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Original Article

Internal Medicine Section

Brixia Chest X-ray Scoring System in Critically Ill Patients with COVID-19 Pneumonia for Determining Outcomes

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ABSTRACT

Introduction: In early stage of disease of Coronavirus Disease 2019 (COVID-19) infection chest Computed Tomography (CT) imaging is considered as the most effective method for detecting lung abnormalities. A Brixia Chest X-ray (CXR) scoring system which uses an 18-point severity scale to grade lung abnormalities due to COVID-19 was developed to improve the risk stratification for infected patients.

Aim: To ascertain the validity of Brixia scoring system and to measure the outcome in COVID-19 patients.

Materials and Methods: A retrospective study was conducted from 1st April 2020 to 31st July 2020, at a tertiary care hospital in India. Baseline CXR of COVID-19 patients were scored based on Brixia scoring system. The lungs were divided into six equal zones. Subsequently, scores (from 0-3) were assigned to each zone, based on lung abnormalities. A group comparison was implemented using Chi-Square test for categorical variables. Whereas an independent t-test was applied for continuous variables that followed normal distribution.

Results: The study included 130 patients. The mean age was 57.09±13.73 years, 70.8% patients included were males. Out of 130 patients, 79 patients died. Among patients who died the mean CXR score was calculated to be 12.13±2.50. The mean CXR score was calculated to be 11.18±2.30 in patients who recovered and got discharged. During the process of comparison of CXR scores with the outcomes, the t-value came out to be 2.20 and the resulting p-value was 0.03 (statistically significant).

Conclusion: Brixia score more than 12 was associated with increased mortality due to COVID-19, with p-value of 0.03.

Keywords: Coronavirus disease-2019, Outcome scoring, Pneumonia severity, Radiographic abnormality

INTRODUCTION

The prodigious burden of coronavirus disease 2019 (COVID-19) pandemic has challenged the healthcare system. Globally there have been 170 million cases and more than three million deaths reported till date [1].

A new beta coronavirus, the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) belonging to Orthocoronavirinae sub family of *Coronaviridae* family, is a causative agent for COVID-19 [2,3] It causes pneumonia with severe respiratory distress [4]. Though the mortality rate in mild COVID-19 disease is not significantly high, in the critically ill patients it is high with COVID-19 pneumonia. Considering recent mortality estimates [5] one should be aware of the risks associated with its fatal outcome. Of this factors, older age, co-morbidities like diabetes and hypertension and severity of disease at presentation are directly associated with the outcome [6]. Similarly disease severity in the form of deranged laboratory parameters such as virus induced cytokine storm syndrome and radiological lung involvement can also be used as predictor of fatal mortality [7]. CXR at the time of presentation has role in depicting the mortality when it is scored using Brixia system.

As of date, in patients infected with COVID-19 lung abnormalities in early course of the disease and for quantitatively assessing severity and progression, chest CT imaging is considered as the most effective method [4,8]. In spite of CXR not being considered sensitive enough for detecting pulmonary involvement in the early course of disease [4,9]. CXR is a useful diagnostic tool for monitoring lung abnormalities in Intensive Care Units (ICUs) while CT imaging can be used in the early stage of disease [10]. CXR has low sensitivity (about 69%) to diagnose COVID-19, but it can be used in predicting clinical outcomes [10]. In order to increase the risk stratification within infected patients, a CXR scoring system titled as Brixia score is created for quantifying as well as monitoring the severity of lung abnormalities [10]. Not many studies have evaluated the predictive value of the scoring system. Therefore, the aim of this study was to compare the novel CXR severity score with that of mortality in patients with moderate to severe COVID-19 disease in ICU (patients having Saturation of Peripheral Oxygen (SpO_2) <94%).

MATERIALS AND METHODS

It was a study carried out on a retrospective basis at a tertiary care hospital in India. As it is a retrospective observational, non interventional study, departmental approval was taken and institute ethical committee approval was waivered. Through retrospective analysis, baseline CXR of COVID-19 patients admitted in critical care unit were retrieved, from 1st April 2020 to 31st July 2020 and the data was analysed on 27th October 2020.

Inclusion criteria: Data of every COVID-19 patient admitted to the ICU and requiring oxygen either in the form of High Flow Nasal Cannula (HFNC), a non rebreathing reservoir mask with 15L of O_2/min, Non Invasive Ventilation (NIV) or invasive mechanical ventilation was selected and their baseline CXR taken at the time of admission was scored.

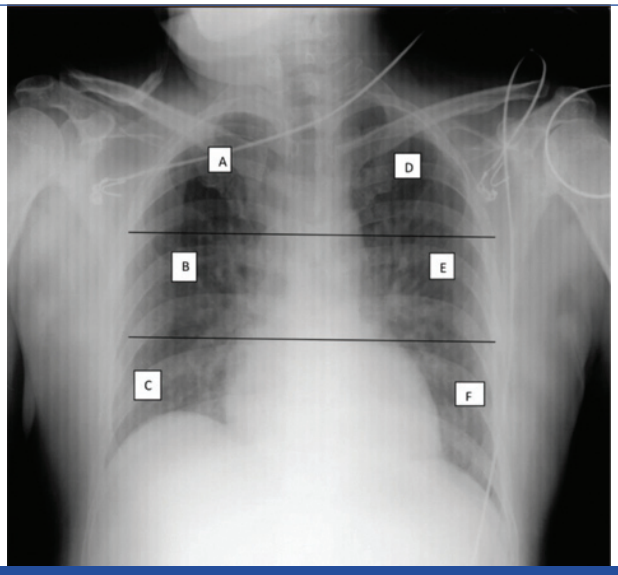
Exclusion criteria: Patients who had chronic organ failure in the form of chronic liver disease, chronic respiratory failure, chronic kidney failure or cardiac arrest and those with chronic neurological were excluded from the study.

Study Procedure

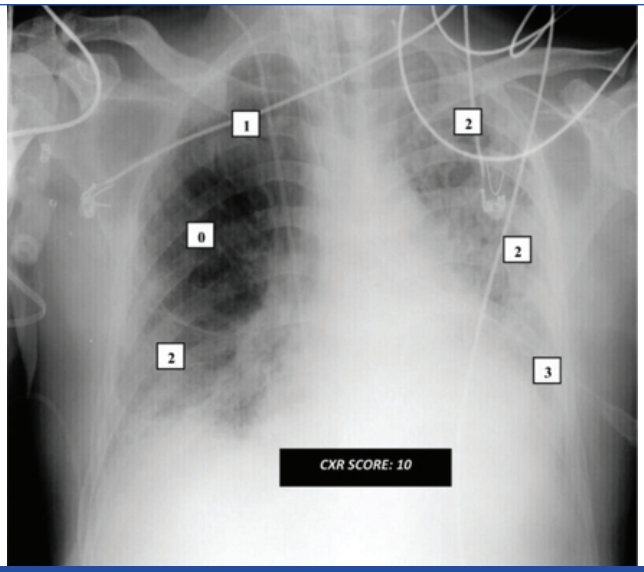
An experienced radiologist, who was blinded to the patient's details and outcome, had scored these CXR, on the basis of Brixia scoring system. The final scores were compared against final outcomes of the patients, death or discharge. Correlation of final outcome with gender and with age was also calculated.

This Brixia CXR scoring system includes two steps:

Initially on frontal chest x-ray (antero-posterior projection according to the patient position) the lungs were divided into six zones [Table/Fig-1].



[Table/Fig-1]: Division of frontal CXR in 6 zones.



[Table/Fig-2]: Example of CXR with Brixia score of 10.

- Upper zones A and D- above the inferior wall of the aortic arch.
- Middle zones B and E- from below the inferior wall of the aortic arch to above the inferior wall of the right inferior pulmonary vein (i.e., the hilar structures).
- Lower zones C and F- below the inferior wall of the right inferior pulmonary vein (i.e., the lung bases).

For technical reasons, for bedside CXR (in critically ill patients) it was difficult to identify some anatomical landmarks and hence in these cases, each lung was divided into three equal zones. Scoring was done then with similar steps given below.

The next step was scoring the lung zones from 0-3 based on lung abnormalities that were detected on the frontal chest radiograph as follows:

- Score of 0 was assigned for no lung abnormalities
- Score of 1 implied the presence of interstitial infiltrates
- Score of 2 meant both interstitial and alveolar infiltrates but with interstitial predominance
- Score of 3 implied both interstitial and alveolar infiltrates but with alveolar predominance

Subsequently, the total scores of all the six lung zones were added to obtain an overall "CXR SCORE" ranging 0-18. An example of our CXR report is shown in [Table/Fig-2], in which a total score is of 10.

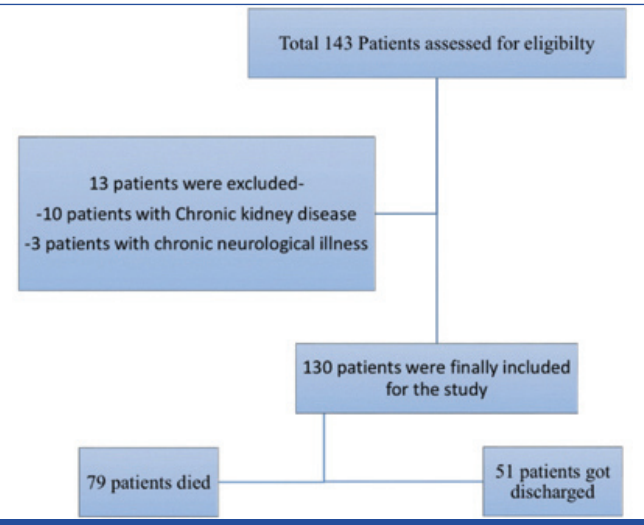
STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) software version 25.0 was used for all statistical analysis. Descriptive statistics was used to show the results of continuous variables whereas, frequency and percentages were used for categorical variables. Chi-square test was done for group comparison of categorical variables. Independent t-test was done for continuous variables exhibiting normal distribution. Across all results, a level of significance of 5% was used. Results are shown with a confidence interval of 95% and a p-value <0.05 was considered to be significant.

RESULTS

[Table/Fig-3] shows the flowchart of patients, 13 out of 143 patients were excluded and finally 130 were assessed for eligibility. Out of 130 patients, 79 patients died.

The mean age was 57.09 years among the patients who did not survive, whereas, the mean CXR score was found to be 12.13±2.498, whereas 53.94 years was the mean age among patients who were finally discharged, and their mean CXR score was 11.18±2.304. There was no significant association between age and gender with CXR score [Table/Fig-4-6].



[Table/Fig-3]: Flow chart demonstrating patient's stratification.

Outcome		n (number of patients)	Minimum	Maximum	Mean±Standard deviation	p-value (independent t-test)
CXR score	Death	79	5	17	12.13±2.498	0.03
	Discharged	51	6	16	11.18±2.304	

[Table/Fig-4]: CXR score and outcome.

Outcome		Number of patients	Minimum (years)	Maximum (years)	Mean±Stanard deviaion	p-value (independent t-test)
Age	Death	79	30	95	57.09±13.732	0.19
	Discharged	51	18	75	53.94±13.459	

[Table/Fig-5]: Age and outcome.

Gender	Outcome			
	Discharge	Death	Total (percentage)	p-value (Chi-square test)
Male	33	59	92 (70.8%)	0.222
Female	18	20	38 (29.2%)	
Total	51	79	130	

[Table/Fig-6]: Gender and outcome.

DISCUSSION

COVID-19 pandemic has challenged us in last few months, starting from diagnosing to managing the disease.To manage and predict the outcomes there is need of an easy-to-use, robust chest radiography algorithm. In present study, authors have explored the value of initial chest radiography in predicting final outcome in patients with COVID-19 admitting in critical care unit. The Brixia CXR scoring system was actually

designed for assessing the severity of lung involvement in patients who are admitted with COVID-19 illness. It is a very simple method which can be duplicated even in other clinical scenarios. When baseline CXR score was compared with patient's final outcome, the p-value was 0.03, which was statistically significant implying association between the two. Hence, this scoring system can be adopted for accurately predicting the outcome in patients infected with COVID-19. The results were in sync with study by Bhorgesi A et al., [6].

Bhorgesi A et al., in his study scored initial CXRs of 302 patients with Brixia scoring system and concluded that high Brixia score was associated with a highest risk of in hospital mortality [6]. According to the study by Toussie D et al., [11], each patient's Emergency Department (ED) chest radiograph was divided into six zones and examined for opacities, scores were collated into a total concordant lung zone severity score and according to this chest radiograph severity score was predictive of risk for hospital admission and intubation.

In the present study, most of the patients who died had score of more than 12; while among patients with score of less than 12, most of them were recovered and got discharged.

There are other CXR scoring systems such as Severe Acute Respiratory Infection (SARI) CXR Severity Scoring System and Radiographic Assessment of Lung Edema (RALE) classification [12]. The SARI CXR scoring system was used in the pre COVID era for confirmed acute respiratory infections and its goal was to simplify the clinical grading of CXR reports into five different severity categories in hospitalised patients. It is subjective for a reporting physician [13]. The RALE classification system presented by Wong HYF et al., [10]. The authors adapted and simplified the RALE score proposed by Warren MA et al., in 2018 [14].

The major strength of this study is its large sample size. This is one such study which has assessed the effectiveness of this particular scoring system to forecast the final outcome with regard to discharges and deaths in patients infected with COVID-19.However, several other studies like Bernheim A et al., and Pan F et al., have investigated role of CT [15,16]. Advantage of CXR in critically ill over CT is that CXR can be done bedside easily; on contrary for CT patient needs to be shifted to the CT room. The radiologist who was the observer was blinded to the patient's details and outcome, in turn decreasing the observer bias.

The average age in this study was found to be higher in death outcome group which is in-line with other studies like Ruan Q et al., [7], Wang Z et al., [17], Yuan M et al., [18], Zhou F et al., [19]. The mentioned studies have shown a linkage between elderly age and poor prognosis in COVID-19 patients. As CT imaging could not be done for all patients, as the hospital is a large teaching hospital with just one CT machine available and hence becomes difficult to carry out the same on a routine basis.

Limitation(s)

The major limitation of this study was that the authors used only the baseline CXR severity score as an independent indicator of prognosis of the final outcome. The next limitation was the absence of a follow-up on a long-term basis for all the discharged patients. Therefore, many more studies will be required to analyse the worsening of opacities on the chest radiographs which will be done on a follow-up basis with regard to the final outcome of our patients.

CONCLUSION(S)

Brixia score more than 12 was associated with higher risk of mortality due to COVID-19. It provides the point information for bedside clinical assessment of COVID-19 patients. Considering difficulty in shifting of patients with severe disease for CT, and its non-feasibility for all the patients, reliance on CXR is the need of time for COVID-19 management in ICU.

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