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CHEST ULTRASOUND VERSUS CHEST COMPUTED TOMOGRAPHY FOR ASSESSMENT OF UNDIAGNOSED PLEURAL EFFUSION BEFORE MEDICAL THORACOSCOPY

By

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ABSTRACT

Background: The definitive diagnosis of pleural malignancy depends upon histological confirmation by pleural biopsy.

Objective: To compare chest U/S and chest CT findings of undiagnosed pleural effusion before medical thoracoscopy to examine the concordance and discordance between them.

Patients and Methods: This study was conducted on 30 patients admitted at the Department of Chest Diseases, Al-Hussein University Hospital during the period between January 2021 and June 2021.

Results: Chest CT was superior to chest ultrasound in the detection of pulmonary nodules, mediastinal lymphadenopathy and mediastinal shift. However, CT findings missed by U/S did not affect the procedure conductance, technique or outcome. Chest U/S was superior to CT chest in the detection of multiloculations, septations, diaphragmatic pleural nodules and visceral pleural nodules. These findings, detected by ultrasound, were consistent with the operative findings. The most common complications of medical thoracoscopy in the study were subcutaneous emphysema in 16.7%, failure of full lung expansion in 10 %, and intractable cough in 3.3% of patients.

Conclusion: Sonography overcame the shortcomings of CT, as it used no ionizing radiation, being portable and could be performed while the patient was in the supine, sitting and lateral decubitus positions. U/S has the capacity to clarify the nature of pleural effusions and underlying abnormalities.

Keywords: Ultrasound, medical thoracoscopy, computed tomography.

INTRODUCTION

Pleural disease is common, affecting over 300 people per 100 000 of the population each year. The definitive diagnosis of pleural malignancy depends upon histological confirmation by pleural biopsy *(Du Rand and Maskell, 2010)*.

Chest imaging is required for assessment before medical thoracoscopy (MT). The imaging commonly used include chest X-ray (CXR), chest computed tomography (CT), and chest ultrasound (US) *(Rahman et al., 2010)*.

Contrast-enhanced thoracic CT is reported to have a high sensitivity and specificity to help differentiate between benign and malignant disease, and is therefore an essential part of the

diagnostic workup of these patients. Features of malignant disease on CT scanning are nodular pleural thickening, mediastinal pleural thickening, parietal pleural thickening >1 cm and circumferential pleural thickening *(Rahman et al., 2010)*.

Chest US was found to be equally able to detect pleural fluid location when compared with chest CT and to be superior to chest CT in its ability to resolve the internal components of pleural fluid including fibrin strands *(Kim et al., 2012)*.

A chest ultrasound is a noninvasive diagnostic exam that produces images, which used to assess pleural space. Ultrasound has been demonstrated to better quantify the amount of the effusion present in the chest cavity, Furthermore, ultrasound can determine if a complicated pleural effusion is present, such as an effusion with fibrin stranding and loculations *(Beckh et al., 2014)*.

The aim of this work was to compare chest US and computed tomography for assessment undiagnosed pleural effusion before medical thoracoscopy.

PATIENTS AND METHODS

This prospective study was carried out on 30 patients admitted at chest departments, Al-Hussein University Hospital during period between January 2021 and June 2021. All consecutive patients referred to the medical thoracoscopy unit for undiagnosed pleural exudates. Informed consent was obtained from every patient. The study was approved by the Research and Ethical Committee of the Chest Department, Faculty of Medicine, Al -Azhar University.

Inclusion criteria: All patients with undiagnosed exudative pleural effusion before thoracoscopy.

Exclusion criteria: Patients with transudative pleural effusion. Renal impairment due to use of CT chest with contrast .blood clotting abnormality.

All- studied patients were subjected to detailed history taking and clinical examination (general and chest examination), routine laboratory investigation including (CBC, KFT, LFT, RBS and coagulation profile) and pleural fluid analysis including physical, chemical, bacteriological and cytological examination of malignant cells.

Radiological evaluation was carried out by plain chest X-ray PA view and chest ultrasonography examination of the pleural cavity.

The procedure was performed at the ultarsonographic unit of Chest Department, Al-Hussein University Hospital.

The procedure was performed using a 2-5 MHz convex probe for examination of the pleural effusion, visceral pleura, and lung parenchyma, whereas the parietal pleura and thoracic wall were examined with the use of a linear 5-10 MHz probe.

Thoracic US was best performed with the patient in sitting position. However, this was not possible in all hospitalized patient. Some patients were positioned in a semi-sitting position with approximately 30 degree, the arms externally rotated and abducted, and in lateral position when needed.

In this study, chest ultrasonography was performed in sitting and supine posture using both abdominal and direct intercostal approaches, firstly in supine position to examine anterior and lateral chest wall, then in sitting position to examine posterior chest wall. .

Findings were reported by chest US examination:

Echo pattern of pleural effusion:

- **Anechoic:** Complete absence of internal echoes, black uniform appearance.
- **Echogenic:** Diffuse internal echoes, gray uniform appearance.
- **Complex non septated:** Heterogenous echogenic materials inside the pleural effusions. Under real-time conditions, echoes may float or swirl with respiration and heartbeat, making circular movements.
- **Complex septated** was defined as fibrin strands or septa floating inside the pleural effusions.

Pleural thickening: Its types (diffuse or focal), and its site (pleural thickening parietal dosal, costal, diaphragmatic, or visceral).

Pleural nodules: Its site (dorsal, costal, diaphragmatic, or visceral).

Pleura septations.

Underlying parenchymal lesion: Either underlying lung collapse or consolidation patch or lung mass.

Quantify amount of pleural effusion: Minimal: if the hypoechoic space was seen only at thecostophrenic angle. Small: if it coved the costophrenic angle but limited within the image formed by the transducer. Moderate: if the space was larger than the image but limited within two images. Massive: if it was larger than two images formed by the transducer *(Ferreira et al., 2014)*.

Computed tomographic (CT) scan of the chest with contrast except if there was contraindication to dye: Chest CT was performed on a 4-MDCT scanner (Asteion; Toshiba, Japan). Images were obtained in the supine position from the level of the thoracic inlet to the diaphragm using a pitch of 1.0 and slide thickness of 5 mm.

Medical thoracoscopy: MT was performed according to a preplanned weekly schedule. All MTs were performed at the endoscopy suite, with a rigid thoracoscope (Karl Storz, Germany) under local anesthesia and as necessary, intravenous analog-sedation with midazolam and paracetamol, if necessary, with appropriate monitoring.

Statistical analysis:

Data entry, coding, and analysis were conducted using SPSS (22), IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0 Armonk, NY: IBM Corp. USA. Description of quantitative variables was in the form of Mean and Standard Deviation (mean ± SD) and range Description of qualitative variables was by frequency and percentage, chi square test was used to assess the relationship between two qualitative groups,. P value ≤ 0.05 was set to be statistically significant.

RESULTS

Thirty patients included male patients representing 60%, and female patients constituted 40%, their mean age was 52.1±17.07 years (range: 20–78 years). As regard smoking, there were non-smoker patients (36.7%) and smoker patients (63.3%) **(Table 1)**.

Table (1): Description of personal data in all studied patients

Paramters		**Studied patients (N = 30)**	
Age (years)	**Mean ±SD**	52.1 ± 17.07	
	Min – Max	20 – 78	
Sex	**Male**	18	60%
	Female	12	40%
Smoking	**Non-smoker**	11	36.7%
	Smoker	19	63.3%

In the radiological pattern by CT chest, most patients presented by moderate amount of pleural effusion (60%). It also showed pleural thickening and its type as focal or diffuse 75 % and 25% respectively. Pleural thickening was more in parietal than visceral pleura (93.7%). Pleural nodules were found in one patient who was parietal. Septations presented in one patient. The most commonly found parenchymal lesion was consolidation patch and found in 33.3% **(Table 2)**.

Table (2): Radiological patterns of pleural effusion in chest CT

Paramters	Frequency(n=30)	Percentage
Effusion size		
- **Small**	4	13.3%
- **Moderate**	18	60%
- **Massive**	8	26.7%
Pleural thickening		
- **Positive**	16	53.3%
- **Negative**	14	46.7%
Type of pleural thickening (n=16)		
- **Focal**	12	75%
- **Diffuse**	4	25%
Site of pleural thickening (n=16)		
- **Parietal**	15	93.7%
- **Visceral**	1	6.3%
Pleural nodules		
- **Positive**	1	3.3%
- **Negative**	29	96.7%
Site of pleural nodules (n=1)		
- **Parietal**	1	100%
- **Visceral**	0	0%
Septations		
- **Positive**	1	3.3%
- **Negative**	29	96.7 %
Parenchymal lesion		
- **Collapse**	5	16.7 %
- **Mass**	4	13.3 %
- **Consolidation patch**	10	33.3%
- **None**	11	36.7 %
Side		
- **Unilateral**	28	93.3%
- **Bilateral**	2	6.7%

By chest US, most patients presented by moderate amount of pleural effusion (60%). Pleural thickening was found in 73.3% which was parietal in 95.5%. Pleural nodules were found in 33.3 % which were located more in diaphragmatic pleura (80%). Septations were found in 23.3%. US showed underlying parenchymal lesion as collapse, mass, consolidation patch or no parenchymal lesion (26.7%, 16.7%, 20%, 36.6% respectively). Lung collapse was found in 26.7% **(Table 3)**.

Table (3): Ultrasonography patterns of pleural effusion

Parameters		Frequency(n=30)	Percentage
Effusion size			
- **Small**		4	13.3%
- **Moderate**		18	60%
- **Massive**		8	26.7%
Pleural thickening (n=22)			
- **Positive**		22	73.3%
- **Negative**		8	26.7%
Type of pleural thickening (n=22)			
- **Focal**		15	68.2 %
- **Diffuse**		7	31.8 %
Site of pleural thickening (n=22)			
- **Parietal**	**Dorsal & costal**	13	59.1 %
	Diaphragmatic	8	36.4 %
- **Visceral**		1	4.5 %
Pleural nodules			
- **Positive**		10	33.3%
- **Negative**		20	66.7 %
Site of pleural nodules (n=10)			
Parietal	**Dorsal & costal**	2	20 %
	Diaphragmatic	8	80 %
Septations			
- **Positive**		7	23.3 %
- **Negative**		23	76.7 %
Parenchymal lesion			
- **Collapse**		8	26.7%
- **Mass**		5	16.7 %
- **Consolidation patch**		6	20%
- **None**		11	36.6 %
Echopattern			
- **Anechoic**		12	40%
- **Echogenic**		5	16.7%
- **Complex non septated**		6	20%
- **Complex septated**		7	23.3%
Side			
- **Unilateral**		28	93.3%
- **Bilateral**		2	6.7 %

There was adisconcordance between chest ultrasound and chest CT in detection of pleural thickening, pleural mass, lung consolidation, pleural nodularity, septation and loculation **(Table 4)**.

Table (4): CT chest disconcordant with U/S results in all studied patients

Paramters / Methods	CT (N = 30)		U/S (N = 30)		P-value
Pleural thickening	16	53.3%	22	33.3%	0.108
Pleural mass	4	13.3%	5	16.7%	0.718
Lung consolidation	10	33.3%	6	20%	0.243
Pleural nodule	1	3.3%	10	33.3%	**0.003**
Septations and loculations	1	3.3%	7	23.3%	**0.023**

There was astatistically significant difference between chest CT and chest U/S as regard pulmonary nodule, mediastinal lymph node, astherosclerosed aorta, and ground glass opacification, and between chest CT and chest U/S as regard mediastinal shift and spondylodegenartive changes **(Table 5)**.

Table (5): Abnormality missed with chest U/S but detected in CT chest in all studied patients

Paramters / Methods		CT (N = 30)		U/S (N = 30)		P-value
Pulmonary nodule	**Positive**	8	26.7%	0	0%	**0.002**
Mediastinal Lymph node	**Positive**	7	23.3%	0	0%	**0.005**
Mediastinal Shift	**Positive**	16	53.3%	0	0%	**< 0.001**
Spondylodegenartive changes	**Positive**	19	63.3%	0	0%	**< 0.001**
Astherosclerosed aorta	**Positive**	6	20%	0	0%	**0.009**
Ground glass opacification	**Positive**	7	23.3%	0	0%	**0.005**

Thoracic ultrasound missed fibrous septations and multiloculation was in 10 % due to morbid obesity that degraded the image quality **(Table 6)**.

Table (6): Abnormalities missed in chest computed tomography and chest ultrasound detected intra-operatively by medical thoracoscopy

Findings	No. of cases	Percent
Fibrin strands and Multiloculation	3	10 %

The description of pathological results showed adenocarcinoma in 23.3%, mesothelioma in 63.7%, metastatic carcinoma in 3.3%, non-specific inflammation in 13.3%, TB in 13.3%, and undiagnosed in 10% **(Table 7)**.

Table (7): Description of pathological results in all studied patients.

Pathological results	Studied patients (N = 30)	
Adenocarcinoma	7	23.3%
Mesothelioma	11	36.7%
Metastatic carcinoma	1	3.3%
Non-specific inflammation	4	13.3%
TB	4	13.3%
Undiagnosed	3	10%

The description of thoracoscpic complications showed intractable cough in 3.3%, surgical emphysema in 16.7%, trapped lung in 10%, while there were no complications in 70% **(Table 8)**.

Table (8): Description of thoracoscopy complication in all studied patients

Thoracoscpic complications	Studied patients (N = 30)	
No complications	21	70%
Intractable cough	1	3.3%
Surgical emphysema	5	16.7%
Trapped lung	3	10%

DISCUSSION

MT can serve as an excellent diagnostic procedure in patients with undiagnosed pleural effusion. Chest imaging is required for assessment before medical thoracoscopy (MT). The imaging commonly used include chest X-ray (CXR), chest computed tomography (CT), and chest ultrasound (US) *(Rahman et al., 2010).*

In the current study, male patients represented 60%, and female patients constituted 40% as regard smoking. There were non-smoker patients (36.7%), and smokers (63.3%). *Ahmed et al. (2017)* showed that male patients represented 56% and female patients constituted 44%.

The result of the present study showed that the radiological pattern by CT chest in most patients presented by moderate amount of pleural effusion (60%). Pleural thickening and its type as focal or diffuse were 75 % and 25% respectively. Pleural thickening was more in parietal than visceral pleura (93.7%). Pleural nodules were found in one patient who was parietal. Septations presented in one patient. The most commonly found of parenchymal lesion was consolidation patch and found in 33.3%. This result was compatible with that done by *Abd El Aziz et al. (2020)* who showed that the radiological pattern mostly presented by moderate amount of pleural effusion (60%). It also showed that pleural thickening and its type as focal or diffuse

was 46.9% and 53.1% respectively. Pleural thickening represented about 45.7%. Pleural thickening was more in parietal than visceral pleura (96.9%). Pleural nodules were found only in one patient who was parietal.

The result of the present study showed that the diagnosis by chest US, mostly presented by moderate amount of pleural effusion (60%). Pleural thickening was found in 73.3%, pleural thickening was parietal in 95.5%. Pleural nodules were found in 33.3 % which were located more in diaphragmatic pleura (80%). Septations were found in 23.3%. Lung collapse was found in 40%.

This result was compatible with that done by *Abd El Aziz et al. (2020)* who showed that the radiological pattern by chest US in most patients presented by moderate amount of pleural effusion (64.3%). Pleural thickening which was found in 68.6%, pleural thickening was focal in half of cases and diffuse in the other half. Pleural thickening was parietal in 58.3%. Pleural nodules were found in 20% which were located more in diaphragmatic pleura (92.9%). Septations were found in 18.5%, and lung collapse was found in 40%.

The result of the present study showed that no statistical significant difference between chest CT and chest U/S as regard effusion side, amount, plural thickening, pleural mass and lung consolidation. Statistically significant difference between chest CT and chest U/S as regard plural nodularity, septations, loculations, pulmonary nodule, mediastinal lymph node, astherosclerosed aorta and ground glass opacification. Statistical significant difference was between chest CT and chest U/S as regard mediastinal shift and spondoylodegenative change.

Also *Kurian et al. (2010)* reported that effusion was confirmed on both chest CT and chest ultrasound, and one had no effusion on either examination. Consolidation was shown in all patients on both chest CT and chest ultrasound except for one chest ultrasound in which technical limitations precluded evaluation of the lung.

The result of the present study showed that nature of effusion by U/S as compared with CT chest that unable to detect internal echogenicity of pleural effusion. Chest US was able to detect four sonographic pattern of internal echogenicity of pleural effusion. Pleural effusion with anechoic in 40%, complex septated in 23.3%, complex non-septated in 20%, and homogenous echogenic in 16.7%. *Khalil et al. (2014)* showed that pleural effusion was anechoic in 32.7%, complex non-septated in 13.5%, complex septated in 46.1%, and homogeneously echogenic in 7.7%. The homogenously echogenic pattern was seen in hemorrhagic effusion. *Yang et al. (2014)* reported that four basic sonographic patterns of internal echogenicity were seen where 53.7% were anechoic, 15.6% were complex non-septated, 23.7% were complex septated, and 6.8% were homogeneously echogenic. *Kearney et al. (2016)* reported that by ultrasound, 19% pleural collections were anechoic, 14% were hyperechoic without septae, and 67% were hyperechoic with septae.

The result of the present study showed that CT chest superior to chest ultrasound in detection of pulmonary nodule was in 26.7%, mediastinal lymphadenopathy in

23.3%, mediastinal shift in 53.3%, spondylodegenartive changes in 63.3%, astherosclerosis aorta in 20%,and ground glass opacification in 23.3%. These results agree with that done by *Khalil et al. (2014)* who showed that TUS was not able to detect with parietal pleural nodules (costal and mediastinal) as they were small, with pulmonary nodules which were not pleural based, with ground glass opacification, and with mediastinal lymphadenopathy. *Abd Elmalak (2012)* reported that ultrasound was not able to detect any of the two cases of hilar lymphadenopathy.

The result of the present study showed that chest ultrasound was superior to CT chest in detection of septation, loculation in 23.3 %, diaphragmatic pleural nodule was in 80%. These findings were detected by ultrasound consistent with the operative findings but not detected by chest CT in any of them.

The result of the present study was compatible with that done by *Khalil et al. (2014)* who showed that chest ultrasound was superior to chest CT with fibrin strands and multiloculation. Seventeen out of showed thick fibrous septation and multiloculation, whereas 29.1% showed few fibrin strands. Thoracic ultrasound (TUS) missed fibrous septation and multiloculation in only one patient as compared with the operative findings due to morbid obesity that degraded the image quality. These findings did not appear in chest CT.

This was in agreement with *Medford et al. (2010)* who reported that TUS identified all cases of fibrous septation in TUS cohort (eight out of the eight septated cases) (100%) versus only one out of the eight septated cases (12.5%) in non-TUS cohort which was identified by CT. *Kurian et al., (2010)* reported that fibrin strands were identified in all patients with effusion on chest ultrasound except for one patient with only trace fluid; some patients showed few fibrin strands, whereas others showed numerous strands of variable thickness. Although presumably present, fibrin strands could not be clearly delineated on any of the chest CT images. *Jeong et al., (2010)* reported that of 91.6% who did not have pleural adhesions on ultrasound, 16.6% revealed mild adhesions. However, ultrasound showed pleural adhesions in 8.3%, consistent with the operative findings.

The result of the present study showed that thoracic ultrasound missed fibrous septations and multiloculation in (10 %) due to morbid obesity that degraded the image quality.

The finding of thick fibrous adhesions and loculations has a strong impact on MT, either changing or modifying the plan of the operator. Virtually, the presence of fibrous adhesions may be the most important abnormality the thoracoscopist seeks imaging assessment for. US has proved to be the best imaging modality to clarify this abnormality.

The result of the present study showed that the most final diagnosis of cases were adenocarcinoma in 23.3%, mesothelioma in 36.7%, metastatic adenocarcinoma in 3.3%, non-specific inflammation and TB in 13.3%, while undiagnosed cases in 10%. Most common complications of medical thoracoscopy were surgical emphysema (16.7%), then failure of full lung expansion (10%), and intractable

cough in 3.3%. These results agreed with that done by *Khalil et al (2014)*, who showed that most common complications of medical thoracoscopy were surgical emphysema (35%), then failure of full lung expansion patients (17.5%), bronchopleural fistula (2.5%) and intractable cough (2.5%).

CONCLUSION

Chest ultrasonography was more valuable than chest CT in diagnostic alogarithm of pleural effusion. Chest US identified more explicitly the imaging information relevant to MT as compared with Chest CT. Chest ultrasonographic findings can be used confidently to confirm diagnosis of exudative effusion especially in malignant and para pneumonic pleural effusion.

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الموجات فوق الصوتية علي الصدر مقارنة بالأشعة المقطعية في تقييم الانسكاب البللوري غير المشخص قبل إجراء منظار التجويف الصدري

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خلفيـــة البحث: يعتمـــد التشـــخيص الجـــازم لســـرطانات الغشـــاء البللـــوري علـــى الفحـــص النسيجيّ المؤكَّد للخزعة (العينة) البللوريَّة.

الهدف من البحث: المقارنـــة بـــين مكتشـــفات الموجـــات فـــوق الصـــوتية علـــى الصـــدر والاشـــعة المقطعيـــة للصـــدر لمرضـــى الانســـكاب البللـــوريّ غيـــر المُشـــخَّص قبـــل إجـــراء منظار التجويف الصدريّ لاستجلاء أوجه التشابه والاختلاف بينهم.

المرضى وطريقة البحث: أُجريـــت هـــذه الدراســـة علـــى 30 مريضـــا يعـــانون مـــن إنســـكاب بللـــورى بعد الموافقة من المرضـــى على الاشتراك في البحث الذي تم طبقا للجنة الأخلاقيـــات الطبيـــة بجامعة الازهـــر وذلك في الفترة الزمنيـــة بـــين شـــهري ينـــاير ويونيـــو 2021 حـــال حجـــزهم بقســـم الأمـــراض الصـــدريَّة بمستشـــفى الحســـين الجـــامعيّ. وبعد استبعاد الحالات التي لاتتماشى مع هـــذة الدراسة تم أخذ التـــاريخ المرضي كاملا لكل المرضى، ثم اجراء فحص إكلينيكـــى شامل، وصورة دم، ووظائف كبد وكلي، وتحليـــل ســـيولة الـــدم، عمـــل أشـــعه عاديـــة علي الصدر خلفي أمامي و جانبى، أشـــعة مقطعيـــة علـــى الصـــدر والموجـــات فـــوق الصـــوتية علـــى الصـــدر ومنظـــار التجويـــف الصدرى.

نتائج البحث: أظهـــرت الاشـــعة المقطعيـــة للصـــدر أفضـــليَّة علـــى الموجـــات فـــوق الصـــوتيَّة علـــى الصـــدر فـــي إكتشـــاف العُقـــد الرئويَّـــة، الاعـــتلال العُقـــديّ اللِمفـــيّ الحيزومـــيّ والانتقـــال الحيزومـــيّ. وعلـــى الـــرغم مـــن ذلـــك، فـــإن مكتشـــفات الأشـــعة المقطعيـــة التـــي أخطأتهـــا الموجـــات فـــوق الصـــوتيَّة علـــى الصـــدر لـــم تـــؤثِّر علـــى كيفيَّـــة

الإجـــراء، أو تقنيَّتـــه، أو نتائجـــه. وأظهـــرت الموجـــات فـــوق الصـــوتيَّة علـــى الصـــدر أفضـــليَّة علـــى الأشـــعة المقطعيـــة للصـــدر فـــي إكتشـــاف التموقعـــات الانســـكابيَّة المتعـــدِّدة، والحـــواجز الفاصـــلة، والعُقـــد البللوريَّـــة الحاجزيَّـــة، والعُقـــد البللوريَّـــة الحَشَـــويَّة. وقـــد كانـــت مكتشـــفات الموجـــات فـــوق الصـــوتيَّة علـــى الصـــدر مُتَّســـقة مـــع المكتشـــفات الجراحيَّـــة. وكانـــت المضـــاعفات الأكثـــر حـــدوثاً مـــن منظـــار التجويـــف الصـــدريّ هـــي النُفـــاخ تحـــت الجلـــديّ فـــي (16.7%) مـــن المرضـــى، فشـــل التمـــدُّد الرئـــويّ الكامـــل فـــي (10%) من المرضى، والسعال المُستعصي في (3.3%) من المرضى.

الاستنتاج: تســـتطيع الموجـــات فـــوق الصـــوتيَّة تجـــاوز نقـــائص الاشـــعة المقطعيـــة للصـــدر، حيـــث أنَّ الأولـــى لا تســـتخدم الأشـــعة المُتأيِّنـــة، ويمكـــن نقلهـــا وإجرائهـــا بينمـــا المريض في وضعية الاستلقاء، أو الجلوس أو الضجعة الجانبيَّة.

تمتلـــك الموجـــات فـــوق الصـــوتيَّة القـــدرة علـــى إيضـــاح طبيعـــة الانســـكابات البللوريَّـــة والاخـــتلالات التحتيَّـــة. وإجـــراء الموجـــات فـــوق الصـــوتيَّة علـــى الصـــدر بواســـطة طبيـــب أمـــراض صـــدريَّة ذي مهـــارة يـــؤدي إلـــى تـــوفير الوقـــت واجتنـــاب التضاربات التي قد تنشأ عن التفسيرات المتباينة.

الكلمات الدالة: الموجات فوق الصوتة، الأشـــعة المقطعيـــة علـــى الصـــدر، منظـــار التجويف الصدرى.

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