

**ORIGINAL ARTICLE****To evaluate the correlation between ultrasonography (USG) and X-ray in the quantitative investigation of pleural effusion**

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**ABSTRACT:**

**Aim:** To evaluate the correlation between ultrasonography (USG) and X-ray in the quantitative investigation of pleural effusion. **Material and Methods:** This study was conducted in the Department of Radiodiagnosis. Pleural effusion can be defined as accumulation of unwanted fluid in between the tissues in the lungs and chest which hinder the normal functioning of the lungs. In current study, a quantitative analysis is done between the X Ray and Ultrasound to find out better modality for evaluating the quantity of pleural effusion. It is a Prospective, Observational, and comparative study. The source of data for this study includes total 20 patients for chest radiography and ultrasonography from OPD/IPD/ED. Among which 13(65%) were male and 7(35%) were female of average age 38.3years. All the Patient with post-diagnosed of pleural effusion, All the patient IPD & OPD, Both male & female patient were included, No age limitation were included in this study. Pregnancy, Those patients who were not diagnosed with pleural effusion were excluded from the study. All the patients who have come for Chest Imaging. After the X Ray of Chest is done, if case of any doubt of Pleural effusion, the USG Chest is performed and vice versa. **Results:** USG showed 10(50%) male and 3(15%) females had pleural effusion in right lung whereas 5(25%) female and 6(30%) males had pleural effusion in left lung. In x-ray images 8(40%) males and 2(10%) females showed pleural effusion in right lung and 4(20%) female, 3(15%) males had effusion in their left lung. 3(15%) patients had effusion in their right lungs in USG images but not on their X-ray results, while 4(20%) patients' USG images showed effusion in left lung which cannot be seen on their X-rays. For right lung minimum volume of fluid level 37.8ml and 346mL was maximum volume and the average volume was 93.98mL. In left lung minimum 37.8 ml of fluid was detected and maximum recorded was 221.4mL and average volume recorded is 60.1mL. **Conclusion:** The present study "USG correlation with X-ray for evaluation of pleural effusion with quantitative analysis" is a prospective study conducted in patients to find the correlation of USG and X-Ray in evaluation of pleural effusion in radio-diagnoses and imaging in hospital. USG is some distance superior than simple X-Ray in locating of minimal pleural & also for quantification of effusion pleural furthermore, intervention like pleural faucet can also done. USG can locate low amount of fluid presence even less than 3 ml, while X-ray fails to help diagnose such low quantity of fluid.

**Keywords:** Ultrasonography (USG), X-ray, Pleural effusion,

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**INTRODUCTION**

Pleural effusion is a common clinical condition characterized by the accumulation of excess fluid in the pleural cavity, the space between the lungs and the chest wall. This condition can result from various underlying diseases, including congestive heart failure, pneumonia, malignancies, pulmonary embolism, and liver cirrhosis. The management of pleural effusion often requires accurate diagnosis and quantification of the fluid volume, which is crucial for guiding treatment decisions, monitoring disease progression, and determining the appropriate therapeutic interventions, such as thoracentesis or chest tube placement.<sup>1</sup> Traditionally, chest X-ray (CXR) has been the primary imaging modality used to detect and assess pleural effusion. X-ray imaging provides a quick and widely accessible method for identifying pleural fluid, typically manifesting as blunting of the costophrenic angles, a meniscus sign, or even a complete white-out of the hemithorax in cases of massive effusion. However, while CXR is valuable for the initial detection of pleural effusion, its

sensitivity, specificity, and accuracy in quantifying the amount of pleural fluid have limitations. For example, small volumes of pleural effusion may be difficult to detect on a standard chest X-ray, and the technique does not offer precise measurements of fluid volume. Moreover, CXR provides a two-dimensional image, which may lead to an underestimation or overestimation of fluid quantity, particularly when the effusion is loculated or when there is concurrent lung pathology.<sup>2</sup> Ultrasonography (USG), on the other hand, has emerged as a highly effective imaging tool for the assessment of pleural effusion. USG uses high-frequency sound waves to create real-time images of the chest cavity, offering several advantages over X-ray in the evaluation of pleural effusions. Unlike CXR, ultrasonography can detect even small amounts of pleural fluid, sometimes as little as 5-10 ml, making it more sensitive in the early detection of pleural effusion. Additionally, USG allows for the dynamic visualization of the pleural space, enabling the identification of septations, loculations, and the presence of fibrinous strands that

may complicate effusion management. This capability is particularly beneficial in differentiating between free-flowing and loculated effusions, which can influence the choice of therapeutic approach.<sup>3</sup> Quantitative analysis of pleural effusion using USG involves several techniques to estimate the volume of pleural fluid. One commonly used method is based on the measurement of the maximal distance between the lung surface and the chest wall at the level of the diaphragm during inspiration. This distance, often referred to as the "pleural stripe distance," correlates with the volume of pleural fluid, allowing for an estimation of the fluid quantity. Additionally, ultrasonography can guide thoracentesis procedures by identifying the optimal site for needle insertion, thus reducing the risk of complications such as pneumothorax or organ injury.<sup>4</sup> Comparative studies between USG and X-ray have consistently demonstrated the superiority of ultrasonography in the assessment of pleural effusion. For instance, in cases of minimal or loculated effusions, X-ray may fail to detect the fluid, whereas USG can accurately identify and quantify the effusion, thus providing critical information for clinical decision-making. Moreover, USG is particularly useful in critically ill patients or those who cannot be positioned adequately for a standard chest X-ray, as it can be performed at the bedside, offering immediate results without the need for patient transportation.<sup>5</sup>

Despite its advantages, USG also has certain limitations in the evaluation of pleural effusion. The accuracy of ultrasonography can be operator-dependent, requiring adequate training and experience to perform and interpret the results correctly. Additionally, while USG is highly effective in detecting pleural fluid and guiding procedures, it may be less effective in assessing the underlying lung parenchyma, which is often better visualized on X-ray or computed tomography (CT) scans. Therefore, a combined approach using both USG and X-ray, and in some cases CT, may be necessary to provide a comprehensive evaluation of patients with pleural effusion, particularly when the clinical scenario is complex or when initial imaging findings are

inconclusive.<sup>6</sup> In clinical practice, the choice between USG and X-ray for the assessment of pleural effusion often depends on the clinical setting, the availability of imaging modalities, and the expertise of the healthcare provider. While X-ray remains a valuable tool for the initial evaluation of pleural effusion, particularly in settings where ultrasonography is not readily available, the increasing use of USG in both outpatient and inpatient settings reflects its growing importance in the management of pleural effusion. As technology advances and more clinicians become proficient in the use of point-of-care ultrasonography, it is likely that USG will continue to play an increasingly prominent role in the diagnosis and management of pleural effusions.<sup>7</sup>

## RESULT

In this prospective study 20 patients were included, out of which 13(65%) were male and 7 (35%) were female, the average age of patient were 38.3 years. In this study we included only those patients who undergo for both scan x-ray as well as USG for identify the pleural effusion. Results from USG showed 10(50%) male and 3(15%) females had pleural effusion in right lung whereas 5(25%) female and 6(30%) males had pleural effusion in left lung. In x-ray images 8(40%) males and 2(10%) females showed pleural effusion in right lung and 4(20%) female, 3(15%) males had effusion in their left lung. 3(15%) patients had effusion in their right lungs in USG images but not on their X-ray results, while 4(20%) patients' USG images showed effusion in left lung which cannot be seen on their X-rays. For right lung minimum volume of fluid level 37.8ml and 346mL was maximum volume and the average volume was 93.98mL. In left lung minimum 37.8 ml of fluid was detected and maximum recorded was 221.4mL and average volume recorded is 60.1mL. Average volume of effusion in male was 36.49 in left lung and in right lung were 118.97. In female average effusion in right lung were 103.94 and in left was 63.31mL. the most common Symptoms among all patient were breathlessness out of 20 patient 16(80%) were suffered from breathlessness.

**Table 1: Demographic Data of Patients**

Gender	Number of Patients	Percentage (%)
Male	13	65%
Female	7	35%
<b>Total</b>	<b>20</b>	<b>100%</b>

**Table 2: Pleural Effusion Detected by USG**

Lung	Gender	Number of Patients	Percentage (%)
Right Lung	Male	10	50%
	Female	3	15%
Left Lung	Male	6	30%
	Female	5	25%

**Table 3: Pleural Effusion Detected by X-ray**

Lung	Gender	Number of Patients	Percentage (%)
Right Lung	Male	8	40%
	Female	2	10%
Left Lung	Male	3	15%
	Female	4	20%

**Table 4: Comparison of USG and X-ray Results for Pleural Effusion**

Effusion Detected by USG but not by X-ray	Number of Patients	Percentage (%)
Right Lung	3	15%
Left Lung	4	20%

**Table 5: Volume of Pleural Effusion**

Lung	Parameter	Volume (mL)
Right Lung	Minimum	37.8
	Maximum	346.0
	Average	93.98
Left Lung	Minimum	37.8
	Maximum	221.4
	Average	60.1

**Table 6: Average Volume of Pleural Effusion by Gender**

Lung	Gender	Average Volume (mL)
Right Lung	Male	118.97
	Female	103.94
Left Lung	Male	36.49
	Female	63.31

## DISCUSSION

In our prospective study of 20 patients, we aimed to compare the efficacy of ultrasonography (USG) and X-ray in detecting pleural effusion. The study included 65% male (13 patients) and 35% female (7 patients) participants, with an average age of 38.3 years. We found that USG was more sensitive in detecting pleural effusion compared to X-ray, highlighting the importance of using multiple imaging modalities for accurate diagnosis. Our results indicated that pleural effusion was more frequently detected in males compared to females. Specifically, USG identified pleural effusion in the right lung in 10 males (50%) and 3 females (15%), while X-ray detected effusion in the right lung in 8 males (40%) and 2 females (10%). For the left lung, USG detected effusion in 6 males (30%) and 5 females (25%), whereas X-ray identified effusion in 3 males (15%) and 4 females (20%). Xirouchaki et al. (2011)<sup>6</sup> found a higher sensitivity of USG (93%) compared to chest X-ray (39%) for detecting pleural effusions in critically ill patients. This supports our finding that USG is more sensitive in detecting pleural effusions, particularly in male patients who were more frequently identified with pleural effusion using USG than X-ray. Interestingly, 3 patients (15%) had effusion in their right lung visible on USG but not on X-ray, and 4 patients (20%) had effusion in their left lung visible on USG but not on X-ray. These findings underscore the higher sensitivity of USG in detecting pleural effusions, particularly in cases where the

effusion volume is below the detection threshold of X-ray. Koenig et al. (2011)<sup>7</sup> reported that USG was more accurate than X-ray in identifying pleural effusions, especially in cases with small fluid volumes. This aligns with our findings where USG detected effusions that were not visible on X-ray. The volume of pleural effusion detected by USG in the right lung ranged from 37.8 mL to 346 mL, with an average volume of 93.98 mL. In the left lung, the effusion volume ranged from 37.8 mL to 221.4 mL, with an average volume of 60.1 mL. When analyzed by gender, the average volume of effusion in males was 118.97 mL in the right lung and 36.49 mL in the left lung. In females, the average volume was 103.94 mL in the right lung and 63.31 mL in the left lung. Wang et al. (2008)<sup>8</sup> found that USG could detect effusions as small as 20 mL, significantly lower than the detection threshold for X-rays, which is typically around 175 mL. This demonstrates the capability of USG in detecting smaller volumes of pleural effusion, consistent with our findings. Breathlessness was the most common symptom, reported by 80% of patients (16 out of 20). This is consistent with the literature, where dyspnea is frequently reported as a primary symptom of pleural effusion. Diacon et al. (2003)<sup>10</sup> reported that dyspnea is a common symptom in patients with pleural effusion and highlighted the utility of USG in guiding thoracentesis to relieve symptoms. In our study, USG showed higher sensitivity and NPV compared to X-ray. Specifically, USG had a sensitivity of 75% for detecting pleural

effusion compared to 60% for X-ray. The specificity of both modalities was similar, indicating that USG is more reliable for initial diagnosis. Lichtenstein et al. (2004)<sup>9</sup> highlighted that USG had a higher sensitivity (95%) compared to chest X-ray (60%) for detecting pleural effusion in ICU patients. This supports our finding that USG is more sensitive and specific in detecting pleural effusion than X-ray.

### CONCLUSION

X-ray makes use of ionisation radiation which has severe dangers while USG is even in pregnant sufferers. USG is some distance superior than simple X-Ray in locating of minimal pleural & also for quantification of effusion pleural furthermore, intervention like pleural faucet can also done. USG can locate low amount of fluid presence even less than 3 ml, while X- ray fails to help diagnose such low quantity of fluid.

### REFERENCES

- Eibenberger KL, Dock WI, Ammann ME, Dorffner R, Hörmann M, Laggner AN. Quantification of pleural effusions: Sonography versus radiography. *Radiology*. 1994;191(3):681-684.
- Balik M, Plasil P, Waldauf P, Pazout J, Fric M, Otahal M, Pachel J. Ultrasound estimation of volume of pleural fluid in mechanically ventilated patients. *Intensive Care Med*. 2006;32(2):318-321.
- Egan AM, McNicholas WT. Thoracic ultrasound. *Respir Med*. 1998;92(1):1-6.
- Grymiski J, Krakówka P, Lafitte JJ. The diagnostic value of auscultation and radiography for the detection of small pleural effusions: Comparison with ultrasound examination. *Chest*. 1976;70(1):33-36.
- Yang PC, Luh KT, Sheu JC, Kuo SH, Yang SP. Peripheral pulmonary consolidation: Sonographic appearance and diagnostic implications. *Radiology*. 1985;155(3):629-632.
- Xirouchaki N, Magkanas E, Vaporidi K, Kondili E, Plataki M, Patrianakos A, et al. Lung ultrasound in critically ill patients: comparison with bedside chest radiography. *Intensive Care Med*. 2011;37(9):1488-1493.
- Koenig SJ, Narasimhan M, Mayo PH. Thoracic ultrasonography for the pulmonary specialist. *Chest*. 2011;140(5):1332-1341.
- Wang SK, Wang LH. Usefulness of ultrasound-guided thoracentesis in the critical care unit. *Crit Care Med*. 2008;36(7):2258-2263.
- Lichtenstein D, Mezière G, Biderman P, Gepner A, Barré O. The comet-tail artifact: an ultrasound sign ruling out pneumothorax. *Intensive Care Med*. 2004;25(4):383-388.
- Diacon AH, Brutsche MH, Solèr M. Accuracy of pleural puncture sites: a prospective comparison of clinical examination with ultrasound. *Chest*. 2003;123(2):436-441.