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LETTER

Histological–ultrasonographical correlation of pulmonary involvement in severe COVID-19

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Dear Editor,

We read with great interest the recent study of Volpicelli et al. [1], in which the authors propose objective ultrasonographic criteria to evaluate pulmonary alterations in COVID-19. Indeed, ultrasound (US) has been successfully used in the ICU setting and, in a pandemic situation, can represent a valuable option for reducing pressure on computed tomography systems in times of imbalance between demand and the existing imaging structure [2].

In our pathology service, US is routinely used to guide minimally invasive autopsies (MIA/US) of COVID-19 deceased patients [3, 4]. MIA/US was chosen because it is an inexpensive procedure for obtaining tissue samples from several organs and, at the same time, reduces the risks of the autopsy procedure in a highly contagious situation. The first case was studied on March 18, 2020; to date, we have evaluated 30 cases and the series increases daily, encompassing different stages of the disease.

During MIA-US, we observed aspects similar to those described by Volpicelli et al. [1], which oriented the extensive pulmonary tissue sampling in these patients (48 samples in each case, obtained with a 14 G Tru-cut, from four predefined pulmonary areas in each lung).

Three distinct histological patterns were identified in severe COVID-19 affected lungs: A. Acute pulmonary injury: defined as exudative inflammatory changes that include exudative diffuse alveolar damage (DAD), alveolar edema, neutrophilic pneumonia and hemorrhage; B. early fibroproliferative changes: defined as a mixed pattern of acute and fibroproliferative changes, with organization of the exudative process and deposition of loose extracellular matrix; C. predominant pattern of fibroproliferation (fibroproliferative DAD).

We tested the agreement between US image patterns and histological alterations in 10 COVID-19 fatal cases by blindly comparing the diagnosis made by ultrasound and those obtained by histopathological analysis. A full agreement was obtained, fulfilling some criteria of category D of probability ("High probability") of COVID-19 based on patterns of lung ultrasound findings proposed by Volpicelli et al. [1] (Figure 1).

This analysis produced a series of paired histology-ultrasound images that can complement the information presented by Volpicelli et al. [1], contributing to reinforce the usefulness of US imaging in screening for suspected cases and to monitor the severity of affected patients. Here, we prepared a panel of combined US/histopathological images from the same pulmonary areas, using as reference the parameters proposed by Volpicelli et al. [1] Our results support the idea that US imaging can characterize the progressive changes in the pulmonary structure caused by SARS-CoV-2.

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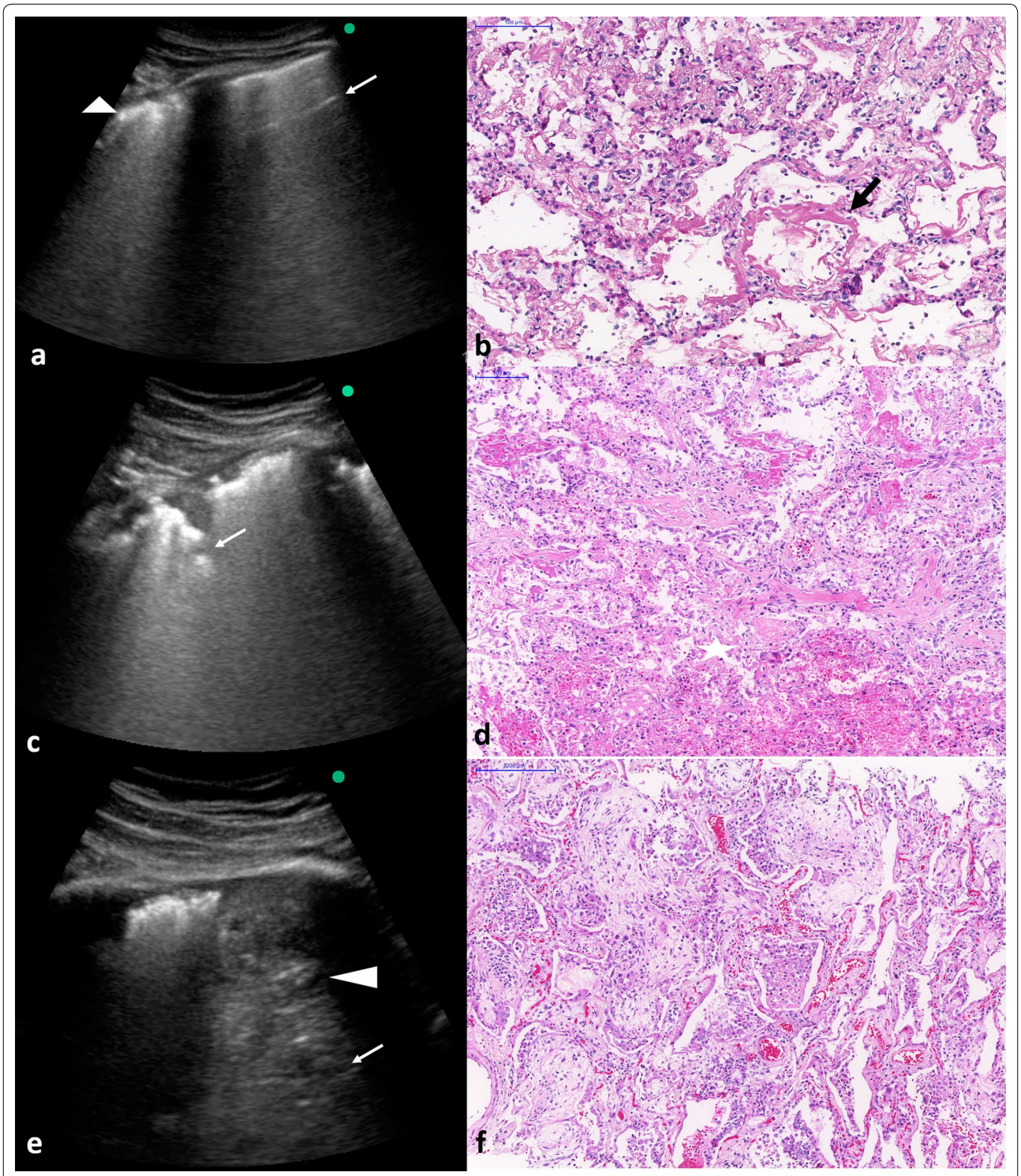

Fig. 1 Correlation between lung ultrasound (LUS) postmortem images with histology findings in fatal cases of COVID-19. **a**, **b** COVID-19 pneumonia in the early phase with irregular and thickened pleural line (arrowhead) and spared areas with A line (arrow) at LUS examination. The histology shows acute pulmonary injury with hyaline membranes (arrow). **c**, **d** intermediary phase with pleural thickening and subpleural consolidations at LUS examination. The histology shows early fibroproliferative changes (in the center) associated with acute diffuse alveolar damage (DAD). **e**, **f** LUS examination shows thickened pleural line and consolidation (arrowhead) with air bronchograms (arrow) in the base of left lung. The histology shows fibroproliferative DAD

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Compliance with ethical standards

Conflicts of interest
The authors declare that they have no conflict of interest.

Ethical approval
This study has been approved by the HC-FMUSP Ethical Committee (Protocol #3951.904).

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