (arrows) in first or second right rib and scapular spine.
FIGURE 2 - Anatomical drawings: (A) - Multiplanar 3D reconstruction of CT scan showing callus formation (arrow) on posteromedial angle of right second rib (lateral view).

(B) - Multiplanar 3D reconstruction of CT scan showing callus formation (arrow) on posteromedial angle of right second rib (anterior view).
FIGURE 3 - Flow chart for diagnosis of pain of osseous origin proposed by Lee and Worsley.¹³

(Reprinted with permission.)