

ORIGINAL ARTICLE

ULTRASOUND AND SUPINE CHEST RADIOGRAPH IN ROAD TRAFFIC ACCIDENT PATIENTS: A RELIABLE AND CONVENIENT WAY TO DIAGNOSE PLEURAL EFFUSION

Uzma Mumtaz, Zainab Zahur*, Muhammad Ali Raza**, Madiha Mumtaz***,

Department of Radiology, Pakistan Institute of Medical Sciences, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad,

*Department of Radiology, Pakistan Atomic Energy Commission General Hospital, Islamabad, **Department of Paediatrics, Ayub Teaching Hospital Abbottabad, ***Student Quaid e Azam Medical College Bahawalpur-Pakistan

Background: Portable bed side ultrasound and supine chest radiograph of 80 traumatic patients excluding very clinically unstable patients who subsequently underwent CT scan chest was done for traumatic effusion showing that ultrasound had a higher sensitivity than CXR, 88.23% and 77.94%, respectively, and a similar specificity of 100% and 100%, respectively. Objective of the study is to compare the diagnostic accuracy of high resolution ultrasound and supine chest x-ray in detection of pleural effusion in road traffic accident patients keeping plain CT chest as gold standard. **Methods:** This study was conducted in PIMS and PAEC General Hospital, Islamabad from 1st January to 15th December 2015. The current study examined total of 80 trauma (blunt and penetrating) patients coming to emergency departments of both hospitals specifically those who had road traffic accident history. Their portable bed side ultrasound and supine chest radiograph were performed for assessing pleural effusion and subsequently CT scan chest was done for confirmation as it's a gold standard. **Results:** Using CT findings as gold standard the sensitivity, specificity, positive predictive value and negative predictive value was assessed for both ultrasonography and chest radiography and found to be 88.23%, 100%, 100%, 40% and 77.94%, 100%, 100%, 55.55% respectively with diagnostic accuracy of ultrasound 90% as compared to 81.25% for supine chest x-rays when compared with gold standard. **Conclusion:** Ultrasound and chest x-ray can be used as a useful and suitable adjunct to CT in road traffic accident patients as these are easily available, non-invasive, no contrast required, can be performed on bed side and carries no or little radiation risk.

Keywords: Ultrasound; Chest x-ray; Computed tomography; Road traffic accident; Trauma

J Ayub Med Coll Abbottabad 2017;29(4):587-90

INTRODUCTION

Thoracic injuries are significant causes of morbidity and mortality in trauma patients. These injuries account for approximately 25% of trauma-related deaths in the United States, second only to head injuries. Road Traffic Accident (RTA) was found to be the commonest cause of Blunt Chest Trauma (90%) while Gunshot injuries constituted the commonest cause of Penetrating Chest Trauma (73%). Radiologic imaging plays an important role in the diagnosis and management of blunt chest trauma.¹

Ultrasound evaluation for these road traffic accident traumatic patients as FAST (Focused Assessment with Sonography for Trauma) is considered as initial step in management.^{2,3} Studies have assessed important characteristics of ultrasound for detecting significant traumatic hemothoraces.^{4,5} In addition to common traumatic thoracic injury, it also identifies complications of blunt trauma⁵ and free fluid of >200 ml is usually detected by this imaging modality^{4,6,7}. Ultrasound has high sensitivity and specificity of 92% and 100% respectively with positive predictive value of 100% and negative predictive value 98% for traumatic hemothorax.^{4,8}

Ultrasound is portable, inexpensive, free of ionizing radiation, and allows the clinician to perform examinations rapidly and repeatedly to obtain diagnostic information at the bedside.^{2,9} Ultrasound provides an important initial screening examination in the adult trauma patient. However, it is not a replacement for the more sensitive imaging studies like CT. Costophrenic area assessed as part of the FAST examination is the site in supine patient where free intrathoracic fluid accumulates.

The chest radiograph (CXR) is the initial test for all patients with blunt thoracic trauma.¹⁰ It is inexpensive, noninvasive, easy to obtain, and in many instances, reveals useful information so it must be performed in all stable patients who have sustained blunt thoracic trauma. A volume of 300 mL is needed for hemothorax to manifest on an upright CXR. (20). CXR is systematically reviewed for evidence of hemothorax, and other traumatic injuries in suspected cases of trauma.^{11,12} Any abnormality on CXR should be followed by a computed tomography (CT) scan of the chest. Sensitivity, specificity and accuracy of portable chest radiograph for hemothorax is 96.2%, 100% and 99.6% respectively.⁸

The diagnostic accuracy of computed tomography (CT) is far greater than plain radiography for intrathoracic injury, and allows for detailed evaluation of the pulmonary and mediastinal structures.^{13,14} CT scan is extremely sensitive and specific for traumatic injuries and considered as Gold standard and provide a basis for treatment planning in these patients.^{15,16}

Rationale of this study is to compare accuracy of bedside ultrasound and supine chest x-rays for pleural effusion in traumatic patients and if it comes out to be equal to CT then apply these modalities as an extension of physical examination on prior bases for traumatic patients as ultrasound is portable, inexpensive, free of ionizing radiation, and allows the clinician to perform examinations rapidly and repeatedly to obtain diagnostic information at the bedside and x-rays is easily available, noninvasive, cost effective, no patient preparation is required and dose exposure is less as compared to CT. CT requires patients be transported out of the resuscitation suite (which is usually contraindicated in unstable trauma patients), exposes patients to ionizing radiation, and also entails higher cost thus delaying management of these patients

MATERIAL AND METHODS

This descriptive validation study was conducted in 10 months duration, extending from 1st January to 31st October 2015. Approval of the study was taken from hospital ethical committees of both hospitals prior to the start of study. A total of 80 patients were selected for the study. Sample size was calculated by using WHO sample size calculator using sensitivity 62%, specificity 100%,⁴ prevalence of 25%,¹ precision level of 10% and confidence level of 95%. All patients with suspected blunt or penetrating trauma were enrolled for the study, however this study excluded all those traumatic patients who were critically and clinically unstable and require emergency surgery before presenting to radiology department for trauma imaging and pregnant women. Informed consent by these traumatic patients were not required.

In addition to thoracic ultrasonography, supine chest radiograph and plain chest CT for a complete evaluation, was included in this study. All imaging examinations were conducted by post graduate trainee under supervision of experienced radiologist. All sonograms were made with the patient in the supine position immediately after arrival to radiology department as an extension of FAST examination. Ultrasonography evaluation of the thoracic cavity was followed by supine chest x-rays and plain CT chest and results were interpreted

by senior radiologist, who was kept blind about sonographic data.

Statistical analysis was performed using SPSS version 17. Mean with standard deviation was calculated for quantitative variables, frequency with percentages were calculated for qualitative variables.

RESULTS

A total of 80 patients (males and females) were included in this study, 57 of whom were males (71.2%) with mean age of 27.30±9.688 years and 23 were females (28.8%) with mean age of 30.91±11.579 years. All were traumatic patients referred to PIMS/PAEC emergency units excluding those who were very unstable and require emergency surgery.

Sixty above mentioned traumatic patients (75% n=80) were positive on ultrasound for pleural effusion, 12 (15% n=30) were true negative that were confirmed latter on CT imaging technique. Eight (10% n=80) patients were false negative on ultrasound modality at time of scan.

In our study ultrasound examination resulted in 0 false-positive, 8 false-negative, 80 true-positive, and 12 true-negative findings with overall sensitivity, specificity and diagnostic accuracy in detecting traumatic haemothorax found to be 88.23%, 100% and 90% respectively keeping plain CT chest as gold standard.

These traumatic patients then undergone supine chest x-rays, 53 out of them (66.2% n=80) were found positive for pleural effusion. Thus sensitivity, specificity and diagnostic accuracy of supine chest x-rays while comparing with gold standard was found to be 77.94%, 100% and 81.25% respectively for traumatic haemothorax, with 53 true-positive, 12 true-negative, 0 false-positive and 15 false-negatives. All these patients were subsequently correlated with gold standard plain CT chest for final confirmation. Results showed 68 (85% n=80) were true positive for haemothorax on CT, with 12 true-negative, 0 false-positive, 8 false-negative results.

Our results showed that thoracic ultrasound examination in traumatic patient done as FAST scan had a sensitivity of 88.23% and a specificity of 100% when compared to the gold standard (Plain CT chest). The FAST scan was also compared to CXR, using CT scan as the gold standard, showing that ultrasound had a higher sensitivity than CXR, 88.23% and 77.94%, respectively, and a similar specificity of 100% and 100%, respectively. In addition, we noted that 15% of all traumatic patients do not had pleural effusion that was finally diagnosed later on a CT scan (true negative). Although CT scan remains the gold

standard, we concluded that ultrasound was more sensitive in identifying traumatic pleural effusion when compared to supine CXR.

Table-1: Cross tabulation of USG and Chest X-ray with CT chest

Result	CT Scan		Total
	Positive	Negative	
Ultrasound			
Positive	60	0	60
Negative	8	12	20
Chest X-ray			
Positive	53	0	53
Negative	15	12	27
Total	68	12	80

Table-2: Validation parameters for USG and CXR taking CT chest as gold standard

Validation Parameters	Ultrasound	Chest X-ray
Sensitivity	88.23%	77.94%
Specificity	100%	100%
Positive Predictive Value	100%	100%
Negative Predictive Value	40%	55.55%
Diagnostic Accuracy	90%	81.25%

DISCUSSION

Being a non-invasive and highly sensitive and easily repeatable diagnostic imaging modality, ultrasonography is becoming an integral part in the emergency setting. Ultrasonography imaging is particularly useful because it allows a non-invasive bedside diagnosis to be made. An early detection of traumatic pleural effusion is even more important in hypotensive patient to detect potential sources of bleeding for definite treatment as in these very unstable patients every second has more impact on their outcome.

For optimal patient outcome in emergency unit efforts should be directed for rapid detection of occult and potentially lethal injuries in traumatic injured patients so that early diagnosis and treatment can be initiated. There is increasing role of the focused assessment of the sonographic examination of the trauma patient (FAST) for better prognosis.¹⁷⁻²³ A focused thoracic ultrasonography examination as a part of FAST can be used for the detection of traumatic pleural effusion.^{17,24}

Retrospective studies showed sensitivity and specificity for thoracic ultrasonography as 97.5% and 99.7% respectively and that of supine chest x-rays as 92.5% and 99.7% respectively.²⁵ Overall, both modalities were found to be 96.2% sensitive, 100% specific, and 99.6% accurate for traumatic haemothorax.⁸

In this study, the focused thoracic ultrasonography examinations as a part of FAST examination was done under supervision of senior radiologist, each patient who had a documented pleural effusion

underwent supine chest x-ray and subsequently plain chest CT as gold standard. Sensitivity and specificity of thoracic ultrasonography was found to be 88.23% and 100% respectively when compared to supine chest x-rays (77.94% and 100% respectively), 12 true negative on both modalities that were latter on confirmed by CT chest, 8 false negative were found on ultrasound which explains the limitation of this imaging modality for not detecting pleural effusion in amount less than 100ml, as reported by Gryminski and colleagues, who compared chest ultrasonography and radiography for the detection of pleural fluid.²⁶

Eight patients were found false negative in this study which can be understandable from view that all these scans were performed in supine position immediately after emergency arrival (10–15 minutes) so positioning of patient and repeatability of this modality can further improve diagnostic accuracy in these traumatic patients as is evident in previous study where repeat ultrasonography examinations and repositioning of the patient in the lateral decubitus or upright position is indicated in traumatic patients to enhance the detection of pleural fluid.²⁶

Plain chest radiography detected 53 cases with 12 true negatives, 15 false negatives and positive predictive value of 100%. Again, these false negative results are attributed to patient’s positioning and amount of fluid (at least 500ml of pleural fluid is required to eliminate false negative results) as previously studied article.²⁶ These are some limitation factors for both ultrasound and x-rays in trauma patients.

CONCLUSION

We conclude that focused thoracic ultrasonography examination along with supine chest x-rays as an extension of physical examination in road traffic accident patients for detection of traumatic effusion is more reliable rapid and diagnostic accurate for early detection of haemothorax and management of patients, particularly in hypotensive, critical ill patients.

Keeping in view its well documented advantages like non-invasiveness, quick, easily repeatable as bedside technique, we encourage use of these routine modalities as part of the physical examination and thoracic evaluation in all injured patients for better outcome, however abovementioned limitations for these techniques for these patients should be considered while interpreting the results.

AUTHORS CONTRIBUTION

UM, ZZ: Data collection, analysis and write-up.
MAC: Conceptualization, guidance in data analysis,
proof reading, final draft.

REFERENCES

1. Kesieme E, Ocheli E, Kesieme C, Kaduru C. Thoracic trauma profile in two semiurban university hospitals in Nigeria. *Prof Med J* 2011;18(3):373–9.
2. American College of Emergency Physicians. Emergency ultrasound imaging criteria compendium. American College of Emergency Physicians. *Ann Emerg Med* 2006;48(4):487–510.
3. American Institute of Ultrasound in Medicine, American College of Emergency Physicians. AIUM practice guideline for the performance of the focused assessment with sonography for trauma (FAST) examination. *J Ultrasound Med* 2014;33(11):2047–56.
4. Brooks A, Davies B, Smethhurst M, Connolly J. Emergency ultrasound in the acute assessment of haemothorax. *Emerg Med J* 2004;21(1):44–6.
5. Leblanc D, Bouvet C, Degiovanni F, Nedelcu C, Bouhours G, Rineau E, *et al.* Early lung ultrasonography predicts the occurrence of acute respiratory distress syndrome in blunt trauma patients. *Intensive Care Med* 2014;40(10):1468–74.
6. McGahan JP, Rose J, Coates TL, Wisner DH, Newberry P. Use of ultrasonography in the patient with acute abdominal trauma. *J Ultrasound Med* 1997;16(10):653–62.
7. Branney SW, Wolfe RE, Moore EE, Albert NP, Heinig M, Mestek M, *et al.* Quantitative sensitivity of ultrasound in detecting free intraperitoneal fluid. *J Trauma* 1995;39(2):375–80.
8. Ma OJ, Mateer JR. Trauma ultrasound examination versus chest radiography in the detection of hemothorax. *Ann Emerg Med* 1997;29(3):312–5.
9. Stengel D, Bauwens K, Sehouli J, Rademacher G, Mutze S, Ekkernkamp A, *et al.* Emergency ultrasound-based algorithms for diagnosing blunt abdominal trauma. *Cochrane Database Syst Rev* 2005;18(2):CD004446.
10. Ho ML, Gutierrez FR. Chest radiography in thoracic polytrauma. *AJR Am J Roentgenol* 2009;192(3):599–612.
11. Ekeh AP, Peterson W, Woods RJ, Walusimbi M, Nwuneli N, Saxe JM, *et al.* Is chest x-ray an adequate screening tool for the diagnosis of blunt thoracic aortic injury? *J Trauma* 2008;65(5):1088–92.
12. Marnocha KE, Maglinte DD, Woods J, Peterson PC, Dolan PA, Nigh A, *et al.* Blunt chest trauma and suspected aortic rupture: reliability of chest radiograph findings. *Ann Emerg Med* 1985;14(7):644–9.
13. Omert L, Yeane WW, Protetch J. Efficacy of thoracic computerized tomography in blunt chest trauma. *Am Surg* 2001;67(7):660–4.
14. Dissanaïke S, Shalhub S, Jurkovich GJ. The evaluation of pneumomediastinum in blunt trauma patients. *J Trauma* 2008;65(6):1340–5.
15. Dyer DS, Moore EE, Mestek MF, Bernstein SM, Iklé DN, Durham JD, *et al.* Can chest CT be used to exclude aortic injury? *Radiology* 1999;213(1):195–202.
16. Dyer DS, Moore EE, Ilke DN, McIntyre RC, Bernstein SM, Durham JD, *et al.* Thoracic aortic injury: how predictive is mechanism and is chest computed tomography a reliable screening tool? A prospective study of 1,561 patients. *J Trauma* 2000;48(4):673–82.
17. Rozycki GS, Ochsner MG, Schmidt JA, Frankel HL, Davis TP, Wang D, *et al.* A prospective study of surgeon-performed ultrasound as the primary adjuvant modality for injured patient assessment. *J Trauma* 1995;39(3):492–8.
18. Rozycki GS, Ochsner MG, Jaffin JH, Champion HR. Prospective evaluation of surgeons' use of ultrasound in the evaluation of trauma patients. *J Trauma* 1993;34(4):516–26.
19. Rozycki GS, Feliciano DV, Schmidt JA, Cushman JG, Sisley AC, Ingram W, *et al.* The role of surgeon-performed ultrasound in patients with possible cardiac wounds. *Ann Surg* 1996;223(6):737–44.
20. Boulanger BR, Brennenman FD, McLellan BA, Rizoli SB, Culhane J, Hamilton P. A prospective study of emergent abdominal sonography after blunt trauma. *J Trauma* 1995;39(2):325–30.
21. Ali J, Rozycki GS, Campbell JP, Boulanger BR, Waddell JP, Gana TJ. Trauma ultrasound workshop improves physician detection of peritoneal and pericardial fluid. *J Surg Res* 1996;63(1):275–9.
22. Rozycki GS, Kraut EJ. Isolated blunt rupture of the infrarenal inferior vena cava: the role of ultrasound and computed tomography in an occult injury. *J Trauma* 1995;3(38):402–5.
23. Tso P, Rodriguez A, Cooper C, Militello P, Mirvis S, Badellino MM, *et al.* Sonography in blunt abdominal trauma: a preliminary progress report. *J Trauma* 1992;33(1):39–43.
24. Ma O, Mateer JR, Ogata MP, Kefer M, Wittmann D, Arahamian C. Prospective analysis of a rapid trauma ultrasound examination performed by emergency physicians. *J Trauma* 1995;38(6):879–85.
25. Sisley AC, Rozycki GS, Ballard RB, Namias N, Salomone JP, Feliciano DV. Rapid detection of traumatic effusion using surgeon-performed ultrasonography. *J Trauma* 1998;44(2):291–6.
26. Grymiski J, Krakówka P, Lypacewicz G. The diagnosis of pleural effusion by ultrasonic and radiologic techniques. *Chest* 1976;70(1):33–7.

Received: 6 January, 2016	Revised: 12 June, 2017	Accepted: 9 October, 2017
---------------------------	------------------------	---------------------------

Address for Correspondence:

Dr. Uzma Mumtaz, Department of Radiology, Pakistan Institute of Medical Sciences, Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad-Pakistan

Cell: +92 333 560 2605

Email: uzmamumtaz89@gmail.com