

Role of Transthoracic Ultrasound in the Detection of Radiographically Undetected Rib Fractures

Rukhsana Nasim, Farooq Ahmad, Khalid Rehman Yousaf, Qamar Sardar Sheikh, Shumaila Seemi Malik, Qamar Sardar Sheikh, Saleem Shahzad Cheema
New Department of Radiology, Services Hospital, Lahore

Abstract

Background: To determine the role of high resolution ultrasound in rib fractures after normal radiography.

Methods: In this cross-sectional study patients presenting with chest trauma in the hospital and having radiography to rule out rib fracture, but having normal chest X-ray, were included. Demographic details were noted. They were assessed for rib fracture using high-resolution ultrasonography.

Results: In this trial, a total of 230 cases were included. The mean age of the patients was calculated as 33.07 ± 10.32 years of age. Rib fracture using high resolution ultrasound in patients with normal radiography after blunt chest trauma was found in 72.17% (n=166) patients while 27.83% (n=64) patients had no finding of the rib fracture. The most commonly fractured rib in this study was found to be 6th rib.

Conclusion: Detection of rib fracture using high resolution ultrasound after blunt chest trauma is higher than radiography.

Key Words: Rib fractures, High resolution, Ultrasound, Radiograph, Blunt chest trauma

Introduction

Traditionally radiography had been considered as a gold standard for detection of rib fractures after chest trauma. However, high-resolution sonography has been found in some studies being more sensitive for detection of rib fractures. It can detect a fracture in six times as many patients as radiography and may detect 10 times more fractures than radiography. Rib fractures are the most common (25%) injuries resulting from blunt chest trauma. Between 10-66% of traumatic injuries result in rib fracture.¹ Early recognition of rib fracture is of clinical importance for the prompt initiation of appropriate medical treatment. Failure to diagnose rib fracture can lead to delay in the proper management of pain and also some legal implications

may arise, depending upon how the injury occurred. The rate of associated injuries in patient with rib fracture is high². Potentially serious complications including pneumothorax, hemothorax, pulmonary contusion, flail chest, pneumonia, vascular injuries, nerve injuries and abdominal visceral injuries may ensue. Even in the absence of associated injuries, confirmation of rib fracture can help in the better management of pain and prevention of complications such as atelectasis and pneumonitis, especially in patient with pulmonary and cardiac co-morbidities.^{3,4} In our setup, conventionally, for the diagnosis of rib fractures, a postero-anterior (PA) chest radiograph followed by an oblique rib view is done if clinically indicated. Radiography is a poor tool for the detection of rib fracture as up to 50 to 80% of rib fractures are missed on conventional radiography⁽⁵⁾. Considering the limitations of the radiography, few authors have investigated the role of ultrasound in the detection of rib fractures. All of them found that ultrasound is more sensitive than radiography but with variable results ranging from a marginal superiority (93% Vs 87%) to six times (78 % Vs 12%)^(6,7). Recently two more authors have evaluated the role of transthoracic ultrasound in the detection of traumatic rib fractures missed by radiography, rib fractures were detected in 82% and 90% of the sample population respectively.^{7,8} These studies were with small sample size (28 & 35 patients) and variable results (93% Vs 87%) to (78 % Vs 12%).

Patients and Methods

After permission from Ethical review board of the hospital, this cross-sectional study was conducted at Emergency department of SIMS/ Services Hospital Lahore. The total span of the study was one year from July, 2015 to June, 2016. All patients of both genders of any age with history of blunt trauma to thorax and clinical diagnosis of rib fracture with normal radiography were included in this study. Our exclusion criteria included: patient with hemodynamic instability; patient with shortness of breath; and patient with severe pain and irritability. All patients

who presented to accident and emergency department with a history of blunt chest trauma with a clinical suspicion of rib fracture, and fulfilled the criteria were enrolled into the study. Informed consent was obtained from all patients. Adequate analgesia was given in the emergency room before radiological workup. Patients had a chest radiograph. If rib fracture was evident on x-ray chest, patients were shifted back to surgical emergency for further management. However if the chest x-ray was normal patient underwent transthoracic ultrasound and the findings were recorded into the proforma. Preliminary frontal chest x-ray and oblique rib view was performed in all patients. The X-ray was performed without grid at a distance of 180 cm and posteroanterior projection with the 80 KVp and 3.2 mAs. The oblique view of the rib was performed with a grid at distance of 100 cm with a 79 KVp and 22 mAs centered, over the area of trauma. Transthoracic ultrasound examination was performed over the most painful area with the transducer aligned in the transverse position parallel to the long axis of the rib. Fracture of rib was denoted by a clear disruption of anterior echogenic margin. Fracture of rib was defined on ultrasound basis after looking at costochondral junction and costal cartilage and was denoted by looking at following criteria: clear disruption in anterior echogenic margin; linear acoustic edge shadow; change of appearance with pressure (Figure 1). Sample size was estimated at 95% confidence level, 5% margin of error with an expected detection of rib fracture in 82% patients which were negative on X-ray and was calculated to be 230 cases. All the demographic findings like age and gender were recorded in the predesigned proforma. By history taking, mode of injury was recorded. Frequency and percentage were calculated for qualitative data like gender and patients with rib fracture diagnosed on ultrasound with normal radiography.

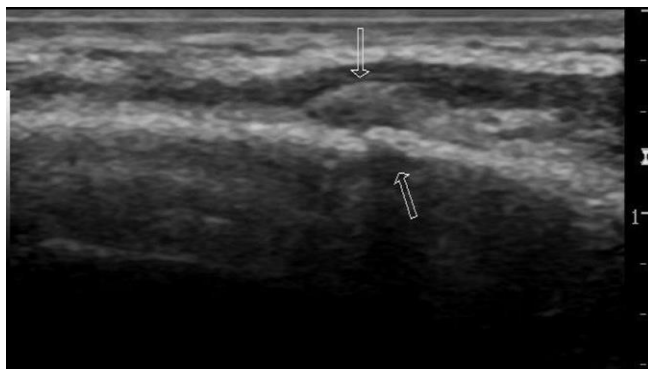


Figure 1:Ultrasound chest showing fracture ribs

Results

A total of 230 cases fulfilling the criteria were enrolled in the study. The mean age of the patients in the study was calculated as 33.07+10.32 years. Most of the patients (n=104) (45.2%) in the study were in the 3rd decade of their life. Most of the patients in this study were male (n=154) (66.96%) while 76 patients (33.04%) in this study were females. The mean duration of days passed since the initial injury were 3.4 days (range being 1-16 days). The most commonly encountered mode of trauma among patients in the study was RTA (42.1%) (Table 1). Rib fractures were found in 166 patients (72.17%) while remaining 64 patients (27.83%) had no findings on ultrasound. The most commonly fractured rib in this study was found to be 6th rib, followed by 8th and 5th rib (Table 2).

Table 1: Mode of trauma as encountered by patients in the study

Mode of trauma	No (%)
Road traffic accident	97 (42.1%)
Fall	74 (32.1%)
Blunt trauma	56 (24.3%)
Sports injury	2 (0.86%)

Table 2: Details of fractures as encountered by patients in the study

	No (%)
Number of ribs fractured	
One	145 (87.3%)
More than one	21 (12.7%)
Side involved	
Right	77 (46.3%)
Left	89 (53.7%)
Fracture displacement	
Displaced	101 (60.8%)
Not displaced	65 (39.2%)
Site of the rib involved	
Anterior	33 (19.8%)
Lateral	69 (41.5%)
Posterior	64 (38.5%)
Number of rib fractured	
2 nd	12 (7.2%)
4 th	21 (12.6%)
5 th	24 (14.4%)
6 th	33 (19.8%)
7 th	16 (9.6%)
8 th	25 (15.0%)
9 th	17 (10.2%)
10 th	11 (6.6%)
11 th	07 (4.2%)

Discussion

In present study 72.17% patients were found having rib fracture on high resolution ultrasonography, with normal radiography. High-resolution sonography can detect a fracture in six times as many patients as radiography and may detect 10 times more fractures than radiography.⁹ Regarding detection of rib fracture on high resolution transthoracic ultrasound, the frequency of detection was carried out on small sample size and the results were also variable in previous studies, so we planned this study with appropriate sample size to evaluate the role of high resolution transthoracic ultrasound in the detection of rib fractures missed by radiography.

Rib fracture is the most common injury occurring after thoracic trauma. Early detection of rib fracture is important as it helps to start the management of the patients timely and in an appropriate way. The most common modality used for it is radiography, however, radiographs cannot detect all the cases of rib fracture. If rib fracture is missed or not properly diagnosed, it leads to unresolved pain and definitely improper healing of the fracture.^{10,11}

Our findings regarding detection of rib fracture are in agreement with previous studies¹²⁻¹³. Recently two more authors have evaluated the role of transthoracic ultrasound in the detection of traumatic rib fractures missed by radiography, rib fractures were detected in 82% and 90%.^{7, 8} Another study had been done by Griffith JF with the view to compare the sensitivities of sonography and radiography for revealing acute rib fracture. They recorded that radiographs revealed eight rib fractures in six (12%) of 50 patients and sonography revealed 83 rib fractures in 39 (78%) of 50 patients. Seventy-four (89%) of the 83 sonographically detected fractures were located in the rib, four (5%) were located at the costochondral junction, and five (6%) in the costal cartilage.⁹ Sang Hyun Paik et al evaluated whether high-resolution sonography can provide additional information concerning rib lesions compared with radiography or bone scintigraphy and concluded that high-resolution sonography of the ribs is a useful method of characterizing rib lesions in patients who have hot-uptake lesions on bone scintigraphy.¹⁴

In a normal patient, when ultrasound probe is placed along long axis of the rib, it appears smooth and continuous line with a small discontinuity at the level of costochondral junction. If there is a subtle fracture in the rib, it appears as small reverberation also known as 'chimney phenomenon'.¹⁵ If the rib fracture is old and callus has been formed, increased echogenic shadows are found.¹³ Rib fracture mostly occurs in 4th-

10th rib. In our study, the most commonly fractured rib was 6th rib (19.8%), followed by 8th rib in 15.0% of patients and 5th rib in 14.4% patients. Turk et al also conducted a similar trial and they also found that the most commonly fractures ribs were 5th to 10th ribs.⁸ High-resolution sonography of the ribs is a useful method for evaluation of rib fractures missed by radiography. It is easy to perform, cost-effective, can be done at bed-side and has no radiation hazard.

Conclusion

Detection of rib fracture using high resolution ultrasound after blunt chest trauma is higher than radiography

References

1. Bhavnagri SJ, Mohammed T. When and how to image a suspected broken rib. *Cleve. Clin. J. Med.* 2009;76:309-14.
2. Reissig A, Copetti R, Kroegel C. Current role of emergency ultrasound of the chest. *Crit. Care Med.* 2011;39:839-45.
3. Sato N, Sekiguchi H, Hirose Y, Yoshida S. Delayed chest wall hematoma caused by progressive displacement of rib fractures after blunt trauma. *Trauma Case Reports.* 2016;4:1-4.
4. Fabricant L, Ham B, Mullins R, Mayberry J. Prospective clinical trial of surgical intervention for painful rib fracture nonunion. *The American Surgeon.* 2014;80:580-86.
5. Lederer W, Mair D, Rabl W, Baubin M. Frequency of rib and sternum fractures associated with out-of-hospital cardiopulmonary resuscitation is underestimated by conventional chest X-ray. *Resuscitation.* 2004;60:157-62.
6. Hurley ME, Keye GD, Hamilton S. Is ultrasound really helpful in the detection of rib fractures? *Injury.* 2004;35:562-66.
7. Yousaf AS, Qadri NS. Usefulness of transthoracic high resolution ultrasound for radiographically undetected rib fractures. *Journal FJMU.* 2011;5:113-35.
8. Turk F, Kurt AB, Saglam S. Evaluation by ultrasound of traumatic rib fractures missed by radiography. *Emergency radiology.* 2010;17:473-77.
9. Griffith J, Rainer T, Ching A, Law K, Cocks R, Metreweli C. Sonography compared with radiography in revealing acute rib fracture. *Am. J. Roentgenol.* 1999;173:1603-39.
10. Holcomb JB, McMullin NR, Kozar RA, Lygas MH, Moore FA. Morbidity from rib fractures increases after age 45. *J. Am. Coll. Surg.* 2003;196:549-55.
11. Swiontkowski M. Pediatric fractures: Patient factors and imaging challenges can delay diagnosis. *JBJS Case Connect.* 2013;3:e100.
12. Kara M, Dikmen E, Erdal HH, Simsir I, Kara SA. Disclosure of unnoticed rib fractures with the use of ultrasonography in minor blunt chest trauma. *Eur. J. Cardiothorac. Surg.* 2003;24:608-13.
13. Chan SS-W. Emergency bedside ultrasound for the diagnosis of rib fractures. *The American journal of emergency medicine.* 2009;27:617-20.
14. Paik SH, Chung MJ, Park JS, Goo JM, Im J-G. High-resolution sonography of the rib: can fracture and metastasis be differentiated? *Am. J. Roentgenol.* 2005;184:969-74.
15. Kreuter M, Mathis G. Emergency ultrasound of the chest. *Respiration.* 2014;87:89-97.