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## Research Article

### A COMPARATIVE STUDY OF SITE LOCALISATION AND DIAGNOSIS OF EFFUSION TYPE BY USING CHEST X-RAY AND ULTRASONOGRAPHY

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#### ABSTRACT

Pleural effusion is excess fluid that accumulates between the two pleural layers, the fluid-filled space that surrounds the lungs. Excessive amounts of such fluid can impair breathing by limiting the expansion of the lungs during ventilation. Pleural effusion is usually diagnosed on the basis of medical history and physical examination, and confirmed by chest x-ray and ultrasonography. This is an open label, comparative, analytical, Interventional and prospective study done on 100 patients suggestive of pleural effusion in department of respiratory medicine, Government Medical College and Hospital Kota, during a period Oct. 2013 to Sept. 2014. The aim of study to localize site for thoracocentesis and diagnosis of effusion type by chest x-ray and ultrasonography and also comparison of results. In our study, we observed that site localization for thoracocentesis and successful aspiration done in 45 (72%) out of 63 patients diagnosed by chest x-ray. The superiority of ultrasonography in diagnosing 33 extra pleural effusion cases and successful thoracocentesis was done in all 33 cases that is a 100 % success rate. We also diagnosed effusion in 63 patients including free fluid in 56 (with one sub pulmonary effusion) and loculated effusion in 7 patients by chest radiography. While Ultrasonography was superior in diagnosing 96 patients of pleural effusion and categorized in to septated effusion type in 26 (27%), Loculated effusion in 17 (18%), and Thick fluid empyema in 8 (9%) and free fluid in 45 (50%) including sub pulmonary effusion in 3 patients.

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## INTRODUCTION

Pleural effusion is excess fluid that accumulates between the two pleural layers, the fluid-filled space that surrounds the lungs. Excessive amounts of such fluid can impair breathing by limiting the expansion of the lungs during ventilation<sup>1</sup>.

Pleural effusion is usually diagnosed on the basis of medical history and physical examination, and confirmed by chest x-ray and ultrasonography. Once accumulated fluid is more than 300 ml, there are usually detectable clinical signs in the patient, such as decreased movement of the chest on the affected side, stony dullness to percussion over the fluid, diminished breath sounds on the affected side, decreased vocal resonance and fremitus (though this is an inconsistent and unreliable sign), and pleural friction rub. Above the effusion, where the lung is compressed, there may be bronchial breathing and egophony<sup>1</sup>. Once a pleural effusion is diagnosed, the cause must be determined. Pleural fluid is drawn out of the pleural space in a process called thoracocentesis. A needle is inserted through the

back of the chest wall in the sixth, seventh, or eighth intercostal space on the midaxillary line, into the pleural space<sup>2</sup>.

As thoracocentesis is blind procedure on basis of clinical examination and chest radiography. So this study was planned to assess the results of site localisation for thoracocentesis and diagnosis of effusion type by using chest radiography and ultrasonography.

## MATERIAL AND METHOD

This is an open label, comparative, analytical, Interventional and prospective study was carried out on patients with signs and symptoms suggestive of pleural effusion above 18 yrs of age of either sex admitted in Dept. of Respiratory medicine, Government Medical College and Hospital Kota, during a period of one year Oct. 2013 to Sept. 2014

### Method of data Collection

This study was done in 100 cases of pleural effusion. The diagnosis was established by a detailed history, clinical examination followed by chest X-ray & chest ultrasonography.

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According to the aims and objectives, patients were studied as follows:-

1. Patients with clinical suspicion of pleural effusion were subjected to chest radiology and ultrasonic examinations. The diagnosis of pleural effusion was confirmed by needle aspiration and the results of radiology and ultrasonic examinations were compared for site localization and type of effusion.
2. Repeat x-ray done in all cases within 24 hours of the procedure to see fluid status and air in space if any.

#### Inclusion criteria

1. Patient with age more than 18 years with clinical features of pleural effusion.
2. Patients who had given valid consent.

#### Exclusion Criteria

1. Patients who had not given valid consent.
2. Hemodynamically unstable patients.

**Ethical consideration:** The study was approved by ethics committee of the Government Medical College, kota. The approval number is F3 () /Acad/Ethical comm./MCK/2014/1087.

**Radiological Examination<sup>3</sup>:** Postero-anterior, Lateral and Lateral decubitus films with the use of horizontal beam were taken whenever required in patients to diagnose pleural effusion. Chest x-rays are the most commonly used examination to assess for the presence of a pleural effusion, however, it should be noted that on a routine erect chest x-ray as much as 250 to 500ml of fluid is required before it becomes evident. A lateral decubitus film is most sensitive, able to identify even a small amount of fluid. At the other extreme, supine films can mask large quantities of fluid.

**Principle of Ultrasonography<sup>4</sup>:** Very high frequency sound (>30,000Hz) is directed into the body from a transducer placed in contact with the skin. Transducer contains piezoelectric crystals. To make good acoustic contact, the skin is smeared with a jelly.

**Ultrasonography Diagnosis of Effusion And It's Type<sup>6</sup>:-** Ultrasound allows the detection of small amounts of pleural locular fluid, with positive identification of amounts as small as 3 to 5 ml, that cannot be identified by x-rays, which is only capable of detecting volumes above 50 ml of liquid<sup>5</sup>. The ultrasound image of pleural effusion is characterized by an echo-free space between the visceral and parietal pleura. Septations (if seen) in the pleural fluid may indicate tuberculous pathology and any thickened fluid. Ultrasound also be used for therapeutic drainage (thoracocentesis)<sup>6</sup>.

#### Needle Puncture

In each patient a needle puncture was performed. The localization of fluid and site for needle puncture was determined by ultrasonic method in cases where thoracocentesis was unsuccessful with chest x-ray. During the puncture, try to withdraw all the fluids from pleural cavity was done. The amount of fluid removed was carefully measured

and send for biochemistry, pathological and microbiological analysis to find out etiology of effusion.

Thoracocentesis should be done in almost all patients who have pleural fluid that is  $\geq 10$  mm in thickness on CT, ultrasonography, or lateral decubitus x-ray and that is new or of uncertain etiology. In all study cases chest x-ray need not be repeated after thoracocentesis or if patients develop symptoms suggesting pneumothorax (dyspnea or chest pain) or any suspects that the air may have entered the pleural space during the procedure. Ultrasonography is helpful for diagnosing and identifying the site for thoracocentesis when the amount of pleural fluid is small, the fluid is loculated, or blind thoracocentesis is unsuccessful

#### Thoracocentesis<sup>2</sup>:-

Pleural fluid is drawn out of the pleural space in a process called thoracocentesis. A needle is inserted through the back of the chest wall in the sixth, seventh, or eighth intercostal space on the midaxillary line, into the pleural space.

#### Site of Aspiration :-<sup>2</sup>

- 6<sup>th</sup> intercostal space in the mid axillary line
- 7<sup>th</sup> intercostal space in the posterior axillary line
- 8<sup>th</sup> intercostal space in the scapular line
- For loculated effusion, aspiration is done at the site of maximal area of dullness.

#### Complications:-

**Pain** during and after thoracocentesis is most common . Others are :-

1. Pleural shock
2. Re-expansion pulmonary edema
3. Pneumothorax, hydropneumothorax, Hemothorax, Pyothorax
4. Injury to intercostal vessels and nerves, Air embolism
5. Bleeding (may be cutaneous or internal)
6. Inadvertent liver/spleen puncture

## RESULTS

**Table 1** Diagnosis of pleural effusion by Chest X-ray v/s Ultrasonography

S.N	Etiology of effusion	Pleural effusion diagnosed by		Extra cases diagnosed by USG (%of total)
		Chest X-Ray (%)	USG Chest (%)	
1	Tuberculosis	43 (68.26)	70 (72.93)	27 (28.13)
2	Malignancy	5 (7.94)	5 (5.21)	0
3	Synpneumonic	7 (11.12)	9 (9.38)	2 (2.09)
4	CHF	2 (3.18)	4 (4.17)	2 (2.09)
5	Empyema	6 (9.53)	8 (8.34)	2 (2.09)
6	No fluid detected	37	4	0
Total effusion cases		63 (65.63)	96(100%)	33(34.38)
Sensitivity of investigation		66%	100 %	

Shows pleural effusion is diagnosed in 63 patients by using the chest x-ray by PA view, Lateral decubitus view and clinical examination, but 37 patients remain undetected out of 100 study cases .While USG could diagnose effusion in 96 study cases, including 33 extra cases of effusion and 4 cases of thickened pleura which were not diagnosed by chest x-ray.

Shows site localization for thoracentesis was successful in 45 patients out of 63 patients, diagnosed by chest x-ray and most of patients had tubercular etiology.

The superiority of ultrasonography in diagnosing 33 extra pleural effusion cases than chest x-ray diagnosed cases. It is 100% Successful in site localization and thoracentesis was done in all remaining 51 study cases. These cases includes 18 failed cases of site localization for thoracentesis by chest x-ray.

**Table 2** Site localization for thoracentesis by CHEST X-RAY V/S Ultrasonography in study cases

S.N	Effusion Etiology	Chest X-ray & Clinically pleural effusion Cases		Ultrasonography pleural effusion Cases		% Increased Benefit by USG for site localization
		Diagnosed	Successful localization	Diagnosed	Successful localization (diag. and failed cases)	
1	TB effusion	43	32 (50.8%)	27	38	11 (33.34%)
2	Synpneumonic	7	4 (6.35%)	2	5	3 (9%)
3	Malignant	5	4 (6.35%)	-	1	1 (3%)
4	CHF	2	2 (3.18%)	2	2	0
5	Empyema	6	3 (4.76%)	2	5	3 (9%)
	Total	63 (100%)	45 (71.43%)	33 (100%)	51	18 (54.55%)

**Table 3** Evaluation of Pleural effusion types by X-Ray v/s USG

S.N	Pleural Effusion types	Chest radiography	Ultrasonography	USG benefit in Differentiation of effusion type (% higher than CXR)
1.(a)	Free effusion	56 (with 1subpulm.)	45 (with 3subpulmo.)	2 subpulmonary (66.67%)
(b)	Sub pulmonary effusion	[89%]	[47%]	
2.	Loculated fluid	7 (11%)	17 (18%)	10 (58.83%)
3.	Septate effusion	0	26 (27%)	26(100%)
4.	Thick fluid	0	8 (8%)	8(100%)
5.	No fluid	37	4	4 Thickened pleura
	Total effusion	63 (100%)	96 (100%)	

Thus USG shows 55% increased benefit in site localization for thoracentesis.

Table Shows chest radiography diagnosed effusion in 63 patients with free fluid in 56 (including one sub pulmonary effusion) and loculated effusion in 7 patients while 37 cases remain undetected.

Ultrasonography is 100% successful in diagnosing and differentiating various types of pleural effusion. It is superior in diagnosing septated effusion in 26 (100%), Loculated effusion in 17 (diagnosis increased by 59%), thick fluid empyema in 8 (100%), these results were better than chest x-ray.

Sub pulmonary effusion in 3 patients (diagnosis increased by 67%) by USG while chest x-ray diagnosed 1patient of sub pulmonary effusion.

**Table 4** Complication by Thoracentesis With Chest X-Ray V/S Ultrasonography

S.N	Investigation method used	Therapeutic Thoracentesis done in cases	Hydro pneumothorax Occurred in	ICTD required
1.	Chest x-ray	34	3	1
2.	Ultrasonography	62	2	0

The table shows, that 3 out of 34 patients develop hydro pneumothorax during thoracentesis procedure done by using chest x-ray, and one of these patients required intercostal tube drainage for management. While by USG for thoracentesis procedure 2 patients developed hydro pneumothorax out of 62 patients used. None of them required intercostal tube drainage for management.

## DISCUSSION

In our study, pleural effusion was diagnosed by chest x-ray in 63 cases and by ultrasonography 96 cases, out of 100 study cases. Thus ultrasonography is superior in diagnosis of pleural effusion by detecting 33 extra cases. On analysis of data obtained, we concluded that chest radiography had a sensitivity of 66%, specificity 81%, while USG had a sensitivity of 96%, specificity 100% and diagnostic accuracy of 100%.

Similar results were observed by, [Kamila Sikora et al \(Aug 2012\)](#)<sup>7</sup> as they found sensitivity of 65%, a specificity of 81%, and diagnostic accuracy of 69% with chest radiography, while sensitivity of 100%, a specificity of 100%, and a diagnostic accuracy of 100% with ultrasound. Also by [D T Ashton Cleary \(July 2013\)](#)<sup>8</sup>; demonstrated high sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), for USG than Chest X-ray.

We observed using chest x-ray in site localization for thoracentesis, successful aspiration done in 45 out of 63 patients, that is 72% success rate. The superiority of ultrasonography in diagnosing 33 extra pleural effusion cases and successful thoracentesis was done in all 33 cases that is a 100 % success rate. The remaining 18 patients with failed thoracentesis site by chest x-ray were also done by using chest ultrasonography. Our study also showed that, 55% increased benefit by USG in site localization for thoracentesis in pleural effusion cases than the chest radiological method.

Similarly [Doust et al. in \(1975\)](#)<sup>9</sup> observed that USG successfully localized site for thoracentesis in 93% pleural effusion cases. It is better than chest radiography. [Joyner et al. \(1967\)](#)<sup>10</sup> also used ultrasonography on 46 patients, in their study and result in 100% successful in pleural fluid aspiration under USG guidance.

In our study chest radiography diagnosed effusion in 63 patients, including free fluid in 56 (with one sub pulmonary effusion) and loculated effusion in 7 patients. While Ultrasonography was superior in diagnosing 96 patients of

pleural effusion. These patients categorized into septated effusion in 26 (27%), Loculated effusion in 17 (18%), and Thick fluid empyema in 8 (9%) and free fluid in 45 (50%) including sub pulmonary in 3.

Similar results obtained by Yang PC et al (1992)<sup>11</sup>; on analysis of 320 cases of pleural effusion they observed, 172 (54%) cases were anechoic free fluid type, 50 (16%) cases were complex nonseptated, 76 (24%) were complex septated and 22 (7%) were homogeneously echogenic may be transudate or exudates effusion.

Ultrasonography is a useful modality in the evaluation of pleural diseases. It is also useful to demonstrate fibrin bands of varying length, septations and encysted pleural effusion shows its superiority, demonstrated by Mathis G et al (1997)<sup>12</sup>, Diacon AH et al (2005)<sup>13</sup> & Koh DM et al (2002).<sup>14</sup>

In our study complication were less frequent with thoracocentesis procedure done using USG, 2 out of 62 patients ie 3.2% developed pneumothorax but did not require chest tube for management. While thoracocentesis procedure done using chest x-ray, had made Pneumothorax in 3 out of 34 patients, ie.9% and one (3%) patient required a chest tube for management. Similar study by John PW, et al (2003)<sup>15</sup> on 941 patients thoracocentesis performed, and 24 (2.5%) developed a pneumothorax and 8 (0.8%) required a chest tube under USG guidance.

## CONCLUSION

On radiological examination 65% cases show evidence of pleural effusion while USG could diagnose 100% cases of effusion.

USG is also superior in further evaluation of pleural effusion:-

1. It diagnosed 3 (100%) subpulmonary effusion cases, while chest x-ray diagnosed only 1 (33%) case of subpulmonary effusion.
2. All 17 (100%) loculated effusion cases were diagnosed by USG, while chest x-ray could detect 7 (41%) cases only.
3. USG detected all 26 (100%) septated Effusion, while chest radiography did not detect any septations.
4. It also helped in diagnosing any other pleural and parenchymal lung pathology eg. Pleural thickening, empyema and effusion.
5. All 4 cases of thickened pleura were diagnosed by USG shows 100% sensitivity & superior to chest X-ray.

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