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ORIGINAL ARTICLE

Association of Chest X- ray findings with SARS-CoV-2 severity

SANTOSH KUMAR SIDHWANI[1], SYED ALI RAZA[2], FATIMA ZAINA[3], ALI ABBAS[4], OMER AHMED SHAIKH[5], SADIA MANAN[6]
[1,2,3]*Assistant Professor of Pathology, Ziauddin University Clifton Campus, Karachi*
[4]*Head of Pulmonology and Critical Care, Department of Pulmonolgy, Ziauddin Hospital North Nazimabad, Karachi*
[5,6]*Ziauddin University and Hospital, Karachi, PAK*
Correspondence to Dr. Santosh Kumar Sidhwani, Email: santosh.kumar@zu.edu.pk, Cell: 03009314173

ABSTRACT

Background: The COVID-19 first surfaced when cluster of pneumonia patients arose in Wuhan, Hubei Province, China. Although the current gold standard for COVID-19 diagnosis is reverse transcriptase-polymerase chain reaction (RT-PCR), chest x-ray (CXR) and computed tomography (CT) play a vital role in sickness diagnosis due to their limited sensitivity and availability.
Aim: To evaluate retrospectively the role of CXR, the main radiological findings in it and its diagnostic accuracy in COVID-19 pneumonia.
Methods: This is a cross sectional study involving 264 PCR positive COVID-19 patients with their clinical–epidemiological findings admitted at Ziauddin Hospital from May-July 2020. CXRs were taken as digital radiographs in our emergency department's isolation wards using the same portable X-ray device, according to local norms. CXRs were taken in two directions: antero-posterior (AP) and postero-anterior (PA). The hospitals' database had all of the images. To determine the number of radiological findings, multiple radiologists on duty completed an independent and retrospective examination of each CXR. In the event of disagreement, a mutual agreement was reached. SPSS version 20 was used for statistical analysis.
Results: We were able to find 264 patients who met our criteria. With a mean age of 56.4214.89, the majority of individuals were determined to be males 189(71.6%) and females 75(28.4%). (Range of 16 to 87 years). 127 patients (48.1%) had severe illness symptoms and were admitted to the ICU, while the remaining 102(38.6%) had mild to moderate disease 35(13.3%). Diffuse (29.2%) and middle and lower co-existing distribution (25.8%) whereas just lower lobe (13.3%) were the most common predominance in severity. Peripheral involvement was also seen in (8.7%) cases.
Conclusion: Both lungs are equally affected with the disease having the consolidation and opacifications while the effusion is the major complication in the severe cases. Diffuse involvement of the lung lobes is seen in the study followed by the middle and lower lobe involvement.
Keywords: X-ray, COVID-19, pneumonia, lungs, consolidation, opacification

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) first surfaced when a cluster of pneumonia patients arose in Wuhan City, Hubei Province, China. This highly contagious disease is caused by the coronavirus 2 that produces severe acute respiratory syndrome (SARS-CoV-2). Since then, it has swiftly spread over the world, resulting in an outbreak. On January 30, 2020, the World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC), indicating a major threat to the healthcare system[1,2].

As of June 25, 2021, WHO had received reports of 179,686,071 confirmed cases worldwide, with 3,899,172 deaths. (3) Cases of COVID-19 have been reported in all provinces of Pakistan with the highest numbers recorded from Punjab (347,347); followed by Sindh (343,303), KPK (138,855), Islamabad (83,259), Balochistan (27,502) & AJK (20,728)[4].

The main modes of human-to-human transmission of COVID-19 include inhalation of infected person's respiratory droplets and contact with contaminated surfaces. Dry cough, fever, tiredness, myalgia, gastrointestinal, and neurological problems are just few of the symptoms. The majority of infected patients have mild to moderate symptoms and recover without needing to be admitted to the hospital. Patients over 65 with underlying medical conditions such diabetes, cardiovascular disease (CVD), chronic respiratory disease (CRD), or cancer are more prone to acquire serious illnesses[5,6].

The spike (S) protein identified in SARS-genomic CoV-2's structure has been discovered to have a key function in the host-microbe interaction. The ACE -2 receptor, which also serves as a binding site for the S protein, is the major host receptor for viral entrance into cells. All main organ systems of the body, including the heart, liver, lung, kidney, testes, endothelium, skin, and other tissues, have been found to express the ACE 2 receptor. The S protein also interacts with a type II cellular transmembrane serine protease (TMPRSS2) found on epithelial surfaces, which activates it by enhancing the ACE 2 receptor's binding affinity. SARS-Cov-2 releases its RNA inside the host's epithelial cells, allowing it to produce copies of itself and infect neighbouring cells, due to the virus's high affinity for these receptors, particularly the ACE 2 receptors. The infection spreads from the nasal tube to the lung alveoli as a result[7].

Although the current gold standard for COVID-19 diagnosis is reverse transcriptase-polymerase chain reaction (RT-PCR), chest x-ray (CXR) and computed tomography (CT) play a vital role in sickness diagnosis due to their limited sensitivity and availability. In contrast, CXR has gotten almost no attention in the literature[8]. As a result, our goal was to present crucial CXR results in order to better understand the primary characteristics of COVID-19 pneumonia.

The use of CXR for COVID-19 detection provides a number of advantages. In circumstances of high clinical suspicion, a positive CXR would negate the necessity for a CT scan. In fact, according to the American College of Radiology (ACR), CXR may help to lower the danger of cross-infection caused by inefficiencies in CT decontamination after scanning COVID-19 patients. Furthermore, the paucity of CT scanning facilities in some parts of the world contributes to CXR's importance. Finally, in locations where reliable RT-PCR is scarce, CXR may serve a critical role in early diagnosis and timely prevention of disease spread[9].

Thus, the main objective of this study is to evaluate retrospectively the role of CXR, the main radiological findings in it and its diagnostic accuracy in COVID-19 pneumonia. We hope our findings will provide useful information for early detection, timely treatment and minimizing the spread of disease.

METHODOLOGY

Patients selection and inclusion criteria: This is a cross sectional study involving 264 diagnosed COVID-19 patients with their clinical–epidemiological findings admitted at Ziauddin Hospital, confirmed by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR) nasopharyngeal–throat swab test before or during the admission in the period of May-July 2020. The epidemiological data of patients and their associated symptoms of COVID-19 infection were retrieved from the electronic medical

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records. Data was taken with the explicit permission of Ziauddin University and Ziauddin Hospital.

Inclusion criteria for this study were: age of patient more than 16 years, positive RT-PCR nasopharyngeal–throat swab and CXR performed at or during the course of admission.

The final outcome of patients was determined from the records and expressed as patients who expired during the hospital stay, discharged, left against medical advice and those who were transferred to other healthcare centres.

Acquisition and analysis of images: All CXRs were taken as digital radiographs in our emergency department's isolation wards using the same portable X-ray device, according to local norms. CXRs were taken in two directions: antero-posterior (AP) and postero-anterior (PA). The hospitals' database had all of the images. To determine the number of radiological findings, multiple radiologists on duty completed an independent and retrospective examination of each CXR. In the event of disagreement, a mutual agreement was reached.

Clinical signs and symptoms reported in medical records, observations on chest radiographs, and the patient's oxygenation condition were used to classify COVID-19 severity according to WHO standards. (1) According to the COVID-19 diagnosis and treatment criteria, all patients were assessed and categorised into mild, moderate, severe/critical categories based on the severity of their symptoms. At least one of the following requirements should be met by severe patients: Shortness of breath is the first symptom, with a respiration rate (RR) of 30 times per minute. Second, in a resting state, oxygen saturation is 93 percent. Second, in a resting state, oxygen saturation is at 93 percent. Finally, a ratio of 300 mm Hg between arterial oxygen partial pressure (PaO2) and proportion of inspired oxygen (FiO2). In less than 24 hours, lung imaging revealed lesions that had grown by more than 50%.

Statistical Analysis: For continuous variables, mean SD will be used, and for categorical variables, percent were used. The Shapiro-Wilk test was used to determine the data's normality. The connection between outcome, x-ray results, and clinicopathological features was assessed using "the Chi-square (2) test" and "Fischer's exact test." SPSS version 20 was used for statistical analysis. A statistically significant P value of 0.05 was used.

RESULTS

We were able to find 264 patients who met our criteria. With a mean age of 56.4214.89, the majority of individuals were determined to be males 189(71.6%) and females 75(28.4%). (Range of 16 to 87 years). 127 patients (48.1%) had severe illness symptoms and were admitted to the ICU, while the remaining 102 (38.6%) had mild to moderate disease 35(13.3%). To see if there was a link between age and severity, we divided the patients into two age groups: 50 years and >50 years. We discovered that there was a very significant association, with 103 severe cases having an age greater than 50 years, with a p value of 0.001. Severe disease impacted males (91) more than females (36) but there was no statistically significant association between severity and gender (p value 0.695) (Table 1). Patients were further divided in accordance to their severity in order to substantiate the causal relation between the severity and multiple radio-graphical findings on CXR.

Patient presented with diverse symptoms of fever 230(87.1%), cough 152(57.6%), SOB 191(72.3%), body ache 91(34.5%), congestion 35(13.3%) and other systemic complaints like diarrhoea, nausea, vomiting, abdominal pain, decreased appetite, headache, altered mental status, insomnia and anxiety. Fever and severity of COVID-19 have highly statistically significant link with severity of COVID-19. Patient CXRs were taken during the course of admission, which demonstrated bilateral lung involvement within all levels of severity to be 195 (73.9%) while 26 (9.8%) had left and 19 (7.2%) had right lung involvement respectively. That showed the highly significance statistical link between the site of lung involvement with the severity of the disease (Table 3, 4).

Diffuse (29.2%) and middle and lower co-existing distribution (25.8%) whereas just lower lobe (13.3%) were the most common predominance in severity. Peripheral involvement was also seen in (8.7%) cases. Both mild and moderate severity were most commonly observed in diffuse lung involvement (32.4%) and (31.4%) respectively whereas severe was coexistent in middle and lower lobes (29.9%). Only 5 cases (1.9%) showed pleural effusion whereas 7 cases (2.7%) showed atelectasis which reveals insignificant association of both these findings with severity (p=0.2 and p=0.172 respectively). In our study, the most frequent findings observed were patients with opacification 113(42.8%), consolidation 37(14%), infiltrates 32(12.1%). Findings most frequently coexisting in the same radiography were infiltrates & haziness 16(6.1%) (Table 4 and Figure 1.

Figure: 1: X-rays films with different chest findings from our study population

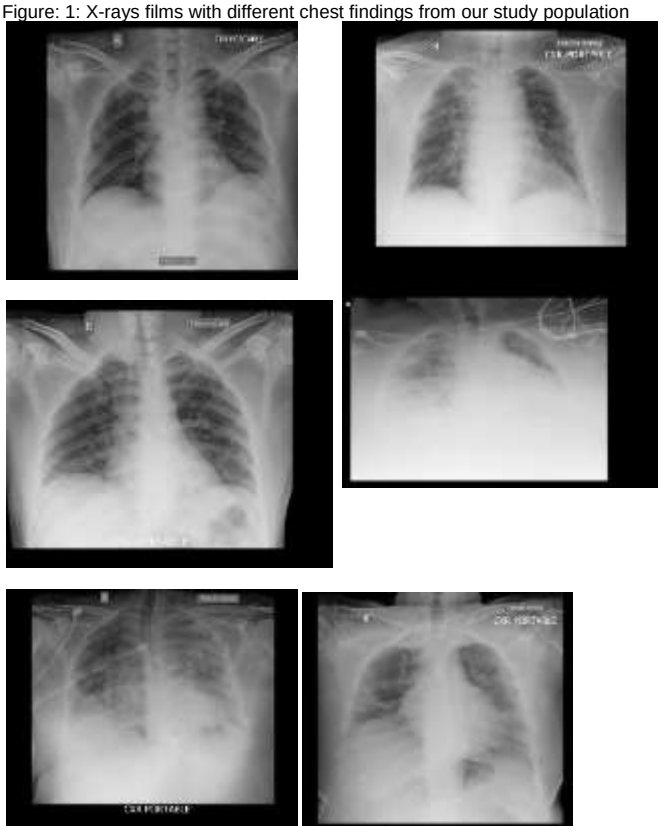

Table 1: Statistical estimates and association of sex and age with severity of COVID-19

Parameter		Severity			P-Value
		Mild	Moderate	Severe/Critical	
Gender	Male	71	27	91	0.695[a]
	Female	31	8	36	
Age	<=50	43	10	24	0.001[a]
	>50	59	25	103	

[a]Chi-square test

Table 2: Association of symptoms with severity of COVID-19

Symptoms	N=264	Severity			P-Value
		Mild	Moderate	Severe/Critical	
Fever					
Yes	230	81	31	118	0.010[a]
No	34	21	4	9	
Cough					
Yes	152	61	19	72	0.818[a]
No	112	41	16	55	
SOB					
Yes	191	58	20	113	0.001[a]
No	73	44	15	14	
Body ache					
Yes	91	37	15	39	0.362[a]
No	173	65	20	88	
Congestion					
Yes	35	13	3	19	0.603[a]
No	229	89	32	108	
Abdominal pain	2	1	0	1	0.133[s]
Altered mental status	5	1	0	4	
Loss of appetite	13	4	2	7	
Diarrhoea	9	1	3	5	
Nausea	3	0	2	1	
Headache	2	1	0	1	
Vomiting	3	2	1	0	
Insomnia	1	0	0	1	
Anxiety	1	0	1	0	

[a]Chi-square Test [b]Fischer-exact Test

Table 3: Association of symptoms with severity of COVID-19

Site	N=264	Severity			P-Value
		Mild	Moderate	Severe	
Bilateral	195	70	23	102	0.005[a]
Left	26	9	5	12	
Right	19	6	2	11	

[a]Chi-Square Test

Table 4: Association of radiographic findings on CXR with severity of COVID-19

Symptoms	N=264	Severity			P-Value
		Mild	Moderate	Severe/Critical	
Diffuse	77	33	11	33	0.123[b]
Hilar	12	4	2	6	
Perihilar	18	4	0	14	
Hilar & Perihilar	1	1	0	1	
Upper	2	1	0	1	
Lower	35	11	6	18	
Middle	2	1	0	1	
Middle & Upper	1	0	0	1	
Middle & Lower	68	24	6	38	
Periphery	23	7	5	11	
Perihilar & Periphery	1	0	0	1	
Radiologic Findings					
Effusion					
Yes	5	0	1	4	0.200[a]
No	259	102	34	123	
Atelectasis					
Yes	7	5	0	2	0.172[a]
No	257	97	35	125	
Opacification					
Yes	124	48	15	61	0.126[a]
No	140	54	20	66	
Consolidation					
Yes	42	14	4	24	0.126[a]
No	222	88	31	103	
Infiltrates					
Yes	58	12	10	36	0.126[a]
No	206	90	25	91	

[a]Chi-square Test [b]Fischer-exact Test

DISCUSSION

COVID-19 disease outbreak started in Wuhan, China, in December 2019 and has rapidly spread at an alarming rate throughout the world. It has been a major health concern since then and was declared a pandemic in early 2020. COVID-19 is highly contagious so early detection and diagnosis are highly important in order to timely isolate the suspected cases and control the transmission.

RT-PCR is considered as the diagnostic gold standard of SARS-CoV-2 via nucleic acid detection but due to its lack of availability in certain parts of the globe and delay in results other alternate methods are sleeked.

Radiological evaluation may serve as a diagnostically helpful and rapid method prompting to decide on the most effective treatment regime. To our best of knowledge most of the studies focus mainly on findings on chest CT scan which has a higher sensitivity and is more advanced as compared to CXR but due to greater chance of cross infectivity ACR suggests that CXR is more suitable[10-12].

In our study, greater number of male were found to be hospitalized due to COVID-19 189(71.6%) in respect to female 75(28.4%). This finding is consistent with a study done by K. Yuki et al. in 2020 which explained this association due to comorbidities more prevalent in males which includes hypertension, cardiovascular and lung diseases; these conditions are linked to social and behavioural factors more common in men such as smoking and alcohol consumption[13]. In addition to this sex-based immunological differences between males and females play a major role in the male-biased COVID-19 infectivity along with its severity[13,14,15].

Our study revealed radiological findings on CXR which are concordant with those of the authors who performed a similar study previously retrieved from RT-PCR positive for SARS-CoV-2 patients that mainly included opacification 124(46.9%), consolidation 42(15.9%) and infiltrates (58,21.9%) while pleural effusion 5(1.9%) and atelectasis 7(2.7%) had a low incidence[16-19].. These data combined with the fact that ACE2 is strongly expressed on the apical side of lung epithelial cells in the alveolar area which provides a good chance for the virus to infect and damage them. This is consistent with the fact that early lung injury frequently manifested in the distal airway[20,21].

As described in previous studies our study also coincides with the finding of bilateral lung involvement being the most common but in case of unilateral involvement left lung is predominant which is not consistent to previously available literature due to no specific or known reason[17,19,22].

CXRs were assessed for the lobular distribution of the disease predominance; diffuse, middle and lower lobes concomitantly affected followed by lower and periphery respectively reinforcing the pattern already described in recent literature[17-19,23,24] of note Kunwei Li et al[25] pointed the fact that the virus has a relatively small diameter, around 60-140 nm, making the terminal lung structure easily accessible.

Severity of COVID-19 is classified into mild, moderate and severe/critical according to the WHO recommendations based on clinical symptoms as explained previously. The most prevalent finding in our study was found to be severe/critical followed by mild and moderate which does not acquiesce with previous studies[16,26]. The fact that disease outbreaks constitute a considerable challenge to the healthcare system in a developing nation like Pakistan supports this conclusion. A lack of basic health facilities, inadequate health policies, weak management, hesitancy towards hospitalization in milder forms of the disease is also contributing towards under reporting of such cases[27].

CONCLUSION

In current study we concluded that male of more than 50 years of age have more chances of having the sever disease. Both lungs are equally affected with the disease having the consolidation and opacifications while the effusion is the major complication in the severe cases. Diffuse involvement of the lung lobes is seen in the study followed by the middle and lower lobe involvement.

Conflict of interest: Nil

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