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ORIGINAL ARTICLE

Sensitivity of ultrasound for the evaluation of trauma. Experience in Cuba

Sensibilidad de la ecografía para la evaluación del trauma. Experiencia en Cuba

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Abstract

Introduction. Ultrasound is now an essential tool in assessing trauma patients. It is the preferred initial imaging method for trauma care and is included in the Advanced Trauma Life Support guidelines established by the American College of Surgeons.

Methods. A prospective, cross-sectional, observational study was conducted to determine the sensitivity and specificity of E-FAST (Extended Focused Assessment with Sonography in Trauma) performed by general surgeons at Hospital Universitario "Miguel Enríquez", in Havana, Cuba.

Results. The diagnostic accuracy (AUC) for E-FAST was 0.964 (0.909 - 0.990), with a sensitivity in the detection of free fluid and pneumothorax of 96.4% (87.8-99.5%), and a specificity of 96.2% (87.0-99.5%). The confidence interval (CI) for these measures was 95%.

Conclusions. The E-FAST test performed by general surgeons presents diagnostic values that make it a fast, reliable tool for the evaluation of trauma patients. It is a feasible method with high sensitivity, specificity and positive and negative predictive values.

Keywords: ultrasonography; focused assessment with sonography for trauma; wounds and injuries; emergencies; general surgery.

Resumen

Introducción. La ecografía es actualmente una herramienta esencial en la evaluación de los pacientes con trauma. Es el método de imagen inicial preferido para la atención del trauma y está incluido en las guías de soporte vital avanzado en trauma establecidas por el Colegio Americano de Cirujanos.

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Métodos. Se realizó un estudio observacional, transversal y prospectivo para determinar la sensibilidad y especificidad de la prueba E-FAST *(Extended Focused Assessment with Sonography in Trauma)* realizada por cirujanos generales en el Hospital Universitario "Miguel Enríquez", en La Habana, Cuba.

Resultados. La precisión diagnóstica (AUC) de la prueba E-FAST fue de 0,964 (0,909 - 0,990), con una sensibilidad en la detección de líquido libre y neumotórax del 96,4 % (87,8-99,5 %) y una especificidad del 96,2 % (87,0-99,5 %). El intervalo de confianza (IC) para estas medidas fue del 95 %.

Conclusiones. La evaluación ecográfica del trauma realizada por cirujanos generales presenta valores diagnósticos que la convierten en una herramienta rápida y confiable para la valoración de los pacientes con trauma. Es un método factible, con alta sensibilidad, especificidad y valores predictivos positivos y negativos.

Palabras clave: ultrasonografía; evaluación enfocada con ecografía para trauma; heridas y lesiones; urgencias médicas; cirugía general.

Introduction

Trauma is one of the most important medical conditions in modern life. It claims millions of lives and results in enormous economic burdens. It is regarded as the ongoing pandemic of our time [1] and is the main cause of death in Cuba for people under 45 years of age [2].

Ultrasound has been used as diagnostic tool for more than 60 years, for example, gynaecologists to differentiate abdominal masses [3]. It has also been promoted in the United States as a tool for surgeons by the American College of Surgeons, which create a training program for surgeons in the use of ultrasound [4-7].

Bedside ultrasound has become the preferred initial imaging method for trauma care and is incorporated into the Advanced Trauma Life Support guidelines created by the American College of Surgeons [8-12].

Scientific evidence has shown that ultrasound is more sensitive (49-99%) than traditional chest X-rays (27-75%) in detecting hemothorax and pneumothorax. It is important to note that chest radiography has been shown to miss 30-50% of pneumothoraces [8,9,13].

This study aimed to determine the sensitivity and specificity of Extended Focused Assessment with Sonography for Trauma (E-FAST), when conducted by general surgeons.

Methods

This observational, cross-sectional, prospective study was conducted at the Hospital Universitario Miguel Enríquez to determine the sensitivity and specificity of E-FAST , as performed by general surgeons. The population consisted of patients admitted to the emergency department of the Miguel Enríquez University Hospital with a history or suspicion of sustained a traumatic injury, whether penetrating or not, for whom a trained general surgeon performed E-FAST ultrasound during the initial evaluation.

Statistical analysis

Computed tomography (CT), the gold standard test in trauma assessment, was performed for cases that were hemodynamically stability. For those who were not hemodynamically stable and who required immediate surgery, E-FAST analysis was compared with intraoperative findings. The results of these tests were converted into dichotomous variables with values of positive and negative. The data obtained were processed using SPSS software and were plotted in appropriate frequency distribution tables, 2 x 2 tables, and ROC (Receiver Operating Characteristics) curves. The information was analysed and compared with the results obtained by national and international authors.

Results

General characteristics of the patients studied

One hundred and ten patients were examined after experiencing acute traumatic injuries and being admitted to the emergency department; 72.7% were male (n=80), and 27.3% were female (n=30). The median age was 38 years. The E-FAST analysis

allowed a quick assessment to be performed in the trauma room, while initial trauma resuscitation maneuvers were being performed. The predominant ultrasound finding was the absence of pleural sliding in both hemithoraxes, and presence of free fluid in the cul-de-sac (Table 1).

Comparison of E-FAST with gold standard tests

The entire sample of 110 patients was assessed for trauma using E-FAST. Of these, 65 patients were hemodynamically stable, which allowed them undergo CT. The CT results coincided with those of the ultrasound results in 62 cases. The E-FAST analysis showed 17 patients who presented criteria interpreted as a positive test; two of these cases were not confirmed by CT. The E-FAST analysis found 48 negative cases; in one of these cases, the CT examination found a left traumatic pneumothorax with small volume of 15%, which was treated conservatively.

In the remaining 45 patients, whose hemodynamic status necessitated emergency surgery, E-FAST analysis matched the intraoperative findings in 44 cases. One patient was found to have 300 ml of free blood in the cavity, as well as a pelvic fracture with large hematoma in the preperitoneal area. The details of these tests are shown in table 2.

In the study, the diagnostic accuracy for E-FAST was 0.964 (0.909 - 0.990), with a sensitivity in the detection of free fluid and pneumothorax of 96.4% (87.8 - 99.5%) and a specificity of 96.2% (87 - 99.5%); the confidence interval (CI) for these measures was 95%. The diagnostic utility of the E-FAST exam components is shown in table 3 and figure 1.

Table 1. General characteristics of the patients.

Variable	Number of patients (n=110)
Age, median (interquartile range)	38 (28-49)
Sex, n (%)	
Male	80 (72.7)
Female	30 (27.3)
Ultrasound Findings, n (%)	
Free liquid in upper right quadrant	11 (6.3)
Free liquid in upper left quadrant	4 (3.6)
Free liquid in bottom of bag	17 (5.4)
Free fluid in right hemithorax	13 (11.8)
Free fluid in left hemithorax	7 (6.3)
Absence of right pleural slippage	21 (7.2)
Absence of left pleural slippage	22 (13.6)
Negative	49 (45.4)

Source: Trauma clinical records, Hospital Miguel Enríquez.

Discussion

This is the first study in Cuba to evaluate the diagnostic accuracy of the E-FAST test in trauma patients. This research indicates that E-FAST evaluations are a useful tool in the detection of intra-abdominal free fluid, traumatic hemothorax, and traumatic pneumothorax, given their high sensitivity, specificity, and positive and negative predictive values. When compared these results with studies published in the literature from different institutions worldwide, a range of sensitivity (67-99%), specificity (89-99%), and diagnostic precision (85-100%) is found for the

Table 2. Comparison of E-FAST with gold standard tests.

Gold Standard		Intraoperative Findings (n=45)		CT (n=65)		
Values		**Positive**	**Negative**	**Positive**	**Negative**	**Total**
	Positive	40	0	15	2	57
E-FAST	Negative	1	4	1	47	53
	Total	41	4	16	49	110

E-FAST: Extended Focused Assessment with Sonography in Trauma; CT: Computed Tomography.

Source: Trauma clinical records, Hospital Miguel Enríquez.

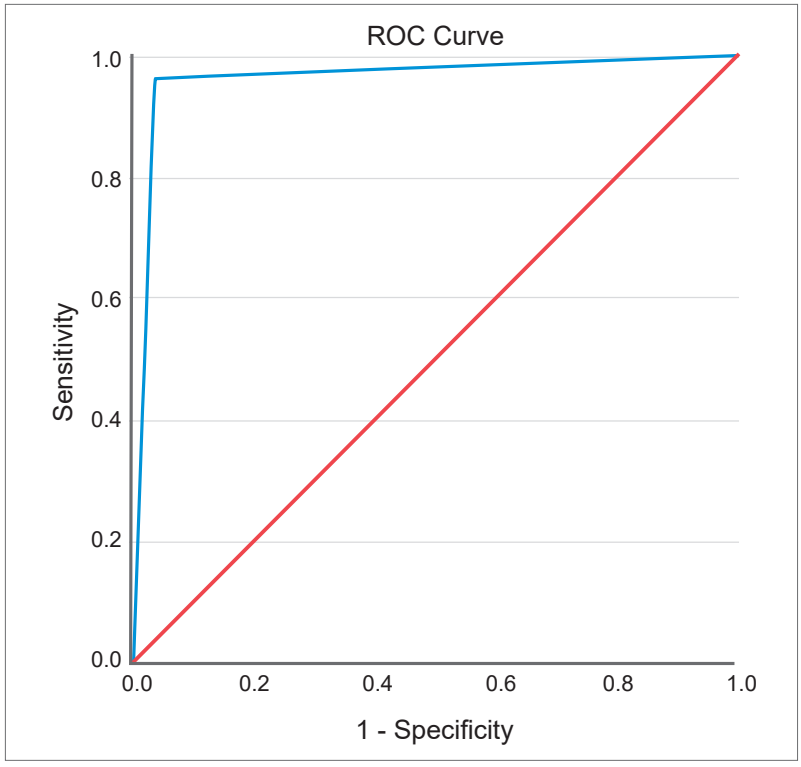

Figure 1. ROC curve corresponding to E-FAST.

Calculation of the sensitivity and specificity tests with an area under the curve of 0.964 (0.923 - 100) for a 95% confidence interval.

Table 3. Diagnostic utility of the E-FAST exam compared with the gold standard.

Confidence interval (CI) = 95%		
Sensitivity	96.4%	87.8 - 99.5%
Specificity	96.2%	87 - 99.5%
Diagnostic accuracy	0.964	0.909 – 0.99
Positive predictive value	96.4%	87.5 - 99%
Negative predictive value	96.2%	86.7 - 99%
Likelihood ratios +	26	6.56 – 99.6
Likelihood ratios -	0.04	0.01 – 0.14
Prevalence		51%

Source: Calculated by the authors from the database.

usefulness of the E-FAST examination [14-19]. A recent systematic review by Netherton et al. [20] evaluated 75 studies to determine the diagnostic values of the E-FAST test, which showed ranges of values for sensitivity (40 - 100%) and specificity (94 - 100%). In a recent study reported by Basnet et al. [21] in 261 patients with trauma, they determined a sensitivity of 94.8%, specificity of 99.5%, negative predictive value of 98.5%, positive predictive value of 98.2, and diagnostic accuracy of 98.4 for the E-FAST examination compared with chest X-ray, chest and abdominal CT and exploratory laparotomy. This last study had similar results as ours. Among the patients in the study, most were male (72.7%), aligning with another study that found 74% of patients were male. This gender

disparity is further highlighted by the higher rate of disability-adjusted life years from transport injuries in men compared to women [22].

Conclusions

This research shows that the E-FAST test performed by a general surgeon presents diagnostic values that make it a reliable and fast tool to evaluate trauma patients. It is a feasible method with high sensitivity, specificity, and positive and negative predictive values. The E-FAST test is particularly beneficial in the early assessment of trauma patients to determine the necessity for immediate surgery.

Compliance with ethical standards

Informed consent: Approval to conduct the research was obtained from the Statistics Department of the Hospital Universitario Miguel Enríquez, and informed consent was obtained from all participants. The confidentiality of patient data was maintained at all times. This study adhered to the regulations set forth by Resolution 008430 of 1993 from the Ministry of Health of Colombia.

Conflicts of interest: The authors declare no conflict of interest.

Use of Artificial Intelligence: The authors declared that they did not use artificial intelligence (AI)-assisted technologies (such as large language models, chatbots, or image creators) in the production of this work.

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Author's contribution

- Conception and design of the study: Alain David Medina-Lago.
- Acquisition of data: Isabela Bezerra Ferreira da Silva, Yoján Garrido-León.
- Data analysis and interpretation: Alain David Medina-Lago, Oscar Diaz-Pi, Yoján Garrido-León.
- Drafting the manuscript: Alain David Medina-Lago, Isabela Bezerra Ferreira da Silva.
- Critical review and final approval: Alain David Medina-Lago, Oscar Diaz-Pi.

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