THORACIC ULTRASOUND IN COVID-19 IN CORRELATION TO LAB AND CHEST RADIOLOGY

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ABSTRACT

Although chest CT is the most common scan, its long-term safety for repeat use has not been determined. A chest computed tomography (CT) scan may be used to identify coronavirus disease 2019 (COVID-19), which is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2). The diagnosis accuracy of Lung Ultrasound (LUS) for Alveolar Consolidation and Interstitial Lung Diseases is high.

The purpose of this investigation is to compare the results of transthoracic ultrasonography for the diagnosis of covid pneumonia to those obtained using conventional methods (clinical characteristics, laboratory tests, and chest computed tomography).

Methods and Patients One hundred patients with confirmed cases of COVID-19 pneumonia were recruited from the isolation sections (ward or ICU) at Benha University Hospital between June 2021 and January 2022 for this prospective observational research.

The average age of the patients in the study was 53 15 years. There were more men than women among the patients (58%). In the population under study, fever was the most prevalent symptom. The most prevalent result was GGO, and the CT chest score ranged from 3 to 25 with a median of 14. The median LUS score was 16 and the most frequent result was a B line. There was a negative link between chest CT, LUS, and oxygen saturation, and a positive correlation between these variables and inflammatory markers such C-reactive protein, lactate dehydrogenase, and D-dimer. There was a favourable correlation between LUS and chest CT score. When predicting death, a LUS score > 24 had a sensitivity of 95.2% and a specificity of 96.2%, whereas a chest CT cutoff of > 18 had a sensitivity of 100% and a specificity of 87.3%. The LUS score was a strong indicator of mortality risk.

Patients with suspected cases of COVID-19 pneumonia may benefit from LUS as a safe and effective diagnostic tool, as shown by CT results. The LUS score was highly associated with both the lab results and the CT severity score, making it a reliable mortality predictor.

Coronavirus pneumonia, HRCT severity score, transthoracic ultrasound, ultrasound at the point of treatment.

Introduction

The coronavirus family includes the newly identified beta-corona virus that causes severe acute respiratory syndrome (SARS-CoV-2). The pandemic status of the SARS CoV-2 epidemic (1) reflects its worldwide dissemination.

High-resolution chest computed tomography (HRCT) is the gold standard for detecting damage and evaluating the degree of lung involvement from the new coronavirus disease (COVID-19) (2), and a nasopharyngeal swab is all that's needed for a diagnosis of infection. Multiple lung involvement severity ratings are under investigation. To assess the pulmonary illness burden using COVID-19 (3), the CT severity score established by Pan et al. is helpful.

Lung ultrasonography (LUS) at the point-of-care is becoming an established method for assessing the severity of COVID-19-related damage. Pleural line anomalies, B-lines, and lung 'consolidations' are some of the findings that contribute to the LUS score, a semi-quantitative measure of lung injury severity.

The purpose of this research was to evaluate the accuracy of trans-thoracic ultrasonography for diagnosing covid pneumonia and to determine whether or not this technique correlates with other diagnostic tools such chest CT and laboratory data.

WHO WE TREAT AND HOW

From June 2021 to January 2022, researchers observed one hundred patients admitted to the isolation units (ward or ICU) at Benha University

Hospital with confirmed cases of COVID-19 pneumonia.

Criteria for inclusion:

Patients admitted to the isolation units (ward and ICU) with respiratory symptoms are diagnosed with COVID-19 if a nasopharyngeal swab reveals SARS-CoV-2 using RT-PCR.

b) A CT finding suggestive with COVID-19 illness in patients admitted with respiratory symptoms.

Criteria for disqualification

a) Diffuse parenchymal lung disease (DPLD) diagnosis.

Congestive heart failure patients b).

c) The presence of malignant tumours in the lungs or distant metastases in the lungs.

d) Participants in the research have declined to take part.

e) Delays in between lung ultrasonography and radiography of greater than 24 hours.

The following were applied to all patients:

a) Taking a medical history and doing a physical assessment,

CBC, LDH, ferritin, D.dimer, and a blood glucose (ABG) lab

c) Swabs from the nasal cavity and the back of the throat to do RT-PCR for SARS-COPV-2,

d) Chest HRCT with no contrast,

Diagnostic chest ultrasound (method e).

The CT Method

Without intravenous administration of contrast media, all research participants had high-resolution CT (HRCT) in the supine position at end inspiration on a 16-row scanner (Toshiba Jaban) immediately before to admission. On the 16-row scanner, we used an acquisition setting of 110 kVp.

The existence and severity of thoracic anomalies were determined by analysing HRCT data.

Method of partially quantitative evaluation

Quantitative estimates of the lung involvement of all these anomalies were made using an area-based semi-quantitative scoring method. Based on the level of lobar participation, the CT-SS was determined. On a visual scale from 0 to 5, the degree of engagement in each of the five lobes of the lungs was quantified as follows: 0 for no involvement, 1 for less than 5% involvement, 2 for between 25 and 29% involvement, 3 for between 50 and 75% involvement, and 5 for over 75% involvement. As shown in Fig. 1, the overall CT score was calculated by adding the scores for each lobar segment, and it could be anywhere from 0 (no participation) to 25 (highest involvement).

The final CT score (0 to 25) was calculated by adding the scores from each lobar region. Lymphadenopathy, fibrosis, subpleural lines, pleural and pericardial effusion, and fibrosis were all mentioned as possible side effects.

Diagnostic Methods Using Ultrasound and Picture Analysis

The TTUS (Philips Hd5 Colour Doppler Ultrasound Machine.Tokyo, Japan) was used to scan the lungs and pleura of all patients, using both low-frequency convex (Philips C5-2 Curved Array Probe) and high-frequency linear (Philips L12-3 linear probe) transducers.

The Transthoracic Ultrasound Method

Bedside transthoracic US was conducted as a supplement to the physical examination within 24 hours of admission and CT scanning, and operators wore appropriate personal protective equipment. The patient was examined while seated, lying flat, on their side, on their back, and on their stomach. Depending on the current ventilatory strategy, this is often done in either the supine or prone position in cases of respiratory discomfort or airway control.

First, the pleural line and the ultrasound artefacts (A lines, comet-tail artefacts like B lines, and consolidations) related to the lung parenchyma's state were mapped out using a convex probe. To learn more about the pleural line and any subpleural anomalies, a linear probe was employed (7).

Using the third intercostal space as a reference point, we separated each hemithorax into an anterior sector, a lateral sector, and a posterior sector. We then subdivided each of these sectors into an upper and lower half. Ultrasound software captured images, which were evaluated after the test to cut down on patient waiting times. B lines, pleural line thickening or breaks, consolidations, and air bronchograms were analysed for presence, location, and pattern.

Criteria for Evaluation (9):

• Using LUS, researchers analysed all 12 lung zones, including the anterior, lateral, and posterior regions of both lungs' upper and lower halves. Each region was assigned a grade based on one of four distinct ultrasonic aeration patterns. Each of the 12 studied zones received a score based on the worst ultrasonography pattern seen there. Negative values indicate the presence of A lines or a single or double isolated B line in addition to lung sliding. A significant decrease in lung oxygenation (septal rockets) and an additional three to four B lines for every point. When five or more B lines (Diffuse coalescent B lines) are seen in the lungs, it indicates a considerable loss of oxygen. Three dots denote the presence of hypoechoic, poorly defined tissue that shows no evidence of lung aeration (consolidation) in Fig. 2.

The operation ended with the highest possible scores in each category. The patient's Lung Score, which may range from 0 to 36, was calculated by adding the highest scores from each zone. Lung involvement is rated as mild (0–7), moderate (8–18), or severe (19–36) on a scale from 1–36.

Techniques for Statistics

SPSS version 28 (IBM, Armonk, NY, USA) was used for data management and statistical analysis. At first, we used the Kolmogorov-Smirnov statistic, the Shapiro-Wilk test, and direct data visualisation techniques to check whether our quantitative data followed a normal distribution. Means and standard deviations or medians and ranges were calculated from quantitative data in accordance with the assumption of normalcy. Numbers and percentages were used to summarise the categorical information. The Chi-square test or Fisher's exact test was used to compare categorical data. CT and US scores for normalcy prediction were analysed using ROC curves. Diagnostic indices, optimal cutoff points, and areas under the curves were determined. Spearman's rho was used to find the correlations. CT and US scores were analysed using multivariate logistic regression to predict death. The odds ratios and 95% CIs were determined. All statistical analysis was unidirectional. P values below 0.05 were used to indicate statistical significance.

RESULTS

The patients in the study had a mean age of 53 15 years (see Table 1). There were more men than women among the patients (58%). Twenty-six percent had diabetes, and thirty percent had high blood pressure. Comorbidities such as IHD, stroke, CKD, and others were found in 12% of patients. A larger percentage of patients (63%) were admitted to the intensive care unit than to the ward (37%).

According to table (2), fever was the most common symptom among those who had illness. This was followed by dyspnea (85%), cough (81%) and body pains (27%). Almost half of the people experienced additional symptoms. Symptoms lasted an average of 6.5 2.9 days but may last anywhere from 1 to 15 days. Temperatures averaged 38.0 1.0 degrees Celsius. Systolic blood pressure was found to be 118 15 and diastolic blood pressure to be 73 12 on average. The average number of breaths taken per minute was 29.6. Patients' average heart rates were 105.23 12.4 beats per minute, and only 5% showed signs of cyanosis.

According to Table 3, the average oxygen content in the room was 80 11%. Systolic blood pressure was found to be 118 15 and diastolic blood pressure to be 73 12 on average. pH levels averaged 7.4 0.09. Results showed that average PCO2 was 35.7 7.1 mmHg and average PO2 was 52.1 13.3 mmHg. Ferritin levels varied from 130 to 8046 with a median of 612.5. In a range from 100 to 2900, a median LDH of 430 was found. D-dimer levels ranged from 150 to 8000, with 900 being the middle value. The CRP ranged from a median of 56 to an extreme of 296. TLC ranged from 2.8 to 25, with 10.8 being the median value. Median relative lymphocyte was 9.5, ranging from 1 to 37, while median absolute lymphocyte was 0.899, ranging from 0.5 to 3.75.

Most patients (99%, per Table 4) had bilateral affection. More than a third (36%) had a central distribution, whereas more than half (54%) were periphery-limited. The median number of afflicted lobes was 4. Ground glass opacities were seen in every patient. Only 1 in 5 had the wacky asphalt. Consolidation occurred in almost 67% of the sample. Only around 28% of people didn't have a subpleural line. Only 10% of the population exhibited nodule/reticulation. Seven percent exhibited a holo sign, and just four percent had pleural effusion. The CT scores varied from a minimum of 3 to a maximum of 25.

Nearly all patients (99%) had both sides affected, as seen in table 5. Pleural lines were irregular in more than half (58%) of the sample. Only around one-seventh had continuous lines, while about one-third had broken ones. The B lines of 50% of the patients were completely joined. More over a third of patients showed evidence of displaced B-lines (42%), whereas just one showed evidence of focal B-lines. Consolidations were observed in almost 66 percent of patients, with effusions present in just 4 percent. Between 0 to 36, the median score in the US was 16.

Table (6), Figure (3) demonstrate that US score exhibited substantial positive connection with respiratory rate (r= 0.543, P < 0.001), ferritin (r= 0.570, P < 0.001), LDH (r = 0.543, P < 0.001), D-dimer (r = 0.476, P < 0.001), CRP (r = 0.416, P < 0.001), TLC (r = 0.355, P < 0.001). There were substantial negative associations between the US score and both SO2 and PO2 levels measured in a room's air (r = -0.741, P 0.001). The absolute number of lymphocytes and the ratio of these cells to the total number of lymphocytes were not significantly correlated with the US score.

The LUS score was shown to have a very significant positive connection with CT scores (r = 0.886, P 0.001), as shown in Table (7) and Figure (4).

The predictive accuracy of the US score for mortality was investigated using ROC. The AUC for LUS was 0.994, with a 95% confidence interval (CI) from 0.983 to 1 (P 0.001). Figure 5 shows that the optimal cutoff was > 24, with a sensitivity of 95.2% and a specificity of 96.2%.

DISCUSSI0N

By late 2019, the new beta coronavirus 2019-nCov that originated in China has spread over the world, giving rise to the so-called coronavirus illness 2019 (COVID-19) (11). This virus was formerly known as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Interstitial pneumonia, respiratory failure, and myocardial damage (12), thrombosis (13), multiorgan failure (14), and death (15) are all possible outcomes of an infection of the respiratory tract.

This research aims to determine how well transthoracic ultrasonography can diagnose covid pneumonia and how well it correlates with other diagnostic tools like chest CT and laboratory analysis.

A total of 100 patients (58 males, or 58% of the total) with a mean age of 53 15 years participated in this prospective observational research. One-third (30%) of the patients in this research had hypertension, and nearly one-quarter (26%) have diabetes, demonstrating the high prevalence of comorbidities within the study group. Only 12% of the individuals analysed also had other co-morbidities, such as hypothyroidism or CVD. About two-thirds of patients (63%) in this research were admitted to the intensive care unit (ICU) because they needed a high-flow nasal cannula or other forms of supplemental oxygen therapy to treat hypoxemia.

Females may be less susceptible to viral infections because sex hormones (X chromosome) protect against infections in both the innate and adaptive immune systems. Because of their compromised immune systems, COVID-19 is more likely to infect elderly guys with several chronic conditions (15).

The findings of a research by Chen and colleagues (16) on COVID-19 pneumonia in 99 individuals are consistent with ours. Their typical patient was 55 years old (with a standard deviation of 13 years). A total of 67 males and 32 women were analysed. Fifty individuals (51%!) were diagnosed with chronic conditions. Fratianni et al. (17) had a much greater proportion of male patients than we did (88.46, 23/26) in their research. They also had an older average patient age than we did (66 15), which is consistent with the idea that severe COVID-19 illness is more common in the elderly. Like our research, they discovered that hypertension was the most common comorbidity among their patients.

This research found that the average duration of symptoms at admission was six days, with a range of one to fifteen days. Quarato et al. (18) similarly reported that the median time from the onset of symptoms and admission was 5 1 days, therefore our findings are consistent with theirs. The median period between the beginning of symptoms and the first hospital admission was 7 days, according to both Huang et al. (14) and Lanza et al. (20).

The current study found that among the patients studied, fever was the most common symptom (89%), followed by dyspnea (85%), cough (81%), and body aches (27%), while more than a third of patients had other symptoms like disturbed consciousness, GIT manifestations, loss of smell (43%).

Similar findings were reported by Chen et al. (16), who analysed the epidemiological and clinical characteristics of 2019-nCoV pneumonia in 99 patients and found that 82 of them (83% of the total) had fever, while 81 (82%) had cough and 31 (31%) had shortness of breath. About 42% of patients also had the other symptoms, which included muscular discomfort, disorientation, headache, and diarrhoea.

Analysis of the patients' vital signs showed that, on average, their body temperature was 37.9 0.7 degrees Celsius. Systolic blood pressure was found to be 118 15 and diastolic blood pressure to be 73 12 on average. The average number of breaths taken per minute was 29.6. Patients' average heart rates were 105.23 12.4 beats per minute, and only 5% showed signs of cyanosis.

The average heart rate was 94 (82-107) beats per minute, the average temperature was 37 (37-38), and the average respiratory rate was 19 (18-20) in a study by Rechtman et al. (21) that aimed to assess vital signs in initial clinical encounters to predict COVID-19 mortality in a NYC hospital system and included 8770 patients. Our findings are consistent with those of Lanza et al. (20), who measured a median body temperature of 37.7 °C (36.9°-38.4°) during the CT examination.

The majority of patients in this research exhibited hypoxemia, as shown by ABG tests, with a mean oxygen saturation of 80 11% on room air and a mean partial oxygen pressure of 52.1 13.3 mm Hg. The average values for pH, PCO2, and HCO3 were 7.4 0.09, 35.7 7.1, and 20.63 2.6, respectively; the average values for Na+ and K+ were 134.8 12.3, and 3.8 0.6 mEq/L.

Patients whose ABG levels are low when they arrive in the ED may have an elevated prognosis risk even if they are clinically unimpaired because this signals a larger underlying extension of the inflammatory process.

Similarly, Mansouri et al. (22) found that pulmonary alkalosis was more common among COVID-19 patients than metabolic alkalosis and that there was a correlation between arterial blood gas levels, acid-base abnormalities, and clinical outcomes. They showed that on average, the pH was 7.44 0.079, the PCO2 was 36.9 9.88 mmHg, the HCO3 was 25.43 4.53 mEq/L, and the Na+ and K+ concentrations were 136.55 4 mEq/L and 4.14 0.86 mEq/L, respectively. The results also demonstrated that the individuals investigated had hypoxemia, with a mean Po2 of 42.08 28.77 mmHg and a SO2 of 74.37 18.03%.

Patients in this study had elevated levels of ferritin (median: 612.5 g/l; range: 130–8046 g/l), LDH (median: 430 u/l; range: 100–2900 u/l), D-dimer (median: 900 g/l; range: 150–8000 u/l), and C-reactive protein (CRP; range: 7–296 mg/dl). TLC ranged from 2.8103 to 25103, with a median of 10.8103. There was a wide range of absolute and relative lymphocyte counts, with the medians being 0.899x103(0.5-3.75) and 9.5x103(1-37).

Consistently high levels of LDH, Ferritin, D-dimer, and CRP were also found in patients with COVID-19 by Abdul Kader et al. (23), who investigated the utility of these measures as biomarkers. Mean values were 495.28(124.9) for LDH, 394.69(337.1) for ferritin, 82.34(113.5) for CRP, and 1650.4(2233.2) for D.dimer.

Since CRP is an inflammatory response protein, its blood levels will naturally rise in response to inflammation. Thrombi are formed when the coagulation cascade is set in motion, which in turn triggers the complement system (24).

D-dimer elevations have been recorded in 3.75-68.0% of COVID-19 patients (25), suggesting that this virus may be linked to coagulopathy.

Most patients in this research exhibited bilateral lung infiltrations (99%), with 54% having a peripheral distribution and 46% reporting a mixed distribution, according to CT scans. Most patients (62%) had their lower lobe impacted, with the range of afflicted lobes being from 1 to 5. Ground glass opacities were seen in every patient, although only 19% had crazy paving. Consolidation occurred in almost 67% of the sample. Subpleural lines were seen in around 28% of the population. Only 10% of them had nodule/reticulation, 7% had a holo sign, and 4% had pleural effusion. The CT scores varied from a minimum of 3 to a maximum of 25.

These findings corroborated those of Abdollahi et al. (26), who showed that ground glass (94.1% of cases) and consolidation (91.0%) were the most often detected imaging abnormalities in COVID-19 patients. In addition, they discovered that 95% of patients had bilateral involvement, 96% had peripheral involvement, 8% had pleural effusion, and the median CT score was 19 (range: 13-23).

These findings were corroborated by the work of Mohamed et al. (27), who used chest computed tomography (CT) and laboratory data in 164 patients with confirmed COVID-19 pneumonia to draw their conclusions. Ground-glass opacities and consolidation were determined to be the most prevalent chest CT results. The lung periphery was the most prevalent location for infection. This thickening of the interlobular septum was common. Despite being indicative of COVID 19 pneumonia, crazy paving and reverse halo symptoms are rather rare. Mediastinal lymph node enlargement and pleural effusion were also infrequent.

Nearly all patients (99%) in this analysis reported experiencing feelings on both sides. Pleural abnormalities were seen in almost 93% of patients (irregular in 58% and broken in 35%, with just 7% having normal lines). The majority of patients had B lines (both displaced B-lines (50%) and confluent B-lines). (42%), but just one patient showed diffuse B lines in their brain. Consolidations were seen in almost two-thirds of the individuals. Only 4% of patients in our sample exhibited pleural effusion, suggesting that it is a rare finding in COVID-19 and likely results from a coexisting disorder. Between 0 to 36, the median score in the US was 16.

The most common finding in patients with COVID-19 was the presence of B lines (91%), especially in ICU patients (99%), according to a study conducted by Gil-Rodrguez et al. (28), who aimed to identify the de-fininng lung ultrasound (LUS) findings of COVID-19 and establish its association to the initial severity of the disease and prognostic outcomes. Eighty percent of patients had confluent B lines, with at least three B-lines being more prevalent in the ED (83 percent). Pleural thickening was seen in a somewhat higher percentage of patients (84%). Indicative of advanced illness, consolidations occurred in fewer (43%) of the trials reviewed. The incidence of pleural effusion was low (14%), and aberrant LUS results were seen on both sides of the chest in 59% of patients. The average LUS score, however, was 11.27 across all participants in the study.

Tan et al. (29) also identified diffuse B-line and rocket sign in 33.3%, diffuse B-lines in 100%, and totally diffuse B-lines or white lung in 83.3%, therefore these findings are consistent with their findings. Forty-one percent of the patients had pulmonary consolidations or subpleural localised lesions as well. Only 8.3% of individuals had pleural effusion. There may be a correlation between the greater sample size in our research (100 verified COVID-19 patients) and the smaller sample size in the work of Tan et al. (2020) (32 patients with only 12 confirmed COVID-19 patients).

The current study discovered a positive and statistically significant (P0.001) correlation between US score and respiratory rate. There were no statistically significant relationships found between the US score and demographic variables such age, systolic BP, diastolic BP, temperature, or heart rate.

Portale et al. (30) studied LUS scoring in hospitalised COVID patients and found that LUS score strongly linked with age, which runs counter to our findings.

Our research shows that the oxygenation parameters, including SO2 and PO2, go worse with increasing LUS, as measured by the US score (r = -0.741, P0.001 and r = -0.587, P0.001, respectively). There were no statistically significant associations between US score and pH, PCO2, HCO3, Na+, or K+.

Consistent with these findings, Lugara et al. (31) discovered that lower levels of PO2 were associated with greater LUS ratings. This was shown by a substantial negative correlation between the two (r = -0.400, p=0.001). In contrast to our results, others have shown a negative association between pH and LUS score (rho = -0.363, p=0.003) but not between SO2 and LUS score (rho = -0.113, p=0.366). Our result is supported by the research of Portale et al. (30), who discovered an inverse association between LUS and a critical oxygenation parameter (PO2/FiO2).

This investigation found a good association between the US score and many laboratory markers in our patients, including ferritin (r= 0.570, P0.001), LDH (r= 0.543, P0.001), D-dimer (r= 0.476, P0.001), CRP (r= 0.416, P0.001), and TLC (r= 0.355, P0.001). There was no statistically significant relationship between the US score and the absolute or relative number of lymphocytes.

Similar findings were found in a study investigating the possible involvement of lung ultrasound score (LUS) in 36 participants with COVID-19, conducted by Trias-Sabrià et al. (32). A number of laboratory tests were shown to be significantly correlated with LUS, including D-dimer (r = 0.424, P =.01), C-reactive protein (r = 0.373, P = 0.02), and lactate dehydrogenase (r = 0.460, P = 0.004). However, the authors did find a link between LUS and lymphocyte count (r = -0.487, P = 0.002), which runs counter to our findings.

Lung ultrasound (LUS) scores for B-lines and consolidations were significantly correlated both positively and negatively with markers of hemato-inflammatory activation and organ damage in a retrospective study by Senter et al. (33). While the direct link between CRP, LDH, and D-dimer with LUS scores for B-lines and consolidations is consistent with our findings, the negative correlation between LUS and lymphocyte count is not.

The current study found a favourable association between US and CT scores (r = 0.886, P 0.001).

Elhefnawy et al. (34), who attempted to categorise lung anomalies by lung ultrasonography in 30 SARS-CoV-2 patients and linked US finding likewise with chest CT results, found results consistent with these. LUS was shown to be significantly correlated with CTSI (p0.05).

Twenty-six patients with SARS-COV-2 pneumonia were studied by Fratianni et al. (17), and they discovered a direct but weak link between total LUS and chest CT scores (r = 0.45, P = 0.049).

In contrast, Baciarello et al. (35) found no significant relationship between LUS and CT score. Our CT and their LUS were both conducted within 24 hours of admission, but theirs were performed 7–10 days after admission by intensivists who were sent to the intensive care unit. If LUS is delayed too long after the first chest CT, the results may be impacted by the progression or regression of abnormalities shown on the second CT.

The current study assessed the ability of the LUS score to predict patient death and found that it had a significant-excellent AUC of 0.994, with the best cutoff being >24 (sensitivity 95.2%, specificity 96.2%).

In a study of 59 patients with COVID-19 who were hospitalised to the intensive care unit, Sosa et al. (36) assessed the ability of the LUS score to predict death. The researchers determined a cutoff value of 25 to have the highest area under the curve (AUC), sensitivity of 0.63, and specificity of 0.59. Thus, they found that the LUS score was less effective than we did in predicting death.

CONCLUSION

LUS is a noninvasive diagnostic method that shows promise in enhancing the detection and treatment of COVID-19 pneumonia in both inpatient and outpatient settings. The results from LUS are consistent with those from chest CT, and the severity of the LUS findings positively correlates with the severity score from chest CT. Laboratory parameters and the LUS score both correlate well with the severity score on the chest CT, allowing for more accurate prediction of the fate of COVID-19 illness.

Authors state they have no competing interests.

No particular grant was awarded for this study by any governmental, commercial, or non-profit funding agency.

Equal time and effort was put in by each author.

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Table (1): Demographic and clinical characteristics of the studied patients

General characteristics	
Age in years (M±SD)	53 ±15
Sex	**No. (%)**
Males	58 (58%)
Females	42 (42%)
Comorbidities	**No. (%)**
No comorbidities	32 (32%)

Diabetes mellitus	26 (26%)
Hypertension	30 (30%)
IHD	4 (4%)
Stroke	4(4%)
CKD	2 (2%)
Other	3 (3%)
Admission unit	**No. (%)**
ICU	63 (63%)
Ward	37 (37%)

Data are presented as mean ±SD or number (percentage)

Table (2): Symptoms and signs in the studied patients

Symptoms & signs	
Duration of symptoms (days)	6 (1 - 15)
Symptoms	**No. (%)**
Dyspnea	85 (85%)
Fever	89 (89%)
Cough	81 (81%)
Body ache	27 (27%)
Other symptoms:	43 (43%)
Abdominal pain	7 (7%)
Loss smell & taste	8 (8%)
Diarrhea	5 (5%)
Dizziness	8 (8%)
Fatigue	9 (9%)
Headache	5 (5%)
Loss conscious	1 (1%)
Signs	
Temperature	37.9 ± 0.7
Heart rate	105.23 ± 12.4
Systolic blood pressure	118 ±15
Diastolic blood pressure	73 ±12
Respiratory rate (b/m)	29 ±6
Cyanosis	5 (5%)

Table (3): Laboratory results of the studied patients

Lab parameter	Median (range)
PH	7.4 ±0.09
PCO_2	35.7 ±7.1
HCO3	20.63 ± 2.6
PO_2	52.1 ±13.3
SO_2 in room air (%)	80 ±11
Na+	134.8 ±12.3
K+	3.8 ± 0.6
Ferritin(µg/l)	612.5 (130 - 8046)
LDH(U/l)	430 (100 - 2900)
D-dimer(µg/l)	900 (150 - 8000)
CRP(mg/dl)	56 (7 - 296)
TLC	10.8 (2.8 - 25)x10^3
Lymphocytes (absolute)	0.899 (0.5 - 3.75)x10^3
Lymphocytes % (relative)	9.5 (1 - 37)

Data are presented as mean ±SD, median (min-max), or number (percentage

Table (4): CT findings of the studied patients

CT findings	No. (%)
Side	
Unilateral	1 (1%)
Bilateral	99 (99%)
Distribution of lesion	
Peripheral	54 (54%)
Mixed (central & peripheral)	46 (46%)
Number affected lobes	4 ±1
Type of opacities	
Ground glass opacity (GGO)	100 (100%)
Crazy paving	19 (19%)
Consolidation	67 (67%)
Subpleural line	28 (28%)
Nodule/reticulation	10 (10%)
Halo sign	7 (7%)
Pleural effusion	4 (4%)
CT score	14 (3 - 25)

Data are presented as mean ±SD, median (min-max), or number (percentage); GGO: ground glass opacity

Table (5): US findings of the studied patients

Findings	**No. (%)**
Side	
Unilateral	1 (1)
Bilateral	99 (99)
Pleural line	
Regular	7 (7)
Irregular	58 (58)
Broken	35 (35)
B lines	
Confluent	50 (50)
Displaced	42 (42)
Focal	1 (1)
No	7 (7)
Consolidations	66 (66)
Others	
Effusion	4 (4%)
LUS score	16 (0 - 36)

Data are presented as number (percentage) or median (min-max)

Table (6) Correlation between US score and clinical and laboratory parameters

	LUS score	
	R	**P**
Age (years)	0.11	0.278
Systolic blood pressure	-0.096	0.340
Diastolic blood pressure	-0.120	0.236
Respiratory rate (b/m)	.543	**<.001**
PH	-0.073	0.474
PCO_2	-0.155	0.126
PO_2	-.587	**<.001**
SO_2% in room air	-.741	**<.001**
HCO3	-0.196	0.051
Na	-0.0672	0.5068
K	-0.0447	0.659
Ferritin	.570	**<.001**
LDH	.543	**<.001**
D-dimer	.476	**<.001**
CRP	.416	**<.001**
TLC	.355	**<.001**
Lymphocytes (absolute)	-0.155	0.125
Lymphocytes (relative)	-0.121	0.231

r: Correlation coefficient

Table (7): Correlation between LUS score and CT score

	R	P	Significance
LUS score			
CT score	0.886	<.001	S

r: Correlation coefficient, S: significant, NS: non- significant

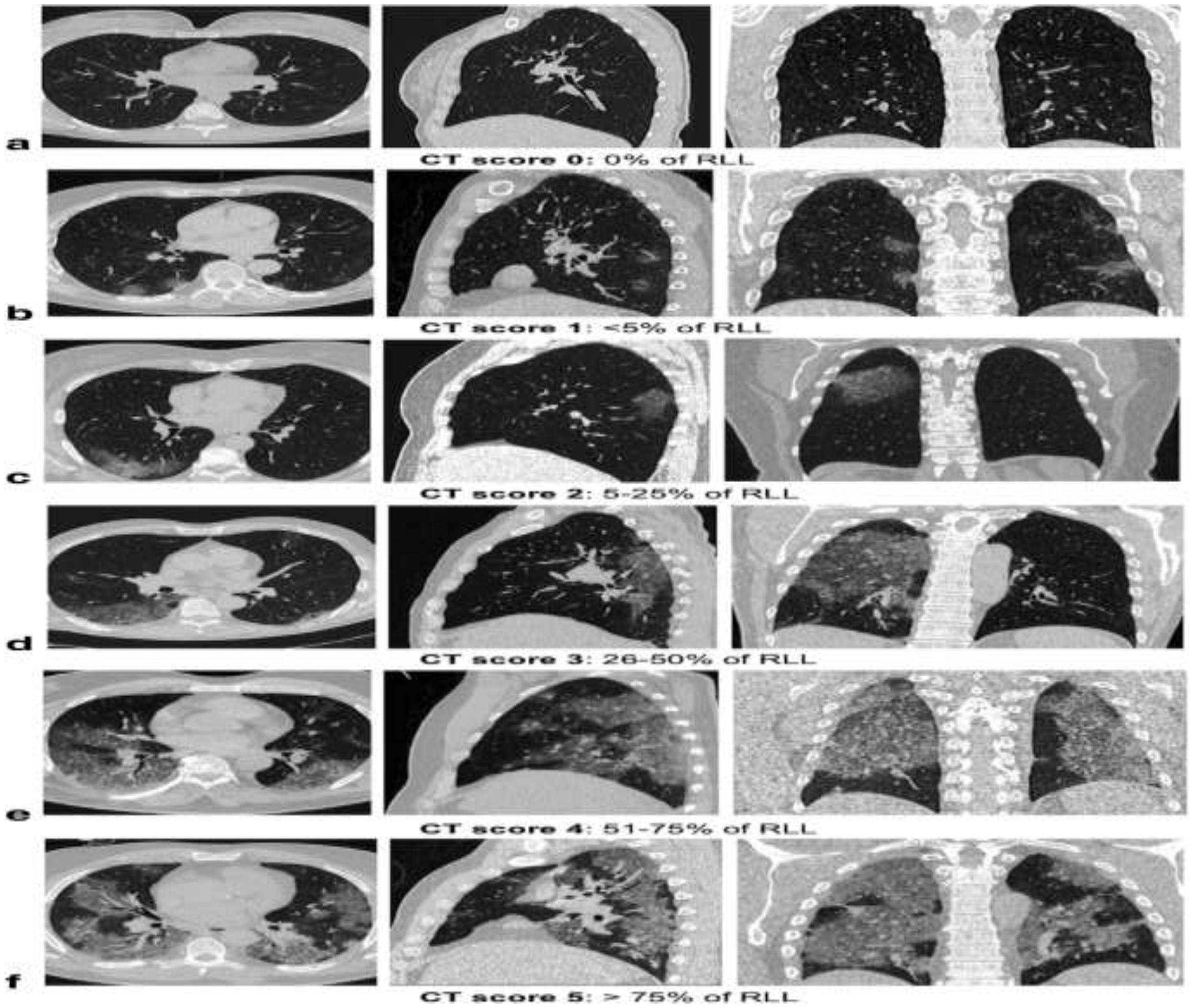

fig.(1);Different CT score of RLL involvement in COVID-19 pneumonia on axial, sagittal, and coronal images. 0% of RLL lobe involvement (**a**); < 5% of RLL involvement (**b**); 20% of RLL involvement (**c**); 40% of RLL lobe involvement (**d**); 70% of RLL involvement (**e**); > 75% of RLL involvement (**f**) [(6)].

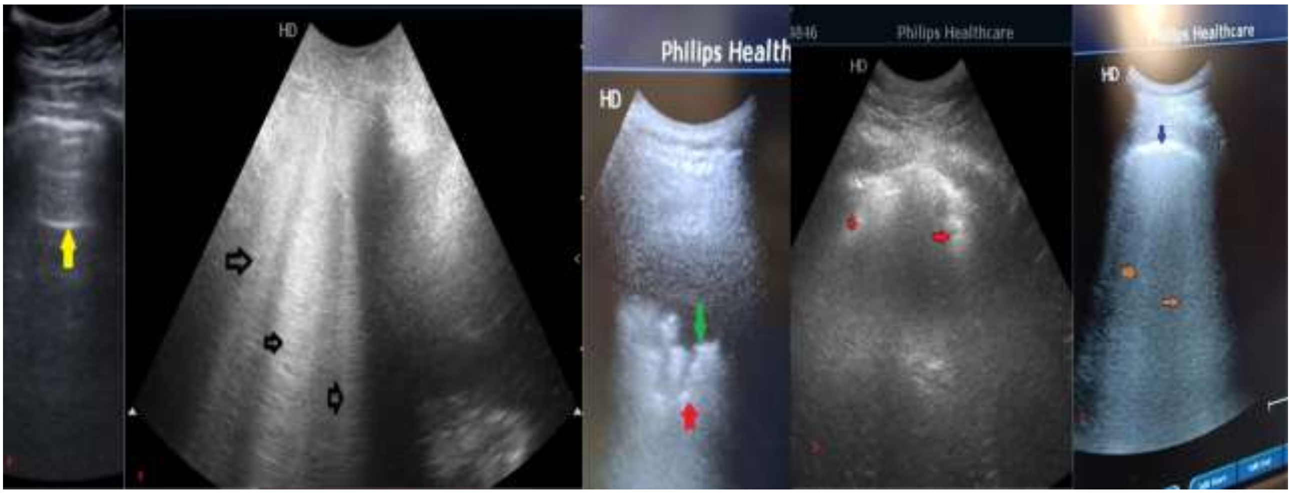

Figure (2): LUS showing (A) normal appearances-A line (yellow arrow), (B) B lines (black arrow), (C-D) Subpleural consolidation (red arrow)& Brocken pleural line (green arrow), (E) thick pleura)(blue arrow) & white lung (brown arrow).

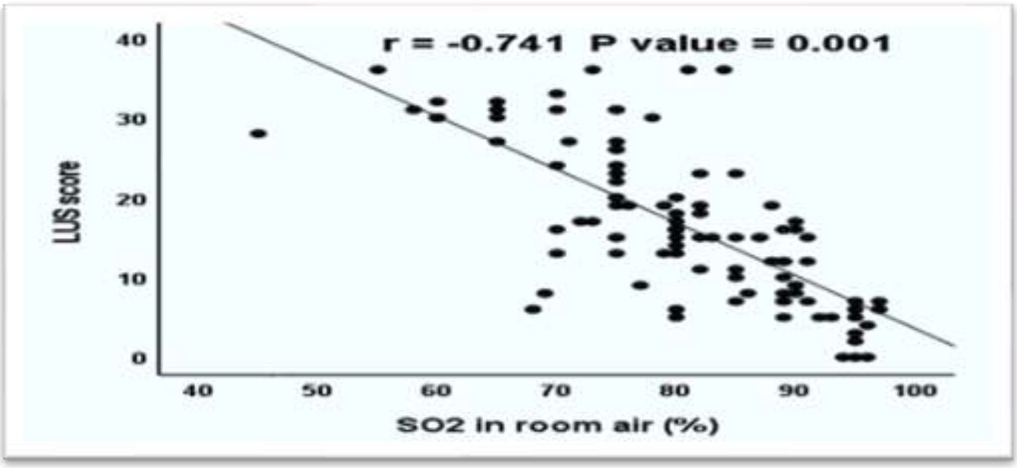

Figure (3): Correlation between US score and SO_2 in room air

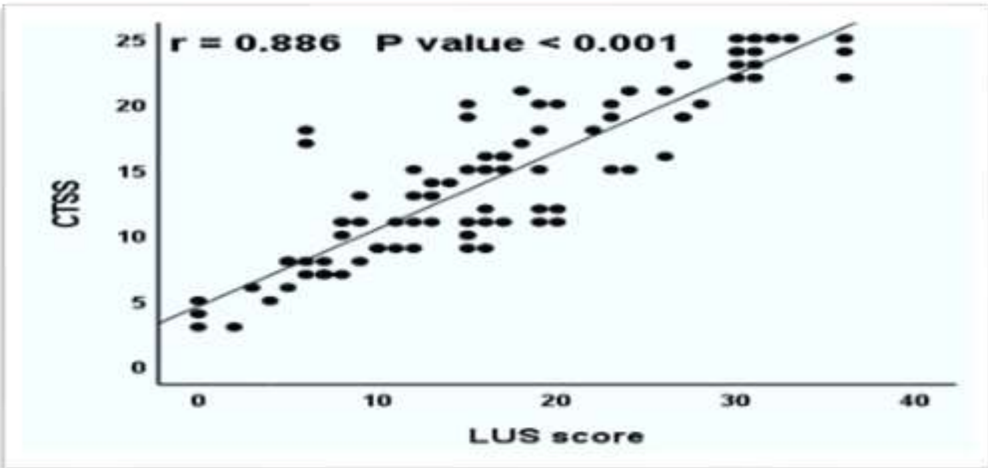

Figure (4): Correlation between CT score and US score

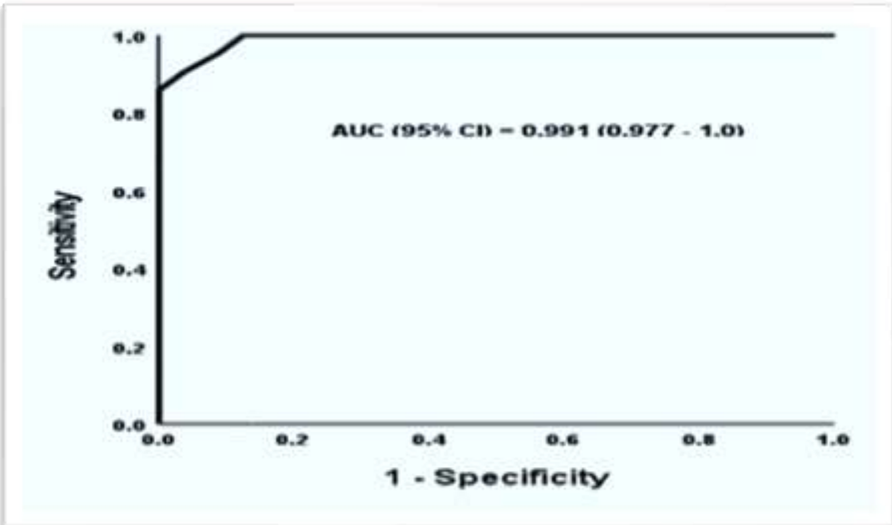

Figure (5) ROC analysis of US score to predict mortality