Section: General Surgery

Original Research Article

APPLICATION OF BLUE PROTOCOL ON TRAUMA AMONGST PATIENTS WITH CHEST INJURY IN TAEI WARD AT A TERTIARY CARE HOSPITAL

S. Thirumuruganand[1], V. Balaji[2], M. Thiruvikkaraman[2], A. Divya Kalyani[3]

[1]Associate Professor, Department of General Surgery, Government Stanley Medical College, Tamilnadu, India
[2]Assistant Professor, Department of General Surgery, Government Chengalpattu medical College, Tamilnadu, India
[3]Assistant Surgeon, Department of General Surgery, Melapalayam Government Hospital, Tirunelveli, Tamilnadu, India

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Corresponding Author:
Dr. A.Divya Kalyani,
Email: drsurumd@gmail.com

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Abstract

Background: Trauma, a leading cause of global mortality, often involves thoracic injuries, with road traffic accidents (RTAs) being major contributors. Pneumothorax is a critical consequence of blunt chest trauma and requires timely intervention to prevent mortality. This study aimed to assess EFAST's efficacy of EFAST in diagnosing pneumothorax compared to traditional methods using chest CT as the reference. **Materials and Methods:** This prospective observational study was conducted at Chengalpattu Medical College and Hospital between March 2021 and April 2022 in 80 patients with blunt chest trauma. Clinical examinations and various imaging modalities were employed, including USG, chest radiography, and chest CT. Lung ultrasonography was performed during the primary survey after securing the airway and establishing adequate oxygenation/ventilation. **Result:** Most patients were male (86.3%), primarily in the 31-40 age group (31.3%), and RTAs were the predominant mechanism (81.3%). RTA was found to be a common cause of pneumothorax and was common among the male population. USG exhibited a 30% positive detection rate for pneumothorax. Sensitivity and specificity comparisons revealed USG's superiority of USG (68.6% sensitivity, 100% specificity) over clinical findings, chest X-ray, and bilateral incidence. The clinical implications highlighted USG's diagnostic advantage of USG, especially in identifying clinical presentations ($p<0.001$). **Conclusion:** This study underscores the diagnostic superiority of USG in detecting pneumothorax resulting from blunt chest trauma compared with traditional methods. With its high sensitivity, specificity, and portability, USG has emerged as a valuable tool, particularly in settings where access to CT is limited.

INTRODUCTION

Although USG was an essential diagnostic tool in the 1970s, its position in trauma was mild in 1996 when Rozycki et al. delivered the Focused Assessment with Sonography for Trauma (FAST). Its use was identified and generic as a secondary device in the Advanced Trauma Life Support (ATLS) in 1997.[1] The predominant advantage of sonography as a diagnostic device in trauma is that it can be shifted to the mattress facet and can be accomplished by a surgeon/radiologist at some point in the resuscitation process. It is wonderful and can be handy even in small centres. Since avenue site visitors, accidents have been on the upward shove; blunt damage chest & incidence of pneumothorax (>20% in primary blunt traumas) have been additionally rising, especially in the creating countries.[2]

Pneumothorax is an acute emergency, and a well-timed intervention is needed to stop mortality. Pneumothorax is regularly detected using a mixture of scientific examination and chest radiography.[3] Although these methods are dependable for detecting massive pneumothorax, delicate pneumothorax may be difficult to achieve in a trauma scenario for various reasons. Pneumothorax may not be clinically evident if it no longer proposes great respiratory compromise or reasons solely for a refined limit in air entry, which may also not be detectable at auscultation. Until now, chest radiography has been used as the most important modality of investigation in blunt-damaged chest to rule out hemopneumothorax in many centres, although its sensitivity and specificity

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are questionable. The problem with chest X-rays consists of moving unstable patients to X-ray rooms, which is now not virtually possible, positioning suspected backbone damage sufferers for X-ray, radiation hazard and ultimately, its terrible sensitivity in detecting pneumothorax.[4]

CT-chest is the gold standard for detecting pneumothorax. However, their cost, availability, and radiation hazards limit their use. The use of ultrasound for chest injuries is a new modality of investigation in trauma which is gaining importance as it has no radiation hazard, can be carried out safely in pregnant ladies and children, is cheap, is on hand in most centres, can be shifted to mattress facet of the affected person and can be executed alongside with resuscitation process.[5] This FAST (Focused Assessment with Sonography for Trauma) for chest injuries is called Extended Focused Assessment with Sonography for Trauma (EFAST).[6]

This study aimed to evaluate the utility of EFAST in blunt chest trauma for diagnosing pneumothorax and its accuracy in comparison with chest radiography and clinical examination, keeping chest CT as the gold standard.

MATERIALS AND METHODS

This prospective observational study included 80 patients with a history of blunt chest trauma at the Department of General Surgery, Chengalpattu Medical College & Hospital, Chengalpattu, from March 2021 to April 2022.

Inclusion Criteria

All patients with suspected or apparent blunt trauma to the chest were included.

Exclusion Criteria

Patients with advanced and obvious disease, those not willing to undergo further surgical management, those not willing to provide informed written consent, haemodynamically unstable patients, and patients with polytrauma were excluded.

Patients meeting the above criteria were clinically examined and subjected to bedside imaging. The study was conducted on an emergency basis, focusing on uncooperative paediatric patients. The patient was prone, and the transducer was placed beneath the xiphisternum in the transverse plane. The transducer was moved slowly down the abdomen, angling to the right and left to view organs, such as the pancreas, liver, gall bladder, and pancreas. The transducer was kept in both flanks to look for fluid in the paracolic gutters. The subcostal plane was used to scan the entire liver and the gallbladder.

This study involved intercostal views of the liver, hepatorenal recess, kidneys, and pelvis. The transducer was placed at various positions to visualise the liver, spleen, kidneys, and pelvic anatomy. The patient was placed in decubitus to allow axial scanning of the kidneys and retroperitoneum, detection of splenic lesions, perisplenic collection, and left pleural effusion.

The patients were then scheduled for tube thoracostomy with proper consent. Lung ultrasound involving the blue protocol application in trauma is considered a reasonable bedside gold standard for diagnosing pneumothorax. Lung ultrasonography was performed during the primary survey after securing the airway and establishing adequate oxygenation/ventilation.

Statistical Analysis

After recording the injuries, patients were categorised based on haemodynamic stability, distinguishing between stable and unstable individuals. Haemodynamically unstable patients who required admission to the intensive care unit were excluded from the study. The focus was solely on haemodynamically stable patients who underwent non-contrast computed tomography (NCCT) of the chest following basic resuscitation and initial documentation. The radiologist's written report identified abnormal findings in the chest NCCT, and the data were subsequently entered into Microsoft Excel (version 16.47). Data analysis was conducted using IBM SPSS version 24, and the results were tabulated. Sensitivity, specificity, and positive predictive values were determined using a two-by-two table, with the level of significance set at a " p-value of 0.05.

RESULTS

Most patients were male (69 cases, 86.3%), and females constituted only 11 cases (13.8%). The most common age group of cases with blunt chest trauma was 31-40 years (N=25, 31.3%), followed by 41-50 years with 18 cases (22.5%) and 51-60 years with 16 cases (20%).

The most common mechanism of trauma was a road traffic accident (RTA) (N=65, 81.3%), followed by accidental fall (AF) in 10 cases (12.5%) and fall from height (FFH) in 5 cases (6.3%). Ultrasonography (USG) analysis of the patients showed that 24 cases (30%) exhibited positive findings for pneumothorax. The clinical findings showed that 21 cases (26.3%) exhibited positive findings for pneumothorax. Chest X1 Ray of the patients showed that only 6 cases (7.5%) exhibited positive findings for pneumothorax. Chest CT of the patients showed that 35 (43.8%) of the 80 cases reported positive results for pneumothorax. Of chest injury patients, bilateral incidence was reported positive in 8 cases (10%) out of 80 for pneumothorax [Table 1].

RTA was found to be a common cause of pneumothorax and was common among the male population. Of the 69 male patients, 56 (70%) were reported to have pneumothorax due to RTA. Of the 11 female patients, nine (11.3%) had pneumothorax due to RTA. AF was the second most common cause of pneumothorax in males (n = 9, 11.3%). The association between sex and the mechanism of trauma was not significant (p = 0.868).

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RTA was found to be a common cause of pneumothorax, and it is common among the younger male population who frequently drive. Of the 80 patients, 22 (27.5%) were reported to have RTA in the age group of 31-40 years. Similarly, 13 patients (16.3%) from the age group of 41-50 years had episodes of pneumothorax due to RTA. Of the 12 patients aged < 30, 10 (12.5%) were diagnosed with pneumothorax due to RTA. The association between age and the trauma mechanism is insignificant, as the p-value is 0.47 [Table 2].

Twenty-one cases (26.3%) were reported to be positive for both clinical and USG findings, and three cases (3.8%) were reported to be negative. The association between USG and Clinical findings was significant ($p<0.001$). Six cases (7.5%) were reported to be positive in both Chest X1 Ray and USG findings, and 18 cases (22.5%) were negative in Chest X1 Ray and positive in USG findings. The association between USG findings and Chest X1 Ray findings was significant ($p<0.001$).

Twenty-four cases (30%) were reported to be positive for both chest CT and USG findings. Eleven cases (13.8%) were positive on chest CT and negative on USG. The association between USG and chest CT findings was significant ($p<0.001$). Eight cases (10%) were positive for both Bilateral Incidence and USG findings. Sixteen cases (20%) were positive for USG findings and negative for Bilateral Incidence. The association between the USG findings and Bilateral Incidence was significant ($p<0.001$) [Table 3].

Of the 80 patients, 35 were found to have pneumothorax based on chest CT investigations. The USG Findings produced the best sensitivity of 68.6%, followed by the clinical findings with a sensitivity of 60%. The sensitivity of Chest X1 Ray was the lowest, at 17.1% (N=6). The bilateral incidence method had a sensitivity of 22.9%.

The specificity of all modalities of diagnostic measurements, such as USG findings, clinical findings, Chest X1 Ray and Bilateral incidence, was 100%. No false-positive cases were recorded for any modalities [Table 4]. Positive pneumothorax cases were predominant among males compared to women [Table 5].

Table 1: Demographic data of the study

		Frequency	Percentage
Gender	Female	11	13.8
	Male	69	86.3
Age	<30	12	15
	31 - 40	25	31.3
	41 - 50	18	22.5
	51 - 60	16	20
	Above 60	9	11.3
Mechanism of Trauma	Accidental Fall (AF)	10	12.5
	Fall From Height (FFH)	5	6.3
	Road Traffic Accident (RTA)	65	81.3
USG Findings	Negative	56	70
	Positive	24	30
Clinical Finding	Negative	59	73.8
	Positive	21	26.3
Chest X1 Ray	Negative	74	92.5
	Positive	6	7.5
CT Chest	Negative	45	56.3
	Positive	35	43.8
Bilateral	Negative	72	90
	Positive	8	10

Table 2: Comparison of sex and age between the mechanism of trauma

		Mechanism of Trauma			P-value
		AF	FFH	RTA	
Sex	Female	1 (1.3%)	1 (1.3%)	9 (11.3%)	0.868
	Male	9 (11.3%)	4 (5%)	56 (70%)	
Age	<30	1 (1.3%)	1 (1.3%)	10 (12.5%)	0.47
	31 - 40	3 (3.8%)	0.00%	22 (27.5%)	
	41 - 50	2 (2.5%)	3 (3.8%)	13 (16.3%)	
	51 - 60	2 (2.5%)	0.00%	14 (17.5%)	
	61 - 100	2 (2.5%)	1 (1.3%)	6 (7.5%)	

Table 3: Comparison of clinical findings, Chest X1 ray, CT chest and bilateral between the USG finding

		USG Finding		P-value
		Negative	Positive	
Clinical Finding	Negative	56 (70%)	3 (3.8%)	<0.001
	Positive	0	21 (26.3%)	
Chest X1 Ray	Negative	56 (70%)	18 (22.5%)	<0.001
	Positive	0	6 (7.5%)	
CT Chest	Negative	45 (56.3%)	0	<0.001
	Positive	11 (13.8%)	24 (30%)	

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Bilateral	Negative	56 (70%)	16 (20%)	<0.001
	Positive	0	8 (10%)	

Table 4: Sensitivity and specificity of various findings

Findings	Sensitivity		Specificity	
	N	%	N	%
CT Chest	35	100	45	100%
USG	24	68.6%	45	100%
Clinical findings	21	60%	45	100%
Chest X1 Ray	6	17.1%	45	100%
Bilateral	8	22.9%	45	100%

Table 5: Comparison between Sex and Positive Cases in Findings

Findings	Sex		Total
	Female (11)	Male (69)	
USG Finding	1	23	24
Clinical Finding	1	20	21
Chest X1 Ray	1	5	6
CT Chest	3	32	35
Bilateral	1	7	8

DISCUSSION

Trauma is the foremost cause of mortality globally, predominantly affecting the young adult population, with road traffic accidents emerging as the primary contributor to trauma-related deaths worldwide. Approximately 40% of fatalities resulting from trauma are attributed to uncontrolled haemorrhage. The timely identification of intra-abdominal and intrathoracic haemorrhage is imperative for preserving lives.[5,7]

The extensive adoption of ultrasonography for the detection of internal bleeding, integrated into the trauma life support algorithm (ATLS) protocol, has significantly revolutionised the management of internal haemorrhage. The use of sonography to address abdominal and thoracic trauma, particularly in identifying life-threatening occult bleeding, has proven to be a crucial intervention in numerous instances. The consistent and accurate diagnostic capabilities, applicable in both emergency room and prehospital contexts, have elevated FAST (Focused Assessment with Sonography for Trauma) to a pivotal tool in the comprehensive management of trauma.[5]

The Extended Focused Assessment with Sonography for Trauma (e-FAST) protocol was designed to diagnose pneumothorax (PTX), haemothorax (HTX), and hemoperitoneum (HPTX) through a straightforward bedside procedure. This facilitates prompt surgical intervention for the affected individual without exposure to non-contrast computed tomography (NCCT) radiation or invasive diagnostic intraperitoneal lavage.[8]

The data from our study showed a substantial correlation between the USG findings and clinical assessment. Our study showed that USG findings could diagnose clinical presentations more accurately ($p<0.001$). In addition, 7.5% of the cases reported clinical findings with chest X-rays and USG. However, USG findings were reported in 22.5% of the patients ($p<0.001$). A significant finding was also reported using chest radiography and USG, which can be used for a comprehensive evaluation ($p<0.001$).

The clinical implications of this study indicate that the Bilateral Incidence method exhibited a sensitivity of 22.9%, suggesting its limited effectiveness in detecting certain cases. However, all modalities, including USG, clinical findings, chest radiography, and bilateral incidence, demonstrated a high specificity of 100%, signifying their accuracy in correctly identifying negative cases without false positives. Additionally, the data revealed a sex difference, with positive pneumothorax cases being more prevalent among male patients.

Although the Bilateral Incidence method showed lower sensitivity, all diagnostic modalities exhibited excellent specificity without recording false-positive cases. The sex disparity in positive pneumothorax cases underscores the importance of considering demographic factors in the clinical evaluation of thoracic conditions.

The trauma management protocol recommends employing the airway, breathing, and circulation (ABC) approach, prioritising the assessment and support of patient airways, followed by the evaluation of breathing, specifically focusing on pneumothorax (PTX) and haemothorax (HTX), and subsequently addressing circulation, with an emphasis on detecting hemoperitoneum. Notably, one in every five major trauma cases revealed the presence of pneumothorax, underscoring the critical importance of its identification to prevent severe haemodynamic complications and potential fatality. The recognised limitations of Focused Assessment with Sonography for Trauma (FAST) include challenges in assessment among pediatric trauma cases and individuals with high injury severity scores (ISS).[9] Nonetheless, a meta-analysis conducted by Holmes et al. showcased that applying Focused Assessment with Sonography for Trauma (FAST) in the pediatric demographic exhibited a sensitivity of 66% and a specificity of 98%, all achieved without subjecting the patients to radiation exposure.[10] In their comprehensive 7-year investigation involving

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2,130 patients, Natarajan et al. illustrated that solely relying on Focused Assessment with Sonography for Trauma (FAST) without the inclusion of Non-Contrast Computed Tomography (NCCT) may lead to overlooking intra-abdominal injuries.[11]

In a study conducted by Devadoss et al., out of 110 cases assessed, chest radiography identified two cases of pneumothorax (PTX). In comparison, e-FAST indicated three PTX cases, subsequently confirmed by a Non-Contrast Computed Tomography (NCCT) chest. Notably, 73.6% of the patients (81 individuals) exhibited decreased breath sounds, with e-FAST demonstrating abnormalities in 79% (87 patients) and NCCT, considered the gold standard, revealing abnormalities in 68.2% (75 patients). A recent systematic review provided moderate evidence supporting the prehospital use of e-FAST, demonstrating successful application in the air medical transport of injured patients.[12]

Desai and Harris emphasised that implementing e-FAST in prehospital settings and during transportation has enhanced diagnostic capabilities and improved survival rates among casualties.[6] The most extensive meta-analysis and systematic review of e-FAST was conducted by Netherton et al. in 2019. Their analysis included 75 studies involving 24,350 patients. Pooled calculations indicated sensitivities and specificities of 69% and 99% for pneumothorax (PTX), affirming e-FAST as a valuable bedside tool for PTX evaluation.[13] This study highlights the importance of integrating USG, clinical findings, and complementary imaging methods for effective pneumothorax diagnosis in cases of blunt chest trauma.

CONCLUSION

From our observations, chest ultrasonography is superior to chest radiography, clinical examination, or a combination of chest radiography and clinical findings for diagnosing pneumothorax in patients with blunt injuries. We concluded that it was a screening test available in small centres, cost, radiation exposure, bedside device portability, assessment of haemodynamically unstable patients, and diagnostic sensitivity. Ultrasound chest is a better examination modality for blunt chest and can be combined with Fast as Extended Fast.

Limitations

This study's retrospective nature, single-centre design, small sample size, potential for selection bias, and incomplete follow-up duration limit the generalizability of its findings. Future research should address these limitations to improve the generalizability and credibility of the results.

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