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Original Article

A Clinical Study on the Role of Color Doppler in Differentiating Pleural Thickening and Minimal Pleural Effusion in Adults

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Abstract

Background: The wide application of color Doppler ultrasound (CDUS) in the diagnosis of thoracic lesions helps in detecting minimal pleural effusions. The discrimination of pleural thickening from minimal pleural effusion may be difficult as both lesions appear as anechoic on grayscale ultrasound. The CDUS fluid color sign helps in detecting minimal fluid in the pleural space.

Aim of the Study: The aim of the study was to evaluate the role of CDUS in differentiating minimal pleural effusion that could be aspirated from pleural thickening and to compare it with grayscale ultrasound.

Materials and Methods: A prospective analytical study conducted on 54 patients presenting with blunting of costophrenic angles on plain X-rays of the chest compatible with minimal pleural effusion. Initial grayscale ultrasound was done in all patients followed by CDUS examination. The fluid color sign was observed and later confirmed by thoracocentesis.

Observations and Results: The sensitivity of real-time grayscale ultrasound in detecting minimal pleural effusion and differentiating it from pleural thickening was 89.47% while, specificity was 41.10%, and accuracy was 69%. The specificity of CDUS in discriminating minimal pleural effusion from pleural thickening was nearing 98.75% while the sensitivity was 89.32% and accuracy was 96%.

Conclusions: Usage of CDUS increases the accuracy of real-time chest ultrasound to discriminate pleural thickening from minimal pleural effusion and hence color Doppler examination proved to be a useful diagnostic tool especially in minimal pleural effusion.

Key words: Color Doppler ultrasound, Effusion, Grayscale ultrasound, Pleura, Pleural thickening

INTRODUCTION

Pleural effusion is defined as the accumulation of fluid in the pleural space due to not only pulmonary disease but also many other pleural and extrapulmonary diseases.[1,2] The ultrasound image of effusion is characterized by an echo-free space between visceral and parietal pleurae which may change in shape with respiration. With grayscale ultrasound examination of the chest, the sensitivity of identifying minimal fluid in the pleural space is high. However, differentiating it from pleural thickening is difficult as both the lesions may appear anechoic in grayscale ultrasound. Free echoes do not guarantee the presence of fluid.[3,4] Whereas in color Doppler ultrasound (CDUS) as any movement of body fluid will be transferred as colored images; and hence, CDUS is being used widely in differentiating the pleural thickening and effusion. The fluid movement may occur during respiration or cardiac pulsations giving it a fluid color sign.[5] In pleural thickening, such clolored signals are not elicited as it has no movable fluid in the pleural space.[6] The present study was conducted to evaluate the role of CDUS in the diagnosis and differentiation of minimal pleural effusion and pleural thickening and later on confirmed with thoracic aspiration.

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Institution of Study

The study was conducted at Kannur Medical College, Anjarakandy, Kannur.

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Period of Study

The study period was from June 2013 to May/April 2016.

MATERIALS AND METHODS

The present study was a prospective analytical study conducted over a cross-section of patients attending the Department of Medicine of a tertiary teaching Hospital in Northern Kerala. 54 patients with an X-ray chest finding of blunting of costphrenic angle (blunting of costophrenic [CP] angle) were included in the study. An Ethical Committee clearance was obtained, and an Ethical Committee cleared consent letter was used to collect the data.

Inclusion Criteria

1. Patients aged between 20 and 60 years were included in the study.
2. Patients with X-ray chests showing blunting of CP angle were included.
3. Patients with both pulmonary and non-pulmonary diseases with effusion were included.
4. Patients with benign or malignant diseases of the lung were included.

Exclusion Criteria

1. Patients below 20 and above 60 years were not included.

All the patients included in the study were elicited of thorough clinical history and clinical examination. X-ray chests posteroanterior view and lateral views were taken. Patients with X-rays showing blunting of CP angle in either anterior-posterior or lateral view were included. Grayscale ultrasound of the chest was performed in all the patients to detect the presence of pleural effusion. The acoustic window used was intercostals space with the patient either in sitting or supine position with the arm away from the chest. Presence of an anechoic space between the visceral pleura and the parietal pleura was taken as positive to pleural effusion. The presence of any of the signs such as split pleural signs, the internal echogenicity of the effusion, the change of shape during respiration, the presence of the mobile septa, and thickening of the pleura, and the presence of organized fluid in the pleural space was taken as pleural effusion. CDUS was done in all the patients and presence of colored signals was noted. As pleural thickening has no movable part, the colored signals will not be detected in cases of pleural thickening. After confirmation of pleural effusion by both grayscale and CDUS finally, thoracocentesis was done to aspirate pleural fluid. All the data were collected and analyzed using standard statistical methods.

OBSERVATIONS AND RESULTS

Among the 54 patients included in the present study, the age groups were 20–60 years with a mean age of 36.38 ± 4.62 years. There were 31 male and 23 female patients with a male to female ratio of 1.34:1 [Table 1].

Among the 54 patients, all had blunting of CP angles findings in their X-ray chests (100%). Grayscale ultrasound showed anechoic areas, and other signs in 38/54 patients (70.37%) and 16 patients showed signs of pleural thickening (29.62%). Among the 38 reports of positive for anechoic areas positive pleural tap was found in 34 (89.47%) of the patients, the remaining 4 (10.52%) were negative for pleural fluid [Table 2]. Pleural thickening was reported in 16/54 patients (29.62%); pleural tap was positive in 2/16 patients (12.5%), and the remaining 14 patients it was negative (87.5%), [Table 2]. The sensitivity of grayscale ultrasound in the diagnosis of pleural effusion was 89.47%, and the specificity was 70.37%.

Similarly following CDUS 29/54 showed colored signal indicating pleural effusion but 27/29 only had positive pleural tap for fluid (93.10%). The pleural tap was negative in 2/29 patients (06.89%). In 25/54 patients the report was given as pleural thickening; among these patients, the tap was negative in 22/25 (88%) and positive in 03/25 (12%) patients [Table 3]. The sensitivity of CDUS in the diagnosis of pleural effusion was 93.10%, and the specificity was 53.70%. Similarly, the sensitivity of CDUS in diagnosing pleural thickening was 88%, and the specificity was 46.29%.

DISCUSSION

Pleural effusion is a common clinical entity treated by physicians all over the world. The effusion results either

Table 1: The age and gender incidence in the study (*n*=54)

Observation (years)	Male-31	Female-23
20–30	08	04
30–40	07	07
40–50	09	05
50–60	07	07

Table 2: The findings of grayscale ultrasound with positive and negative pleural tap (*n*=54)

Observation	Grayscale ultrasound (%)
CP angle blunting	-
Anechoic areas	38/54–70.37
Pleural tap positive	34/38–89.47
Pleural tap negative	04/38–10.52
Pleural thickening	16/54–29.62
Pleural tap positive	02–12.5
Pleural tap negative	14–87.5

CP: Costophrenic

Table 3: The findings of CDUS with positive and negative pleural tap (*n*=54)

Observation	CDUS (%)
CP angle blunting	-
Colored signal	29/54–53.70
Pleural tap positive	27/29–93.10
Pleural tap negative	02/29–06.89
Pleural thickening	25/54–46.29
Pleural tap positive	03/25–12
Pleural tap negative	22/25–88

CDUS: Color Doppler ultrasound, CP: Costophrenic

due to disease in the lung parenchyma, disease proper in the pleural layers and non-pulmonary causes such as malignant diseases of the ovaries, liver, and distant metastases. Imaging studies are the cornerstones in their appropriate diagnosis and treatment. X-ray chest is the initial diagnostic method which is cost-effective but not sensitive in detecting the pleural effusions. At least 150 ml must have accumulated in the pleural space for the radiological evidence to appear on an upright X-ray.[7] Sometimes pleural lesions as pleural thickening and fibrosis may mimic minimal pleural effusion in plain radiograph.[8] Grayscale ultrasonography of the chest has been documented in the world literature as an important primary diagnostic tool for pleural effusion to confirm the presence of effusion in a patient with abnormal chest radiographs. Grayscale ultrasound will detect as little as 5–50 ml of pleural fluid and with 100% sensitivity in effusions ≥100 ml.[9] Another added advantage being the machine a portable one, low cost without radiation exposure with an ability to perform both dynamic and real-time procedures.[10] In the present study, the grayscale ultrasound showed sensitivity in the diagnosis of pleural effusion of 89.47% and the specificity being 70.37%. In pleural effusion patients, the grayscale US gives anechoic areas within the pleural space which change its shape on respiratory movements. The effusion may also present with movable septae confirming the presence of fluid. When the fluid collection is small and associated with septae, these features are absent and aspiration may be difficult.[11,12] Benign lesions of the visceral or parietal pleura and pleural thickening on grayscale appear as focal echogenic lesions mimicking fluid collection hence it is mandatory that these lesions are identified before pleural tap is attempted.[13] CDUS is useful in such situations where there is difficulty in identifying fluid with the help of grayscale ultrasound.[14] In the present study, CDUS was used in 54 patients to differentiate between pleural thickening and effusion and was observed that the sensitivity of CDUS in the diagnosis of pleural effusion was 93.10% and the specificity was 53.70%. Similarly, the sensitivity of CDUS in diagnosing pleural thickening was 88%, and the specificity was 46.29%. Tsai and Yang *et al*.[15] from their study confirmed that the presence of an echo-free space between the visceral and parietal pleura that changes shape with respiration or contains movable strands or echo densities on grayscale US, or displays a fluid color sign on color Doppler US, indicates the presence of fluid accumulation.

CONCLUSION

Usage of CDUS increases the accuracy of real-time chest ultrasound to discriminate pleural thickening from minimal pleural effusion, and hence, color Doppler examination proved to be a useful diagnostic tool especially in minimal pleural effusion.

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