

Usefulness of Transthoracic High-Resolution Ultrasound for Radiographically Undetected Rib Fractures

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ABSTRACT

Background: Blunt thoracic trauma comprises more than half of the rib fractures along with soft tissue injury. The sensitivity of conventional chest X-rays has been shown to be limited in showing rib fractures.

Aims / Objectives: To determine the usefulness of transthoracic high resolution ultrasound in investigating the possible acute rib fractures which are overlooked on chest X-rays in minor blunt chest trauma.

Material and Methods: This cross-sectional study was conducted in Department of Radiology, Omer Hospital, Lahore, between January and December 2010. A total of 28 adult subjects of either gender (25 male, 3 females; age range 18–65 years) were enrolled with minor blunt chest trauma, divided in two age groups; less than 40 years and above 40 years. The etiologies of trauma were: road traffic accident (n=13, 46.5%), direct trauma (n=7, 25%), fall (n=6, 21.4%) and sports injury (n=2, 7.1%). The site of the trauma was the right hemithorax in 11 (39.2%), left hemithorax in 8 (28.7%) and bilateral in 9 (32.1%) cases. Ecchymosis on the traumatized site was found in 5 (17.85%) patients only; although variable degree of tenderness was more frequently observed on the affected site of the chest wall. Preliminary chest radiograph showed no evidence of rib fracture. On follow up after 5 days, transthoracic ultrasound examination of most painful area with focal rib tenderness was examined.

Results: A total of 23 (82.1%) patients demonstrated rib and chondral fractures on transthoracic ultrasound examination. There were 15 cases rib fracture (65.3%), 6 cases of chondral fracture (26%) and 2 cases of costochondral disruption (8.7%). An associated subperiosteal hematoma was found in 4 (17.4%) patients. The intensity and duration of pain in patients with bony rib fractures was significantly higher than that of patients with chondral rib fractures.

Conclusion: Targeted high resolution ultrasound examination of chest wall should be performed as a more rewarding modality for the detection of occult rib and chondral fractures in the subjects having long standing chest wall pain after minor blunt trauma besides normal chest radiograph.

Key words: Transthoracic ultrasound, high-resolution, rib fracture, blunt chest trauma.

INTRODUCTION

Blunt thoracic trauma is a common clinical presentation in emergency department. Minor blunt chest trauma comprises more than half of the rib fractures along with soft tissue injury, and is often treated on an outpatient basis¹. Rib fracture may cause severe pain with resultant limitation of deep breathing, subsequent atelectasis and pneumonitis². An accurate radiological examination and diagnosis of a rib fracture is, therefore, of clinical significance in minor blunt chest trauma³. The sensitivity of conventional chest X-rays has been shown to be limited in showing rib fractures⁴. Moreover, chondral rib fractures are almost invisible on chest X-rays unless the fracture involves a strongly calcified cartilage⁵.

The aim of our study was to determine the usefulness of transthoracic high resolution ultrasound in investigating the possible acute rib

fractures which are overlooked on chest X-rays in minor blunt chest trauma.

MATERIAL AND METHODS

We carried out this cross-sectional study in Department of Radiology, Omer Hospital, Lahore, between January and December 2010. A total of 28 adult subjects of either gender were enrolled as a sample population who presented with minor blunt chest trauma to Accident and Emergency (A & E) Department of our hospital. There were 25 (89.2%) males and 3 (10.7%) females with age range of 18–65 years. We divided the patients into two age groups; less than 40 years age group consisted of 16 patients, similarly 12 patients were falling in above 40 years age group. Chest wall pain was the presenting symptom in all patients which aggravated on coughing, sneezing, deep breathing and moving. The duration of the symptom ranged from less than 1 hour to few

days. The etiologies of trauma were: road traffic accident (n=13, 46.5%), direct trauma (n=7, 25%), fall (n=6, 21.4%) and sports injury (n=2, 7.1%). The site of the trauma was the right hemithorax in 11 (39.2%), left hemithorax in 8 (28.7%) and bilateral in 9 (32.1%) cases. Ecchymosis on the traumatized site was found in 5 (17.85%) patients only; although variable degree of tenderness was more frequently observed on the affected site of the chest wall.

Preliminary frontal chest radiograph acquired in A & E Department showed no evidence of rib fracture. The patients were given intravenous analgesia (narcotic and non-steroidal anti-inflammatory analgesics) prior discharging all patients with oral non-steroidal anti-inflammatory drugs and muscle relaxants. The patients were followed up after 5 days. Moderate to intense pain

persisted in 24 patients which was relieved after oral analgesics but recurred. Transthoracic ultrasound examination was performed over the most painful area with focal rib tenderness with the transducer aligned in the transverse position parallel to the long axis of the rib. All examinations were performed by a single radiologist using 11 MHz high frequency linear array transducer (Toshiba Nemio XG ultrasound equipment SSA 660A; Tokyo, Japan). Fractures of the rib, costochondral junction and costal cartilage were denoted by a clear disruption of the anterior echogenic margin. Associated subperiosteal hematomas were also documented. A possible underlying visceral injury including the lung, liver, spleen, kidney, and the subdiaphragmatic space were also examined at the same session.

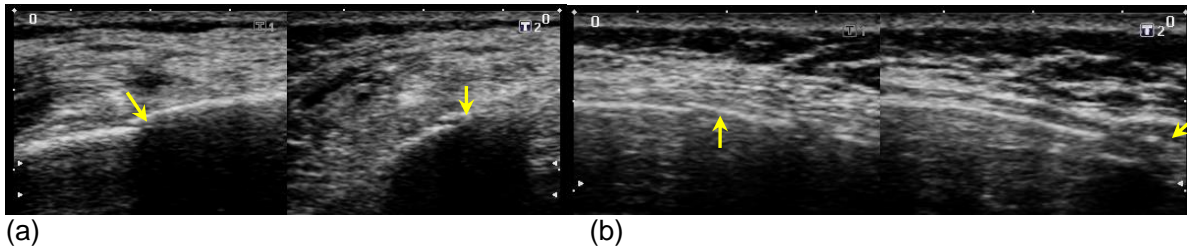


Fig. 1: (a & b). Fractures of the rib denoted by a clear disruption of the anterior echogenic margin (yellow arrows).

RESULTS

A total of 23 (82.1%) patients demonstrated rib and chondral fractures on transthoracic ultrasound examination. There were 15 cases rib fracture (65.3%), 6 cases of chondral fracture (26%) and 2 cases of costochondral disruption (8.7%). An associated subperiosteal hematoma was found in 4 (17.4%) patients. There were 8 cases of rib fractures and 2 cases of chondral fractures besides 2 costochondral disruptions under 40 years of age. Similarly, 7 cases of rib fractures and 4 cases of chondral fractures were documented in age group above 40 years. We didn't find any particular age group distribution for rib and chondral fractures. The intensity and duration of pain in patients with bony rib fractures was significantly higher than that of patients with chondral rib fractures.

DISCUSSION

An isolated single rib fracture may cause severe pain, thereby resulting in labor loss and low quality of life⁶. Thus, accurate clarification of a rib fracture is an essential prerequisite in designing better

treatment protocols. Treatment of rib fractures should be directed toward the relief of pain and prevention of a possible atelectasis⁷. Transthoracic ultrasound has been widely used as a sensitive imaging technique in better evaluation of pleural and chest wall injuries including rib fractures⁸. Early recognition of rib fractures is of clinical importance for the prompt initiation of an appropriate treatment for pain management. Physical examination may only yield the diagnosis of a rib fracture when a crepitation is present. Many patients with minor blunt chest trauma present without any physical or radiological findings apart from the tenderness on the affected site of the chest wall.

A chest X-ray is the initial investigation for a possible rib fracture and an associated complication. A low kilovoltage (kV) X-ray during expiration can be obtained to outline the bone detail⁹. However, X-rays solely have little value in blunt chest trauma to detect rib fracture, as up to 50–80% of rib fractures go undetected on conventional chest X-rays¹⁰. Also, the cartilage fractures cannot be diagnosed with conventional radiography¹¹. In this way, long standing pain due

to fractured rib or a cartilage may be considered as malingering by the patient as no crepitation or slipping of the cartilage over the bony part of the rib can be elicited on physical examination¹².

Transthoracic ultrasound's sensitivity to detect a fractured rib is up to 78% compared with 12% detection rate on radiography. Lower rib fracture should arouse suspicion for a possible injury to spleen, liver, kidneys or diaphragm and can be easily evaluated by ultrasound. Unlike radiography or bone scintigraphy, it avoids ionizing radiation. Ultrasound can examine each rib parallel to its long axis which remains difficult on cross sectional imaging like computed tomography (CT)¹³. Magnetic resonance imaging has a disadvantage of respiratory motion artefacts. Few limitations of ultrasound include its inaccessibility for the subscapular and the infraclavicular portion of the first rib, which are usually uncommon sites for rib fractures. In addition, large breasts and obesity may also limit the optimal detection of rib fractures.

Intravenous analgesia including narcotic and non-steroidal anti-inflammatory analgesics are first line treatment choice prior discharging the patients with oral non-steroidal anti-inflammatory drugs and muscle relaxants. Intense pain may be relieved by an intercostal nerve block with a local anaesthetic (0.5% bupivacaine HCl)¹⁴.

CONCLUSION

Transthoracic ultrasound is a highly sensitivity imaging technique for detecting insidious and occult rib fractures. An accurate diagnosis with prompt treatment of rib fractures is crucial to prevent subsequent pulmonary as well as extrapulmonary complications. Targeted high resolution ultrasound examination of chest wall should be performed as a more rewarding modality for the detection of occult rib and chondral fractures in the subjects having long standing chest wall pain after minor blunt trauma besides normal chest radiograph.

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