Application of Brexia – An Italian experimental chest X-Ray scoring system: Evaluation and progress monitoring of COVID-19 pneumonia

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ABSTRACT

Objective: To evaluate and monitor Covid-19 Pneumonia in Pakistani population by applying Brexia, an Experimental Italian Chest X-ray Scoring System

Study Design: Retrospective Descriptive Cross-Sectional study

Place and Duration: Department of Radiology of Combined Military Hospital Malir from 1st March to 30th June 2020

Methodology: Through non-probability consecutive sampling technique all the standard frontal projections of chest X-Ray of PCR confirmed COVID-19 patients were studied on computer and findings were assessed by applying Brexia (an Experimental Italian Chest X-ray) Scoring System

Results: A total of 548 Chest X-Rays were studied. Mean age of patients was 40.79±16.082 years. The mean scores (Brexia score) in recovered patients was 1.91±3.788 and that of deceased was 16.59 ±3.068.By keeping confidence interval 95% and *p* value of 0.01.The *r* for Brexia score versus age was .557(fair) and Brexia score versus clinical output was 0.751(moderate).

Conclusion: High Brexia score is associated with increased in radiological severity of COVID-19 pneumonia and poor outcome.

Keywords: COVID-19, Chest X-ray, Scoring, COVID-19 severity, COVID-19 stratification, BREXIA scoring

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INTRODUCTION

COVID-19 SARS. is caused by a recently isolated virus in human beings which is a jumped up viral species[1,2]. This infection was seen in Wuhan province of China and diagnosed in Chinese population in December 2019[3,4]. It belongs to Corona virus family which has already caused SARS, MERS type of infections[4].This infection is different from its precursors in term of its virulence and speedy spread[5]. Now the COVID -19 has been declared a pandemic as it has spread to almost whole world.

More than 3500 COVID-19 related deaths have been reported in China till writing of this article[6]. So far more than four hundred thousand deaths have been reported globally[7]. Pakistan has been affected by the COVID-19 as well. More than 160 thousands cases and 3500 deaths have been reported. The rt-PCR is the gold standard for the diagnosis of the COVID-19[8]. Radiology is also playing an important role in screening, diagnosis and monitoring progression of the disease. The HRCT chest has been found to be superior to rt-PCR in some studies[9]. But it has limited role due to availability and high radiation. Cost effectiveness and solo machine in department are also limiting factors in countries like Pakistan. Therefore in radiology departments like ours, Chest X-Rays play a pivotal role. Portable Chest X-Ray is being used for the ICU patients as well. Chest X-Ray is not considered effective in screening and disease evaluation[10] Though Chest X-Ray has been used to classify the disease severity on the basis of percentage involvement of the lungs[11]. But we believe that in current pandemic, and with limited resources, Chest X-Ray (standard or portable) can be a useful tool for disease severity stratification, monitoring progress and response evaluation. We have used BREXIA – An experimental Chest X-Ray scoring system of radiographic severity index already implemented in Italy[12] to seen the possible outcomes in Pakistani population. Similar scoring systems have been used in past for various diseases[13] and for

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COVID-19 as well. They have found satisfactory practical results, especially when guiding the clinicians in the management of COVID-19 patients.

To the best of our knowledge no such study has been published in Pakistan or surrounding regions, where BREXIA - Chest X-Ray scoring system was used to classify, monitor and predict clinical outcome of COVID-19 patients. So, this study was designed to present Chest X-Ray scoring system that can been applied to the hospitalized patients. This would help the clinicians and radiologists to manage the patients in a better way, especially in the peripheral rural setups where the facilities like HRCT chest and rt-PCR are not present. The objective of our study was to evaluate and monitor Covid-19 Pneumonia in Pakistani population by applying Brexia, an Experimental Italian Chest X-ray Scoring System.

METHODOLOGY

This Descriptive Cross-sectional Retrospective Study was conducted in the Department of Radiology of Combined Military Hospital, Malir from 1st March to 30th June 2020. Non-probability consecutive sampling technique was used to collect the data. Inclusion criteria comprises of Chest X-Rays (standard or portable, indoor or outdoor patients) of confirmed COVID-19 by PCR of any age and gender, symptomatic or asymptomatic. All the patients who were suspected of COVID -19 despite having high probability of COVID-19 and positive contact history but were negative on PCR were excluded from study.

The Chest X-ray of the patients was done with standard technique of Chest X-ray (PA-view) on Digital Radiography machine by Canon by using 800 mA. The patients who were in serious condition went under bedside chest radiology by using portable X-ray machine 200 mA by Siemens. The Chest X-Ray films were developed and read on CR system. The BREXIA Chest X-ray scoring system used in Italy [12] was used by radiologists in our study. The Chest X-ray of the same patients was reported by two different radiologists and the highest Chest X-Ray score among the two was used. Inversion of the Chest X-ray on console was also used to evaluate the findings. In Brexia Scoring, the Chest X-Ray was divided into six equal zones, three on each side on frontal projection (antero-posterior for portable or posterior-anterior for standard views – Fig-1), as employed in Italy. The scoring used was pre-assigned values for area involvement by pathological findings on frontal Chest X-Rays. As it was similarly done in previous study[12]. The values are as under:

0 = Normal
1 = Interstitial Infiltrates
2 = Mixed infiltrates with interstitial predominance
3 = Mixed Infiltrates with alveolar predominance

Above mentioned pre-designated values for the individual zone was assigned according to the type of involvement or radiological appearance. Interstitial infiltrates were defined as opacities that can be individually and easily isolated. Alveolar infiltrates were fluffy opacities, more confluent and dense on chest x-rays than infiltrates. Two mix patterns with either of predominant findings were also analyzed. Summation of score from individual zones was done. (Figure 1). It ranges from 0 to 18.

Data Analysis: Data was analyzed with statistical analysis program (SPSS version22). Frequency, percentage, means of ages, Chest X-Ray scores were calculated. Comparison of the means of Chest X-Ray scores on the basis of genders, clinical outcome and age groups were computed by using t-test for comparisons. Levene's testing was applied to calculate the probability.

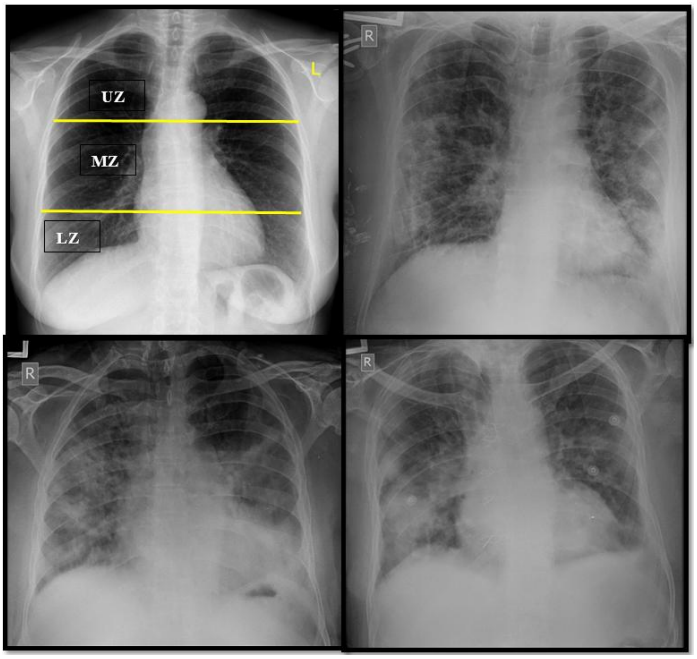

Figure-1: Showing four types of chest x-rays. A is a normal chest x-ray with zonal distribution. B is with interstitial infiltrates with mid and lower zones predominance. C mixed opacities with interstitial predominance. D Mixed opacities with alveolar predominance. UZ = upper zone, MZ = middle zone and LZ = Lower zone

RESULTS

Total number of 548 Chest X-Rays were studied. The mean age was 40.79±16.082 years. The range was 1 year and maximum was 93 years respectively. The median age was 38.00 years. The variance calculated was 258.641, kurtosis -.157 and standard error of Kurtosis .209. In our study out of 548 patients, 466(85.03%) were male and 82(14.097%) were females.

The mean age of males was 38.31± 14.64 years and that of females was 41.48±15.065 years. The stratification of the age by decades is shown in Figure-2.

Total of 50 (9.12%) patients out of 548 died due to COVID-19 pneumonia and associated complications.

Table-I shows that the mean Brexia score of male patients died (35/50) of COVID-19 was very high (16.89/18) when compared to recovered male patients (1.81/18). Similarly the mean Brexia score of deceased females was also high (16.00/18) as compared to recover one (2.53/18).

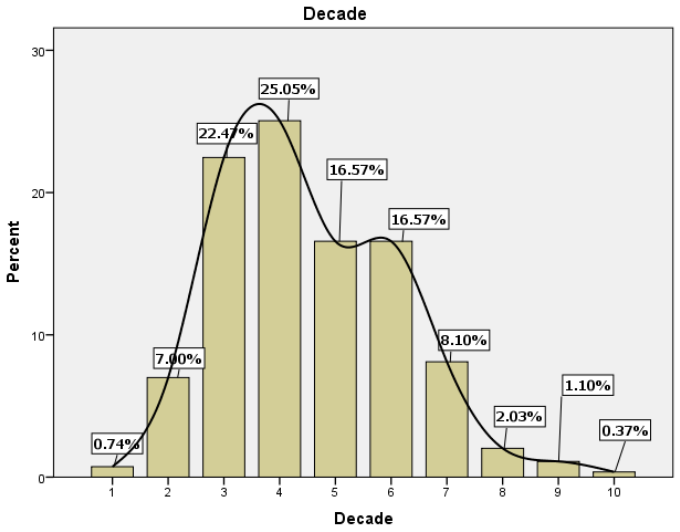

Figure-2 Graphical representation of Age Stratification (N=548)

Table-I: Showing Comparison of Means of Brexia Score and Ages in Recovered and Deceased and in both gender (N=548)

	Gender	Clinical Output					
		Recovered			Dead		
		Mean	N	Std. Deviation	Mean	N	Std. Deviation
Brexia Score	Male	1.82	431	3.702	16.89	35	3.169
	Female	2.53	67	4.316	16.00	15	2.726
	Total	1.92	498	3.793	16.62	50	3.043
Age in Years	Male	38.31	431	14.646	66.63	35	12.966
	Female	41.48	67	15.065	49.93	15	12.203
	Total	38.73	498	14.728	61.62	50	14.796

The Pearson correlation *r* for the age versus Brexia score was fair, calculated to be .557 having lower limit of .496 and upper limit of .619 by keeping *p* value of 0.01 and confidence interval of 95%. Similarly for the clinical output versus Brexia Pearson *r* was found to be .751 having lower limit of .686 and upper limit of .806. The Pearson correlation calculated for the Brexia versus gender, ethnicity were not clinically significant.

The Table-II shows application of independent t-test sample to compare the means of Brexia score of recovered versus deceased patients by keeping the *p* value 0.05 and confidence interval of 95%.

Table-III shows the mean Brexia scores of deceased from various ethnic backgrounds. It is evident from the results that there is not much of difference among the mean scores for deceased when recorded on the basis of ethnicity.

DISCUSSION

Pandemic of COVID-19 began from Wuhan province of China and rapidly spread around the globe[8]. The infection is highly virulent[14,15]. So far no definitive treatment for the disease has been found. Major portion of the patients had respiratory involvement, though patients did present with cardiac[16], central nervous system[17] and gastrointestinal[18] symptoms. rt-PCR remains the gold standard for the diagnosis of the Covid-19. Chest radiology plays a pivotal role in the diagnosis, disease monitoring and prediction of clinical outcome, particularly of COVID-19 pneumonia. In some studies HRCT chest is proven to be superior to rt-PCR in screening and diagnosis of COVID-19. Although Chest X-Ray has been thought to be less sensitive and specific in COVID-19 pneumonia diagnosis[10]. It has been extensively used in progress monitoring and severity stratification of pneumonia[19].

Various scoring systems for radiologic severity index of COVID-19 pneumonia have been used for both HRCT chest and Chest X-Ray[20]. Brexia scoring was done in Italy and has been published in May 2020[12]. Italy has been one of the severely affected European countries[21]. Brexia score has been successfully applied in Italy. Pakistan has limited resources and availability of HRCT chest is also restricted. Therefore Chest X-Ray remains the main radiological modality in Covid-19 pneumonia progress monitoring and predicting the clinical outcome. Chest X-Ray is also widely used for indoor Intensive Care Patients and for those who for various reasons can't undertake HRCT chest. No such study has been carried out in local or regional population. We also made use of Italian experience for the subject study. We smeared the same scoring system of Chest X-Ray radiological severity index for COVID-19 pneumonia in our population.

Table-II: Independent samples test for comparison of means of deceased and recovered (N=548)

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI of the Difference	
									Lower	Upper
Brexia Score	Equal variances assumed	4.175	.042	-26.279	541	.000	-14.681	.559	-15.779	-13.584
	Equal variances not assumed			-31.219	63.474	.000	-14.681	.470	-15.621	-13.742

Table-III: Mean Brexia score - deceased -ethnic groups (N=548)

	Punjabi	Sindhi	Pashtoon	Balochi	Urdu Speaking	Kashmiri	Gilgit Baltistan	Foreigners
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
Brexia Score	17	18	16	.	15	.	.	.
Clinical Output = Dead								

In this study we found that the mean Brexia scores were significantly different among recovered and deceased patients. There was considerable difference between the means. When independent t-test was applied by keeping the P value 0.05 and confidence interval of 95%, it was found that significant difference existed between means of Brexia scores of both the recovered and deceased patients. Since the table value of z at the significance level of 0.05 is 1.96 and our calculated value of t-test is 26.28 which is greater than 1.96. So we reject Null Hypothesis and say that $P < 0.05$. Probability of occurrence of difference in Chest X ray Brexia scores among recovered and deceased patients is not due to chance and is because of the disease process. This reveals that Brexia scoring can be used to monitor and predict the clinical outcome in COVID-19 pneumonia patients. Fair amount of positive linear correlation was found between age and Brexia score, suggesting that increase in age is associated in increase Brexia score. Similarly moderate linear positive association was found among Brexia and clinical outcome. Both these results are comparable to original study done in Italy and have more or less same inference drawn already[12,22].

Majority of the patients were male and were in 3rd and 4th decades (45%-collectively). This is possible since majority of the males belonging to this age group work in offices or jobs that require them to leave the house increasing the chances of exposure. It was also noted that females have relatively higher means for recovered patients but lower means for deceased patients when compared to males. No statistically useful differences between Brexia means scores was found when genders or various ethnic groups of deceased were compared as shown in Table-IV. This shows that COVID-19 pneumonia has no propensity towards any specific gender or ethnic background in Pakistan. COVID-19 has infected both the genders and people belonging from all spheres of life with no predisposition for any specific ethnicity.

Chest X-Ray is widely used radiological investigation for COVID-19 pneumonia. It is easily done, readily available and less hazardous than HRCT chest. Furthermore the chest x-rays can be easily done when compared to HRCT chest. In addition they are conducted for bed bound or ICU patients. We believe that utility of chest x-rays clearly surpasses the HRCT chest in aforementioned scenario.

Brexia scores in our study are significantly high in deceased patients. They lack any propensity towards gender or ethnic group. There are considerable differences among the scores of recovered and dead patients. Possible reason for this the severity of the COVID-19 pneumonia. It is clearly evident that high scores are associated with increase mortality. Similarly the low scores are directly related with good outcome. These indicators suggest that this simple scoring system can easily predict the clinical outcome. This critical information can significantly modify the management. There is some direct relationship observed among increasing age and Brexia scores. Both these factors if combined can prove useful in Covid-19 pneumonia management. Concluding, this scoring system can be easily utilized in monitoring the disease progression and predicting the clinical outcome. These results are comparable to the original study carried out in Italy and various other international studies as well.

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CONCLUSION

Brexia scores for assessing radiological severity of COVID-19 pneumonia are useful and should be employed for evaluation and progress monitoring for meaningful prediction of clinical outcome.

AUTHOR'S CONTRIBUTION

Hassan KMB: Conceived idea, Design methodology, Statistical Analysis, Manuscript writing
Hassan TB: Statistical Analysis, Data collection, Literature review
Sarwar S: Data Collection, Review of Chest X-Ray Reports
Siddique HJ: Manuscript final reading and approval
Zaidi ST: Manuscript writing, Final proof reading

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