



## Ultrasonography Application for Detection and Management of Pneumothorax following Pleural Catheter Insertion; A Case Report

Golnar Sabetian<sup>1</sup>, Fatemeh Aalinezhad<sup>2</sup>, Mansoor Masjedi<sup>3\*</sup>, Shahram Paydar<sup>1</sup>

<sup>1</sup>Trauma Research Center, Rajaee (Emtiaz) Trauma Hospital, Shiraz University of Medical Sciences, Shiraz, Iran

<sup>2</sup>Critical Care Unit, Shiraz University of medical Sciences, Shiraz, Iran

<sup>3</sup>Anesthesiology and Critical Care Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

\*Corresponding author: Mansoor Masjedi

Address: Anesthesiology and Critical Care Research Center, Shiraz University of Medical Sciences, Shiraz, Iran.

e-mail: mansoormasjedi@yahoo.com

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### ABSTRACT

Pneumothorax as a complication of pleural catheter insertion could be very dangerous in patients under mechanical ventilation. In ICU patients, physical examination and supine chest x-ray (CXR) are poorly sensitive in diagnosis of pneumothorax. Moreover, CT scan has also disadvantages, such as radiation, high cost, time consuming and need for patient transfer to radiology suit. In comparison to CXR and CT scan, ultrasonography is an available tool for early and rapid detection of this complication. In this study, we reported a 21-year-old woman, a victim of trauma, undergone pleural catheter insertion for drainage of hemothorax. She developed pneumothorax after the procedure. We discuss the usefulness of ultrasonography after pleural catheter insertion and concluded its adequacy and effectiveness in early diagnosis and also follow-up of pneumothorax.

**Keywords:** Pneumothorax; Pleural catheter; Ultrasonography; Intensive care unit.

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### Introduction

Pleural catheters are increasingly used in the intensive care units. Iatrogenic pneumothorax can occur following pleural catheter insertion. Tension pneumothorax is a potential dangerous consequence in patients under positive pressure ventilation and can lead to hemodynamic disturbance [1]. Thoracic ultrasonography is an appealing method for early diagnosis of pneumothorax after invasive thoracic procedures, especially in critical care setting. The BLUE-protocol is a method based on chest

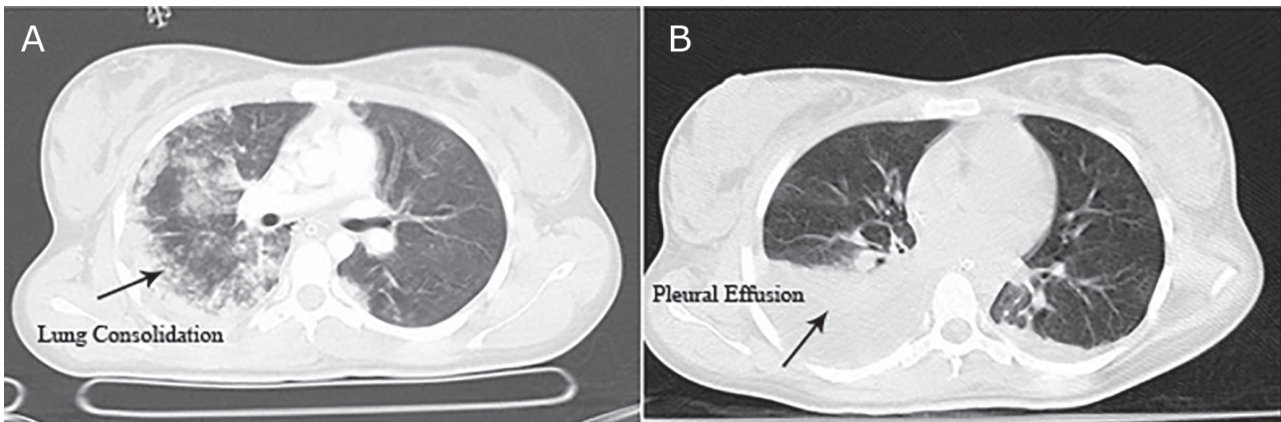
sonography, defined as a loop associating urgent diagnoses with immediate therapeutic decisions. According to this protocol chest sonography is done in standardized areas of the chest. As a fast protocol performing in less than three minutes it enables rapid diagnosis of acute respiratory failure. It also plays a special role in diagnosis of pulmonary edema, pulmonary embolism, pneumonia, COPD, asthma and pneumothorax. Ultrasound is a reliable, efficient and informative imaging modality for the evaluation of lung and pleura, especially in critically ill patient [2, 3]. Post pleural catheter insertion, routine

follow up chest radiography is not required [1]. We discussed necessity and efficacy of ultrasonography after pleural catheter insertion and its role in follow up till pneumothorax disappearance.

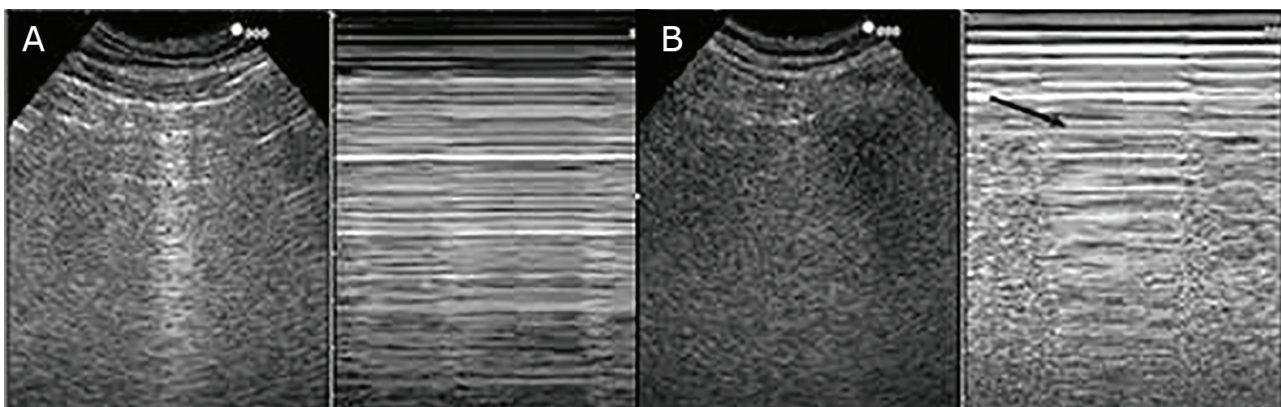
### Case Report

A 21-year-old woman admitted to ICU following car accident with diagnosis of intraventricular hemorrhage, brain contusion and lung contusion. On ICU arrival, GCS was 7/10 (Motor: 5; Verbal: 1; Eye opening: 2) with endotracheal tube in place and mechanically ventilated. Because of decreased breath sounds in the base of right lung, a follow-up chest CT scan on the fourth day of ICU admission was done, showed moderate right side pleural effusion besides underlying lung contusion (Figure 1). Considering patient's clinical condition, decision was made to insert a pleural catheter. Appropriate site for catheter insertion was determined by ultrasound (Sonosite, edge II) and then needle was guided to be inserted into the pleural cavity. In this case, we used pigtail catheter (catheter, 10F). The first attempt to advance the catheter over the guide wire was unsuccessful. On the second attempt, catheter was inserted. In peri-procedure period the patient had normal hemodynamic variables and respiratory pattern. Oxygen saturation did not change. Post

procedure, to rule out any associated complication, thoracic ultrasonography was done with linear probe 5-10MHz. In the 2D ultrasound view, in zones 1, 2, 3 and 4 of the blue points, "lung sliding" was absent (as the lung inflates or deflates, the visceral pleura moves against the parietal pleura. The ultrasound images show this to and fro pleural movement, called lung sliding). Also in M-mode, in zones 1, 2, 3 and 4 of the BLUE points, "barcode sign" was observed (this would give the appearance of multiple horizontal lines similar to a barcode) and in zone 2 of the blue points, "lung point" was seen (that is a point at which the lung and air can easily be visualized in the same M-mode image) (Figure 2). According to ultrasonographic findings and lack of the Heimlich valve, the pleural catheter was attached to the bottle. Chest radiography and CT-scan was done and ultrasonographic diagnosis was confirmed (Figure 3). The patient was followed up by daily thoracic ultrasonography. On 1<sup>st</sup> and 2<sup>nd</sup> day Sonographic findings included "barcode sign" in zones 2 and 4 of the BLUE points. Ultrasound findings on the third day included "barcode sign" in zone 2. On the fourth day, there was no ultrasonographic evidence of pneumothorax. This issue was confirmed with chest CT scan (Figure 4). Ultimately, the pleural catheter was removed and the patient was discharged from ICU and hospital with good general condition.

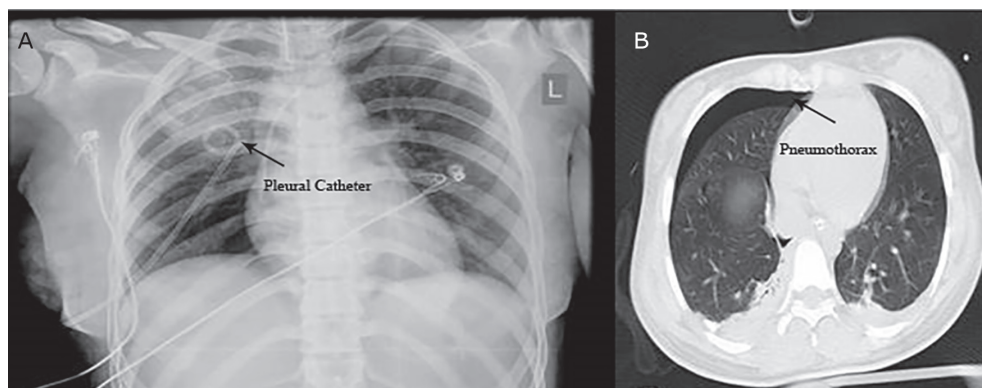


**Fig. 1.** The axial chest Ct-scan of the patient on the first day of admission demonstrating the right sided chest consolidation and contusion along with hemothorax (A); the axial chest CT-scan of the patient on day 4 of admission demonstrating severe right sided hemothorax (B).

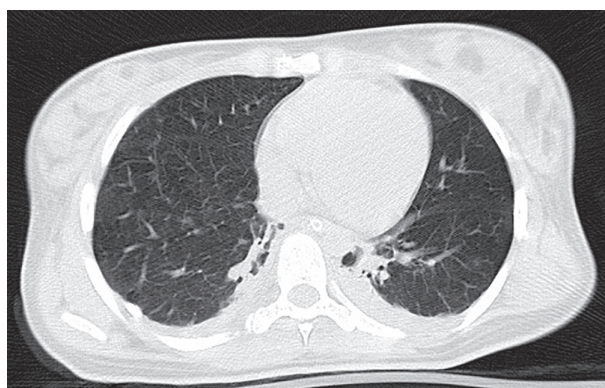


**Fig. 2 .** The ultrasonography of the chest after the pneumothorax demonstrating the barcode sign (A) and lung point (B) the classic findings of the pneumothorax on ultrasonography (the arrow).





**Fig. 3.** The Supine chest radiography of the patient demonstrating the pleural catheter (arrow) in the left upper lung along with pneumothorax (A); axial chest CT-scan demonstrating the pneumothorax (arrow) after catheter insertion (B).



**Fig. 4.** Improvement of pneumothorax after connecting the catheter to the bottle demonstrated on the axial chest CT-scan.

## Discussion

This study showed a remarkable experience for rapid ultrasonographic assisted diagnosis and follow up Pneumothorax. Early detection and treatment of tension pneumothorax is critical. Delay in the diagnosis and management, especially in those who are mechanically ventilated, may lead to the progression of a tension pneumothorax and resultant hemodynamic instability [3]. Ultrasonography (US) is a reliable, efficient and informative imaging modality for evaluation of lung and pleura. Major advantages of Ultrasound include omission of radiation exposure to the staff and patient, reduction in cost, beside availability and short time of examination, compared with CT scan. The sensitivity of US in certain studies has been similar to that found in CT scan, which is still considered to be the gold standard for the detection of a pneumothorax [3, 4]. In one study has shown that US has a sensitivity of 95.3% and a specificity of 91.1% for detecting pneumothorax in ICU patients [5, 6].

Invasive procedures such as pleural catheter insertion for drainage of effusion can be performed under ultrasound guidance to improve accuracy and safety [7]. Ultrasound provide real time information

for physician and it can be done at patient's bedside. These advantages make chest ultrasound a useful diagnostic tool for management of critically ill patients, especially when their transport is associated with a high risk [8].

Although, as a routine in our center, we take a CXR, after invasive chest procedures for detection of any complication, but recent experience, indicates that ultrasound can be a suitable substitute diagnostic tool for ICU physicians. It should be considered to complete the general objective examination, especially in emergency situations, at the bedside. Also it can be useful to keep track of the patient's clinical course [9]. Our case report revealed how chest ultrasound can detect and monitor pneumothorax as a complication of pleural catheter insertion [10, 11].

The rapid and safe diagnosis of pneumothorax, especially in patients with positive-pressure ventilation, is important because rapid diagnosis and timely detection can prevent tension pneumothorax. Our experience denotes that bedside thoracic ultrasonography can play an important role in early detection of pneumothorax especially in critically ill patients. Ultrasonography should also be considered as a useful tool in tracking the volume of pneumothorax and the clinical course of patients, especially in critical care setting.

In conclusion, chest sonography is a reliable, efficient and informative tool for the evaluation of complications associated with post invasive thoracic procedures in patients admitted to intensive care units and should be emphasized in this regard.

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**Conflicts of Interest:** None declared.

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