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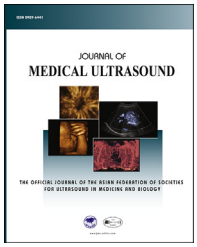

Brief Communication

The Curtain Sign in Lung Ultrasound

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Abstract The curtain sign (CS) is a sonographic artifact found in lung ultrasound studies. It is generally used to describe the appearance of an expanded and aerated lung, often in the context of pleural effusion diagnosis. In emergency and critical care ultrasound use, the recognition of changes to the CS is very useful in the detection of early pulmonary pathological processes occurring at the lateral lung bases and costophrenic recesses. The author suggests a simple standardisation of the CS description and describes its use in lung ultrasound.

Introduction

The curtain sign (CS) is the ultrasound characteristics of the inferior aspect of the lung field, corresponding to the costophrenic recesses and peripheral lung bases. It is an important sign of normality in these areas but is unfortunately rarely discussed in ultrasound practise. Subtle lung pathologies at the lung bases may be missed simply because the normal ultrasound appearance of the lung in that area is not recognised. This article aims to promote the recognition of this sign in the ultrasound diagnosis of peripheral lung disease processes.

Conflict of interest: I declare that I do not have any conflict of interests.

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The curtain sign

The CS was first coined to describe an ultrasound artifact resulting from the presence of free air within a pleural effusion [1,2]. It was also regarded as a sign of an aerated lung, often in the context of a pleural effusion diagnosis [3,4].

In the normal lung sonography, the CS is seen at the costophrenic recess of the thorax. It is created by the combination of two factors. The first is the acoustic impedance mismatch between the soft tissue and the lung air, casting the characteristic sonographic appearance of air. The second is the anatomical relationship of the thorax with the abdomen, resulting in the costophrenic recess covering parts of the upper abdomen and the diaphragm. The overlap of the costophrenic recess onto the abdomen creates a demarcated leading edge of the lung air artifact, giving the impression of a lung curtain (Fig. 1). In lung scanning, the finding of the CS also signifies the study

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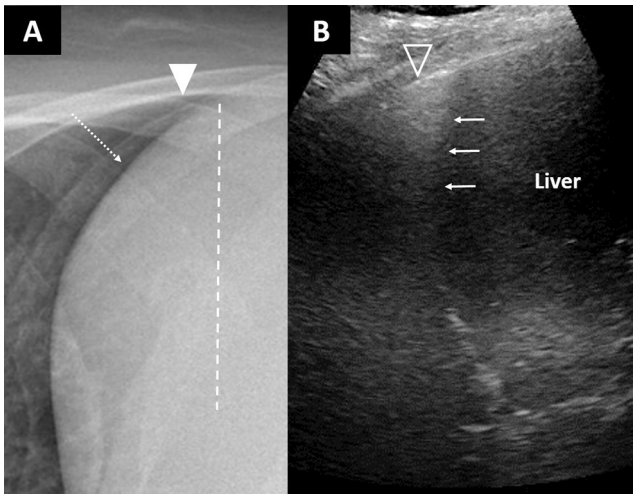

Fig. 1. Formation of normal curtain sign. **A.** CXR illustration of the overlap of costophrenic recess (arrowhead) over the abdomen. In U/S, the air in the costophrenic recess will cast an "air curtain" (dotted line), hiding the lateral diaphragm (dotted arrow) **B.** Ultrasound appearance of the normal CS (thin arrows), which moves with respiration and cover the lateral diaphragm throughout all phases of the respiratory cycle. The open arrow head denotes the lowest limit of the pleural line at the level of the costophrenic recess.

reaching the most inferior aspect of lung; beyond which is the abdominal region.

The CS in a normal lung always demonstrate two features. Firstly, the lung curtain is dynamic and swings in a cranial-caudal axis in concert with the respiratory expansion and retraction of the lung. During inspiration, as the lung expands into the costophrenic recess, the leading edge of the lung curtain appears to move downwards, covering more of the intraabdominal structure. Notably, the movement of the curtain is caused by lung expansion and therefore not perfectly synchronous to the movement of the intra-abdominal structure from diaphragmatic action in the respiratory cycle. Secondly, regardless of the phase of the respiratory cycle, the lateral aspect of the diaphragm is always covered by the lung curtain.

The combination of these two features (dynamic movement of the lung curtain and non-visualisation of the lateral diaphragm) implies that the lung at peripheral bases and costophrenic recess are fully aerated. The author suggests that this should be termed the normal CS. The failure to demonstrate either of these features is regarded as the loss of CS or abnormal CS.

Abnormal curtain sign

Following the definitions above, we could then use the abnormal CS to detect pathological changes occurring at the costophrenic recess of the lung. In practise, 4 variations of the abnormal CS are commonly observed.

Dynamic lung curtain is observed but lateral diaphragm seen (Fig. 2)

This is the earliest sign of a pleural effusion and is visualised at the most dependent part of the chest during scanning. A small effusion first occupies the costophrenic recess and causes compressive atelectasis of the adjacent lung tissues. As the adjacent lung is still largely expanded and air-filled, a lung curtain is still present but this could not cover the lateral diaphragm in the full cycle of the respiration (especially in expiration). With increasing volume of effusion and more of the lung is compressed, the lung curtain fails to cover the lateral diaphragm in all phases of the respiration cycle. In massive pleural effusion, both features of the normal CS are not seen.

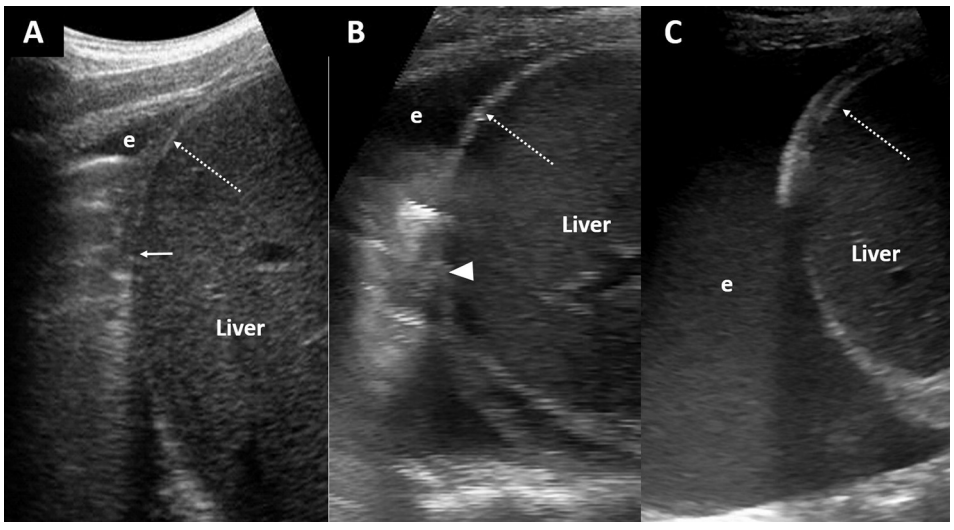

Fig. 2. Dynamic lung curtain present but lateral diaphragm seen. **A.** A small effusion (e) causing an abnormal CS. The lung curtain (solid arrow) is unable to fully conceal the lateral diaphragm (dotted arrow) **B.** A larger effusion (e) with compressive atelectasis of the lung (arrowhead) which is unable to form a CS. **C.** A massive effusion (e) without a lung curtain.

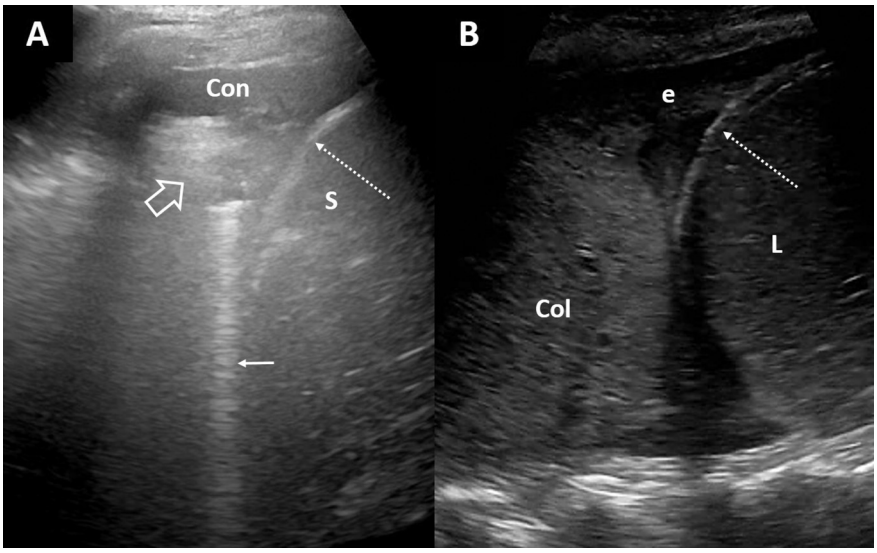

Fig. 3. Dynamic lung curtain is absent and lateral diaphragm seen. **A.** Consolidation (Con) at the lung base. The loss of aeration of the lung results in loss of CS, exposing the diaphragm (dotted arrow) over lying the spleen (S). The interface between the consolidation and aerated lung is an irregular hyperechoic border called the shred line (open arrow). Incidental ring-down artefact from the shred line (thin arrow) **B.** A massive collapse (col) with effusion (e), causing total loss of lung air and hence no CS. The diaphragm (dotted arrow) over the liver is obvious.

Dynamic lung curtain is absent and lateral diaphragm seen (Fig. 3)

This is seen when air is lost in peripheral lung base because of intrapulmonary disease processes, such as consolidation or atelectasis. The "solidification" of lung in these pathological processes creates an acoustic window that allows the visualisation of the lateral diaphragm. The interface between the "solid" part of the lung and the aerated portion creates an irregular hyperechoic artifact margin known as Shred Sign, marking the border and extent of the lung pathology and this feature disrupts the formation of a lung curtain. The absence of a lung curtain in the context of an intrapulmonary lesion was also demonstrated in the study of lung abscesses [3]. A massive pleural effusion also shares these features.

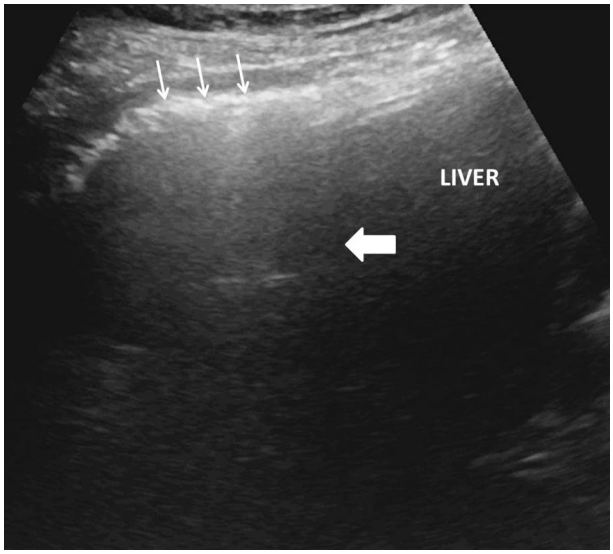

Fig. 4. Static curtain sign. Subcutaneous emphysema at the base of the lung (thin arrows) distributed linearly resembling the pleural line. The subcutaneous air cast a CS (thick arrow), concealing the lateral diaphragm. Because subcutaneous air does no change much with respiration, the CS will be static.

Static curtain sign (Fig. 4)

In this instance, an unmoving lung curtain which covers the lateral diaphragm is present. A single example of this phenomenon is a significant subcutaneous emphysema occurring near the lung base that creates the appearance of a lung curtain and its pathological significance may not be appreciated at first glance. However, tell-tale signs on careful examination: the "pleural line" mimicked by the subcutaneous air is thick, irregular and uneven looking; CS arises from the subcutaneous plane; loss of visualisation of the ribs and costocartilages; allows the sonographer to arrive at this diagnosis.

Pseudo-curtain sign (Fig. 5)

A large or complete pneumothorax extending to the lung base will demonstrate all the features of a normal CS, i.e. dynamic curtain and non-visualisation of the lateral diaphragm. The reasons for these are: free air in the costophrenic recesses would similarly cast a lung curtain and the curtain appears to move primarily due to the diaphragm excursion, increasing and decreasing the space within costophrenic recesses, allowing free air to "move in and out". To tell apart the normal CS from the pseudo-CS in a pneumothorax falls back to the basics of pneumothorax diagnosis: the lung sliding sign and comet tail artifacts [5] which are both absent in pneumothorax.

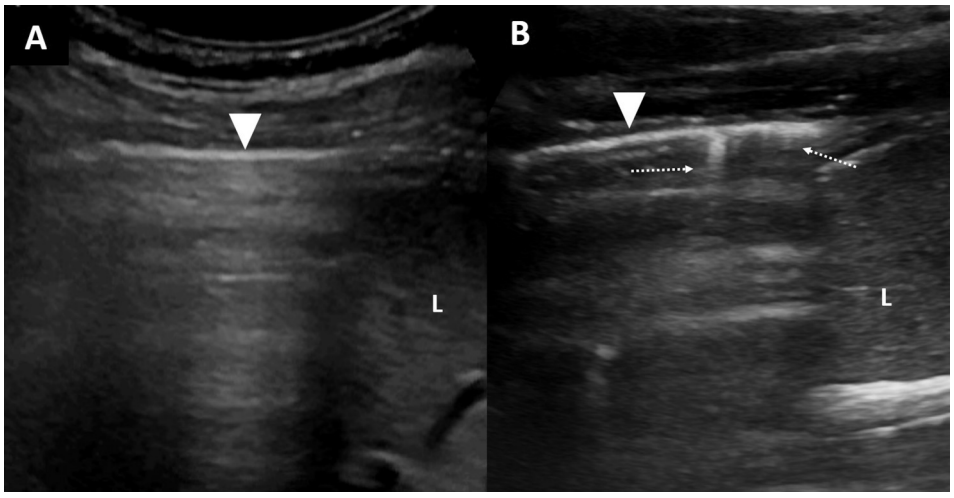

Fig. 5. Pseudo-curtain sign. **A.** A case of right large pneumothorax extending to the costophrenic recess, casting CS over the liver (L). Note the relatively "clean" pleural line (arrowhead) without comet tail artifacts. **B.** CS without pneumothorax and normality of the lung in this area is supported by the presence of comet tail artifacts (dotted arrows) arising from the pleural line (arrowhead).

Conclusion

Identification of CS is important in lung ultrasound as it signifies a thorough lung scanning reaching the costophrenic recesses, the most inferior extent of the lung and confirms the relatively normality of the peripheral lung bases. Alterations in the CS is very useful for the detection of early or subtle pulmonary pathology involving the peripheral lung bases. The use of a standardised description of the CS should be incorporated and taught in the lung sonography.

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