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Diagnostic Accuracy of Ultrasound and Computed Tomography in Differentiating Transudate from Exudate in Patients with Pleural Effusion

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ABSTRACT

Objective: To compare the diagnostic accuracy of Computed Tomography and Ultrasonography in differentiating trans-dative and exudative pleural effusion.

Study Design: Cross-sectional study.

Place and Duration of Study: Radiology Department of Pakistan Institute of Medical Sciences, Islamabad Pakistan, from Jul to Oct 2021.

Methodology: Patients suffering (n=80) from pleural effusion were involved, and all were assessed with ultrasound and computed Tomography along with diagnostic thoracocentesis. In addition, we investigated pleural thickening, pleural nodules, and loculations along with the USG signs and Computed Tomography attenuation values to detect transudate and exudate in individuals suffering from pleural effusion.

Results: Participants had a mean age of 36.20±6.67 years, ranging from 25 to 49 years. Out of 80 patients, 50(62.5 %) were males, and 30(37.5%) were females. Of the eighty patients with pleural effusion, 29 were transudative 36(25%), and 51 were exudative 63(75%). Overall, USG showed better results for loculations, while CT showed better results for pleural thickening and nodules.

Conclusion: Attenuation values of Computed Tomography play an essential role in differentiating the type of pleural effusion. In addition, ultrasound is a supporting non-invasive imaging modality that helps define the characteristics of pleural effusion.

Keywords: Computed Tomography, Exudate, Pleural Effusion, Transudate Ultrasonography.

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INTRODUCTION

Presently pleural effusion has been reported as one of the most frequently occurring medical conditions that may arise for numerous reasons.[1,2] Clinical history and physical examination play a vital role in evaluating pleural effusion. Every individual's signs and symptoms differ, but cough, chest pain and dyspnea are common. The principal stage in evaluating pleural effusion is distinguishing between the exudate and transudate. Changes in the hydrostatic and oncotic pressures result in the production of transudative fluid.[3,4] Multiple techniques in imaging are used to diagnose and find out the cause of pleural effusion, including conventional radiography, Computed Tomography (CT), Ultrasonography (USG), and MRI.[5,6] Ultrasound is the most frequently used imaging technique with advanced tools to confirm the pleural effusion detected on chest X-ray.[7]

Ultrasound shows a crucial elevated perceptivity than the traditional imaging methods used in radiology to analyse effusion, its surrounding environment, differentiation of the fluid type, and detection of pleural thickening.[5] Computed Tomography is commonly performed to evaluate patients with pleural irregularities linked with empyema, neoplasm, and pneumonia.[8] A meagre amount of literature can be found on the practice of Ultrasound, Computed Tomography attenuation values, and linked outcomes as assistance in describing pleural effusion in Asia. It is highly beneficial to asses through such a non-invasive modality in the patients contraindicated for invasive diagnostic approaches to evaluate the nature of pleural effusion and avoid any complications related to diagnostic thoracocentesis.[9,10]

We assessed the multiple features of Ultrasound and Computed Tomography examinations in distinguishing transudative and exudative pleural effusion. This research aimed to assess the diagnostic accuracy of CT and USG in distinguishing transudate from exudate in individuals suffering from pleural effusion.

METHODOLOGY

The cross-sectional study was performed at Radiology Department of Pakistan Institute of Medical Sciences, Islamabad Pakistan, from July to October 2021 after approval by the Ethical Review Board of

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Shaheed Zulfiqar Ali Bhutto Medical University (F.1-1/2015/ERB/SZABMU/796). Using the WHO calculator, the sample size was calculated with a 70% expected prevalence of pleural effusion in the study population.[10] patients were included in the study through simple consecutive non-probability sampling technique.

Inclusion Criteria: Patients aged 18 years or above, doubted for pleural effusion, sent to the Radiology Department for screening through USG and CT Thorax were included in the study.

Exclusion Criteria: Patients with trace amounts of effusions, pregnancy, and previous trauma were excluded from the study.

Patients suspected of pleural effusion the medically or radiographically sent for the CT thorax, and Ultrasonography was examined for the study. All the patients suffering from pleural effusion underwent ultrasound and CT scans. Ultrasound was performed using APLIO 500 in the supine and semi-recumbent positions by the intercostals and abdominal approaches. The probes used were a 2.5MHz curvilinear probe and a 5MHz linear probe. Computed Tomography was performed using Optima CT540;16 slices were engaged from near the thoracic opening to the adrenal glands. IV contrast agent administration was not done when the patient's renal function tests were irregular.

The findings of ultrasound and CT were correlated with the pathological examination done under light criteria. In addition, this was considered our gold standard. Effusions detected on ultrasound were categorised as complex septated, echogenic, complex non-septated, and anechoic.[11]

Data were analysed using SPSS-25 and MS Excel 2016 software. Mean±SD was calculated for continuous variables. Frequency and percentage were calculated for categorical variables. Diagnostic accuracy was calculated using a two by two table. Chi-square and t-tests were applied, and the *p*-value of ≤0.05 was considered significant.

RESULTS

A total of eighty patients were involved in the research that underwent USG and CT within 72 hours. It was seen that pleural effusion could be caused by multiple factors, including congestive heart failure 8(10.0%), malignant infections 15(18.8%), acute pulmonary embolism 3(3.8%), chronic kidney disease 4(5.0%), liver cirrhosis 4(5.0%) and other diseases like dengue or typhoid 10(12.5%) as shown in Table-I.

Table-I: Baseline Demographic Characteristics of Study Participants (n=80)

Variables	n(%)
Age (years) (Mean±S.D)	36.20±6.67
Gender	
Male	50(62.5%)
Female	30(37.5%)
Etiological Factors	
Congestive Heart Failure	8(10.0%)
Malignant Infections	15(18.8%)
Acute Pulmonary Embolism	3(3.8%)
Chronic Kidney Disease	4(5.0%)
Liver Cirrhosis	4(5.0%)
Other Diseases	10(12.5%)

Loculations were detected better on Ultrasonography than Computed Tomography. Pleural thickening and pleural nodules were better seen on computed Tomography than ultrasound. Moderate to Large effusion size was noted in Exudates, while transudate had a smaller effusion size in most cases, as shown in Table–II.

Table-II: Ultrasound and Computed Tomography Measurements and Findings in both Exudative and Transudative Fluids (n=80)

Characteristic Features	Transudate (n= 29)	Exudates (n= 51)
Anechoic	24(30.0%)	2(3.9%)
Non-Septated Complex	-	11(21.6%)
Septated Complex	-	24(47.1%)
Echogenic	5(17.2%)	14(27.5%)
Size of Effusion		
Small	16(55.5%)	7(13.7%)
Moderate	9(31.0%)	33(64.7%)
Large	4(13.8%)	11(21.6%)
Loculations	2(6.89%)	8(15.6%)
Pleural Thickening	3(10.3%)	24(47.0%)
Pleural Nodules	3(10.3%)	6(11.7%)

Pleural thickening (49.0%;6.89%), pleural nodules (9.8 %;6.89%), and loculations (33.3%;17.2%) were seen more frequently in exudative effusions than in transudative effusions (Figure).

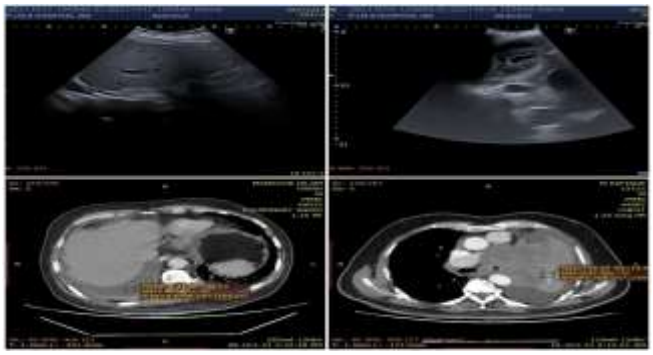

Figure: Radiographic presentation of Exudative and Transudative Effusions on USG and CT Scan

Causes of effusions were interrelated with the average attenuation values. It was noted that mean attenuation values in exudative effu-sions (14.6) were undoubtedly higher than the tran-sudative (4.60), the Lights Criteria, out of 80 patients enrolled in the study, 29(36.3%) were transudates, and 51(63.7%) were exudates. Transudative effusions were frequently seen bilaterally 22(75.9%). On the other hand, exudative effusions were frequently seen unila-terally 49(83.1%) with a significant *p*-value of less than 0.01, as shown in Table-III.

Table-III: Computed Tomography Conclusions of Study Participants with Exudative and Transudative Effusions (n=80)

Variables	Transudate (n= 29)	Exudates (n= 51)	*p*-value
CT Attenuation (HU)	4.60 (1.3–8.2)	14.60 (4.5-34)	<0.01
Effusion size (mm)	37.10 (17.6-107)	75.90 (18.8-181)	-
Loculations	5(17.2%)	17(33.3%)	<0.01
Pleural Thickening	2(6.89%)	25(49.0%)	<0.01
Pleural Nodules	2(6.89%)	6(9.8%)	<0.01
Lights Criteria	29(36.3%)	51(63.7%)	<0.01
Unilateral	7(24.1%)	49(96.0%)	<0.01
Bilateral	22(75.8%)	2(4.0%)	<0.01

Diagnostic Accuracy of CT in distinguishing Transudates from Exudates

	Pleural Thickening (n=27)	Pleural Nodules (n=8)	Loculations (n=23)
Sensitivity	81.39%	84.8%	75.80%
Specificity	91.83%	96.20%	94.40%
PPV	89.70%	93.30%	92.30%
NPV	84.90%	91.20%	94.40%
Diagnostic Accuracy	86.90%	91.95%	94.11%

On relating the ultrasound echogenicity forms against mean computed tomography attenuation values, anechoic effusions presented much lesser attenuation measurements (5.37±3.25) than the other echogenicity patterns of effusion, i.e., complex septated (12.10±6.89), complex septated (14.83±4.57) and Echo-genicity (15.16 ±4.40). This difference is well illustrated in Table-IV.

Table-IV: Mean of Computed Tomography Attenuation values of Effusions (n=80)

USG Echogenicity	CT Attenuation Values Mean±S.D
Anechoic	5.37±3.25
Complex non-septated	12.10±6.89
Complex septated	14.83±4.57
Echogenic	15.16±4.40

DISCUSSION

Differentiation of transudative effusion from exudative effusion is significant for diagnosing and treating pleural effusion.[11] In the analysis and assessment of pleural effusion, ultrasound and computed Tomography have been essential com-ponents. Ultrasound shows to have a critically elevated perceptivity than the traditional imaging methods used in radiology for the analysis of effusion, its surrounding environment, differentiation of the fluid type, and detection of pleural thickening before the thoracocentesis.[9,12]

USG is the most frequently used imaging technique with advanced tools to confirm the pleural effusion detected on chest X-rays.[13] Furthermore, we can classify pleural effusion as complex septated, non-septated, anechoic, and homogenously echoic. In general, most of the time, transudates are found to be anechoic, while on the other hand, it is difficult to tell whether the anechoic is transudate or exudate. It was found that the pleural effusions can be complex septated, complex non-septated, anechoic, and homogenously echoic.[14] Similar results were seen in our study, where 24(30.0%) out of 29 transudative were anechoic, while only 2(3.9%) out of 51 exudative effusions were anechoic. As stated by Jaworska *et al.* signs like thickened pleura and variation in lung parenchymal tissue were also important indicators of exudative fluid.[9]

A computed Tomography checkup is not only a delicate and precise outfit for relating pleural effusions; it is also a salutary outfit for defining sources of effusions. Numerous researchers have tried to analyse the diagnostic effectiveness of CT attenuation values for differentiating exudates from transudates based on pleural thickening, loculations, and pleural nodes.[15,16]

Indeed although the average values of attenuation for exudates are suggestively elevated compared to transudates, a crossroad can be observed between the values. Hence, analysing these values and the other Computed Tomography findings is crucial.[17]

Former readings described the chances of thickening of pleura; nodules in pleura and loculations were exact for exudates, with exploration affirming that they were appreciated in exudates only.[18] Brogi *et al.* stated that associated with transudates, exudates had a suggestively lesser prevalence of loculations and pleural stiffening.[14] Pleural stiffening, pleural nodules, and loculations were perceived in individuals with exudative effusion within elevation particularity (91.3, 64.8,100 independently) that was completely in harmony with the studies conducted earlier. Participators with transudative effusions had no septations, and

none of them established septations on ultrasound also, associated before studies.[18]

LIMITATIONS OF STUDY

There were certain limitations to the study conducted. First, primarily the radiologist knew the medical background and the likely outcome of the patients. Secondarily this research enclosed a smaller population size which can affect the results of the larger population.

CONCLUSION

Computed Tomography attenuation values are important in differentiating different types of pleural effusions. Ultrasound is a non-invasive imaging modality found to help define the characteristics of pleural effusion.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

MRB & AIM: Study design, drafting the manuscript, critical review, approval of the final version to be published.

IZ & AK: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

HA & SUD: Conception, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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