Section: Radiodiagnosis

Original Research Article

A STUDY OF DIAGNOSTIC EFFICACY OF CHEST ULTRASONOGRAPHY IN DETECTION OF ACUTE RIB FRACTURES IN COMPARISON WITH CHEST RADIOGRAPHY IN A TERTIARY CARE CENTRE

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Received : 02/11/2023
Received in revised form : 13/12/2023
Accepted : 29/12/2023

Keywords:
Rib fractures, Radiography, Ultrasonography.

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DOI: 10.47009/jamp.2024.6.1.21

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (1); 109-112

Abstract

Background: Our aim is to study the diagnostic efficacy of chest ultrasonography in detection of acute rib fractures in patients referred with blunt chest trauma in comparison with chest radiography. **Materials and Methods:** In this present cross sectional study, patients with blunt chest trauma referred to the department of Radiology with clinical suspicion of rib fracture were subjected to routine AP chest radiography after which chest ultrasonography was performed at the site of pain, maximum tenderness, and external injury or at the site of superficial swelling. Ultrasonography was performed using 12 MHz linear transducer. Fracture is identified as disruption in the anterior linear margin of the rib, costal cartilage and costochondral junction. Incidence , location , site, degree of displacement of fracture, presence of hematoma and associated complications such as pneumothorax or hemothorax are recorded and compared with that of chest radiography. **Result:** A total of 60 consecutive patients with chest trauma referred for chest radiography who satisfied the inclusion and exclusion criteria are enrolled into the study and focused ultrasonography performed. Among the study group 48(80%) were males and 12(20 %) were females with age ranging from 18–88 years. Most of these patients were victims of road traffic accidents. Small number of about 5 patients (8%) presented with history of fall. Among these 60 patients about 72 individual ribs were examined out of which 62 rib fractures were identified. Radiograph depicted 10 fractures whereas USG depicted 56 fractures. Out of which 34(60.7 %) were undisplaced, 12(21.4%) were minimally displaced and remaining 10(17.8%) were moderately displaced, 8(14.2 %) cases were associated with hematoma, 6(10.7 %) with hemothorax and 3(5.3%) with pneumothorax. **Conclusion:** Our research indicates that, when compared to chest radiography, ultrasonography is a more effective imaging modality for identifying acute rib fractures in the context of minor chest trauma.

INTRODUCTION

Blunt chest trauma is present in over 15 % of all trauma admissions to casualty department.[1] Most of these admissions are secondary to road traffic accidents , other causes include high or low velocity fall or direct blow to the chest. Rib fractures represent the most frequent blunt chest trauma and can be associated with complications such as hemothorax and pneumothorax. Even while these fractures are rarely fatal, they can be an outward sign of a serious visceral injury. Chest radiography AP view is currently the most frequently used modality to detect rib fractures. But only 49 % rib fractures are detected upon detailed physical examination and radiography.[2] Radiography is unable to show fractures in the costal cartilage or fractures that are undisplaced or minimally displaced. Therefore, a more advanced and reasonably priced imaging

technique is required to identify rib fractures that go undetected.

According to published research, ultrasonography's ability to identify acute rib fractures ranges greatly, from negligible to significantly more effective than radiography.[3-6] On the other hand, ultrasonography is a preferred diagnostic method due to its advantages, which include noninvasiveness, cost effectiveness, lack of radiation, portability, and repeatability. We attempted to compare the diagnostic performance of radiography and ultrasonography in the current study in order to identify acute rib fractures, and the results were significantly more promising for ultrasonography.

MATERIALS AND METHODS

Methods: In this present cross-sectional study, patients with blunt chest trauma referred to the department of Radiology with clinical suspicion of rib fracture were subjected to routine anteroposterior (AP) view chest radiography after which chest ultrasonography was performed at the site of pain, maximum tenderness, and external injury or at the site of superficial swelling. The study period for this investigation was November 2022–November 2023.

Radiography was performed with Fujifilm DR system, Allengers 600 MA machines in anteroposterior view. The results were documented and reported by a qualified radiologist.

USG Protocol: We used Samsung S70 linear transducer 3-12 Hz and scanning was performed at point of maximum tenderness which was informed by the patient during the study in few of the cases the referring physician surface marked the site of suspicious fracture rib. We followed standard protocol of rib USG which includes scanning along the long axis of rib parallel to long axis of transducer. Appearance of normal rib on ultrasonography is represented by integrity of anterior linear echogenic representing intact cortex of rib as shown in [Figure 1].

Signs which are considered to diagnose rib fractures are following:

1. Break or discontinuity in the anterior linear echogenic line representing anterior cortex of rib [Figure 2].
2. Loss of congruity between the two cortical margins representing displaced fracture [Figure 3, 4].
3. Small anechoic/ hypoechoic collection just anterior to the cortical margin at the site of tenderness which represent hematoma is also sign of undisplaced rib fractures. [Figure 5]

Care should be taken while scanning at the costochondral junction which gives false impression of the fracture due to abrupt transition from linear echogenic line of the anterior cortex of ossified rib and sudden discontinuity at the costochondral junction and non-visualization of anterior echogenic line representing costal cartilage which is not ossified and allow through transmission of sound waves.

It is important to avoid scanning the rib holding the transducer obliquely since this could result in a false impression of a displaced fracture [Figure 6].

We assumed that there is no gold standard for rib fracture, on the other hand whatever we have diagnosed as rib fractures by radiography and ultrasonography is a correct diagnosis and there is no false positive result.

All data were represented on excel sheet, levels of agreement in the diagnostic tools for the rib fractures were assessed by kappa coefficients.

RESULTS

A total of 60 consecutive patients with minor blunt chest trauma were included into the study who satisfied the inclusion and exclusion criteria as aforementioned.

Among the study group 48(80%) were males and 12(20 %) were females with age ranging from 18–88 years. Most of these patients were victims of road traffic accidents. Small number of about 5 patients (8%) presented with history of fall. Among these 60 patients about 72 individual ribs were scanned using ultrasonography, out of which 62 rib fractures were identified. Radiograph depicted 10 fractures whereas USG depicted 56 fractures [Table 1 and Figure 7]. Among the 56 fractures which were identified on ultrasonography, 34(60.7 %) were undisplaced [Figure 2], 12(21.4%) were minimally displaced [Figure 3] and remaining 10(17.8%) were moderately displaced [Figure 4], 8(14.2 %) cases were associated with hematoma [Figure 5], 6(10.7 %) with hemothorax and 3(5.3%) with pneumothorax.

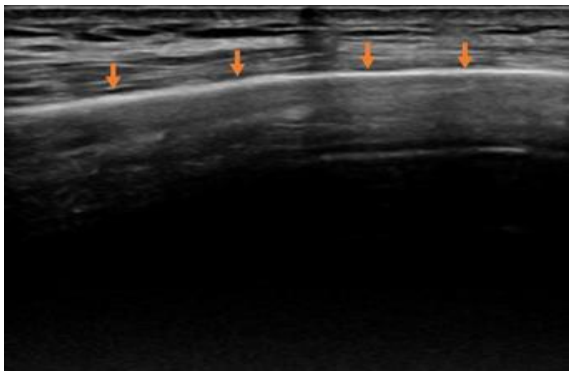

Figure 1: Normal rib on ultrasonography, arrows indicates intact linear echogenic line which represents anterior cortical margin of the rib.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

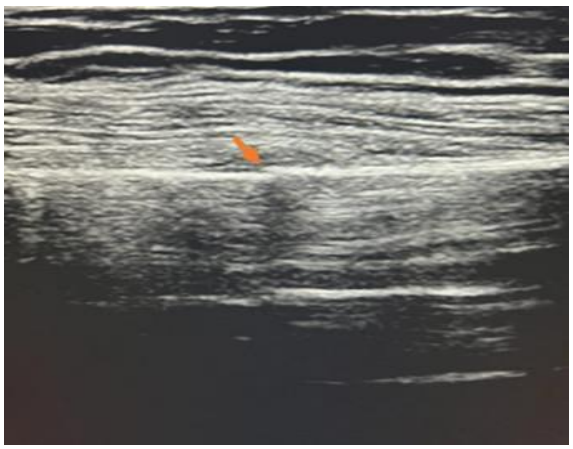

Figure 2: Undisplaced rib fracture, arrow indicates focal discontinuity in the linear anterior echogenic line representing breach in anterior cortex.

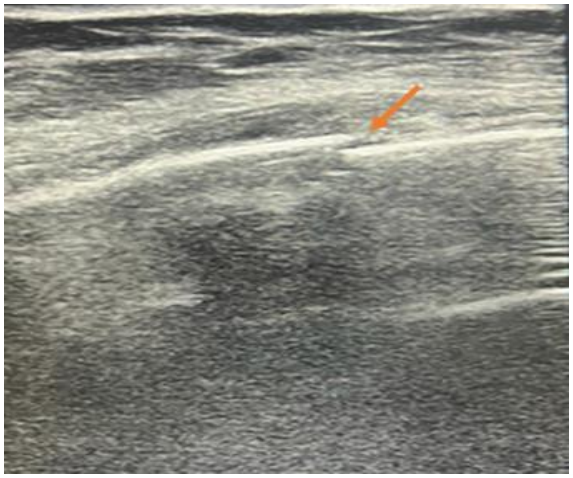

Figure 3: Minimally displaced fracture, arrow indicates focal discontinuity in the anterior linear echogenic line with minimal displacement.

Figure 4: Moderately displaced fracture, arrow indicates focal discontinuity in the anterior linear echogenic line with moderate displacement.

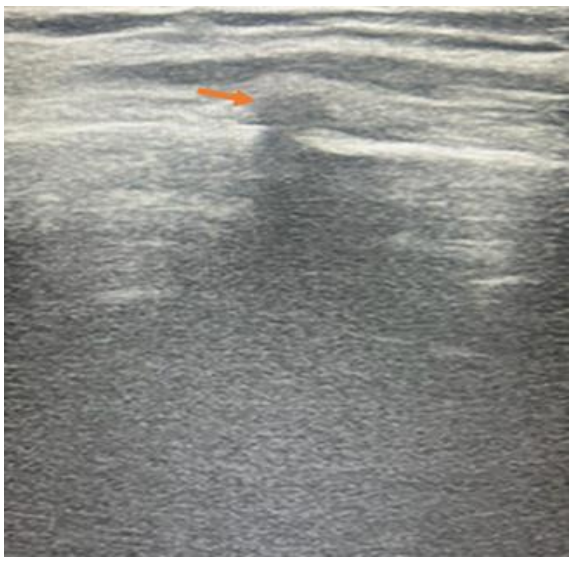

Figure 5: Hematoma at site of rib fracture, arrow indicates focal hypoechoic area just anterior to focal discontinuity of the rib.

There were overall 62 rib fractures in 60 patients based on both radiography and ultrasonography. In our present study the sensitivity of ultrasonography in detecting rib fractures is 83.3 % and specificity is 88.8 %. Among the 10 rib fractures identified on radiography, we were able to detect 8 fractures on ultrasonography. The only two sonography missed rib fractures was posterior portion of left 3rd and right 4th ribs which were obscured by scapula shadow.

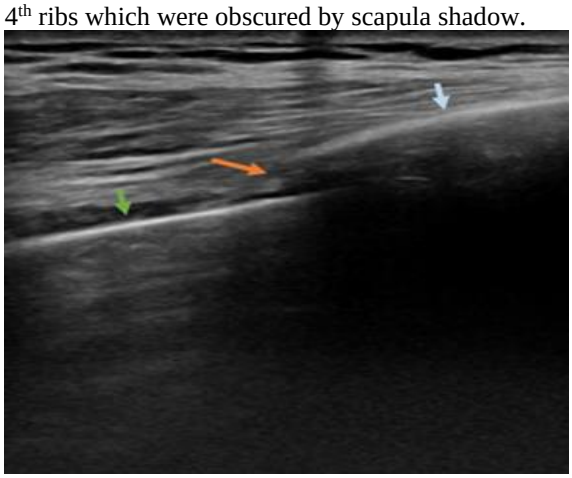

Figure 6: Fracture mimics: when scanned in an oblique transducer position, the image shows a pseudofracture, denoted by an orange arrow. Blue arrow denotes the anterior cortex of the ribcage, while green shows the pleural surface.

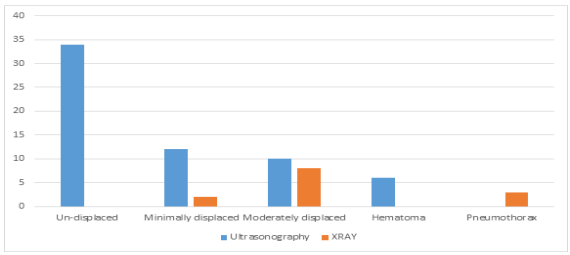

Figure 7: Bar diagram depicting number of rib fractures and its complications as seen on ultrasonography and radiography.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 1: Depicting number of rib fractures and its complications as seen on ultrasonography and radiography.

	USG	%age	XRAY	%age
Un-displaced	34	60.7%	-	-
Minimally displaced	12	21.4%	2	3.2%
Moderately displaced	10	17.8%	8	12.9%
Hematoma	6	10.7%	-	-
Pneumothorax	-	-	3	4.8%
Hemothorax	3	5.3%	1	1.6%

DISCUSSION

This study shows that ultrasonography can detect fractures 5-6 times as many patients as radiography will detect. This is in par with study done by griffith et al.[7] The majority of studies have obtained great discrepancies for rib fracture detection by ultrasonography and radiography and have proposed ultrasonography has more sensitive (sensitivity 83.3% and specificity (88.8%) imaging modality in detection of rib fractures.[8-10]

Chest radiography showed fractures in only 16.6 % patients presenting with suspected rib fractures. This detection is comparable with other studies.

Although sonography is unlikely to detect deep seated pulmonary contusions. It is has sensitivity comparable with that of radiographs in hemothorax and pneumothorax detection. In a study done by Ma and Mateer in 240 patients comparing radiography and sonography with CT in hemothorax detection.[10]

Sonography also enables assessment of subclavian vessels in fracture of upper ribs and abdominal organs such as liver and spleen in lower rib fractures.

This study shows that ultrasonography is considerably more sensitive than radiography in rib fractures detection .We are recommending routine use of ultrasonography in rib fractures detection in mild chest trauma patients , as it more accurate and provides more definitive diagnosis and also helps in better management of the patient , may allow more precise targeting of therapeutic intercostal analgesia and enable a more accurate prediction of potential complications such as hemothorax and pneumothorax. Sonoraphy allows simultaneous examination of the costochondral junction, the costal cartilage and the ribs. Thus ultrasonography could be more useful in treating sport injuries.

Disadvantages of rib sonography were identified. First it is time consuming and second relatively costly. Thirdly the retroscapular ribs and infraclavicular ribs are inaccessible to sonography, fourthly rib sonography is difficult to perform in dyspneic, uncooperative, unconscious and severely traumatized patients.

In this study ultrasonography shows 5-6 times as many fractures as compared to radiography. This study indicated that most patients in emergency department settings with suspected rib fractures have sustained a rib fracture. Chest radiography as a means to reveal traumatic rib fracture appears to be lacking sensitivity when compared with sonography. Further studies should consider using sonography and not radiography to detect rib fractures.

CONCLUSION

Our research led us to the conclusion that, in patients presenting with mild chest injuries, USG is a more sensitive means of diagnosing rib fractures than radiography. We suggested that when diagnosing patients with chest injuries, targeted chest ultrasonography be a regular part of the process.

Not only may ultrasound be used to detect fractures of the ribs, but it can also be used to detect consequences including hemothorax, pneumothorax, and simultaneous examination of the spleen and liver in one setting. It aids in better medical care, recordkeeping, and the avoidance of medicolegal issues.

Acknowledgements: The authors would like to express their gratitude to the entire Department of Radiology at PESIMSR, Kuppam, for their support and contributions to this study.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556