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A Study Describing Diagnostic Accuracy of Ultrasonography And Radiography in Initial Evaluation of Chest Trauma Patients

KEYWORDS: USG, chest trauma.

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Introduction:

Traumatic intrathoracic injuries comprise 25-40% of trauma mortalities (1, 2). Prompt diagnosis of such injuries can decrease mortality and the resultant burden. Computed tomography (CT) scan is the gold standard for this diagnosis (3-5). Although this diagnostic tool is highly accurate in detection of intrathoracic injuries, patients undergoing CT scan examination receive a high radiation dose (6). Currently, chest radiography is used as the initial diagnostic tool in these cases. Although these techniques are inexpensive and non-invasive, their application for all multiple trauma patients is associated with a significant increase in total costs, exposure to radiation, and overcrowding of the emergency department. Some recent studies have reported not very high sensitivity and specificity of chest radiography in this regard (7-10). These studies have shown the low diagnostic yield of chest x-rays (6.3–12.4%) in identifying intrathoracic injuries (7, 11-13). During recent years, chest ultrasonography has been introduced as a portable, inexpensive, safe, and fast alternative for radiography in detection of traumatic intrathoracic injuries (14). However, this tool is largely dependent on the experience and expertise of the operator and its results are not very reliable in identifying parenchymal injuries and where no fluid is present (15). Based on the above-mentioned points, the present study was designed to compare the diagnostic accuracy of chest ultrasonography and radiography in identifying traumatic intrathoracic injuries.

Methods:

Study design and setting

In the present prospective cross-sectional study, patients with traumatic intrathoracic injuries, who were referred to the emergency department of Vasantrao Naik Government Medical College & Hospital (VNGMC), Yavatmal from January 2013 to January 2014, were assessed. The study was done to calculate the diagnostic accuracy of chest ultrasonography and radiography in the initial evaluation of patients with chest trauma. Thoracic CT scan was used as the gold standard. All patients in need for chest CT scan based on standard indications of advanced trauma life support (ATLS) guidelines were included in a consecutive manner. Exclusion criteria consisted of pregnancy, hemodynamic instability, and lack of interest in participating in the study. The data collection forms were anonymous and a code was assigned to each patient. All the patients submitted an informed consent form before being included in the study.

Measurements

Demographic (age, gender, and mechanism of trauma) and clinical data, as well as imaging findings of each patient were recorded using a checklist. Immediately after collection of data, the patients underwent chest ultrasonography. Examinations were carried out at 2–6 intercostal spaces on both sides of para-sternal, mid-clavicular, anterior axillary and mid-axillary lines. Then, the patients underwent an anterior posterior (AP) chest x-ray examination using a portable x-ray machine and chest CT scan in supine position. Pneumothorax, hemothorax, rib fracture, and pulmonary contusion were considered as traumatic intrathoracic injuries.

Statistical analysis

The sample size was calculated to be 139 cases by considering a minimum sensitivity of 98% for the ultrasonography in detection of traumatic intrathoracic injuries and a 30% prevalence rate of pneumothorax in patients with chest trauma (16), at 95% confidence interval ($\alpha = 0.05$), a power of 90% ($\beta = 0.1$) and maximum error of 1% ($d = 0.12$). Data were analyzed with SPSS 21.0. In order to evaluate the adequacy of radiography and ultrasonography, receiver operating characteristic (ROC) curves were drawn and sensitivity, specificity, positive and negative likelihood ratio and positive and negative predictive values of radiography and ultrasonography were calculated. Significance level was set at $p < 0.05$.

Results:

152 chest trauma patients with a mean age of 31.4 ± 13.8 years (range: 4 – 67), were enrolled (77.6% male). Table 1 presents baseline characteristics of patients. Chest CT scan showed pulmonary contusion in 48 (31.6%) patients, hemothorax in 29 (19.1%), and pneumothorax in 55 (36.2%) cases. Table 2 summarizes the screening performance characteristics of chest ultrasonography and radiography in detection of traumatic intrathoracic injuries (pneumothorax, hemothorax, contusion). Area under the ROC curve of ultrasonography in detection of pneumothorax, hemothorax, and pulmonary contusion were 0.91 (95% CI: 0.86–0.96), 0.86 (95% CI: 0.78–0.94), and 0.80 (95% CI: 0.736–0.88), respectively. Area under the ROC curve of radiography was 0.80 (95% CI: 0.736–0.87) for detection of pneumothorax, 0.77 (95% CI: 0.68–0.86) for hemothorax, and 0.58 (95% CI: 0.5–0.67) for pulmonary contusion. Comparison of areas under the ROC curve declared the significant superiority of ultrasonography in detection of pneumothorax ($p = 0.02$) and pulmonary contusion ($p <$

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0.001). However, the diagnostic value of the two tests was equal in detection of hemothorax (p = 0.08).

(TABLE 1 COMES HERE)

(TABLE 2 COMES HERE)

Screening performance characteristics of chest ultrasonography and radiography in detection of traumatic intrathoracic injuries in comparison to CT scan

Discussion:

The results of the present study showed that chest ultrasonography had higher diagnostic value in detection of pneumothorax and pulmonary contusion compared to radiography. This value in detection of hemothorax for two studied tools was equal. Various studies have evaluated the diagnostic accuracy of ultrasonography in trauma patients (17, 18). In this context, Hyacinthe et al. showed that the diagnostic accuracy of ultrasonography was higher than that of chest x-ray. The study showed that the sensitivity and specificity of ultrasonography, compared to CT scan as the gold standard, in diagnosis of thoracic cavity lesions were in the 37–61% and 61–96% ranges, respectively (19). However, in the Hyacinthe et al. study a blinded specialist carried out ultrasonography, which might be the reason for the higher sensitivity rate in the present study. Wilkerson and Stone meta-analysis reported a sensitivity of 85–100% for ultrasonography in diagnosis of thoracic cavity injuries (7). Other studies, have also reported similar findings (20-22). The differences might be attributed to inclusion and exclusion criteria of the studies. Those studies have excluded patients with subcutaneous emphysema and intubated patients. Comparison of the results of these two techniques with those of CT scan showed that ultrasonography is superior to chest x-ray in initial evaluations. However, ultrasonography alone has a lower diagnostic value. Therefore, it is advisable to find ways to increase the efficacy and accuracy of the ultrasonography technique. One of these ways is to combine ultrasonography with other indexes used for the diagnosis of traumatic lesions (22). This needs to be studied further.

Conclusion:

The results of the present study showed that ultrasonography is preferable to radiography in the initial evaluation of patients with traumatic injuries to the thoracic cavity. However, the low sensitivity of the ultrasonography technique in comparison to CT scan, its reliance on operator skill, and some other limitations have made it only an initial test, necessitating confirmation using other techniques.

TABLES :

TABLE 1: Baseline characteristics of the studied participants

VARIABLE	FREQUENCY	PERCENTAGE
AGE		
UNDER 18	24	15.8
19-40	92	60.5
41-60	27	17.8
OVER 60	9	6.9
GENDER		
MALE	118	77.6
FEMALE	34	22.4
MECHANISM OF TRAUMA		
PENETRATING WOUND	22	14.5
BLUNT TRAUMA DUE TO ACCIDENT	93	61.2
BLUNT TRAUMA DUE TO FALLING	23	15.1
BLUNT TRAUMA DUE TO DIRECT IMPACT	14	9.2
SUBCUTANEOUS EMPHYSEMA		
NO	133	86.2
YES	21	13.8
CREPITATION		
NO	133	86.2
YES	21	13.8
TRAUMA TO THORACIC SPINAL		
NO	137	90.1
YES	15	9.9
GLASGOW COMA SCALE		
14-15	96	63.1
9-13	39	25.7
3-8	17	11.2
HEMODYNAMIC STATUS		
STABLE	125	82.2
UNSTABLE	27	17.8

TABLE 2: Screening performance characteristics of chest ultrasonography and radiography in detection of traumatic intrathoracic injuries in comparison to CT scan

INDEX	ULTRASONOGRAPHY	CHEST X RAY
PNEUMOTHORAX		
Sensitivity	83.6 (70.7–91.8)	67.3 (53.2–78.95)
Specificity	97.9 (92.0–99.6)	92.7 (85.1–96.8)
Positive predictive value	95.8 (84.6–99.3)	84.1 (69.3–92.8)
Negative predictive value	91.3 (83.8-95.7)	83.2 (74.5-89.5)
HEMOTHORAX		
Sensitivity	75.9 (56.1–90.0)	58.6 (39.1–75.9)
Specificity	95.9 (90.3–98.5)	95.1 (89.2–98.0)
Positive predictive value	81.5 (88.4–97.5)	73.9 (51.3–88.9)
Negative predictive value	94.4 (88.4–97.5)	90.7 (84.0–94.9)
PULMONARY CONTUSION		
Sensitivity	68.8 (53.6–80.9)	43.8 (29.8–58.7)
Specificity	92.3 (84.9–96.4)	73.1 (63.3–81.1)
Positive predictive value	80.5 (64.6–90.6)	42.8 (29.1–57.7)
Negative predictive value	86.5 (78.4–92.0)	73.7 (64.0–81.7)

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