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Conventional radiography or ultra sound for rib fracture diagnosis: a literature review

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ABSTRACT

Blunt chest trauma accounts for the majority of mortalities and morbidities in traumatized patients. Rib fractures are one of the most common chest wall injuries due to blunt chest trauma, which is estimated to occur in 10% of all traumatic injuries. Conventional radiography and ultra-sonography are two commonly methods used for rib fractures diagnosis with different accuracy. In this study, we described different methods used in diagnosis of injuries related to blunt chest trauma and we aimed to review several studies compared the diagnostic value of these methods.

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Introduction

Blunt chest trauma accounts for the majority of thoracic injuries (81% in children and 78% in elderly) which are known as the 3rd most common injuries in patients with multiple traumas. The incidence of thoracic trauma in multi trauma situations significantly raises the mortality rate, which is responsible for almost 25% of death in traumatic patients (1). The blunt chest trauma includes chest wall injuries (bony and soft tissues), intra-pleural lesions, lung, and mediastinal injuries. Rib fractures without any associated complication are considered as minor blunt chest trauma.

Rib fracture is one of the most common type of chest wall lesions due to blunt chest trauma and almost occurs in 10% of all traumatic injuries (2). Rib fractures can be asso-

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ciated with delayed mortality or wide range of morbidity; from a single injury to life-threatening complications (hemothorax, pulmonary contusion, hypoventilation, hypocapnia, hypoxia, atelectasis, pneumonia, cardiovascular injury and etc.). Motor vehicle accidents are the major cause of blunt chest trauma and the consequent rib fractures (63-78%).

Severe complications may occur following blunt chest trauma even with no rib fracture evidence. Due to significant contribution of rib fracture in increasing the morbidity and mortality rate, accurate diagnosis of injuries is a clinical priority. Localization of the rib fracture can be indicative of related injured organ. The incidence of first and second rib fractures is rare and these fractures may lead to life-treating multisystem injuries of spine, lungs, aorta, and vascular system. Injured spleen and liver may happen through lower left and right rib fractures, respectively (3). It has been agreed that the severity of rib fractures consequences has a linear relation with age, ossification level of chest wall, and the number of fractures. Sirmali et al. concluded that appearance of 3 or more fractures in patients, necessities the patient hospitalization and follow-up for pulmonary complications (4).

Children of 0-3 years have flexible ribs that can result in lower incidence of rib fractures compared with adolescents (5). Child abuse is another possible cause for most of the rib fractures in children in addition to motor vehicle accidents (6). It has been reported that in patients younger than 45 years, similar to elderly, 4 or fewer rib fractures could be related with increased risk of severe pulmonary or non-pulmonary complications, or death (7).

Diagnostic strategies

Considering the mechanism of injury and the clinical signs (breath sounds and crepitation, thorax instability, dyspnea, pain, cyanosis, etc.) can help better diagnosis of trauma and related injuries. Simple chest X-ray (CXR), high frequency ultrasonography, and computed tomography are common methods for rib fracture diagnosis in patients with blunt chest trauma.

Conventional radiography

Conventional radiography is usually the first step imaging assessment of blunt chest trauma and complications that may need immediate treatments. Radiography of suspected rib fracture patients should be done with postero-anterior (PA), and oblique projections. the patient position and duration of inspiration are important in conventional radiography (8). In some studies, screening with conventional radiography has resulted in normal radiographs with some missed rib fractures or complications. Undetected injuries could be the major cause of mortality and morbidity due to blunt trauma (9,10). So, conventional radiography is not recommended as the best method for the evaluation of thorax bony structures (11).

Routinely, using chest radiographs might have some limitations in providing accurate assessment in situations such as radiography from the obese or older patients with osteoporosis, minor rib fractures, greenstick fractures, cartilage and costochondral separations.

Computed tomography (CT)

Although CT is not used for the diagnosis of rib fractures, it represents the most accurate data about the number and location of rib fractures and internal related injuries of traumatized patients. CT has advantage to radiography in detection of cartilage fractures which are usually missed by radiography (12). Due to the risk of several internal injuries in first rib fracture

situation, CT is suggested to be used for an early diagnosis of fracture in patients with severe thoracic blunt trauma. In the study of Exadaktylos et al., more than 50% of normal conventional radiographs revealed severe injuries following CT scans; 8% of them showed lethal aortic injuries. Based on high accuracy, decreased scanning duration, and ease of use, CT is strongly recommended to be applied routinely after initial assessment of patients for chest blunt trauma diagnosis. In these studies, it is recommended to use conventional radiography only for the follow-up period (13).

Based on several studies, CT is more effective and accurate than conventional radiography in detecting internal injuries of the pleural space (pneumothorax, hemothorax) (14,15), lungs (lung herniation, pulmonary contusion, and laceration) (16,17), airways (bronchial and tracheal lacerations, and esophagus injuries) (18-20), pericardial space, heart valves and chambers, vascular system, diaphragm (21-24), chest wall (rib, scapula, and sternal fractures, sternoclavicular dislocation, flail chest) (25-27).

Ultra-sonography

This is a highly sensitive method, which is increasingly used in the process of blunt chest trauma assessment. Ultrasound (US) is a non-invasive diagnostic method used for diagnosis of pulmonary, pleural, mediastinal diseases, or in emergency conditions (28). In comparison with other diagnostic methods, US has higher sensitivity than conventional radiology and in contrast with CT, it is a non-invasive method which does not use radiation or any radio-contrast agents and can be applied at any time or place for patients at any age, during pregnancy period, or renal damages. Rib fractures as the most common resultant of blunt chest trauma can be visualized through sonography procedure. In this review, we collected studies compared the efficacy of US and radiology in rib fracture diagnosis.

According to Hurley et al., presence of localized pain, plural effusion, pneumothorax, cortical discontinuities, acoustic shadows, reverberation artifacts, and hematoma by ultrasonography can be proposed as the diagnostic criteria for detecting the fractured ribs (29).

Application of radiography and ultrasonography in rib fracture diagnosis has been compared in different studies. Information of the mentioned studies is summarized in Table 1.

Majority of studies have obtained great discrepancy between detection rate of ultrasound and plain radiography and have proposed sonography as the more sensitive method than the conventional radiography in rib fractures detection. Contrary with others, in the study of Hurely et al., with the smaller studied group, ultrasound was not proposed as the gold standard method and its application revealed low superiority to the plain radiography in rib fraction diagnosis. Hurely et al. proposed ultrasound as a time-consuming and painful method which was not comfortable to be performed on traumatized patients with pain and was associated with limited access of transducer to thorax areas such as upper ribs (29-32). In the study of Kara et al. (33), older patients showed higher incidence of bony rib fractures and the frequency of the chondral rib fractures were higher in younger patients. In this study, there was not any significant relation between age, gender, duration of pain, and site of trauma to the prediction of rib fracture.

In considered studies, conventional radiography does not have the capability to detect the costochondral and chondrosternal cartilage fractures which implies the need for more sensitive diagnostic methods

Table1. Studies compared the ultrasound and radiography in rib fracture

Author Reference Year	Patients characteristics	Conventional radiography outcome	Ultrasolography outcome
Kara (33) 2003	Total number: 37 male: 27 (73%) female: 10 (27%) age: 16-85 years	No rib fractures	Rib fracture in 15 (40.5%) of patients-Fracture with subperiosteal hematoma in 10 (66.7%) of patients
Turk (34) 2010	Total number: 20 male: 17(85%) female: 3(15%) age: 25-68 years	No rib fractures was seen	26 rib fractures in 18 (90%) of patients
Huley (29) 2004	Total number: 14 male: 11 female: 3 age: 16-55 years	13 (87%) broken ribs in 10 patients from total 15 sites of fraction	14 (93%) broken ribs in 10 patients from total 15 sites of fraction
Griffith (32) 1999	Total number: 50 male: 33 female: 17 age: 24-89 years	8 rib fractures in six (12%) of 50 patients	83 rib fractures in 39 (78%) of 50 subjects 38 (46%) of fractures were associated with a soft tissue hematoma
Bitschnau (31) 1996	Total number: 80 male: 45 female: 35 average age: 50.4 years	37 rib fractures in 21 (26%) patients	75 rib fractures in 41 (51%) of patients
Rainer TH (35) 2004	Total number: 88 10 years old minimum age	23.7% of rib fractures	80.3% of rib fractures

(33,34). Kara et al. also mentioned that obesity and large breasts are factors that reduce the quality of ultrasonography diagnosis and US is not able to visualize the subscapular ribs and the infraclavicular parts of the ribs (33).

In the study of Griffith et al., ultrasonography revealed 10 times more fractures and 6 times more patients with fractures than radiography. Using higher resolution transducer and low weight patients have been proposed to be related with higher detection rate of ultrasonography than conventional radiography (32). Bitschnau et al., in 1996, diagnosed the rib fracture in 58% of total patients through ultrasound and in 30% of total patients through plain radiography; almost 2 times as many patients in ultrasound as radiography (31).

According to literature, conventional radiography is not reliable as a sole method in rib fractures diagnosis process. In most of the studies, ultrasonography has showed more sensitivity than conventional radiography, more accessibility, and no radiation compared with computed tomography, which is recommended to be used routinely in patients suspected of rib fractures.

Conclusion

The acceptable practice of rib fracture detection is recommended to start with the evaluation of the event history, performing clinical examinations, using plain radiography, and eventually ultrasound for detecting the fractures which was not observed through conventional radiography. Based on compared studies, ultrasound has not been proposed as the universal gold standard technique to be used routinely in rib fracture diagnosis. Further studies are required to obtain the most comprehensive

data on diagnostic value of ultra-sonography.

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Conflict of Interest

The authors declare no conflict of interest.

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