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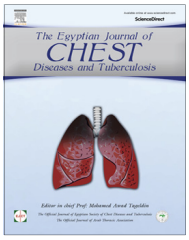

ORIGINAL ARTICLE

Role of chest ultrasonography in the diagnosis of lung contusion

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KEYWORDS

LC lung contusion;
CXR chest X-ray;
CT computed tomography;
AIS alveolointerstitial syndrome;
PPL peripheral parenchymal lesion;
ARDS acute respiratory distress syndrome

Abstract *Objective:* In this study we assessed the diagnostic performance of chest ultrasonography in lung contusion (LC). The study investigated the possible clinical applicability of chest ultrasonography for the diagnosis of LC in comparison to chest X-ray (CXR) and chest computed tomography (CT) (as a gold standard). Design: a screening cross-sectional study. Setting: Critical Care Department, Emergency Department, Alexandria main university hospital.

Patients: 50 patients of both genders admitted to the Emergency Department and the Critical Care Department presented with isolated blunt chest trauma or polytrauma with chest involvement.

Methods: 50 patients admitted for blunt chest trauma were investigated using ultrasonography to detect LC. After the ultrasound study, all patients were submitted to chest X-ray and CT. The sonographic patterns indicative of LC included the following: (1) the alveolointerstitial syndrome (AIS) [defined by increase in B-line artifacts]; and (2) peripheral parenchymal lesion (PPL) [defined by the presence of C-lines: hypoechoic subpleural focal images with or without pleural line gap].

Results: The diagnosis of LC was established by CT scan in 40 patients. If AIS is considered, sensitivity of lung ultrasonography in detection of AIS was 97.50%, specificity was 90.0%, PPV 97.50%, NPV 90.0% and accuracy was 96.0%. If PPL is alternatively considered, sensitivity of lung ultrasonography in detection of PPL was 92.50%, specificity was 100.0%, PPV was 100.0%, NPV was 76.92% and accuracy was 94.0%. As a whole sensitivity of lung ultrasonography in detection of lung contusion was 97.50%, specificity was 90.0%, PPV was 97.50%, NPV was 90.0% and accuracy was 96.0%. Chest X-ray had sensitivity of 40.0%, specificity was 90.0%, with PPV 94.12%, NPV 27.27% and accuracy of 50.0%.

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Conclusion: Lung ultrasound is a bedside, reliable, dynamic, rapid, and non-invasive technique and may be of significant value in the diagnosis of lung contusion in blunt chest trauma patients.
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Introduction

Pulmonary contusions are typically the result of blunt trauma to the chest wall. Motor vehicle and motorcycle crashes are the most common causes of this injury pattern, but it can also be seen with blast trauma. Approximately 25–35% of blunt chest traumas involve injury to the lung itself. The lungs are the second most common organ injured in blast injuries [1].

After the initial blunt or blast thoracic trauma, the edematous phase is notable for worsening interstitial edema and infiltrates, occurring within the first 1–2 h after injury. The air spaces become inundated with blood, inflammatory markers, and tissue debris, as there is an increase in alveolar and capillary permeability along with a reduction in surfactant production. Within 24–48 h after the onset of injury, there is alveolar collapse and further consolidation due to the extravasation of blood into the alveoli. Lung consolidation can lead to increased vascular pressures causing pulmonary hypertension and retention of blood. The resulting ventilation/perfusion mismatch, increased pulmonary shunting, decreased gas exchange, and decreased compliance can predispose patients to clinically apparent symptoms such as hypoxia, hypercarbia, tachypnea, hemoptysis, and wheezing. It is also these mechanisms of consolidation, shunting, and mismatch that predispose patients with pulmonary contusions to pneumonia and acute respiratory distress syndrome (ARDS) [2].

Initial signs of pulmonary contusion on chest X-ray are focal or diffuse lung opacities, which classically appear within the first 6 h after injury, but may take 24–48 h to demonstrate maximum consolidation. During that time, the acute phase inflammatory response is driving the underlying cellular and sub-cellular injury with activation of the coagulation and complement cascades and release of multiple inflammatory mediators such as cytokines, chemokines, and free radicals. Much of the acute phase mechanisms have yet to be fully elucidated, but researchers believe that inflammation is responsible for much of the morbidity and mortality associated with pulmonary contusions. These markers are likely present with any lung parenchymal injury and predispose patients to delayed complications such as pneumonia, ARDS, and long-term disability. Despite these effects to the lung parenchyma from pulmonary contusions, most resolve within 7–14 days with overall minimal long-term effects [3,4].

Role of chest ultrasonography in diagnosis of lung contusion

- Ultrasonography is now becoming an accurate method for detecting interstitial edema. Based on this statement, it is assumed that chest ultrasound may be able to find pulmonary contusions at an earlier stage than CXR, therefore reaching a higher sensitivity in the ED [5,6]. The normal sonographic appearance of the lung [6]: a longitudinal scan of an intercostal space, with the ribs as topographic reference:
  (1) The gliding sign is present when the visceral pleura slides are on the parietal pleura, excluding pneumothorax.
  (2) Horizontal artifacts—the A-lines appear cyclically at an interval that reproduces the distance of the transducer to the pleural line. The gliding sign is not always evident, and the pleural contact and lung movement may be shown in the M mode, this image is called the seashore sign, characterized by horizontal lines (“waves”) representing the static chest wall and by a scattered region (“sand”), formed by the dynamic artifacts beyond the pleural line, which would be absent in the case of pneumothorax.
  (3) Eventually, a type of vertical artifact-B-lines-(formerly called comet tails) can be found in normal examination.
- The recognition of a few other artifacts must be mastered when looking for B-lines:
  – Z-line artifacts are lines that arise from the pleural line and fade away vertically, do not reach the edge of the screen.
  – E-lines are generated by subcutaneous emphysema; they are vertical laser-like lines that reach the edge of the screen but do not arise from the pleural line.

- An examination was considered normal in the presence of the gliding sign, the presence of fewer than three B-line artifacts in the entire scanned surface, and the absence of peripheral consolidations [6,7].

LC is diagnosed in the presence of the following: Alveolo-interstitial syndrome (AIS), ultrasonographically defined as

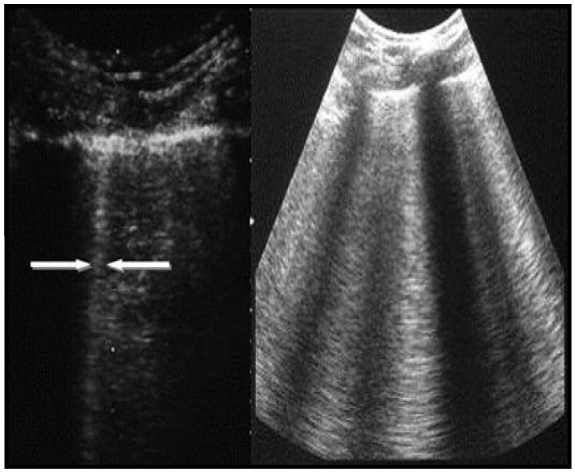

Figure 1 Left: normal image, with one isolated B-line (arrows). Right: ultrasonographic pattern of AIS.

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