

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Rib Fractures

Variant 1: Adult: <65 years of age.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
X-ray chest	8	PA view.	☼
CT chest without contrast	3		☼ ☼ ☼
X-ray rib views	2		☼ ☼ ☼
Tc-99m bone scan ribs	2		☼ ☼ ☼
CT chest with contrast	1		☼ ☼ ☼
CT chest without and with contrast	1		☼ ☼ ☼
US chest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: Adult: >65 years of age.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
X-ray chest	8	PA view.	☼
X-ray rib views	5		☼ ☼ ☼
CT chest without contrast	3		☼ ☼ ☼
Tc-99m bone scan ribs	2		☼ ☼ ☼
CT chest with contrast	1		☼ ☼ ☼
CT chest without and with contrast	1		☼ ☼ ☼
US chest	1		O
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

RIB FRACTURES

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Summary of Literature Review

Introduction/Background

Rib fracture is the most common thoracic injury and is thought to be present in 10% of all traumatic injuries and in almost 40% of patients who sustain severe nonpenetrating trauma [1,2]. Rib fractures typically affect the fifth through ninth ribs. This may be due to the fact that the shoulder girdle affords relative protection to the upper ribs and the lower ribs are relatively mobile and may deflect before fracturing [1]. Neither clinical examination nor radiography is ideal for the diagnosis of rib fractures. While rib fractures can produce significant morbidity, the diagnosis of associated complications (such as pneumothorax, hemothorax, pulmonary contusion, atelectasis, flail chest, cardiovascular injury, and injuries to solid and hollow abdominal organs) may have a more significant clinical impact [1,2]. Radiographs are specific but not very sensitive for undisplaced fractures, and clinical examination is sensitive but not specific [2,3]. In a study of 552 patients who had blunt chest trauma and resultant rib fracture (diagnosed on clinical or radiographic grounds), 93% of affected patients ultimately resumed daily activities without significant disability. Routine radiographic follow-up for these patients was not useful in the absence of clinical deterioration [2].

Radiography

Rib detail radiographs rarely add additional information to the posteroanterior (PA) film that would change treatment. A review of 271 patients who presented to a community hospital emergency department after minor trauma showed no difference in treatment (use of pain medications, etc) between patients who did and did not have rib fractures diagnosed [4].

Computed Tomography

Multidetector computed tomography (MDCT) is increasingly used as the method of choice for the radiologic evaluation of the traumatized patient. It provides an accurate assessment of fractures and associated internal injuries. CT also provides an accurate means of assessing cartilage fractures, which are typically missed on radiography [1,5]. However, CT is not usually performed only to evaluate for the presence of rib fractures; rather, it is used to evaluate for other associated complications of trauma. Postprocessing techniques such as volume-rendered display may depict rib fractures with high accuracy and may provide a more time-efficient method of evaluation compared to the sequential evaluation of numerous axial images. Multiplanar or 3D image processing may require a second console or workstation [1].

Ultrasound

Several articles have noted that ultrasound can detect fractures not seen on conventional radiographs [3,5,6]. Griffith et al [3] compared sonography and radiography (chest radiography plus one oblique rib radiograph) in 50 patients and found that radiographs detected only 8 of 83 (10%) sonographically detected rib fractures and were positive in only 6 of the 39 patients who had demonstrated fractures. In this study, sonography allowed evaluation of the costochondral junction, the costal cartilage, and the ribs and was able to show nondisplaced fractures. Kara et al [6] found rib fractures in 40.5% of 37 patients with minor blunt chest trauma and negative radiographs by using ultrasound; osseous fractures were more common in the elderly, and duration of pain was significantly longer in these patients compared to those with chondral injuries [3,5,6]. However, Hurley et al [7] found ultrasound to be only marginally superior to conventional radiographs, and its routine use was not indicated due to the lengthy time of the examination, averaging 13 minutes in this series, and patient discomfort from the pressure of the ultrasound probe, particularly since identification of the fracture was unlikely to impact patient care.

Organ Injury

Certain types of rib fractures are associated with an increased incidence of various organ injuries. There is increased likelihood of injury to the adjacent subclavian and innominate vessels with displaced first and second rib fractures, but this injury can usually be suspected on clinical grounds or from the chest radiograph [8].

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Suspicion of serious thoracic or abdominal complications of trauma based on the mechanism and severity of injury and physical examination should lead to a period of observation or abdominal CT for verification if indicated. Schurink et al [9] reported that the negative predictive value for abdominal organ injury with lower rib fractures due to low-energy impact was 100%; with lower rib fractures in the setting of a reliable negative physical examination, negative predictive value was 97%. Based on a study of 69 patients with nonthreatening trauma (stable vital signs with no evidence of cardiac injury, solid or hollow viscus rupture, or fractures associated with significant blood loss), Dubinsky and Low [10] concluded that neither rib studies nor even chest radiographs were of clinical benefit. A study of 55 patients with hepatic injury matched with 55 patients without hepatic injury following trauma showed that right rib fractures did not predict hepatic laceration, while there was a negative association of hepatic laceration with left-sided fractures [11].

Early literature emphasized that rib fractures (especially of the first and second ribs) were predictors for aortic injury, but several studies have demonstrated no increased likelihood of aortic injury with upper rib fractures, nor with multiple fractures [8,12,13]. In a study of 548 patients who underwent aortography, Lee et al [12] reported that fractures of the clavicle, sternum, scapula, and thoracic spine had no positive predictive value for aortic injury, and that rib fractures had a very weak positive predictive value. (Thoracic spine fractures actually had a negative predictive value for aortic injury.)

A flail chest can usually be diagnosed at physical examination. It is conceivable that in a heavy patient, a flail chest could be missed by clinical examination. However, a chest radiograph almost always shows the displaced fragments.

Rib Fractures after CPR

Lederer et al [14] showed that rib fractures are underreported on radiography performed following cardiopulmonary resuscitation (CPR). These fractures are more common on the left side and are more numerous in the elderly. The diagnosis of such fractures in CPR survivors is important. Approximately half of CPR survivors with rib fractures experience complications, and the presence of rib fractures in these patients may impair ventilation and compromise recovery. It should be noted that many of these patients are examined with portable supine radiography, which may contribute to underdiagnosis.

Multiple Rib Fractures

The presence and number of rib fractures do carry prognostic significance, and detection of rib fractures may be indicated under certain circumstances. Rib fractures are associated with pulmonary dysfunction (atelectasis, shunting, impairment of clearance of secretions, pneumonia, and adult respiratory distress syndrome). Treatment of rib fractures is aimed at pain control and avoidance of respiratory distress and intubation [2]. Morbidity and mortality are increased in patients with

three or more fractures, particularly in the elderly as they may have additional comorbid conditions that contribute to poor cardiopulmonary reserve [2,13]. The diagnosis of multiple fractures in an elderly patient may warrant transfer from a community hospital to a tertiary care center [13].

“Stress” Rib Fractures

Radiographically occult nondisplaced (“stress”) rib fractures may result from severe coughing, especially in women with chronic cough. Nuclear scintigraphy and chest CT may be used to diagnose these injuries. While scintigraphic findings are nonspecific, CT may demonstrate the fracture, fracture-related osteosclerosis or osteolysis, or callus formation. More importantly, metastatic or primary neoplasia may be successfully excluded [15-18].

Nuclear Medicine

Nuclear medicine bone scans may result in false-positive diagnosis of malignancy in patients with rib fractures [19]. In addition, patients with known malignancy and benign rib fractures may exhibit false-positive findings on FDG-PET studies performed 17 days to 8 weeks after injury [20].

Summary

- It is usually unnecessary to perform dedicated rib radiography (in addition to chest radiography) for the diagnosis of fractures in adults, because CT is almost always used to evaluate potential organ injury in patients with significant chest and upper abdominal trauma.
- Although the diagnosis of multiple fractures has prognostic implications, there is no evidence that performing rib studies is beneficial (as opposed to performing other diagnostic procedures to evaluate the presence or absence of internal organ injury).
- A possible exception is to establish the diagnosis of multiple fractures in the elderly if such information is to be used clinically to determine the need for tertiary or intensive care.
- CT, skeletal scintigraphy and ultrasound may be helpful in evaluating selected patients with occult “stress” fractures and in evaluating selected CPR survivors or in situations in which identifying a rib fracture is deemed to be clinically important.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of

organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® [Radiation Dose Assessment Introduction](#) document.

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼ ☼	0.1-1 mSv	0.03-0.3 mSv
☼ ☼ ☼	1-10 mSv	0.3-3 mSv
☼ ☼ ☼ ☼	10-30 mSv	3-10 mSv
☼ ☼ ☼ ☼ ☼	30-100 mSv	10-30 mSv

*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as NS (not specified).

Supporting Document(s)

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

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The ACR Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the FDA have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.