

ROLE OF IMAGING TECHNOLOGY AND CURRENT STATUS OF CORONA VIRUS DISEASE 2019 (COVID-19): A CRITICAL REVIEW

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Contribution

MS conceived the idea and
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ABSTRACT

Lately, there was an outbreak of Coronavirus disease (COVID-19) in Wuhan, a city of province Hubei, China. The infectious and transferrable virus originated in bats, seafood and animals. COVID-19 belongs to Coronaviridae family. Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) also belong to this family and their outbreak occurred in China and Saudi Arabia back in 2003 and 2012. number of deaths due to COVID-19 is much greater than that of SARS and MERS. The clinical symptoms of infected individuals from virus are almost the same but diagnostically they are different from one another. Reverse transcription polymerase chain reaction (RT-PCR) laboratory technique is a standard test for evaluation and confirmation of COVID-19 disease. In early stages, imaging modalities can be used for screening purposes. X-Ray is used to identify the gross changes within the chest region while Computed Tomography Scanning (CT Scan) chest is used for detailed modification which occurs due to coronavirus. CT scan evaluates the different characteristics in the individuals infected from COVID-19 such as presence of bilateral ground glass opacities, presence of diffuse consolidation, presence of nodules with halo sign, enlarge thoracic lymph nodes, presence of thicken inter-lobar septa, presence of bronchiectasis and pleural effusion. Each lung lobe was assigned different score on the basis of lobe area involvement. A lobe having no involvement is of score 0, minimal involvement lobe score is 1, mild involvement lobe score is 2, moderate involvement lobe score is 3, and severe involvement lobe score is 4. The lobes are assessed for different degree of involvement and then are divided as none (0%), minimal (1% to 25%), mild (26% to 50%), moderate (51% to 75%) and severe 76% to above level. These all techniques are very effective and responsible for the exact location of the area involved and also show the extension of pathology that can only be possible on CT scan. CT scan not only evaluates the disease but it also provides the assessment of the disease severity.

Keywords: Computed Tomography scan; Coronavirus; Real time polymerase chain reaction; SARS; SARS-CoV-2; MERS

INTRODUCTION

Coronavirus Disease 2019 (COVID-19) was reported for the first time in Wuhan, Hubei, China in December 2019.¹ It spreads promptly in the whole China as well as neighboring countries and in the world.² This virus is newly discovered and has been named the 2019 Novel Coronavirus because it belongs to the family Coronaviridae and order Nidovirales. This family includes those types of viruses which is responsible for disease ranging from common cold to Severe Acute Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome (MERS).³ The Severe Acute Respiratory Syndrome (SARS) and the Middle East Respiratory Syndrome (MERS) are the other two species that also cause fatal illness. There was an outbreak of SARS in Southern China and was quickly recognized as a worldwide public health threat in March 2003, the total 774 deaths out of 8098 infected individuals occurred in November 2002 to March 2003. MERS was reported first time in Saudi Arabia back in 2012, resulting in 858 deaths out of 2494 infected individuals to till date.⁴ As up March 27, 2020, 509,164 confirmed (COVID-19) cases have been globally reported with mortality rate up to 4.58%.⁵

Coronavirus is spreading globally and leading to pandemic.¹¹

The COVID-19 reproduces at the rate of approximately 2.2, which means that a single infected patient is spreading infection in 2.2 other people. According to the study done by Wu et al, the basic reproductive number was predicted to be approximately 2.68% for COVID-19.¹²

The COVID-19 is responsible for acute respiratory illness among the people who are being reported and they are related to seafood, animal meat and bats.¹³ The COVID-19 is basically human –to- human transmitted virus through respiratory droplets produced by infected person or close contact with one another.¹⁴

MATERIALS

This review study was conducted since outbreak has been occurred. The aim of critical study was to diagnosed COVID-19 patients through imaging technology. Literature was searched on Google scholar, Google web search, World Health Organization website along with National Institute of Health, Pakistan for retrieving of articles about this review

Table 1. Total number of deaths and individuals affected by Coronaviridae

Disease	Outbreaks	Place of Origin	Infected Individuals	Total Number of deaths	References
SARS	2003	China	8098	774	6
MERS	2012	Saudia Arabia	2494	858	7,8
COVID-19	2019	China	509,164	23,335	5

CLINICAL MANIFESTATION

The illness have been reported which range from mild symptoms to severe illness and death for the known and confirmed cases of corona virus (COVID-19).⁹

The main clinical manifestation of corona virus COVID-19 is quite complicated and characterized as fever, myalgia, cough, headache, shortness of breath, dyspnea, pneumonia, dizziness and gastrointestinal tract syndrome.¹⁰

TRANSMISSION OF COVID-19

The outbreak of COVID-19 in Wuhan to pandemic involves different steps. 1) Initially, the COVID-19 spread locally in Wuhan. 2) then transmitted to the surrounding cities of province Hubei of China. 3) then spread across worldwide from Wuhan through infected travelers. Further, the

and current outbreak status. All the downloaded articles were critical reviewed many times and draw a beneficial conclusion about the role of radiologist and imaging technology in diagnosis and prevention of COVID-19.

CURRENT STATUS OF COVID-19

According to WHO, number of cases and deaths are increasing continuously since outbreak happened in China. The epicenter of SARS-CoV-2 have changed from Wuhan city of Province Hubei, China to European countries especially severe outbreak is continue in Italy and Spain. Till March 28, 2020, a total of 509,164 cases along with 23,335 deaths occurred throughout the world. Out of total, majority of the cases were reported from European countries, in which 286,697 cases reported with 16105 casualties. The cases in China were 82,078 with 3,298 deaths whereas the cases in new epicenter Italy, Spain and Germany were 80,539, 56,188 and 42,288 cases

respectively. The highest mortality rate reported from Italy was 10.1% since this outbreak. The reported cases in USA was 68,334 with 991 deaths, which was gradually increasing. The COVID-19 cases in Eastern Mediterranean Regions were also abruptly grooming from past month of February. The highest number of cases reported in Iran were 29,406 cases with 2234 deaths, followed by Pakistan 1,057 cases with 08 deaths and Saudia Arabia, 1012 cases with 03 deaths.⁵

DIAGNOSIS

The gold standard diagnostic test is laboratory based test called Real-time polymerase chain reaction but the results of RT-PCT may be affected by human error and low load of virus can may increase the false negative reports. Previous study about MERS and SARS shows that, initial result up to 5 days of RT-PCR shows normal report but the Computed Tomography (CT scan) scan clearly demonstrates the viral infection in early stages.¹⁵ In Radiology, the diagnostic test is CT Chest which also plays an important role in the early detection of COVID-19.¹⁶

ROLE OF IMAGING TECHNOLOGY

Chest X-Ray and CT scan are the two basic imaging modalities which play an important role in the assessment of COVID-19 disease in order to rule out the extent and for follow-up purpose.¹⁷ The imaging features of COVID-19 are mostly similar to those which reported for SARS and MERS.¹⁸ The prime pattern of lung abnormalities after onset of symptoms was GGO, the fraction of mixed pattern peaked during illness days 12 to 17, and become the second most prevailing pattern thereafter.¹⁹ Chest X-Ray of infected patients from COVID-19 disease initially shows normal result. After one week or more, the Chest Radiography shows patchy opacities, diffuse air space opacities and might be air bronchogram, similar to the other causes of coronavirus pneumonias.^{20,21}

In the critical and severely infected patients, the Chest Radiograph shows bilateral ground-glass opacity (GGO), infiltrating shadows and diffuse consolidation with high level of pleural effusion.²² The distribution and allocation of abnormalities of lung was recorded as predominantly subpleural, mostly involving the peripheral one-third of lung. Overall the subpleural lesion were more commonly present than the central lesion.²¹ The CT scan findings for diagnosis of coronavirus could be helpful for initial screening who are suspected for having a virus.²² On Computed Tomography (CT Scan), mostly the infected patients from COVID-19 has typical imaging features, such ground-glass opacity (GGO), mixed GGO, crazy-paving pattern, consolidation, traction bronchiectasis, pleural effusion and enlarged lymph node and some other findings were reported such as tree-in-bud

pattern, nodules, cysts, cavitation and large volume of lymphadenopathy which is rare and uncommon.^{23,24} A scoring system was used for the estimation of pulmonary involvement of all these abnormalities on the area involved, called a semi-quantitative scoring system. Each lobe of both lungs has been designated a visual value ranges from 0 to 5. So 0 value means no involvement, 1 value means <5% involvement, 2 value mean 5% to 25% involvement, 3 value mean 26% to 49% involvement, 4 value mean 50% to 75% involvement, 5 value mean >75% involvement.²⁵ On the basis of previous CT Scan findings, it has been revealed that right lower lobe is mostly affected followed by left lower lobe, then left upper lobe, then right upper lobe and afterwards middle lobe of left lung.²⁶ On initial CT scan examination, some patients had normal CT chest report, many patients had unilateral lung infection and about 78% patients had bilateral lung infection. GGO is the most common radiological finding accompanied by consolidation, mixed GGO, inter-lobar septal thickening and vascular enlargement.²⁷

DIFFERENTIATE DIAGNOSIS THROUGH IMAGING MODALITIES

Generally, the imaging features of viral pneumonia and COVID-19 are mostly same but the viral pneumonia is frequently associated with nodules on CT scan. In case on coronavirus the nodules picture is excluded. The main features of COVID-19 are bilateral GGO with diffuse pulmonary consolidation, nodules with halo sign, thicken inter-lobar septa which is absent in other viral pneumonias.²⁸ Some other features also present in the case of COVID-19 and absent in other viral infections such as greater total lung involvement of infections, reverse halo sign, crazy paving pattern and peripheral lung distribution of infection.²⁹

FUTURE RECOMMENDATION

In the view of previous studies about the imaging features and main role of imaging modalities, it has been recommended that the X-Ray modality can be used as a baseline for Chest Radiograph of infected patients. Through Chest Radiography, the gross abnormalities, frequent pleural effusion and parenchyma changes are easily seen. It is also best modality for follow-up after recovery.

Computed Tomography (CT scan) play an important role in the early detection of COVID-19. In the initial stage, CT scan is better than RT-PCR, because CT scan is very sensitive in the early detection of pulmonary changes while RT-PCR may miss the detection of infection due to sampling error or low load of virus. So RT-PCR is less sensitive in the initial stage of disease up to 5 days. On the basis of aforementioned studies, Chest Radiography is

recommended as first choice of diagnosis followed by CT scan for detailed information regarding lung abnormalities. Thus CT scan findings plays a central role and will be considered as a main part of standard criteria for management and discharging the COVID-19 infected patients.

CONCLUSION

In conclusion, the thin 0.1mm slices through CT scan are very important in the early stages because the thin slices do not miss even small changes within lung and playing effective role in the initial prevention, control and diagnosis of COVID-19. GGO is the most common radiological finding in the thoracic CT scan and mostly occurred in bilateral lower lobes of lung. GGO with consolidation is the most seen and common radiological findings in the early stage of disease. In the follow-up CT scan, the GGO and associated consolidation become resolve with the passage of time after recovery. CT scan has been considered as a key determinant in the diagnosis as well as management of COVID-19 patients. CT scan can detect COVID-19 disease accurately and also provide differentiation between COVID-19 and other viral infections.

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