

## **Pneumothorax Supporting Literature:**

*Emergent Question(s):* Is a lung point present? Do I have absence of lung sliding? Do I have absence of B lines? Do I have absence of a lung pulse?

*Probe Type:* Vascular (linear array) probe; 5-10 MhZ preferred for evaluation of pleural interface, but can use curvilinear (2-5 MhZ) probe in resuscitation/trauma type situations where other lung abnormalities are being evaluated. The high frequency linear array probe can be better when analyzing lung sliding or teaching a novice.

*Clinical Scenario:* The patient who can not be easily transported to radiological suite, or arrest patient who has ongoing resuscitation efforts so that portable imaging can not be performed. Also, acute trauma situations where patient is decompensating and concern for pneumothorax as a potential cause.

*Scanning Technique:* The patient usually is in the supine position, so most of the studies performed have evaluated for pneumothorax in the supine position. The sonographer's hand must remain stabilized to prevent artifact, which may make it more difficult to evaluate the sonographic signs of pneumothorax. The probe marker is placed towards the patient's head. The probe is first placed on the sternum in which the operator will see an ultrasound image with large shadowing artifact from the sternum. First move laterally towards the right chest and identify the pleural line between two rib interfaces [Figure 1]. Evaluation consists of identifying 'lung sliding' which is the side to side movement of the pleural line with breathing. Lung sliding is the regular rhythmic movements synchronized with respiration that occur between the parietal and visceral pleura that are in direct contact (without air between them). Once air is between the two layers, the movement seen is absent. If you see lung sliding, there is no pneumothorax in that part of the chest wall examined. The exam can continue laterally towards the mid axillary line. The same is repeated on the left side (may need to go more towards the head due to the cardiac chambers obscuring the lung views]. The evaluation for pneumothorax entails the search for a lung point, which is the point where the visceral pleura and parietal pleura are against each other without air interposition and slides with respiration and corresponds to the lateral edge of the pneumothorax [1]. This can be seen between two ribs as part of the interface with sliding present (representing the parietal and visceral pleural without air between them) and the other part without sliding present (representing air between the parietal and visceral pleura). The more lateral on the chest wall this lung point manifests, the larger the pneumothorax in supine patients. This may be useful since size of the lung collapse usually determines treatment and establishes the prognosis for the pneumothorax [2, 3].

Other sonographic signs of pneumothorax besides absence of lung sliding described above include absence of B lines and absence of lung pulse. B lines are artifacts found that originate from the visceral pleura (B lines discussed further in interstitial syndrome section), and their presence proves that the visceral pleura is opposing the parietal, and therefore excludes pneumothorax at that point in the chest wall [Figure 2]. B lines can be present in other processes

such as pneumonia, pulmonary contusion, pulmonary fibrosis, or aspiration. Last, if a lung pulse is found, there is no pneumothorax. The lung pulse refers to the rhythmic movements of the visceral upon the parietal due to the cardiac oscillations [9]. One must be careful not to use only lung sliding as a determinant of pneumothorax, as this sign is also found in apneic patients, ‘mainstem intubations’ where one lung is ventilated, acute lung injury (ALI), lung fibrosis, pneumonia, blebs, and various other lung disease processes. In the emergent setting, the absence of any movement of the pleural line, either horizontal (lung sliding) or vertical (lung pulse), coupled with absence of B lines allows for diagnosis of pneumothorax without searching for the lung point [10].

Supporting Literature: Supine chest radiography is not sensitive for diagnosis of pneumothorax [4, 5]. Lung ultrasound is more accurate than chest radiography in ruling out pneumothorax and can benefit evaluation in cardiac arrest or unstable patients [6-8]. According to the international recommendations, lung ultrasound more accurately rules out the diagnosis of pneumothorax than supine anterior chest radiography. Although mentioned that the lung point can be used to determine size of pneumothorax, the international point of care recommendations also state that due to controversy over the pathophysiology of expansion of pneumothorax, and lack of evidence in human studies, ultrasound is not a reliable method to assess the volume of pneumothorax as compared to computed tomography and concluded the need for additional evidence [11]. Also the treatment may depend on many other clinical factors that are out of the scope of this text.

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Figure 1a - rib shadows with pleural line (linear array probe); Figure 1b - rib shadows with pleural line and A lines (phased array probe)

Figure 2 - B lines