and clinical significance
patient with multiple rib fractures: Imaging modalities

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MS III

Core Radiology Clerkship
Agenda

Presentation of patient

Basic anatomy of ribs

Menu of radiological tests

When to image the ribs and their significance complications
Causes of rib fractures and associated
Our Patient

crossing street, and landed on the hood of car. A 34 year old female pedestrian presents to the ED after being hit by moving vehicle on her left side at a speed of 30mph while

She had no loss of consciousness.

She was brought to ED by ambulance.

Signs were within normal limits and she was A0x3. Patient was hemodynamically stable with good ventilation. Vital

and a left elbow laceration. Physical exam was normal except for left sided chest wall pain
Her lab work was unremarkable.
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Causes of rib fractures
Thorax consists of the 12 ribs, sternum [with manubrium (M), sternum (S), xiphoid (X)] and clavicle (C). Scapula is located posteriorly.

First 7 ribs are connected with the vertebral column, posteriorly, and with the sternum, anteriorly, by means of the costal cartilages. So called, true ribs cartilage of the rib above. Ribs 8-10 are attached to the anteriorly. The 11th and 12th ribs are free
A Transverse Diagram of the Thorax

CVJ – costovertebral junction
VB – vertebral body
CCJ – costochondral junction
S – sternum

Shown at level of 9
Anatomic Correlation

**Fracture of the first to third ribs** threatening injuries. Fractures of the first rib imply a violent force extremely rare and more commonly associated with either multiple rib fractures or life-plexus. These patterns of fractures may signify injury to the adjacent subclavian vein and brachial plexus. First rib often fractured posteriorly.

**Fracture of the fourth to tenth ribs**
4-10 ribs are most often broken. Multiple fractures can present as flail chest. Inward displacement of the fracture fragments at the time of the injury may lacerate the lung parenchyma, heart and vessels and other internal thoracic structures.

**Fractures of eleventh to twelfth**
Risk of hemorrhage around and within the visceral organs. Fractures of the lower ribs are also commonly associated with liver, spleen, kidneys, and diaphragm.

Source: Doty CI and Sinert RH. http://emedicine.medscape.com/article/825981-overview
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Causes of rib fractures
Menu of Radiological Tests:

- Chest X-ray
- Computed tomography
- Ultrasound
- MRI
- Bone Scan
- Single Photon Emission CT (SPECT)
Menu of radiological tests: Chest X-ray

fractures such as: Initial study of choice. Not sensitive for costal cartilage or stress fracture. CXR may miss up to 50% of rib fractures, but is still useful. Also, important for diagnosing processes associated with rib pneumothorax hemothorax pulmonary contusion pneumomediastinum pneumoperitoneum aortic injury.

Source: Bhavnagri SJ and Mohammed TLH.
and 5 th fractures of the 4 th and 5 th fractures of the 4

Our patient: AP Chest X-ray showing Ribs.

There is a subtle step-off pattern.

Patient was imaged with trauma board.

PACS, BIDMC
Menu of radiological tests: Ultrasound

Advantages
- Better than radiography.
- Pneumothorax and hemothorax as well.
- View of multiple planes and visualize in real time.
- More sensitive than chest radiograph (78% vs. 12%).
- Ribs.

Once rib fracture diagnosed, one can quickly rule out

Detects costal cartilage fractures and costochondral junction fractures.

You can scan entire rib at site of maximal tenderness and then adjacent.

Not widely used.

Skill dependent.

Time consuming and more costly than plain radiograph.

Can't assess first rib under clavicle and upper ribs under scapula.

Role limited to situations in which the diagnosis of a rib fracture alone is important.

Companion patient #1: Rib Ultrasound
Long-axis view of a fractured left third rib of a patient using a 12-MHz linear arrowstransducer. The disruption of the hyperechoic cortical alignment is shown by the

Menu of radiological tests: Computed Tomography

Advantages
- Best modality to visualize ribs
- Pleural hematoma, or pneumothorax. May help detect fracture lines, fracture fragments, callus formation,
- Can be used to evaluate costal cartilage injury.
- Improve detection by CT. Specific bone reconstruction algorithms and 3D reconstructions

Disadvantage
- Costly, time consuming, not always available, radiation exposure

Source: Bhavnagri SJ and Mohammed TLH.
Menu of radiological tests: RN Bone Scan, SPECT,

Radionuclide Bone scan
sensitive but not specific
Technetium (Tc 99m) methylene diphosphonate bone scanning

SPECT

• very sensitive for stress fractures.
• can help localize abnormal hot spot on bone
• can represent number of conditions beside rib fracture.

MRI
• No role yet in rib fracture evaluation
Source: Bhavnagri SJ and Mohammed TLH.
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Causes of rib fractures
When to image the ribs and their significance

- History
  - Major trauma
    - Computed tomography (CT)
      - Chest x-ray normal, patient is asymptomatic
        - Will diagnosis of rib fracture alter clinical management?
          - No
            - Treatment
          - Yes
            - Consider rib series or CT
  - Minor trauma
    - Chest x-ray
      - Chest x-ray normal, patient is asymptomatic
        - Consider CT
Recommended clinical management of patients with a history of chest trauma.

Bhavnagri, SJ and Mohammed, TLH. When and how to image a suspected broken rib. Cleveland journal of medicine. (2009) 76(5):309
When to image the ribs and their significance

Plain radiography is likely sufficient. In patients with minor blunt trauma, with little suspicion of associated injury or complication,

Trauma. CT is imaging study of choice in patients with penetrating or major chest or abdominal

Rib fractures correlate significantly to mortality and morbidity. Intensive care unit days, and length of stay (Bulger et al) in elderly, multiple rib fractures are associated with increased number of ventilator days, vs. 10% in young. Pneumonia occurred in 31% of elderly vs. 17% of young and mortality was 22% in elderly.

Mortality increased as number of rib fractures increased. (Sharma et al) Fractures had a 32% mortality. Patients with 1 or 2 rib fractures had a 3% mortality rate, and patients with 6 or more

Fractures can cause flail chest (when two or more ribs are fractured in two or more places) and can lead to ventilatory insufficiency due to ineffective respiratory action. (Doty
ventilation-This condition requires aggressive pain control, pulmonary toilet, and mechanical
Why confirm a rib fracture?

1. Detect associated injury
   and nerve damage, abdominal organ injury-pneumothorax, hemothorax pulmonary
   contusion, flail chest, pneumonia, vascular

2. Prevent complications such as atelectasis and acute respiratory failure

3. Document the injury
   occupational injury or abuse-medical-legal issues especially in cases of
   assault, motor vehicle crash,

4. Find appropriate pain management
   or nerve block.-undiagnosed patients can have long standing refractory pain.-NSAIDs
   are usually given for soft tissue injury but rib fracture may need narcotics

5. Detect pathologic fractures
6. Count how many ribs are broken
Management of rib fractures

it has little impact on patient management. Uncomplicated rib fractures do not require radiographic diagnosis because

Treatment is aimed at pain management widely. Operative management of rib fractures still topic of debate and not used

Indications: flail chest, chest wall deformity, pain and disability, non-union
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Causes of rib fractures

Rib fractures most commonly identified injuries of the chest. 10% of all traumatic injuries and 14% of all chest-wall injuries abuse, and rarely, paroxysms of coughing. Injury to the chest wall. MVA, assault, sports, cardiopulmonary resuscitation, physical Trauma—the most common cause of rib fractures, includes penetrating injuries and blunt

Cancer—causes pathologic fractures. Primary tumors or metastases.

gymnastics, and swimming. Stress fractures—high level athletes whose activity involves repetitive musculoskeletal loading. Activities include rowing, pitching, throwing, basketball, weight-lifting, ballet, golf,

Metabolic—hyperparathyroidism, glucocortical steroid administration, Paget’s disease, gout

Inflammatory—ankylosing spondylitis

Infection

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complications

Causes of rib fractures and associated
to the ED after being hit by motor vehicle. Back to our Patient: 35 year old female is brought to the ED after being hit by motor vehicle. Back to our Patient: 35 year old female is brought to the ED after being hit by motor vehicle.

A chest x-ray was performed which showed left sided rib fractures (3-6). CT scans of the head, c-spine, abdomen showed no traumatic injury.
fractures. Our patient had a CT which showed multiple rib
rib fractures on CT axial view

PACS, BIDMC
pneumothorax with pulmonary contusion

CT axial image taken superiorly shows a

PACS, BIDMC
CT image of 5th rib fracture on sagittal view

rib fracture seen as hyperdense line
CT coronal view of chest showing fractures of rib 3rd rib and 5th rib. Patient also has fractures of 4th and 6th rib which are not visible on this plane.
(arrow) and periosteal callus formation (c). CT image shows well-defined fracture Rib fracture with callus formation in 76-year-old.
Case continued…

and pain control. Patient was admitted to the medicine floor with chest pulmonary toilet electively in the intensive care unit. Days later, she transferred to the intensive care unit with fractures and her worsening contusions. She was intubated with worsening respirations, partly due to pain control for her rib and transported to the medicine floor. She remained on the ventilator for one week and was later extubated. She later developed a pneumonia, which was treated with levofloxacin. She was discharged in a good condition.
Here are two more examples...
fractures on coronal view. Companion patient #2. CT of a 40 M after 18ft fall with multiple rib fractures of left thorax
He suffered a hemopneumothorax, grade III splenic laceration and an adrenal hematoma (not visible on image)
fractures 6-12), pulmonary contusion, grade V shattered spleen, Companion patient #3. CT of a 60M post MVC with flail chest (rib and shock bowel.
ulmonary contusion

and shattered spleen
Take Home Points

Rib fractures are common pathologies. Most are managed conservatively, complications rib fractures can have associated. Confirmation is important, however, because
References

7. Sharma OP, Oswanski MF, Jolly S, Lauer SK, Dressel R Stombaugh HA. The perils of rib
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