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Role of Bedside Sonography in Detecting Rib Fractures and Related Injuries

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Abstract

Aim: About 40% of patients with trauma, experience chest related injuries. Rib fracture remains the most frequent finding in chest trauma. Some literatures have suggested chest wall ultrasonography as a potential replacement for chest X-ray (CXR) in detecting rib fractures. The aim of this study is to assess sensitivity and specificity of bedside ultrasonography in detecting rib fractures and related injuries.

Materials and Methods: Patients between April 2012 and April 2014 were enrolled in our prospective cross-sectional study. Then emergency medicine specialists performed a bedside ultrasonography to detect any probable fracture and suspected injuries. We took CXRs and an expert radiologist looked for fracture and related injuries. A chest computerized tomography scan was taken and compared with findings of CXR and ultrasonography.

Results: Out of 360 patients, 238 met our inclusion criteria and enrolled in the study; where 222 (93.3%) were male and 16 (6.7%) were female with the average age of 33.78±11.62 (± standard deviation). The sensitivity and specificity of two modalities in detecting fracture, pneumothorax, hemothorax and contusion were analyzed.

Conclusion: Our study showed that bedside ultrasonography could substitute CXR in detecting not only rib fractures but also related comorbidities especially in minor trauma.

Keywords: Rib fracture, bedside ultrasonography, injuries, emergency physician, sensitivity, chest X-ray

Introduction

About 40% of patients with trauma experience chest related injuries. External forces including motor vehicle collisions and falling from height, considered as the most common causes of the blunt trauma (1,2). Rib fracture remains the most frequent finding in chest trauma and occurs because of the blunt trauma in almost half of the cases (3). Rib fractures happen while direct force applied to the sternum caused by a motor vehicle. Aging increases likelihood of rib fractures. Higher thoracic flexibility of children reduces the risk of fracture (1-3).

Due to semi-protected position of the upper ribs (1st to 3rd) and limited range of motion of the lower ribs (9th to 12th), these ribs are less vulnerable to the trauma. Therefore, 4th to 9th ribs fracture more frequently. However, upper rib fractures, accompany higher mortality rate due to comorbid subclavian artery or vein injuries; and lower rib fractures can increase three and four times the rupture probability of the liver and spleen, respectively (4-7). The more the ribs fracture, the higher the comorbidities occur. Patients with three or more fractured ribs require hospitalization for pain alleviation and further investigations (8,9).

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Chest X-ray (CXR) remains a beneficial and sensitive tool in detecting rib fractures.

Bony construction and oblique view of ribs in a CXR make it easy to detect fractures (10-13).

Some literatures have suggested chest wall ultrasonography as a potential replacement for CXR in detecting rib fractures especially in trauma related ones. Moreover, chest wall ultrasonography can differentiate traumatic fractures from pathologic ones (14-21).

A few studies have evaluated the role of ultrasonography in finding fracture of the ribs; however, in none of them emergency physicians have used bedside ultrasonography at emergency departments (22-25). Moreover, small sample size in previous studies made it crucial to perform a study with a larger sample size.

The aim of this study is to assess sensitivity and specificity of bedside ultrasonography in detecting rib fractures and related injuries including pneumothorax, hemothorax and pulmonary contusion.

Materials and Methods

Study Design

Patients who were referred to our tertiary emergency department between April 2012 and April 2014 were enrolled in our prospective cross-sectional study. We included all stable patients with chest trauma who were older than 10 years (being cooperative in localizing pain), fully conscious (Glasgow coma scale=15) and without distracting pain (difficulty in pain localization). After approval of ethics committee, we took written consent form from all patients who were enrolled in the study.

We excluded patients if either they face life-threatening condition or experience decrease in GCS. We also excluded patients without rib fractures, patients who have more than 3 fractures and patients with massive emphysema.

The patients were asked to localize the most excruciating area. Then emergency medicine specialists performed a bedside ultrasonography, using a Medison-X (South Korea) with a linear 7.5-10 mHz probe, for the localized area and surroundings in a sitting position. This was used to detect any probable fracture and suspected injuries such as: Pneumothorax, hemothorax and soft tissue contusion. We used following criteria in detecting probable fracture: Cortical discontinuity, acoustic shadow following fracture, reverberation artifact, and local hematoma.

We took anteroposterior (AP) and lateral CXRs after stabilization of patients. An expert radiologist who was unaware of the study looked for the fracture and related injuries. A chest computerized tomography (CT) scan (64-multislice), as the gold standard, was taken and compared with findings of CXR and ultrasonography.

Data Analysis

We used SPSS-15.0 to calculated sensitivity and specificity of CXR and ultrasonography for detection of fracture, hemothorax, pneumothorax, and contusion.

Ethical Considerations

Ethics Committee of Iran University of Medical Sciences approved the study before patients' enrollment (approval number: 91/D/131/965).

Results

Out of 360 patients, 238 met our inclusion criteria and enrolled in the study; where 222 (93.3%) were male and 16 (6.7%) were female with the average age of 33.78±11.62 (± standard deviation).

Motor vehicle collisions were the most frequent cause of trauma in 171 (71.8%) patients.

Figure 1 shows the incidence of fractures detected by CXR, ultrasonography and CT. Incidence of pneumothorax, hemothorax and contusion based on diagnostic modality is shown in Table 1.

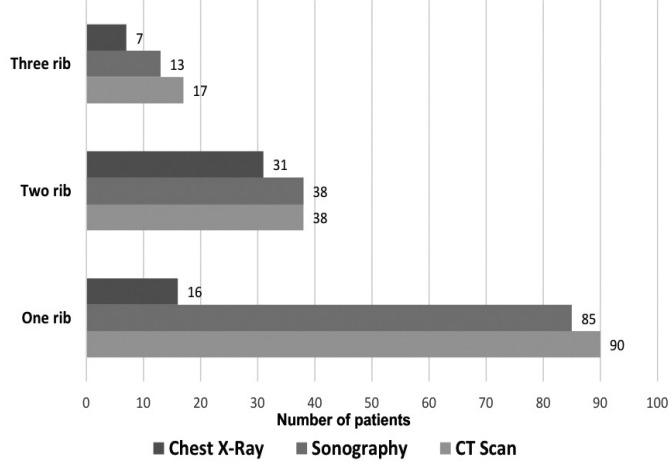

Figure 1. Incidence of fractures detected by chest X-ray, ultrasonography and computerized tomography

CT: Computerized tomography

Table 1. Incidence of injuries based on diagnostic modality

	Modality		
	CXR	Ultrasonography	CT
Hemothorax (n)	0	17	28
Pneumothorax (n)	7	54	58
Contusion (n)	0	3	18

CXR: Chest X-ray, CT: Computerized tomography

Table 2. Sensitivity and specificity of injuries detected on chest X-ray and ultrasonography

	Findings	Sensitivity %	Specificity %
CXR (n=238)	Fracture	37.2	100
	Hemothorax	0	100
	Pneumothorax	12.1	100
	Contusion	0	100
Ultrasonography (n=238)	Fracture	93.8	100
	Hemothorax	60.7	100
	Pneumothorax	93.1	100
	Contusion	16.7	100

CXR: Chest X-ray

In addition, the sensitivity and specificity of two modalities in detecting fracture, pneumothorax, hemothorax and contusion were depicted in Table 2.

Discussion

In the case of thoracic injuries, when physicians suspect fracture or related injuries, they use various imaging modalities such as: AP and lateral CXR, chest ultrasonography and chest CT scan.

Majority of patients in our study were young male people who were referred due to a motor vehicle collision. Most of the detected fractures with CXR were fracture of two ribs, however one rib fractures were the mostly detected ones using CT scan and bedside ultrasonography. This indicates more diagnostic value of CXR in more severe trauma. On the other hand, in less severe trauma usage of ultrasonography or CT is more diagnostic. Higher sensitivity rate of ultrasonography in comparison with CXR (93.8% to 37.2%) in detecting fractures denotes superiority of ultrasonography usage.

Moreover, better results in detecting injuries suggest advantage of ultrasonography comparing with CXR. Nonetheless, low sensitivity rates for detection of contusion (16.7%) and hemothorax (60.7%) make the usage of CT scan inevitable in suspected patients.

Turk et al. (22) studied 20 patients with normal CXR. They performed ultrasonography and found rib fractures in 18 of 20 patients. Kara et al. (24) evaluated 36 patients with chest trauma who had no fracture in their CXRs. Surprisingly, 15 of the patients had rib fractures.

If we consider minor trauma as a cause of these biases, ultrasonography can significantly detect less severe trauma.

Griffith et al. (26) assessed 50 patients with both CXR and ultrasonography. The findings are as follows: 8 fractures in 6 patients detected by CXR in comparison with 83 fractures in 39 patients detected by ultrasonography, where 4 of 83 fractures were in costochondral junction and 5 of them were costal fractures in cartilages.

Study Limitations

Different level of experience in performing ultrasonography was one of our study's limitations, which several one-day workshops were held to minimize the dissimilarity.

Low injury severity was another limitation of our study. It is unclear what impact, if any, multiple fractures on the same rib or adjacent ribs would have on the sensitivity of this mode. We also excluded patients with emphysema. Subcutaneous emphysema can lead to a poor sonographic view.

Conclusion

Our study showed that bedside ultrasonography could substitute CXR in detecting not only rib fractures but also related comorbidities. Moreover, higher sensitivity in fractures with less severe trauma makes ultrasonography a valuable screening method in survey of patients injured with minor trauma.

Ethics

Ethics Committee Approval: Iran University of Medical Sceinces, (approval number: 91/D/131/965).

Informed Consent: After approval of ethics committee, we took written consent form from all patients who were enrolled in the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: A.G., N.G., Concept: H.A., T.R, S.S.V., Design: H.A., N.G., S.S.V., Data Collection or Processing: A.G., T.R., Analysis or Interpretation: A.G., Literature Search: A.G., M.J.B., Writing: M.J.B.

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