Hong Kong J Radiol. 2018;21:262-5 | DOI: 10.12809/hkjr1816873

ORIGINAL ARTICLE

Radiography Versus Computed Tomography in Paediatric Patients after Blunt Thoracic Trauma

K Yalçın-Şafak, A Akça

Kartal Dr Lütfü Kırdar Research and Training Hospital, Istanbul, Turkey

ABSTRACT

Objective: *To compare radiography with computed tomography (CT) in the detection of blunt thoracic injuries in paediatric patients.*

Methods: *Paediatric patients who underwent radiography and CT after blunt thoracic trauma between February 2015 and January 2016 were retrospectively reviewed. Images were independently evaluated by two experienced radiologists and a consensus reached. The spectrum of blunt thoracic injuries was categorised into the lungs, airways, pleural space, oesophagus, heart, aorta, diaphragm, and chest wall. Considering CT as the gold standard, the sensitivity, specificity, and positive and negative predictive values of radiography were calculated.*

Results: *A total of 39 male and nine female patients aged 1 to 18 years were included; 46 of the 48 patients were clinically stable. CT detected 19 thoracic injuries in 11 patients, whereas radiography detected 15 of the thoracic injuries in eight of the patients. Considering CT as the gold standard, radiography had 73% sensitivity, 100% specificity, and 94% accuracy in detecting thoracic blunt injuries.*

Conclusion: *Most thoracic CT scans in paediatric patients with thoracic blunt trauma were normal. Chest radiography can reliably detect blunt trauma in paediatric patients when evaluated by experienced radiologists. Owing to the risk of radiation exposure, thoracic CT should be performed selectively and based on clinical, laboratory, and chest radiography findings.*

Key Words: *Pediatrics; Radiography, thoracic; Thoracic injuries; Tomography, X-ray computed*

中文摘要

胸部X光片與電腦斷層掃描在檢測鈍性胸部創傷的兒童患者應用的比較

K Yalçın-Şafak、A Akça

目的：比較胸部X光片與電腦斷層掃描（CT）在檢測鈍性胸部創傷的兒童患者的應用價值。

方法：回顧性分析2015年2月至2016年1月之間接受胸部X光片與CT檢測鈍性胸部創傷的兒童患者。兩位經驗豐富的放射科醫師對圖像進行獨立評估並達成共識。鈍性胸部創傷的範圍分為肺、氣道、

Correspondence: *Dr K Yalçın-Şafak, Radiology, Kartal Dr Lütfü Kırdar Research and Training Hospital, Acıbadem Cad Eczacı Necip Akar Sok No 8 Daire 4, Istanbul, Turkey.*
Email: drkadihan@yahoo.com

Submitted: 13 Mar 2017; Accepted: 5 Jun 2017.

Disclosure of Conflicts of Interest: All authors have disclosed no conflicts of interest.

Funding/Support: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

胸膜間、食管、心臟、主動脈、隔膜和胸壁。以CT為黃金標準來計算X光片的靈敏性、特異性及陽性和陰性預測值。

結果：共包括39名男性和9名女性年齡由1至18歲的患者。48例患者中46例臨床穩定。CT在11例患者中檢測到19例胸部創傷；X光片在其中8例患者中檢測到其中15例胸部創傷。以CT為黃金標準，X光片檢測到鈍性胸部創傷的靈敏性為73%、特異性為100%和準確性為94%。

結論：大多數鈍性胸部創傷兒童患者的胸廓CT均正常。當由經驗豐富的放射科醫師進行評估時，胸部X光片能有效檢測兒童患者的鈍性胸部創傷。由於輻射暴露的風險，胸廓CT應根據臨床、實驗室和胸部X光片檢查結果選擇性地進行。

INTRODUCTION

Trauma is the leading cause of morbidity and mortality in paediatric patients worldwide, accounting for >5000 deaths every year. Thoracic trauma accounts for 5% to 12% of all trauma cases and is the second most common cause of death after head trauma.[1] Most thoracic injuries are caused by blunt rather than penetrating trauma.[2] Three-quarters of blunt thoracic traumas are caused by motor vehicle accidents; the remaining are caused by falls and bicycle accidents.[3]

In an emergency setting, portable chest radiography is used to detect life-threatening conditions such as tension pneumothorax, large haemothorax, tube malpositioning, and other conditions that require immediate treatment.[4] Nonetheless, computed tomography (CT) is superior to radiography for adult trauma patients in detecting pulmonary contusion, thoracic vascular injuries, and osseous traumas; CT is the gold standard for radiological evaluation of adult patients with thoracic trauma.[5] Nonetheless, the role of CT in the diagnosis of thoracic blunt trauma in paediatric patients is less well defined.[6-9] In paediatric patients with thoracic trauma, the incidence of cardiac and thoracic vascular injuries is much lower, and the risk of radiation exposure is higher, compared with adults.[10] This study aimed to compare radiography with CT in the detection of blunt thoracic injuries in paediatric patients.

METHODS

This study was approved by the ethics committee of the Kartal Dr Lütfü Kırdar Research and Training Hospital and conducted in compliance with the Declaration of Helsinki. Paediatric patients who underwent radiography and CT after blunt thoracic trauma between February 2015 and January 2016 at the Kartal Dr Lütfü Kırdar Research and Training Hospital were retrospectively reviewed. Patients with unacceptable-quality images or insufficient medical information were excluded.

Radiographs were obtained immediately, and CT was performed within 1 hour. Most radiographs were obtained in the supine anteroposterior position unless the patient was clinically unstable in which case a portable X-ray machine was used. CT was performed from the level of the thoracic inlet to the diaphragm using a SOMATOM Sensation 40-MDCT scanner (Siemens Medical Solutions, Erlangen, Germany), with automated current, slice thickness 7 mm, and 1-mm pitch. In 20 patients, CT was performed with administration of non-ionic intravenous contrast agent (320 mg/mL iodixanol) at a dose of 1 mL/kg.

Images were independently evaluated by two experienced radiologists and a consensus reached. The spectrum of blunt thoracic injuries was categorised into the lungs, airways, pleural space, oesophagus, heart, aorta, diaphragm, and chest wall.

Considering CT as the gold standard, the sensitivity, specificity, and positive and negative predictive values of radiography were calculated using the McNemar test. A p value of <0.05 was considered statistically significant.

RESULTS

A total of 39 male and 9 female patients aged 1 to 18 (mean, 12.0; standard deviation, 5.9) years were included; 46 of the 48 patients were clinically stable. CT detected 19 thoracic injuries in 11 patients, whereas radiography detected 15 of the thoracic injuries in eight of the patients. The remaining three patients had mild pneumothorax and mild pulmonary contusion (n = 1), mild pneumothorax (n = 1) or moderate haemomediastinum (n = 1); two of them were clinically unstable. Considering CT as the gold standard, radiography had 73% sensitivity, 100% specificity, and 94% accuracy in detecting thoracic blunt injuries.

Injuries detected by radiography and CT were

Table. Thoracic injuries detected on radiography and computed tomography.

Thoracic injury	Radiography	Computed tomography
Pulmonary contusion	5	6
Pneumothorax	3	5
Subcutaneous emphysema	4	4
Scapula fracture	2	2
Haemothorax	1	1
Haemomediastinum	0	1

comparable (p = 0.250, McNemar test). On radiography, the 15 thoracic injuries were: pulmonary contusion (n = 5), subcutaneous emphysema (n = 4), pneumothorax (n = 3), scapula fracture (n = 2), and haemothorax (n = 1) [Table]. On CT, the 19 thoracic injuries were: heavy (n = 3) or mild-to-moderate (n = 3) pulmonary contusion, mild-to-moderate pneumothorax (n = 5), subcutaneous emphysema (n = 4), scapula fracture (n = 2), haemothorax (n = 1), and haemomediastinum (n = 1) [Table]. Mediastinal vascular, tracheobronchial, diaphragmatic, oesophageal, and other injuries were not observed.

DISCUSSION

Thoracic injuries are the second most common cause of death in paediatric trauma patients.[11] Diagnostic radiology is useful in the evaluation of patients with thoracic trauma.[12] Radiography is the first-line imaging tool to detect thoracic trauma in an emergency setting.[4] Most life-threatening thoracic injuries can be detected by radiography.[13,14] For adult patients, CT is more sensitive than radiography in the detection and characterisation of thoracic injuries.[15,16] Thoracic injuries that are often occult on radiography include major thoracic vascular injuries, pericardial haemorrhage, and small pneumothorax and diaphragm tears. CT can better define the extent of lung contusion, laceration, and osseous fractures.[15]

Severe thoracic injuries in paediatric patients are infrequent; they are indicative of high-energy trauma and associated with increased morbidity and mortality. In paediatric patients, the thorax is elastic and the ribs are infrequently broken, as the energy is transmitted to the thoracic contents. Thus, pulmonary contusions and lacerations are the most common injuries after severe blunt thoracic trauma.[17,18] In a study of the chest radiographs of 137 paediatric patients with blunt thoracic trauma, pulmonary contusion was the most common (n = 68, 49.6%) and most prominent (n = 34, 27%) injury.[18] 41 of the 137 patients (30%) were clinically unstable and the spectrum of injuries was wider than that in our study.

In paediatric patients with thoracic trauma, the incidence of cardiac and great vessel injuries is much lower, and the risk of radiation exposure is higher, compared with adult patients.[10] The risk of ionising radiation is inversely associated with the age of the patient; paediatric patients are up to 10-times more sensitive to ionising radiation than adults.[19]

Radiography is useful in the diagnosis of blunt thoracic trauma in adult patients.[20,21] Nonetheless, the role of CT in the diagnosis of thoracic blunt trauma in paediatric patients is less well defined.[6-9] In a study of 42 paediatric patients with blunt trauma evaluated by thoracic and abdominal CT, only 11 patients were found to have 12 abnormalities, of whom only four had thoracic injuries: mild pulmonary contusion (n = 2), minimal pneumothorax (n = 1), rib fracture (n = 1), and the remaining were abdominal injuries.[6] Thus, routine use of CT in asymptomatic paediatric patients with blunt trauma is not justified.[6] In a study of 30 paediatric patients with blunt thoracic trauma, 26 injuries were detected on CT, of which 17 were also detected on radiography.[7] CT is more sensitive for detection of chest wall, pleural, parenchymal, and mediastinal injuries.[7] In a study of 57 CT scans and 55 radiographs in paediatric patients with thoracic blunt trauma, radiography identified fewer injuries (51% vs. 83%, p<0.001).[8] All seven emergency chest interventions were based on radiography.[8] CT correlated with radiography and did not change patient management, but CT did add radiation exposure.[8] Selective use of thoracic CT is recommended, particularly in the presence of an abnormal mediastinal silhouette on chest radiography after a deceleration injury.[8] In a study of paediatric patients with thoracic blunt trauma, only 5% of initial radiographs falsely reported normal findings that may have altered management.[9]

One limitation of our study was the small sample size in a single hospital. In addition, only 20 of the 48 patients underwent contrast-enhanced CT. Vascular complications are difficult to demonstrate without contrast agents.

CONCLUSION

Most thoracic CT scans in paediatric patients with thoracic blunt trauma were normal. Chest radiography can reliably detect blunt trauma in paediatric patients

when evaluated by experienced radiologists. Owing to the risk of radiation exposure, thoracic CT should be performed selectively and based on clinical, laboratory, and chest radiography findings.

REFERENCES

1. Cooper A. Thoracic injuries. Semin Pediatr Surg. 1995;4:109-15.
2. Peclet MH, Newman KD, Eichelberger MR, Gotschall CS, Garcia VF, Bowman LM. Thoracic trauma in children: an indicator of increased mortality. J Pediatr Surg. 1990;25:961-6. Crossref
3. Coley E, Roach P, Macmillan AI, West AT, Johnston AM. Penetrating paediatric thoracic injury. J R Army Med Corps. 2011;157:243-5. Crossref
4. Exadaktylos AK, Sclabas G, Schmid SW, Schaller B, Zimmermann H. Do we really need routine computed tomographic scanning in the primary evaluation of blunt chest trauma in patients with "normal" chest radiograph? J Trauma. 2001;51:1173-6. Crossref
5. Peters S, Nicolas V, Heyer CM. Multidetector computed tomography–spectrum of blunt chest wall and lung injuries in polytraumatized patients. Clin Radiol. 2010;65:333-8. Crossref
6. Hershkovitz Y, Zoarets I, Stepansky A, Kozer E, Shapira Z, Klin B, et al. Computed tomography is not justified in every pediatric blunt trauma patient with a suspicious mechanism of injury. Am J Emerg Med. 2014;32:697-9. Crossref
7. Dabees NL, Salama AA, Elhamid SA, Sabry MM. Multi-detector computed tomography imaging of blunt chest trauma. Egypt J Radiol Nucl Med. 2014;45:1105-13. Crossref
8. Holscher CM, Faulk LW, Moore EE, Cothren Burlew C, Moore HB, Stewart CL, et al. Chest computed tomography imaging of blunt pediatric trauma: not worth the radiation risk. J Surg Res. 2013;184:352-7. Crossref
9. Markel TA, Kumar R, Koontz NA, Scherer LR, Applegate KE. The utility of computed tomography as a screening tool for the evaluation of pediatric blunt chest trauma. J Trauma. 2009;67:23-8. Crossref
10. Patel RP, Hernanz-Schulman M, Hilmes MA, Yu C, Ray J, Kan JH. Pediatric chest CT after trauma: impact on surgical and clinical management. Pediatr Radiol. 2010;40:1246-53. Crossref
11. Cooper A, Barlow B, DiScala C, String D. Mortality and truncal injury: the pediatric perspective. J Pediatr Surg. 1994;29:33-8. Crossref
12. Mirka H, Ferda J, Baxa J. Multidetector computed tomography of chest trauma: indications, technique and interpretation. Insights Imaging. 2012;3:433-49. Crossref
13. Shanmuganathan K, Mirvis SE. Imaging diagnosis of nonaortic thoracic injury. Radiol Clin North Am. 1999;37:533-51. Crossref
14. Moore MA, Wallace EC, Westra SJ. The imaging of paediatric thoracic trauma. Pediatr Radiol. 2009;39:485-96. Crossref
15. Mirvis SE. Diagnostic imaging of acute thoracic injury. Semin Ultrasound CT MR. 2004;25:156-79. Crossref
16. Sangster GP, González-Beicos A, Carbo AI, Heldmann MG, Ibrahim H, Carrascosa P, et al. Blunt traumatic injuries of the lung parenchyma, pleura, thoracic wall, and intrathoracic airways: multidetector computer tomography imaging findings. Emerg Radiol. 2007;14:297-310. Crossref
17. Black TL, Snyder CL, Miller JP, Mann CM Jr, Copetas AC, Ellis DG. Significance of chest trauma in children. South Med J. 1996;89:494-6. Crossref
18. Balci AE, Kazez A, Eren S, Ayan E, Ozalp K, Eren MN. Blunt thoracic trauma in children: review of 137 cases. Eur J Cardiothorac Surg. 2004;26:387-92. Crossref
19. Brunetti MA, Mahesh M, Nabaweesi R, Locke P, Ziegfeld S, Brown R. Diagnostic radiation exposure in pediatric trauma patients. J Trauma. 2011;70:24-8.
20. Elmali M, Baydin A, Nural SM, Arslan B, Ceyhan M, Gürmen N. Lung parenchymal injury and its frequency in blunt thoracic trauma: the diagnostic value of chest radiography and thoracic CT. Diagn Interv Radiol. 2007;13:179-82.
21. Primack S, Collins J. Blunt nonaortic chest trauma: radiographic and CT findings. Emerg Radiol. 2002;9:5-12. Crossref