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# USE OF ULTRASONIC DIAGNOSTICS FOR INVESTIGATION AND DETECTION OF STRUCTURAL CHANGES IN THE LUNGS IN COVID-19

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## Abstract

Rapid and accurate diagnosis of various lung changes caused by SARS-Co V-2 is extremely important and relevant, as it will allow timely action to take the necessary measures to treat and stop the spread of lesions. Ultrasound diagnosis allows you to quickly, non-invasively, and cheaply conduct research that is accurate and effective enough to make or confirm a diagnosis. The article highlights the main structural changes in the lungs found in 86 patients with a positive PCR test for coronavirus virus. The following sonographic signs were observed during the study: B-line (in 54% of patients), white lung effect (in 20.6% of patients), consolidation (11 people – 17.5%), of which 6 patients with consolidation less than 1 cm and 5 patients had consolidations greater than 1 cm, pleural effusion was observed in 7 patients.

Our research is important both in terms of increasing the informativeness of the diagnosis for physicians and patients, for whom it is important to quickly, non-invasively, and economically compare, detect disease and begin treatment promptly.

**Keywords: ultrasound examination; consolidation; white lung effect; B-line.**

**Introduction.** The number of injuries and deaths from Covid-19 is extremely high, as evidenced by the epidemiological situation around the world. Proper diagnosis is the first step to successful treatment, and in such mass situations, it is important to quickly and effectively confirm the diagnosis [1, 4, 7]. In addition, it is necessary to conduct regular monitoring of patients, because this disease progresses rapidly and structural changes in the lungs are detected in a very short period. The main method of laboratory diagnosis is the PCR test (polymerase chain reaction of reverse transcription) (RT-PCR), which is carried out by taking samples from the nasopharyngeal mucosa [2 - 5]. Occasionally, this test may show erroneous results due to incorrect sampling or excessive viral load. Computed tomography (CT) has become the basic method of radiodiagnosis at the beginning of the pandemic, but due to the high invasiveness of the method and the need for appropriate conditions for research, this method can sometimes be excluded and replaced by other radiological methods [1, 7, 8]. Therefore, ultrasound diagnostics have become widespread. This method of research allows us to examine patients often and effectively, in time to detect structural changes in lung tissue, from which we can draw the right conclusion about the degree of damage. The advantage of ultrasound is that the examination is performed in a polypositional way: at the patient's bedside or in ultrasound rooms, lying down, sitting or half-sitting, ie the procedure is mobile. An important advantage of ultrasound diagnostics is that the study does not use ionizing radiation, so the method is non-invasive and completely safe for patients, which allows its use in pediatric and obstetric practice [1, 3, 5 - 8].

**Background.** Rapid assessment of the qualitative characteristics of the structure of lung tissue in the affected makes it possible to begin in time to conduct resuscitation and treatment. As mentioned above, ultrasound has several advantages over X-ray and CT scans. In addition to rapid diagnosis of lung tissue lesions, it is also important to conduct pre-hospital sorting of patients, which allows determining the extent of the lesion in different patients and, accordingly, different amounts of resuscitation and intensive care. It is necessary to monitor the effectiveness of antiviral drugs, and because ultrasound is a non-invasive, mobile, and relatively inexpensive method, we can often monitor the therapeutic activity and effectiveness of a particular antiviral drug. The main method of treatment and maintenance of life in patients with pneumonia caused by Covid-19 is artificial lung ventilation (ALV), so in this case, ultrasound will allow us to control the process of artificial lung ventilation, which is necessary for intensive care.

The basis of interpretations of changes in lung tissue during the ultrasound is a change in the relationship between air, healthy, compacted lung tissue, and fluid, which in some cases may accumulate. This ratio can be detected qualitatively in the form of artifacts that we see on the monitor of the ultrasound machine, and quantitatively and in the form of digital representations of the degree of change in the ratio and the amount of tissue compaction.

**The aim of the study.** To increase the diagnostic value of ultrasound diagnostics in detecting the main structural changes in the lung tissue affected by SARS-Co V-2.

**Materials and methods**

An ultrasound examination of 86 patients with a positive PCR test was performed. The mean age of patients was (34.9 ± 6.4) years.

Patients were examined on HITACHI ALOCA ARIETTA 70 and TOSHIBA NEMIO. Convex abdominal (C2-5-RS) and micro convex sensors with a frequency of 5 MHz and a linear (L5-11RS) sensor with a frequency of 7-10 MHz were used, which was used to detail the sliding of the visceral pleura and to better search and visualize consolidations. Patients were examined in different positions, depending on their condition: lying on their side or back, sitting and half-sitting. Mand B-modes were used for the study. Sensors were placed according to the standard BLUE protocol and according to it, each half of the chest was divided into 6 zones: between parasternal (PSL) and anterior axillary line (AAL) – zones 1-2, between anterior axillary line (AAL) and posterior axillary line (PAL) – zones 3-4 and between the posterior axillary line (PAL) and the spinal line (VL) – zones 5-6. In these areas, the sensor was placed obliquely, along with the intercostal spaces, as well as longitudinally, ie perpendicular to the ribs. At longitudinal placement, the "bat effect" was observed, and at oblique – a part of a pleural line which did not overlap with edges as in the previous case.

The study was performed in each intercostal space on the three walls of the chest: anterior, lateral, and posterior, because the damage to lung tissue may be insignificant, limited, and in different parts of the lungs. Consolidations smaller than 8 mm or a slight thickening of the pleural line can be difficult to visualize, so it is important to research each intercostal space. Be sure to scan the costal-diaphragmatic angles on both sides for pleural effusion, which on LUS is seen as a hypoechoic, often anechoic space, on the background of the lung with consolidations. Ultrasound has an advantage over CT in the diagnosis of pleural effusion because on ultrasound we see fibrin and septa in the effusion and thus assess the complexity of the exudative process.

**The results of the study.** After examining 86 patients, the main signs of interstitial lung damage were identified in B-line (more than 3 in one intercostal space), "white lung effect", consolidation, pleural effusion. According to the quantitative and percentage ratios of the attribute were distributed as follows:

- B-Lines – 34 (54%);
- White lung effect – 13 (20,6%);
- Consolidation – 11 (17,5%);
- Pleural effusion – 5 (7,9%) (fig.1).

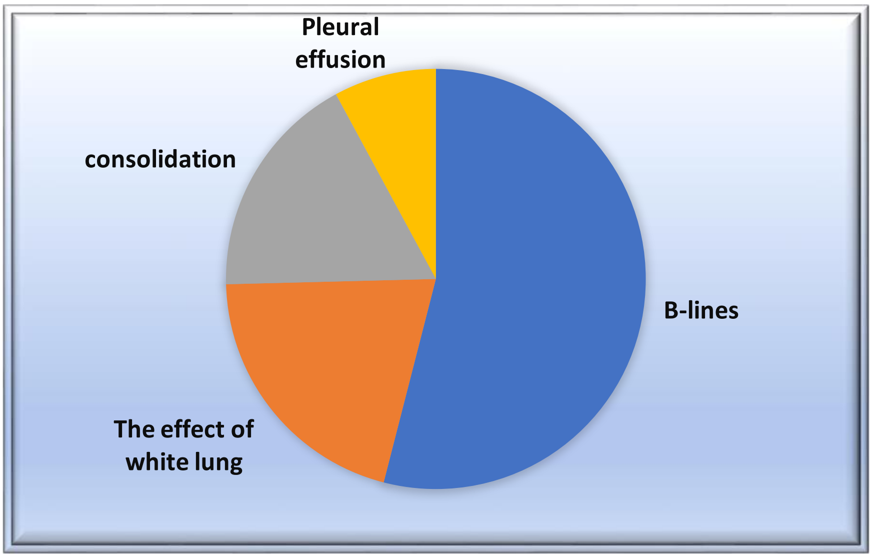


Fig.1. Distribution of the main signs of lung tissue damage in SARS-COV-2

Consolidation less than 1 cm was observed in 6 patients (7%) and more than 1 cm in 5 subjects (5.8%).

The severity of these symptoms in different patients was different and the greater this degree, the more severe the lesion and the worse the aeration of the lung tissue. Therefore, it is important to understand what the signs of lung damage look like in an ultrasound diagnosis to correctly determine the severity of the lesion.

B-lines are normal, but their number does not exceed 3 in one intercostal space. These lines are hyperechoic artifacts of the "comet's tail" type, which depart from the pleural line and cross the ultrasound image completely without attenuation. Pathomorphologically, they are represented by the thickening of the interparticle and intraparticle septa. Thicker B-lines (more than 3 mm) are called coalescent and they correspond to the effect of "frosted glass" on CT (Fig. 2). B-lines intersect normal A-lines (horizontal artifacts) and move synchronously with the visceral pleura during respiratory movements. The number of B-lines and violation of the aeration of lung tissue is directly proportional.

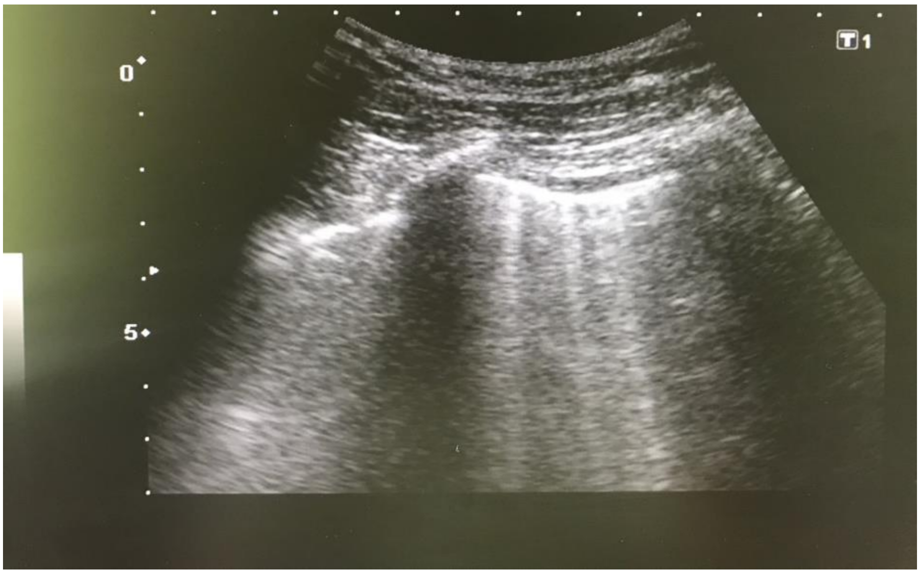

Fig. 2. Ultrasound demonstration of coalescent B-lines in a patient with COVID-19

In patients with longer lesions, we observed B-line fusions and, as a rule, coalescent B-lines merge. As a result of such a merger in 20.6% of subjects, we observed the effect of "white lung", which characterizes large-scale damage to the pleural line and the surface layers of lung tissue (Fig. 3).

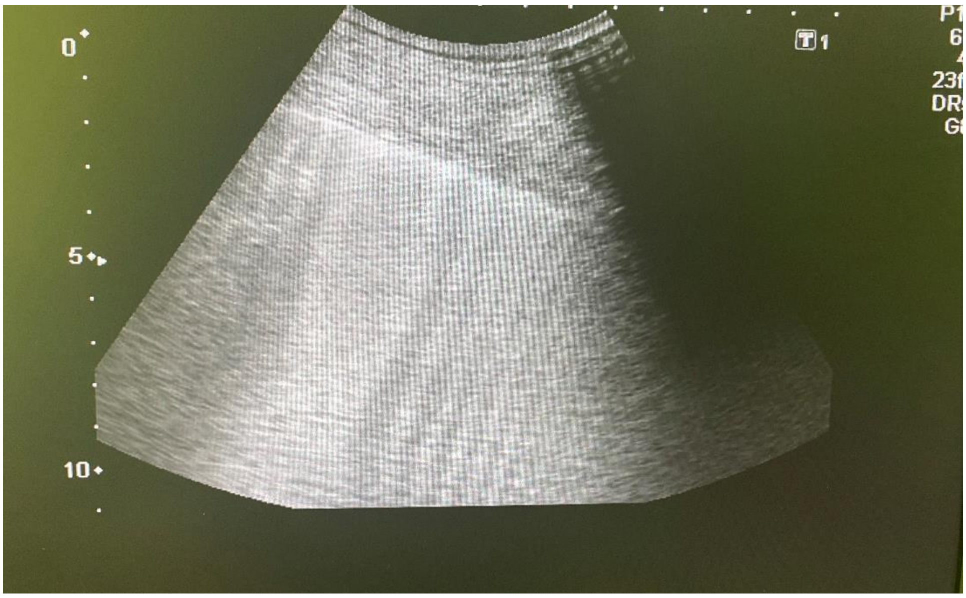

Fig. 3. Sonogram with the effect of "white lung"

Consolidation is a sign that is easy to visualize but a sign of severe lung damage. They are formed when the alveolus is filled with an atypical substance for the alveoli (blood, exudate, connective tissue). In most of our examined patients, we observed the presence of consolidations in the posterolateral area and to a lesser extent in other areas of the lungs. They are presented in the form of a circular seal with torn edges from which the pathological C-lines depart in the form of a "comet tail". It is customary to distinguish small consolidations (less than 2 cm), large (more than 4 cm), and translator consolidations, which occupy the entire share of the lung lobe (Fig. 4).

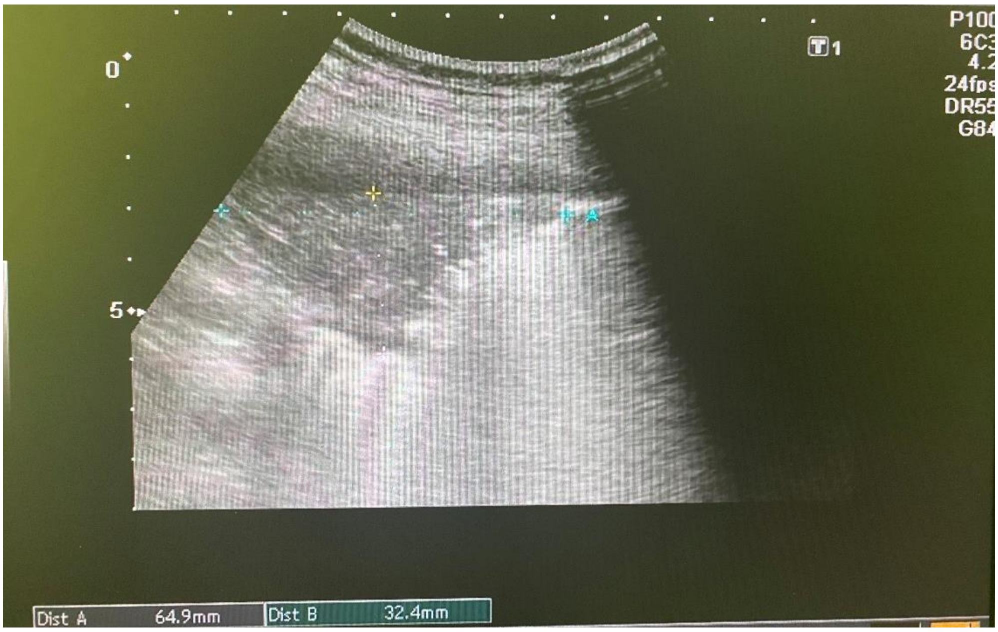


Fig. 4. Sonogram of pulmonary consolidation in a 36-year-old patient with pneumonia caused by COVID-19

Pleural effusion is not common in the diagnosis of COVID-19, but in 5 patients to observe the presence of fluid up to 35 cm3. Ultrasound diagnosis is generally preferred when detecting pleural effusion, as ultrasound rays pass through liquid media, and the latter can be both anechoic and hypoechoic. In these patients, we observed a "sinusoidal signal" that occurred due to floating movements of the lungs in the fluid during a tour of the chest (Fig. 5).

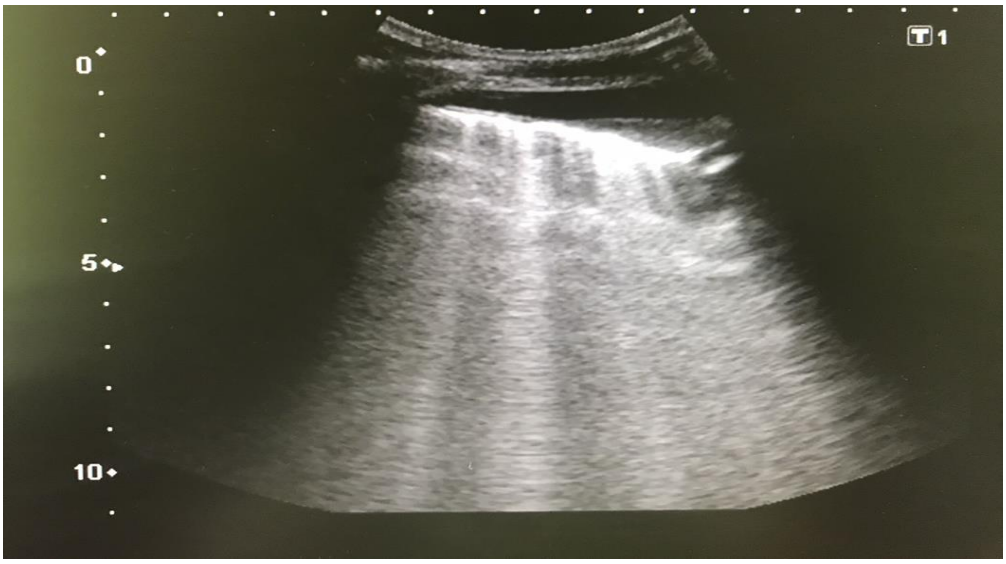


Fig. 5. Detection of pleural effusion in a 33-year-old patient

**Conclusion**

Ultrasound diagnosis is a non-invasive, affordable, and inexpensive method of diagnosing changes in lung tissue in viral etiology.

The sonographic examination allows the diagnosis of interstitial changes with high accuracy.

The main signs of interstitial lung damage are the presence of B-lines (more than 3 in one intercostal space), the effect of "white flax", consolidation and effusion.

Ultrasound is the most sensitive method for detecting effusion.

The most common sign of interstitial lung damage is the B-line, a less common effect of "white lung" and consolidation.

Pleural effusion in covid pneumonia is rare.

**References**

1. Gumenyuk MI, Ignat'va VI, Linnik MI, Gumenyuk GL, Svyatnenko VA, Palivoda MG. Methods of visualization in diagnostics of non-hospital pneumonia and virus etiology (COVID-19). Infusion&chemotherapy.2020;2:11-20.

2. Madzhidov TI, Kurakin GF. Computer technologies against coronavirus: first results. Nature.2020;3:3-15. DOI: 10.7868/ S0032874X20030011.

3. Morozov SP, Protsenko DN, Smetanina SV, Andreichenko AE and all. Radiation diagnosis of coronavirus disease (COVID-19): organization, methodology, interpretation of results. – M., 2020: 60.

4. New Coronavirus Infection (COVID-19): Etiology, Epidemiology, Clinical Presentation, Diagnosis, Treatment, and Prevention: Study Guide №21. – M., 2020.– 71.

5. Chan KW, Wong VT, Tang SCW. COVID-19: an update on the epidemiological, clinical, preventive, and therapeutic evidence and guidelines of integrative Chinese-western medicine for the management of 2019 novel coronavirus disease. Am. J.Chin. Med. 2020:1-26.

6. Peng QY, Wang XT, Zhang LN. Chinese Critical Care Ultrasound Study Group (CCUSG). Finding of lung ultrasonography of novel coronavirus pneumonia during the 2019–2020 epidemic. Intensive Care Med. 2020: 46. 849–850

7. Dargent A, Chatelain E, Kreitmann L. et al. Lung ultrasound score to monitor COVID-19 pneumonia progression in patients with ARDS. PLoS ONE. 2020;15:e0236312. https://doi.org/ 10.1371/journal.pone.0236312.

8. Zhou F, Yu T, Du R. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study [published correction appears in Lancet. 2020, Mar 28. 395(10229). 1038] [published correction appears in Lancet. 2020 Mar 28;395(10229):1038]. Lancet. 2020. 395. 1054-1062. DOI: 10.1016/S0140-6736(20)30566-3.