Minerva Anestesiologica
EDIZIONI MINERVA MEDICA

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Minerva Anestesiologica 2020 Dec 15
DOI: 10.23736/S0375-9393.20.15075-2

Article type: Letter to the Editor (Correspondence)

Article first published online: December 15, 2020
Manuscript accepted: October 5, 2020
Manuscript revised: September 16, 2020
Manuscript received: July 29, 2020

Lung elastosonography for diagnosis and management of COVID-19 pneumonia

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In these stressful times with the novel coronavirus-pneumonia raging, non-invasive techniques to follow the progression or regression of the lung injury can prove quite useful.

Despite the usefulness of ultrasound elastography in assessing the stiffness/elasticity of tissues, and its proven diagnostic accuracy in thyroid, and breast cancers, among others,[1] it is not yet applied to investigate lung with COVID-19 pneumonia.

Based on our experience, lung ultrasound elastosonography could help in the diagnosis and follow-up of patients with COVID-19 pneumonia.

The term "elastography" describe an ultrasound based imaging technique developed by Ophir et al.,[2] whereby local tissue displacements are estimated by applying a quasi-static tissue deformation (compression, palpation) and comparing sets of pre- and postdeformation sets of ultrasound radiofrequency data.[3]

Lung Ultrasound Elastosonography is a simple and easy-to-perform technique that allows us to graphically visualize the stiffness/elasticity of the examined parts, that appears with color scale from blue to red; where blue represents the tissue with greater stiffness and less elasticity, while red color identifies the tissue with greater elasticity and less stiffness.[3]

The elastosonography image of the healthy patient is homogeneus and shows the distinct tissue components based on the different stiffness/elasticity, while in patients with interstitial pathology, like COVID-19 pneumonia, the image appears irregular and the more severe the interstitial involvement, the greater the inhomogeneity shown by ultrasound elastosonography. (Figure 1)

During the COVID-19 outbreak, we observed in our Intensive Care Units, a 58-year old man with a past-medical history notable for arterial hypertension, that was ventilated with volume controlled ventilation, with a PEEP of 8cmH2O and tidal volume of 6 ml/kg, with PaO2/FiO2 [mmHg] ratio: 100.

In the lung ultrasound that we carried out, we observed the presence of diffuse B-pattern, with spared areas, that were predominant in the basal regions with respect to the anterior areas, and with the lung ultrasound elastosonography we observed a greater stiffness of lung parenchyma. Compared to the healthy parenchyma, it probably appeared more stiffness due to the interstitial edema and because the alveoli are filled with fluid (wet lung).

In particular, ultrasound elastosonography showed that the most serious phase of the infection is associated with greater stiffness and inhomogeneity of the lung parenchyma, while with the improvement of the clinical condition the image is more homogeneous

(Figure 1), in fact the improvements assessed with the ultrasound elastosonography, correlate with the clinical findings such as PaO2/FiO2 [mmHg] ratio which has increased from 100 to 204.

The ultrasound elastosonography could be useful for frequent follow-up of COVID-19 pneumonia patients to assess disease progression and treatment, in conjunction with standard ultrasound technologies.The images obtained are easily comparable thanks to the graphic effect, with those of the previous days to obtain simple and inexpensive monitoring and above all we can use it at the patient's bedside.

These technique have proven effective in detecting and assessing many different pathology, because tissue mechanical change often correlate with tissue pathological changes.[3]

There are no other cases in the literature describing its use in patients with covid-19 pneumonia.

Further studies are necessary.

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NOTES

Conflicts of interest: The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

"Authors' contribution"

Pierfrancesco Fusco: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Di Carlo Stefano: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Gian Marco Petroni: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Paolo Scimia: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Giuseppe Sepolvere: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Walter Ciaschi: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

Franco Marinangeli: this autor helped substantial contributions to the conception or design of the work; and final approval of the version to be published

All authors read and approved the final version of the manuscript

TITLES OF FIGURES

Figure 1 A-B-C: Lung ultrasound and Elastosonography images performed in left basal region in mid-axillary line in a healty patient and in the patient of our study.

X : B-line

▲ : A- line

COLOR SCALE FROM BLUE TO RED OF ELASTOSONOGRAPHY IMAGES:

-blue color represents the tissue with greater stiffness and less elasticity;

- red color identifies the tissue with greater elasticity and less stiffness.

A - Shows the homogeneous Elastosonography image of the healthy patient, with the distinct tissue components based on the different stiffness/elasticity

B - Acute phase of covid pneumonia with severe interstitial involvement.

The Lung ultrasound shows the presence of diffuse B lines, while Elastosonography image shows the inhomogeneity due to the stiffer and less elasticity of the lung parenchyma. The more severe the interstitial involvement, the greater the inhomogeneity shown by ultrasound elastosonography images, where the blue color prevails which is an expression of increased tissue stiffness

C -Improvement phase of covid pneumonia in the same patient, with reduction of B lines in the Lung ultrasound, while Elastosonography image shows an increase in the homogeneity of the lung parenchyma due to the less stiffness and greater elasticity, in fact in this case the red color prevails.