DIAGNOSTIC ACCURACY OF ULTRASONOGRAPHY IN DETECTION OF PNEUMOPERITONEUM IN ACUTE ABDOMEN COMPARED TO COMPUTED TOMOGRAPHY

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Introduction

Acute Abdomen is a surgical emergency that warrants urgent surgical intervention upon recognition without delay to avoid significant subsequent morbidity and mortality burdens.

Pneumoperitoneum is one of the life-threatening surgical emergencies that is not always associated with signs of acute abdomen and failure of rapid detection could lead to fatal complications.

The gold standard diagnostic tool for pneumoperitoneum is the Computed Tomography of the abdomen and pelvis but many challenges hindered patient transfer in a safe, timely manner which spotted the light towards the use of POCUS as a safer, quicker efficient tool to make the diagnosis.

Ultrasonography has been developed to become an integrated part of the clinical examination of patients presenting to the emergency department with Acute Abdomen. Ultrasonographic evaluation of intra-peritoneal free air has been proven effective for detecting pneumoperitoneum as some studies reported visualization of as little as 1ml while other studies have reported the detection volumes as little as 0.2 ml.

Aim of the Work

The primary aim of this study was to identify the sensitivity, specificity and accuracy of ultrasonography in the detection of pneumoperitoneum in patients with Acute Abdomen in the emergency department in comparison with the gold-standard Computed Tomography.

The secondary aims of this study were:

To identify the sensitivity, specificity and overall accuracy of the Enhanced Peritoneal Stripe Sign (EPSS), the Shifting phenomenon, Abdominal Sliding absence, Gut point detection and Scissors manoeuvre in detecting pneumoperitoneum by ultrasound.

To evaluate the time taken from patient presentation to obtaining the ultrasound and CT scan results.

Patients and Methods

This study included 110 patients presenting to the Emergency Department of Alexandria Main University Hospital with Acute Abdomen, excluding age <18 years, burn patients and pregnant females.

History taking, clinical assessment, management, abdominal examination, investigations accordingly and bedside ultrasound evaluation of the peritoneum with the curvilinear and the linear probes after verbal consenting.

Supine position: identification of the peritoneal stripe by scanning the right upper quadrant shows a smooth echogenic line with the peritoneal layers demonstrating sliding.

Pneumoperitoneum produces enhancement of the peritoneal stripe, distal reverberation artifacts over the liver, loss of abdominal sliding and the Gut point is detected as an abrupt regain of peritoneal sliding. Compression with the distal end of the probe repetitively demonstrates loss and regain of peritoneal enhancement, the scissors manoeuvre.

Left lateral position, pneumoperitoneum demonstrates air shifting that is immobile with respiration, hence the Shifting phenomenon.

Ultrasound results were compared to Computed Tomography.

Results

Figure1:
Case showing EPSS (yellow arrows), distal reverberation artifacts (blue arrows), Gut point (red arrow) and normal peritoneal enhancement (green arrows).

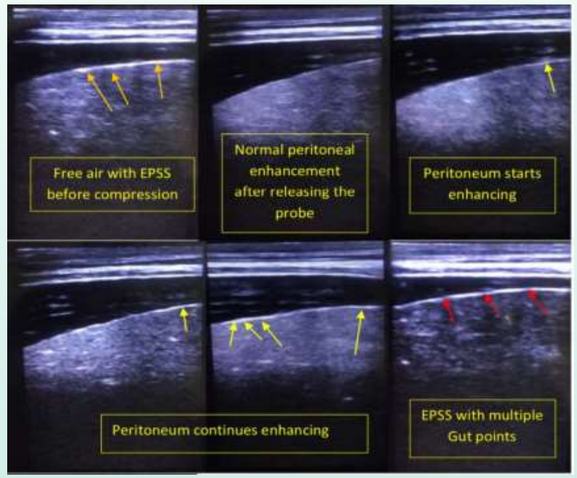

Figure2: Demonstrating detection of EPSS, Gut Points (red arrows) and repetitive attempts of demonstrating the Scissors manoeuvre in which air gets dispersed upon applying pressure to the abdominal wall with the probe and enhancement of the peritoneal stripe disappears then reappears upon releasing the pressure.

		Pneumoperitoneum by CT		
		Yes	No	
Pneumoperitoneum by U/S	**Yes**	35 (34.31%)TP	1 (0.98%)FN	36 (35.29%)
	No	0 (0.00%)FN	66 (64.71%) TN	66 (64.71%)
		35 (34.31%)	67 (64.71%)	102 (100.00%)
Measure of agreement (Kappa)		χ^2=0.978 , SE=0.021 p<.000*		
Measure of agreement (Weighted Kappa)		χ^2=0.978 , SE=0.021 95% CI: 0.936 to 1.000		

Table 1:
Agreement between U/S (Index test) and CT (Standard test) for detection of pneumoperitoneum.

Table 2: Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and Accuracy of Ultrasound signs of pneumoperitoneum.

	Sensitivity	Specificity	PPV	NPV	Overall Accuracy	p value
EPSS	100.00%	89.55%	83.33%	100.00%	93.14%	<.0001*
Shifting Phenomenon	77.78%	100.00%	100.00%	89.66%	92.41%	<.0001*
Absent Abdominal sliding	85.71%	83.58%	73.17%	91.80%	84.31%	<.0001*
Gut point	65.71%	100.00%	100.00%	84.81%	88.24%	<.0001*
Scissors Manoeuvre	100.00%	100.00%	100.00%	100.00%	100.00%	<.0001*

Conclusion

Ultrasound pneumoperitoneum signs are sensitive, specific, accurate and reliable signs for detection of pneumoperitoneum as compared to the gold standard CT and the combination of all five signs for pneumoperitoneum by Ultrasound provides a highly accurate and reliable imaging modality in a timely manner for diagnosis of pneumoperitoneum.

Absence of the Enhanced Peritoneal Stripe Sign combined with negative Scissors Manoeuvre offers a more accurate diagnosis for ruling out pneumoperitoneum, presence of the shifting phenomenon with positive Scissors manoeuvre and detecting the gut point confirm the diagnosis of pneumoperitoneum while the Gut Point is pathognomonic for pneumoperitoneum and Scissors manoeuvre is the single most sensitive, specific and accurate ultrasound sign of pneumoperitoneum and absence of Abdominal Sliding is not necessarily associated with presence of pneumoperitoneum while the Shifting Phenomenon provides an accurate diagnosis of pneumoperitoneum when it is feasible to perform.

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