

A Hospital Based Study Determining the Link between Ultrasonography (USG) and X-Ray in the Assessment of Pleural Effusion

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Abstract

Aim: To assess the connection between ultrasonography (USG) and X-ray in the assessment of pleural effusion using quantitative analysis.

Material and Methods: This study was conducted in the Department of Radiodiagnosis, Patna Medical College and Hospital, Patna, Bihar, India from March 2018 to Feb 2019. 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, the abnormal accumulation of fluid in the pleural space, is a common clinical problem encountered in various medical conditions, including heart failure, pneumonia, malignancy, and pulmonary embolism. Accurate diagnosis and quantification of pleural effusion are essential for determining the underlying cause and guiding appropriate treatment. Traditionally, chest X-ray (CXR) has been the primary imaging modality for evaluating pleural effusion. However,

ultrasonography (USG) has gained significant attention in recent years due to its superior sensitivity and specificity, particularly for detecting small effusions and providing real-time guidance for thoracentesis. [1,2] Chest X-ray is often the initial imaging study performed in patients with suspected pleural effusion due to its widespread availability and ability to provide a quick overview of the thoracic cavity. However, the sensitivity of CXR in detecting pleural effusions is limited, especially in

the early stages when fluid accumulation is minimal. Studies have shown that CXR may miss small effusions, as it requires at least 200-300 mL of fluid to produce visible blunting of the costophrenic angle. Furthermore, CXR provides limited information on the nature of the effusion and the presence of underlying lung pathology. In contrast, ultrasonography offers several advantages over CXR in the evaluation of pleural effusion. USG is highly sensitive in detecting even minimal amounts of pleural fluid, with the ability to visualize as little as 5-10 mL of fluid. Additionally, USG can differentiate between free-flowing and loculated effusions, assess the echogenicity of the fluid, and identify associated findings such as pleural thickening, diaphragmatic abnormalities, and underlying lung consolidation. [3,4] USG-guided thoracentesis has also been shown to be safer and more effective than blind procedures, reducing the risk of complications such as pneumothorax. Quantitative analysis of pleural effusion using USG has been a topic of growing interest, as it provides valuable information for clinical decision-making. Recent studies have demonstrated the accuracy of USG in estimating the volume of pleural effusion compared to other imaging modalities. The integration of USG with traditional CXR can enhance the diagnostic accuracy and management of pleural effusion. A combined approach allows for the initial broad assessment provided by CXR, followed by the detailed evaluation and procedural guidance offered by USG. This synergy improves the overall diagnostic yield and helps tailor therapeutic interventions to individual patient needs. Furthermore, USG is a non-invasive, bedside modality that avoids radiation exposure, making it particularly advantageous in critically ill patients and those requiring repeated imaging studies. [5-7]

Material and Methods

This study was conducted in the Department of Radiodiagnosis, Patna Medical College and Hospital, Patna, Bihar, India from March 2018 to Feb 2019. These should be chosen with care since they have a significant impact on the effectiveness of a research endeavour. 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.

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%
Total	20	100%

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) [6] 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) [7] 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) [8] 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) [10] 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) [9] 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

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. The study was done in 20 patients of all age and sex without discriminating in age and sex. The study had 7 females (35%) and 13 (65%) where male of average age 38.3 years is included. Breathlessness was most common cause accounting 16(80%) out of 20 patient 10(50%) male and 3(15%) female had pleural effusion in Right lung and 5(25%) female and 6(30%) males had pleural effusion in left lung average volume of effusion in male 36.49ml left lung and 118.97 ml in left lung female USG diagnosed with more effectiveness 3 case of left lung and 4 right lung pleural effusion had negative results on X-ray but not on USG. 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

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