

Rib stress fracture in a female athlete caused by bouncing the barbell in bench press exercise: A case report

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Abstract

Rib stress fractures can occur in sports involving repetitive trunk muscle contractions. Few documented cases show rib fractures from repetitive upper-limb training. This report presents a case of a rib stress fracture from micro blunt trauma during bench press exercises. The patient was a 24-year-old elite female sprinter with a history of left navicular stress fracture and secondary amenorrhea treatment a year prior. She modified her bench press technique to involve bouncing the barbell on her rib cage. Within weeks, she experienced anterior chest pain, exacerbated by sneezing. Computed tomography revealed a fifth rib fracture with callus formation. After refraining from bench presses for 4 weeks, her chest pain subsided, allowing her to resume upper-limb training. When athletes performing bench press exercises experience chest pain, rib fractures should be considered, even without acute trauma. Additionally, research on the safety of the bouncing bench pressing technique is required.

Keywords

Rib stress fracture, bench press, female athlete, case report

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Introduction

Stress fractures are common injuries among athletes, with reported incidence rates ranging from 1.4% to 4.4%.^{1,2} Although the prevalence of rib stress fracture has been reported to be less frequent than stress fracture of the lower extremity, it has been observed to occur in a variety of sports that require repetitive contraction of the trunk muscles, such as rowing, swimming, golf, and baseball. Repetitive tensile, angular, and torsional stresses on the ribcage are the main cause of rib stress fractures.^{3–7} Acute traumatic rib fractures induced by weight training exercises have been reported previously⁸; however, there have been few reports of rib stress fractures caused by repetitive bench press exercises.⁹

Our case report highlights a rib stress fracture in an elite female sprinter, resulting from repetitive blunt impact on her rib cage during bench press exercises.

Case presentation

The patient was a 24-year-old elite female sprinter competing at the national level. She underwent conservative

management for right Achilles tendonitis for 3 months. During the rehabilitation period, because of her lower-limb injury, she increased the intensity of upper-limb training, such as bench press exercises. The patient was originally engaged in bench press exercises weekly throughout the year. During this rehabilitation period, the frequency of bench press exercises was increased to three times per week instead of once a week. The load applied was approximately 55 kg, equivalent to her body weight, with repetitions limited to her capability (approximately 6–8 reps and 4–6 sets). In

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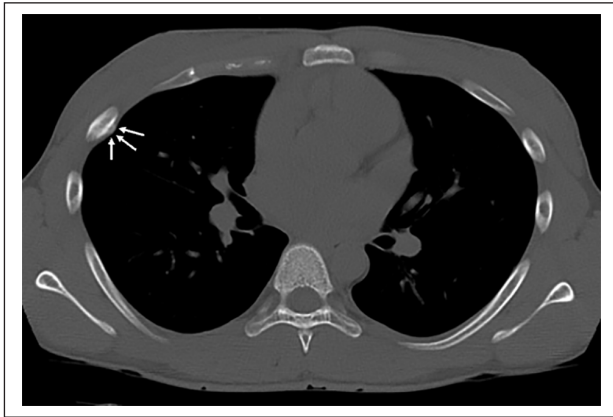


Figure 1. Fracture of the right fifth rib with predominant callus formation on the pleural side (arrows) on chest computed tomography.

addition, she modified the bench press lifting technique, to involve bouncing the barbell on the rib cage for assistance in lifting. Approximately 2 weeks after implementing these modifications, the patient began experiencing gradually progressive discomfort in the right anterior thoracic region, which was aggravated on sneezing. She initially sought medical attention from her primary care physician. Since there were no abnormal findings on chest radiography or electrocardiogram, she continued bench press exercises for a few weeks. As her pain progressively worsened, she visited our hospital for further evaluation.

She was right-hand-dominant, her height was 161.6 cm, and she weighed 53.3 kg, resulting in a body mass index of 20.4. Her medical history did not include previous rib fractures or neoplastic disease; however, she had a history of a left navicular stress fracture sustained a year prior, which had been treated for 4 months. Bone density scans performed at that time revealed a lumbar (L1–L4) bone mineral density of 1.116 g/cm², lumbar (L1–L4) *T*-score of 0.0, and *Z*-score of 0.0.¹⁰ During the same period, the patient also sought treatment for secondary amenorrhea, as menstruation had ceased for 3 months prior to the onset of the chest pain. On physical examination, the patient experienced right anterior chest pain during jumps and forward bending of the trunk, although there was no localized area of tenderness on the chest. Subsequent computed tomography (CT) revealed a fracture at the anterolateral part of the right fifth rib, with evidence of predominant pleural-side callus formation (Figures 1 and 2). The location of the rib fracture corresponded to the area where the rib cage made contact with the barbell during the bench press exercises. The patient was diagnosed with a rib stress fracture resulting from repetitive blunt trauma caused by direct external compression forces on the rib cage. Conservative management was initiated, and bench press exercises were discontinued, while activities such as walking, stationary biking, and lower extremity exercises (body weight squats, calf raises, and single-leg

balance) were permitted. Menstruation status of the patient was normal cycle at this point. Jogging was introduced in the third week. Once the pain subsided during trunk bending, arm swinging, and jumping, bench press exercises were gradually reintroduced with light weights (15 kg) starting in the fifth week. The level of physical activity was progressively increased and patient returned to full training 6 weeks after the initial diagnosis, without any complications or recurrence of symptoms. Although imaging evaluation was not performed to confirm bone union after the return to training and competition, the patient continued to compete for sprinting without any recurrence of symptoms throughout the 2 years after the initial diagnosis with regular follow-up.

Discussion

We herein present a rare case of rib stress fracture caused by repetitive blunt trauma resulting from bench press exercises that involved bouncing the barbell off the rib cage to aid lifting. We emphasize two important points. First, when athletes complain of chest pain, a rib fracture should be considered a possible etiology, even in the absence of acute trauma, especially if they have been engaging in bench press exercises. Second, the use of bouncing movements during bench presses may pose safety concerns and increase the risk of rib stress fracture.

Our patient did not report a sudden onset of pain or any history of acute trauma. Instead, her symptoms developed insidiously, approximately 2 weeks after introducing a modification in the bench press lifting technique. This suggested a stress fracture of the rib caused by repetitive overloading and direct compression impact on the rib cage, rather than a single traumatic event. Stress fractures of the rib due to repetitive contraction of trunk muscles, such as those observed in rowers, swimmers, and golfers, have previously been reported.^{3–7} Rib stress fractures in such athletes are usually seen along the posterior axillary line, as the serratus anterior and external oblique muscles are attached in this region with callus formation usually occurring on both the chest wall and pleural sides.^{4,7} In our case, a rib fracture was observed on the anterolateral part of the rib, which corresponded to the area where the rib cage made contact with the barbell. In addition, callus formation was evident predominantly on the pleural side, which may indicate repetitive compression of the rib cage. To the best of our knowledge, a stress fracture resulting from direct compression of the rib cage during sports activities has not been previously documented. Considering factors such as the location of the fracture and the extent of callus formation, it is suggested that the cause of the rib stress fracture in this instance is not muscle traction but rather the consequence of repeated minor external forces acting directly upon the rib. Despite the presence of several risk factors, namely female sex, a history of previous stress fractures, and secondary amenorrhea,¹¹ the possibility of a rib stress fracture was not considered at the time of initial evaluation for chest pain. The diagnostic accuracy of plain radiographs for rib fractures has

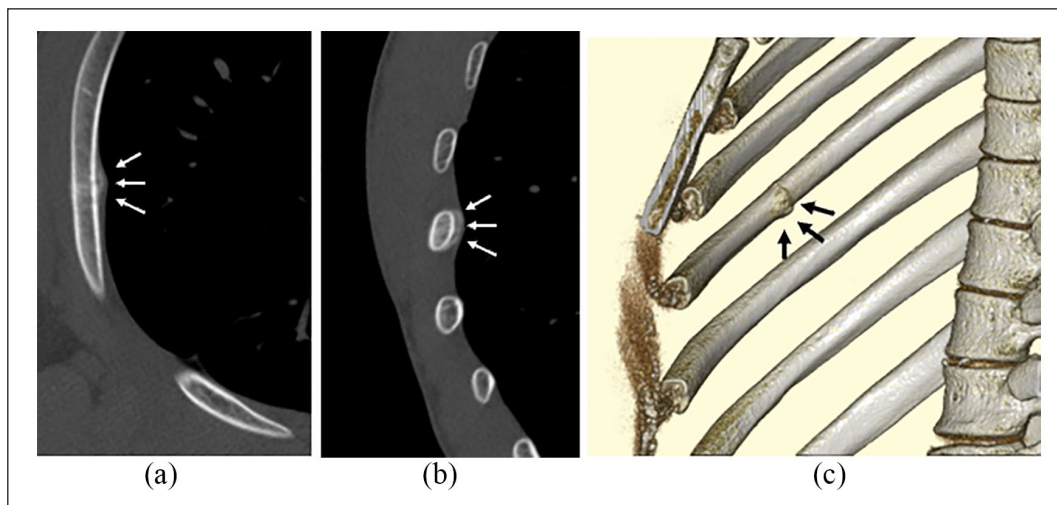


Figure 2. Fracture of the right fifth rib with pleural side predominant callus formation (arrows) on sagittal (a) and axial views (b), and three-dimensional reconstruction (c) on computed tomography.

been reported to be low, sometimes overlooking rib fractures (even those resulting from acute trauma).¹² Our diagnosis was based on CT imaging, and callus formation was observed only on the pleural side of the rib. Sonography has been reported to be a useful tool for detecting rib fractures;¹³ however, it might be difficult to detect the callus formation on the pleural side of the rib. A thorough history, including a review of all past medical conditions and any changes in training techniques at the time of onset of symptoms, proved valuable in arriving at the correct diagnosis.

The bench press is a widely employed strength training exercise; however, specific techniques during this exercise can lead to injuries. Sprinters frequently incorporate bench press exercises into their training regimen to activate specific muscles, such as the pectoralis major, deltoids, and triceps, which are associated positively with sprinting performance.^{14–17} On the contrary, there have been numerous reports of bench press-related injuries that encompass acute conditions, such as pectoralis major and pectoralis minor muscle ruptures, scapulohumeral joint dislocations, superior labrum anterior and posterior lesions, scaphoid fractures, and chronic conditions such as clavicular fractures and distal clavicle osteolysis.^{8,9,18–20} While there has been report of the second rib fractures caused by bench press exercises, this was attributed to muscle traction forces.⁹ The fracture in our case may have been caused by the accumulation of minor external forces, differing from the previously reported cases primarily associated with muscle traction. Previous studies have investigated various techniques to enhance bench press efficacy, including the implementation of the stretch shortening cycle (SSC) to augment the number of repetitions, weight load, and lifting velocity.^{21–23} In our patient, there was an improvement in the ability to lift heavier weights subsequent to modifying the technique to rapidly lower the barbell, allowing it to bounce off the rib cage. However,

this modification may not correspond to the original SSC technique. Ordinarily, the transition from the descent to the ascent phase of the barbell movement is conventionally regulated to stop at or just above chest level to avoid the bounce effect.²⁴ The bouncing effect is achieved by allowing the barbell to collide with the chest, generating immediate momentum that aids in accelerating the upward movement of the barbell. The bench press with the bouncing technique has been incorporated into the training routines of elite track and field throwing athletes, as it offers a more explosive and specific variation in the exercise.²⁵ It is important to note that even in the absence of external forces resulting in acute fractures, the modified bouncing technique could be hazardous for athletes with risk factors, such as a history of stress fractures and secondary amenorrhea as seen in our patient, because cumulative minor external forces may induce stress fractures.

There are several limitations to this case report. Measuring the load on the ribs during bouncing is challenging, and there was no imaging data available before the onset of pain. These limitations should be considered when interpreting the findings in this case report. Analyzing the form of athletes engaged in bench press and conducting imaging examinations on athletes using the bouncing technique could potentially help identify those at risk of developing stress fractures or impending fractures. This approach may provide further insights into the risks associated with bouncing and contribute to a better understanding of its potential hazards.

Conclusion

We present a rare case of a rib stress fracture resulting from repetitive microtrauma caused by direct compression impact on the rib cage during bench press exercises. This case highlights the importance of clinicians, trainers, or athletes paying

attention to the potential of bench presses that incorporate bouncing movements on the thorax to induce rib stress fractures. Close observation of the form and provision of support during training are critical components of prevention. Rib stress fractures should be considered as a differential diagnosis for athletes experiencing chest pain, particularly if they have engaged in bench press exercises. The effective treatment of rib stress fractures involves explaining the importance of rest to individuals and providing a clear plan for their return to the activity protocol. In addition, this case report underscores the importance of conducting research on the safety of the bouncing bench pressing technique.

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Author contributions

K.K. and Y.F. contributed to Conceptualization; K.K. contributed to investigation; K.K. and Y.F. contributed to writing—original draft preparation; K.O., M.H., Y.K., and Y.M. contributed to writing—review and editing; K.K. supervision. All authors have read and agreed to the published version of the manuscript.

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Ethics approval


At our institution, case reports do not require ethics review committee approval.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

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