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Use of Lung Ultrasound Instead of CT Chest in Follow up of Patients with Covid-19 in ICU

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ORIGINAL ARTICLE

Use of Lung Ultrasound Instead of CT Chest in Follow up of Patients with Covid-19 in ICU

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Abstract

Background: **The new coronavirus disease 2019 (COVID-19) struck the central area of China in late December 2019 and quickly spread to several nations across the world. This virus's pandemic breakout, with fast human-to-human transmission, has caused significant devastation in many parts of life as well as a significant loss of human material and financial resources.**

Aim: **The purpose of this study is to assess the use of lung ultrasonography (LUS) instead of computed tomography chest in the ICU follow-up of patients with COVID-19.**

Patients and methods: **From February 2022 to May 2023, 50 patients were hospitalized in the ICU for the isolated critically ill (COVID-19) at Al-Hussein University Hospital.**

Results: **Most of our included patients had lung ultrasonography score involvement index (LUSI) 2 and 3 at admission 32 and 34 % while patients with LUSI 4 and 5 in the first and second weeks were 28 and 22 %, respectively. On the other hand, patients had LUSI 2 and 3 in the third week 28 and 20 %, respectively, while most of our included patients had LUSI 2 in the fourth week 24 %. Regarding the relation between LUSI and COVID-19 Reporting and Data System (CORAD) among the studied group, it was found that at admission CORAD score was statistically significantly higher than LUSI score. Our results indicated that among surviving patients 35 % of them had CORAD grade 4 at admission 42.5 % of them had LUSI 3 at admission and 30 % had LUSI 2 at discharge. Among nonsurvived patients, all of them have CORAD grade 5 at admission, one of them 10 % have LUSI 4 at admission and the remaining nine have LUSI 5 at admission. All of them had LUSI 5 at the time of death.**

Conclusion: **LUS is a simple technology that has a short learning curve and was frequently used during the COVID-19 epidemic. Its importance was reinforced during the latter 2 years of the pandemic because of its accuracy in early diagnosis, triage, and monitoring of pneumonia development and sickness severity. There was also a strong relationship between chest computed tomography and LUS score.**

Keywords: Coronavirus disease 2019, Follow up, Lung ultrasound

1. Introduction

The new coronavirus disease 2019 (COVID-19) struck China in December 2019 and quickly spread to several nations across the world. This pandemic breakout with fast human-to-human transmission has caused significant devastation in many parts of life as well as a significant loss of human material, and financial resources.[1] Diagnosis is an important step in the management and prognosis of COVID-19. Currently, the reverse transcriptase polymerase assay for viral load is regarded as a gold standard in the diagnosis of COVID-19, although results can take several hours or days to arrive.[2] Chest computed tomography (CT) and blood oxygen saturation level[3] are two more common COVID-19 diagnostic techniques. Acute respiratory distress syndrome, septic shock, refractory metabolic acidosis, coagulopathy and multiple organ failure develop in patients with severe

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illness. As a result, rapid identification of critically sick patients is crucial and has a high clinical value in lowering fatality rates. As a result, CT scans are ineffective for the follow-up and dynamic evaluation of critically sick patients, particularly women, and children.[4] Bedside lung ultrasonography (LUS) is a commonly available diagnostic technology that, in addition to physical examination, may give a wealth of diagnostic information in a variety of respiratory disorders and contexts.[5] CT exposes the patient to radiation and cannot be performed at the patient's bedside or in a short amount of time, therefore the patient's health may alter and deteriorate quickly.[6] LUS diagnosis accuracy for bacterial pneumonia is comparable to CT in the chest in the hands of competent doctors.[7] LUS is frequently utilized in emergency rooms and critical care departments; its benefits are especially apparent in elderly patients with many morbidities and limited mobility, for whom high-quality chest radiograph and CT scans are difficult to obtain. As a result, it is especially useful since it may be utilized at the patient's bedside, saving time and capacity.[7] LUS can detect the pulmonary dynamic changes associated with COVID-19; it has several advantages, including the ability to assess patients at the bedside, decrease the time patients spend in the emergency room, prevent radiation exposure, repeat it at minimal cost during follow-up and is simple to implement in locations with limited resources.[8,9] As a bedside and real-time instrument LUS may be useful for observing the impact of therapeutic medicines (immunosuppressive techniques, viral therapies or others) on COVID-19 patients. Point of care LUS has recently been presented as a potential tool for diagnosing, monitoring, evaluating the severity of the disease and predicting the prognosis of interstitial pneumonia brought on by COVID-19.[10,11] The primary goal of this study was to assess the use of LUS instead of CT chest in the ICU follow-up of patients with COVID-19. This cross-sectional study included 50 patients hospitalized in Al-Hussein University Hospital's intensive care unit for the isolated critically ill (COVID-19).

2. Patients and methods

From February 2022 to May 2023, 50 patients were admitted to Al-Hussein University Hospital's ICU as isolated cases of critically ill (COVID-19). They were diagnosed by a positive RT-PCR COVID test. The patients were chosen after being informed about the purpose of the study, and a free-will written approved consent will be obtained and the entire work will be carried out in accordance with the ethics committee, Faculty of Medicine, Al-Azhar University. All patients underwent both CT and bedside LUS within 24 h of arrival. Severe cardio-respiratory sickness, interstitial lung disease and a history of chronic obstructive pulmonary disease unable to get an ultrasound in which performed poor ultrasound pictures were taken at the bedside. All of the patients in the study are required to provide a history of their current condition as well as a past history of chronic illnesses, particularly chronic chest conditions like COPD, ILD, and severe cardiac diseases. They are also required to submit to multiple laboratory tests including a complete blood count C-reactive protein, plasma D-dimer, arterial blood gases, kidney function tests, liver function tests, and random blood glucose. Using B mode, LUS was conducted over the whole chest while avoiding the ribs and placing the probe in the intercostal regions. The probe was positioned longitudinally, perpendicular to the ribs as well as obliquely along the intercostal gaps. Ultrasound scanning was performed on the right and left hemithorax for the anterior and lateral chest from the second to the fourth (on the right side to the fifth) intercostal spaces and from the parasternal line to the axillary line. The paravertebral line, linea scapularis and posterior axillary lines were scanned along the posterior chest.

3. Results

Table 1 shows that, the majority of the included patients (15 individuals) had COVID-19 Reporting and Data System (CORAD) 5 on admission, whereas 17 patients had lung ultrasonography score involvement index (LUSI) 3.

The majority of the enrolled patients (17 individuals) had LUSI 3 at the time of admission. The majority of the included patients (15 patients) had LUSI 3 in the first week and LUSI 5 in the second week. The majority of the included patients had

Table 1. COVID-19 Reporting and Data System and lung ultrasonography score involvement index scores among studied patients on admission.

Number grade	CORAD	LUSI
	N	*N*
1	0	0
2	8	16
3	13	17
4	14	8
5	15	9
Total	50	50

CORAD, COVID-19 Reporting and Data System; LUSI, lung ultrasonography score involvement index.

LUSI 2 in the third week (14 patients) and LUSI 2 in the fourth week (12 patients; Table 2).

P value 0.05 is significant; on admission, CORAD score increased statistically significantly more than LUSI, as seen in Table 3.

Table 4 shows that, leucocytes, heart rate, and respiration rate were statistically significantly higher in deceased patients than in survivors.

Table 2. Lung ultrasonography score involvement index score follow up among studied patients.

Number grade	On admission	1st week	2 nd week	3rd week	4th week
	N	*N*	*N*	*N*	*N*
0	0	0	5	4	5
1	0	0	2	2	7
2	16	7	7	14	12
3	17	15	11	10	3
4	8	14	11	5	0
5	9	14	14	7	0
Total	50	50	50	42	27

Table 3. Comparative study between COVID-19 Reporting and Data System and lung ultrasonography score involvement index on admission among studied patients.

Score item	CORAD	LUSI
Range	2–5	2–5
Mean	3.720	3.200
SD	1.069	1.088
Observative difference of mean	0.520	
SE	0.151	0.154
t	2.410	
P value	0.018	
Significance	Significant	

CORAD, COVID-19 Reporting and Data System; LUSI, lung ultrasonography score involvement index.

Table 4. The association between clinical and laboratory data of the survived and dead patients.

Item patients	WBCs		HR		RR	
	Mean	SD	Mean	SD	Mean	SD
Survived	8.5775	4.70594	90	3.84974	31.15	1.49443
Dead	22.07	6.39723	115.1	16.27165	37.9	4.04008
t	−6.26		−4.844		−5.195	
P value	<0.0001		0.001		<0.0001	

HR, heart rate; R, respiratory rate; WBC, white blood cell.

Table 5 shows that hypoxia, acidosis and hypercarbia were statistically more common in patients who dead than in those who survived.

P values greater than 0.05 are not significant, and the observed difference in mean is 0.1. Table 6 shows that there is no statistically significant difference between LUSI on admission and before death in nonsurvived patients since they were all critically ill from the outset.

The current study also shows that, the identification of viral nucleic acid utilizing reverse transcriptase polymerase reaction from nasopharyngeal swabs and noncontrast high-resolution CT are the cornerstones in COVID-19 diagnosis. Furthermore, LUS for evaluating and monitoring patients' disease severity and mortality risk in order carrying out therapeutic and overall management, as well as the ability to perform it at the bedside, which reduces infection risks associated with patient transfer to radiology units to perform HRCT.

Furthermore, LUS is a reproducible procedure that may be utilized in all patients including children and pregnant women at a reasonable cost and without the use of radiation. Despite a comparison analysis between surviving and nonsurvived patients for clinical and vital signs, CT grades on admission and LUSI scores on admission versus follow up over 4 weeks no negative control cases were included in this study.

4. Discussion

The world has been on edge since December 2019 due to the unique coronavirus infection (COVID-19). The infection is brought on by SARS-CoV2,

Table 6. Comparison of lung ultrasonography score involvement index on admission and before death in nonsurvived patients.

Time item	On admission	Before death
Range	4–5	5
Mean	4.900	5
SD	0.316	0.011
Observative difference of mean	0.1	
SE	0.154	0.046
t	1.000	
P value	0.343	
Significance	Nonsignificant	

Table 5. The association between survived and dead patients for arterial blood gases data of the studied patients.

Item patients	O_2		pH		$PaCO_2$		PaO_2	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Survived	84.8	4.404	7.272	0.04	43.35	12.960	55.6	6.694
Dead	68.1	4.383	7.088	0.072	66	13.743	34.1	4.383
t	10.766		7.658		4.714		12.328	
P value	<0.0001		<0.0001		<0.0001		<0.0001	

which results in viral pneumonia, ARDS, and a number of organ presentations including acute coronary syndrome, acute renal failure, liver failure, thrombotic issues, and neurologic abnormalities.[12]

Currently, most COVID-19 patients are subjected to a reverse transcriptase PCR and a low dose noncontrast chest CT scan.[13] However, there may be certain limits to this imaging modality, such as the transfer of infection and the restriction of moving patients with unstable hemodynamics or contraindications, such as pregnant women or children.[14]

Ultrasonography can identify COVID-19 pulmonary lesions and can be conducted at any stage of the illness.[15] Protocols for LUS in COVID-19 patients have been developed; however, data on the consistency of LUS results with chest CT scans in COVID-19 patients is limited.[16] According to the current study, 88 % of the cases analyzed were men, while 12 % were girls. The average age of the patients investigated was 60.7 years old. The mean BMI of the patients analyzed was 28.1.

Additionally, 16 included 42 COVID-19 ICU patients indicated that the bulk of the cases studied were men ($n = 29$; 69 %) with a mean age of 66 years.[16] The average BMI of the participants investigated was 28.[4] Of 34 critically sick patients treated with COVID-19 had a BMI of 28. Regarding vital signs,[17,18] we discovered that the average breathing rate of the patients tested was 31 cycle/min. The ladies investigated had an average temperature of 38 °C. The individuals investigated had an average heart rate of 94 beats per minute. The ladies investigated had a mean blood pressure of 102 mmHg. The mean PaO_2 of the patients investigated was 51.3 mmHg. The $PaCO_2$ of the patients under study was 47.8 mmHg. The mean O_2 saturation of the patients investigated was 81 %. The population analyzed had a mean pH of 7.23.

Local radiologists used the CORADS to assess the pulmonary involvement of COVID-19 patients. The CORADS scale ranges from 1 (minimal lesion) to 5 (ARDS). The majority of the individuals evaluated (29 cases) had CORAD 4 and 5. The LUSI was a systematic evaluation of six zones in each hemithorax. On admission, 33 patients in the current research had LUSI scores of 2 and 3. A comparison of CORAD grades and LUSI scores revealed that CORAD grades increased statistically more than LUSI scores on admission. This suggests that the chest CT result on admission is more informative and sensitive in diagnosing COVID 19. LUS was utilized for follow-up of present patients for 4 weeks (once every week or when the condition of the patients was necessary) since it was low cost, avoided radiation, decreased patient transportation and minimized infection spread. It can also be readily repeated in patients with mechanical ventilation and pregnant women. The LUS can be used to monitor hospitalized patients for the presence of a new coronavirus illness (COVID-19). The LUS score is a valuable instrument in the ICU for monitoring adult distress syndrome.[19] It may be used to determine the degree of lung involvement make a COVID-19 diagnosis based on the discovery of SARS-CoV2 on RT-PCR from a nasopharyngeal exchange and compare it to accessible noncontrast high-resolution chest CT in emergency hospitals. The present patients' LUSs revealed that lung involvement was greater in the first week than on arrival due to parenchymal disease.[20,21] Despite the fact that there is no substantial change in the third week (eight patients dead with severe lung involvement) there is significant improvement (by lowering of LUSI). The LUSI was significantly lower in the fourth week than it was on admission, since most patients recovered and were released.[19,20]

In the current trial, 10 individuals out of 50 (a 10 % mortality rate) dead. Eight patients dead after 3 weeks, while two dead after 4 weeks. Eighteen (22 %) patients dead within 2 weeks of being followed up on.

After 8 days of hospitalization (5–15 days), 11 (42 %) patients out of 26 dead.[21] The cause of the high death rate is old age and comorbidities.[16,19,20]

In this study, the clinical data (respiratory rate and heart rate) and mean leucocytic count of the dead group were significantly higher than those of the survivors. The deceased group's arterial blood gases (PaO_2, O_2 saturation, and pH) revealed a highly significant reduction, whereas $PaCO_2$ and platelet increased in survived group. In a study of six hospital death patients out of 37 surviving patients with COVID-19, all nonlived patients had CORAD 5 (10 patients) and LUS score 5, whereas the majority of survived patients had 3 or 4 CORAD and 2 or 3 LUS score.[19,20] In a study evaluating the predictive significance of the LUS score in 37 patients admitted to the ICU with COVID-19, they discovered that higher LUS score values were connected to hospital death.[19] CT reveals increased consolidation and ground glass appearance in COVID-19 infected patients, which was associated with a prognosis of protracted hospitalization and prompted the medical team to evaluate which patients required high care.[21]

4.1. Conclusion

The gold standard for diagnosing patients with COVID-19 is viral nucleic acid (RT-PCR) and unenhanced CT chest. The use of chest CT at the

initial presentation of patients suspected of having COVID-19 has been recommended since CT chest exhibits greater consolidation and ground glass look and has higher specificity than LUS in diagnosing COVID-19 patients. The LUS is highly valued in ICU patient follow-up with COVID-19 (as an alternative to CT in monitoring the degree of illness and death risk) since it is low cost, reproducible, and radiation-free.

Conflicts of interest

There are no conflicts of interest.

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