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Comparison of Chest Computed Tomography and Chest X-Ray in the Diagnosis of Rib Fractures in Patients with Blunt Chest Trauma

Künt Göğüs Travmalı Hastalarda Kaburga Kırıklarının Tanısında Bilgisayarlı Göğüs Tomografisi ve Göğüs Radyogramının Karşılaştırılması

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Abstract

Objective: The purpose of this study was to compare computed tomography and chest X-ray in the diagnosis of rib fractures in patients with blunt chest trauma.

Materials and Methods: A total of 83 patients with blunt chest trauma who were treated in three hospitals between May 2010 and June 2011 and who had received both chest computed tomography scan and chest X-ray as part of their initial assessment were included in the study.

Results: The number of rib fractures was 2.15±2.12 on chest X-ray, however, on chest computed tomography the number was 3.75±2.35. There was a significant difference between the chest X-ray and the computed tomography ($p<0.001$).

Conclusion: Chest computed tomography is the best and a significantly more sensitive radiological method than chest X-ray in the detection of rib fracture, and it should be routinely used in the initial assessment of chest trauma. However, chest X-ray can be a suitable method in follow-up period.

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Key words: Computed tomography, chest X-ray, rib, fracture

Özet

Amaç: Bu çalışmanın amacı, künt göğüs travması olan hastalarda kaburga kırıklarının tanısında bilgisayarlı göğüs tomografisi ve göğüs radyogramını karşılaştırmaktır.

Gereç ve Yöntemler: Mayıs 2010 ve Haziran 2011 tarihleri arasında üç hastanede tedavi edilen künt göğüs travmalı toplam 83 hasta başvuru sırasında hem bilgisayarlı göğüs tomografisi hem de göğüs radyogramı ile değerlendirildi.

Bulgular: Göğüs radyogramında tespit edilen kaburga kırığı sayısı 2.15±2.12 iken, bilgisayarlı göğüs tomografisi ile tespit edilen 3.75±2.35 idi. Sonuç bilgisayarlı göğüs tomografisi lehine istatistiksel olarak anlamlı idi ($p<0.001$).

Sonuç: Bilgisayarlı göğüs tomografisi kaburga kırığı tespitinde göğüs radyogramına göre daha iyi ve çok daha hassas bir radyolojik metoddur ve göğüs travmalarının ilk başvurusunda rutin inceleme olmalıdır, öte yandan göğüs radyogramı hastaların takip periyodlarında uygun bir tanı metodu olabilir.

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Anahtar kelimeler: Bilgisayarlı tomografi, göğüs radyogramı, kaburga, kırık

Introduction

Chest traumas constitute 10-15% of all traumas and are the cause of death in 25% of all fatalities due to trauma (1, 2). Blunt chest trauma accounts for 81% of thoracic injuries in children and 78% in the elderly, and minor blunt chest trauma is the most common form of blunt chest trauma (3). Motor vehicle accidents is the most predominant reason for (4), and rib fracures are the most common (25%) injuries resulting from, blunt chest trauma (5). Minor blunt chest trauma comprises more than half of the rib fractures without any complications such as pneumothorax, hemothorax or pulmonary contusion, and is often treated on an outpatient basis (3).

The findings in blunt chest trauma have a wide range, including multiple rib fractures with flail chest and associated underlying visceral injury (3). Rib fractures may cause severe pain with resultant limitation of deep breathing, atelectasis and pneumonitis, and unless detected and properly treated, it may become a life threatening lesion, especially in elderly patients (3). Thus, an appropriate radiological examination and diagnosis of a rib fracture is of clinical significance in chest trauma (3).

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The diagnosis of chest injuries begins with a careful history and examination of the patient (6). Today, because of the complex technology, this simple first step is all too often overlooked (6). The usual diagnostic study in the emergency department for blunt chest injuries is a chest X-ray (7), but in this approach, significant injuries, such as rib fractures, pneumothorax, haemothorax, and lung contusions can be missed during the initial trauma assessment (7, 8). A number of authors have suggested that the computed tomography chest scan should be routinely considered in the initial assessment of chest trauma (9, 10). Some studies have reported clinical changes in management after computed tomography scans in up to 70% of cases (7, 11), whereas others have suggested that routine computed tomography scans do not have a major impact on the management of blunt chest trauma (7, 9, 12).

The sensitivity of conventional chest X-ray has been shown to be limited in showing rib fractures (3), and chondral rib fractures are almost invisible on chest X-ray unless the fracture involves a strongly calcified cartilage. Thus, more sensitive techniques are required to better evaluate the chest wall, and understand the etiology of pain in blunt chest trauma for a proper treatment to prevent possible pulmonary complications (3). The purpose of this study was to compare computed tomography and chest X-ray in the diagnosis of rib fractures in patient with blunt chest trauma.

Materials and Methods

A retrospective review was made of patients with blunt chest trauma who were treated in three hospitals between May 2010 and June 2011 and who had received both chest X-ray (Figure 1) and chest computed tomography scan (Figure 2) as part of their initial assessment. A total of 83 patients were evaluated, and the primary aim was comparison of computed tomography and chest X-ray in the diagnosis of rib fractures in patient with blunt chest trauma. All patients gave written informed consent to participate. Chest X-ray and chest computed tomography were evaluated by a thoracic surgeon for each patient. The complaints were divided into chest pain, dyspnea and chest pain plus dyspnea, etiology of rib fractures were divided into motor vehicle accidents, assaults and falls from heights. We investigated how many rib fractures were detected on chest X-ray and chest computed tomography, the locations of rib fractures on chest X-ray and chest computed tomography were divided into right, left, bilateral and none, localisation of rib fractures' on chest X-ray and chest computed tomography were divided into anterior, lateral, posterior and none.

Statistical analysis

Statistical analysis were made by SPSS for Windows 15.0 Chicago Inc. packet programme, to determine agreement between results of chest X-ray and computed tomography. Kappa test was used for categorical data. The Bland-Altman test was used for continuous data. Linear regression analysis was used to investigate the relationship between rib fracture measurements of chest X-ray and computed tomography.

To describe data, mean±SD were given for continuous data, frequencies and percentages were given for categorical data.

Results

Eighty-three patients were evaluated, the mean age was 40.8±15.8 years (range between 16-92), 61 (73.5%) patients were male and 22 (26.5%) were female. 44 (53%) patients had chest pain, 59 (71%) patients were motor vehicle accidents. The rib fractures could not be detected in 16 (19.3%) patients, right rib fractures were detected in 32 (38.6%) patients, left rib fractures were detected in 28 (33.7%) patients, and bilateral rib fractures were detected in 7 (8.4%) patients on chest X-ray. However, the rib fractures could not be detected in only 1 (1.2%) patient, right rib frac-

Figure 1. Chest X-ray showed no rib fracture (Black arrow)

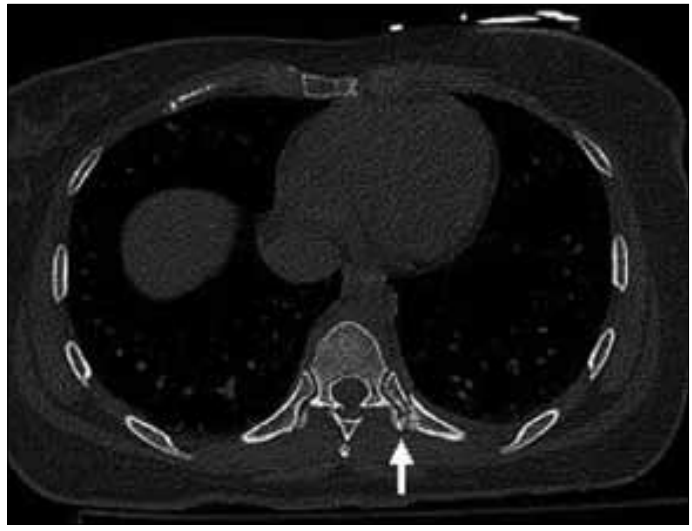

Figure 2. Chest computed tomography showed ninth rib fracture (White arrow)

Table 1. Location of rib fractures

	Right	Left	Bilateral
Chest X-ray n (%)	32 (38.6%)	28 (33.7%)	7 (8.4%)
Chest Computed Tomography n (%)	35 (42.2%)	33 (39.8%)	14 (16.9%)

tures were detected in 35 (42.2%) patients, left rib fractures were detected in 33 (39.8%) patients, and bilateral rib fractures were detected in 14 (16.9%) patients on computed tomography (Table 1, 2). We have obtained a compatible result according to the side of fracture between the chest computed tomography and the chest X-ray (Kappa=0.579, the support rate: 71.08%). The number of fractures was 2.15±2.12 (Median: 2.00) on chest X-ray, but the number of rib fractures was 3.75±2.35 (Median: 3.00) on chest computed tomography. The number of rib fractures was significantly different between the chest X-ray and the computed tomography (p<0.001). The number of rib fractures in 57 patients on computed tomography was more than according to the chest X-ray, in 23 patients the results were same, and only in 3 patients were the rib fractures more in chest X-ray. The number of rib fractures were compared between computed tomography and chest X-ray (r=0.703) (Figure 3), when the number of rib fracture increased by 1 in computed tomography, the number of rib fracture increased by 0.636 unit in chest X-ray, and this was statistically significant (p<0.001). The localisation of rib fractures on chest computed tomography and chest X-ray were compatible (Kappa=0.566, the accuracy rate: 69.88%). The thoracic complication rates were compatible between chest computed tomography and chest X-ray.

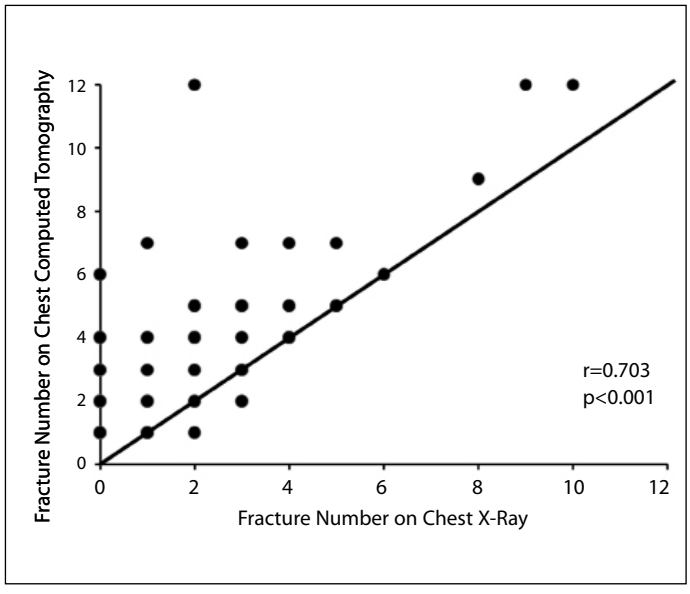

Figure 3. Number of rib fractures and conformity between chest X-ray and chest computed tomography

Discussion

Multiple trauma is the leading cause of death in our country and the world, especially in young adults (13). In all age groups it is in third place after cancer and cardiovascular disease as the cause of death (13). Seventy percent of the chest traumas are blunt and the remaining are penetrating injuries (1). Motor vehicle accidents is the most predominant cause of blunt chest trauma (4), and rib fractures are the most common injuries resulting from blunt chest trauma (5). In our study 59 (71%) patients had been involved in motor vehicle accidents. The incidence of rib fractures due to trauma has been reported by various studies to range between 7 and 40% (1). Most commonly, the 4-9th ribs are fractured, 1st and 2nd ribs usually signify a severe trauma whereby concomitant great vessel injuries are commonplace, fracture of the lower ribs (9-12th) may result in laceration of the spleen, liver or kidneys (1). Early diagnosis of rib fractures is of clinical importance for the prompt initiation of appropriate treatment (5).

Physical examination may yield the diagnosis of a rib fracture when crepitation is present, however, many patients, especially with minor blunt chest trauma, present without any physical or radiological findings apart from tenderness on the affected side of the chest wall (3, 14). Examination of the thorax must be prompt and thorough, because many thoracic injuries that can be rapidly lethal (6). On the other hand, the clinical presentation of patients with blunt chest trauma varies widely and ranges from minor reports of pain to shock (15). Once a rapid but thorough examination is completed, it is time to proceed to diagnostic testing. Radiographic evaluation then proceeds, with studies selected based on the patient's presentation and condition (6). A chest X-ray is the first step in the radiological examination of a possible rib fracture and any associated complication (3). A portable antero-posterior chest X-ray remains the most common first radiograph obtained in most trauma patients (6). The bony thorax including ribs, clavicles, scapulae, and spine should be evaluated, and can be made easily and the results are rapidly available with evaluation in the emergency department (6), but a supine antero-posterior chest X-ray is not the best study to evaluate these structures (6).

Clinically, rib fractures are generally suspected based on the patient's history and pain, which is accentuated with inspiration, cough, and localized palpation (5), a low-kilovoltage X-ray can be obtained to outline the bone detail in cases with symptoms highly suggestive of rib fractures but showing no evidence on chest X-rays (3). The determination of a rib fracture may easily be overlooked unless it presents with an apparent dislocation at the frac-

Table 2. Localization of the undetected rib fractures

		Chest X-ray n (%)		Chest Computed Tomography n (%)	
Un detected rib fractures	Anterior	16 (19.3%)	11 (13.3%)	1 (1.2%)	
	Lateral		2 (2.4%)		
	Posterior		3 (3.6%)		1 (1.2%)

ture site (3), failure to use the correct treatment protocol in undiagnosed patients can lead to delays in the resolution of pain and returning to work (5). 50-88% of rib fractures are undetected on conventional chest X-rays (3, 16, 17), especially cartilage fractures cannot be diagnosed with conventional chest X-rays (3). In our study, 11 (13.3%) anterior (cartilage) rib fractures could not be detected on chest X-ray, however all of these rib fractures were detected on chest computed tomography. On chest X-ray, a total of 16 (19.3%) patients with undetected rib fractures were not life threatening in the acute phase, they were detected on chest computed tomography and we have followed up intermittently after discharge for delayed complications. When the number of rib fracture of 1 increase in computed tomography, the number of rib fracture increased 0.636 unit in chest X-ray, and it was statistically significant ($p<0.001$). The number of rib fractures in 57 patients on computed tomography was more than according to the chest X-ray, in 23 patients results were the same, and only in 3 patients were rib fracturedetected even more on chest X-ray. These results showed that the chest computed tomography was superior to the chest X-Ray, however a small number of patients' fractures may not be detected on chest computed tomography due to skipping tomographic cross-section.

In today's world of complex technology, there are very different diagnostic techniques in thoracic trauma for determination of complications (6). The quality of computed tomography scanners has grown exponentially in recent years (6), and it is not rare for a computed tomography scan to be the first diagnostic study done after an initial assessment of the patient (6). It is a highly sensitive modality for imaging the thorax in the setting of trauma (8). Rib fracture, pulmonary contusion, hemothorax, pneumothorax, foreign body location, mediastinal haematomas and pleural fluid can all be diagnosed (6, 7, 18). Three-dimensional computed tomography is especially useful to explain the details of injury and is strongly recommended for patients with blunt chest trauma (18). Chest computed tomography is useful in the detection of radiographically occult rib fractures in adults (8), especially in the era of multi-detector row computed tomography technology, and has become a widespread imaging modality because of its availability in almost all trauma centers, because the scan times have prominently decreased and it is easy to use (15).

Detection of rib fractures is important in the evaluation of non-accidental trauma (8), and most rib fractures in infants are caused by non-accidental trauma. Some studies (8, 19) have reported that rib fractures in infants resulted from child abuse in more than 80% of cases, and the standard imaging method for evaluating rib fractures in abused infants is the chest X-ray (8, 20). However, rib fractures may be incomplete, non-displaced, superimposed over other bony structures or oriented obliquely with respect to the X-ray beam, and they may be difficult to see (8, 21). Chest computed tomography is significantly more sensitive than chest X-ray in the detection of early subacute, subacute and old rib fractures (8). It is better at detecting fractures in every position (8). In our study, the number of fractures was 2.15±2.12 on chest X-ray, however the number of rib fractures was 3.75±2.35 on chest computed tomography. There was a significant difference between the chest X-ray and the chest computed tomography ($p<0.001$), and chest computed tomography was significantly more sensitive than chest X-ray.

Conclusion

Rib fractures are the most common injuries resulting from blunt chest trauma, most of them are managed conservatively. Confirmation of rib fractures is important, because they can have some associated complications in the early or late period, such as lung contusion, pneumothorax and hemothorax. Chest computed tomography is the best and significantly more sensitive radiological method than chest X-ray in the detection of rib fractures. It should be used routinely in the initial assessment of chest trauma, but chest X-ray can be a suitable method in the follow-up period.

Conflict of Interest
No conflict of interest was declared by the authors.

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