IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

CHEST X-RAY IN COVID-19 PANDEMIC RALE SCORING

[1]Aasif Majeed Lone , [2]Arshad Alam Khan , [3]Ashita Jain
[1]Assistant Professor, [2]Assistant Professor, [3]Assistant Professor[1] Department of Radiology,
[1]Centurion University of Technology and Management , Vizianagaram, Andhra Pradesh, INDIA

Abstract:

Background In this study we could find that during the COVID-19 Pandemic the Radiologists were able to differentiate between chest radiograph's with and without symptoms of pneumonia but have found it more challenging to differentiate coronavirus disease 2019 (COVID-19) pneumonia from non–COVID-19 pneumonia on the radiograph's.

Method : This is the retrospective comparative study in which we included thirty articles in medicine using PUBS, BMJ, AJR and google scholar , out of thirty studies 23 were prospective and 7 studies were retrospective , In these studies we have found that the RT-PCR test results were considered as the reference standard and RALE scoring was done using chest radiographs and gravimetric measurements of lung oedema.

Result : The outbreak of a pneumonia of unknown cause in the city of Wuhan in Hubei , province of China .The pneumonia was later confirmed to be a virus this virus was originally called 2019 Novel coronavirus, the identification of the virus via-nucleic acid detection through RT-PCR and throat swabs were considered as desired standard and formative assessment for the diagnosis of COVID-19, The pathologies that were observed on the chest radiographs after progressive stage were opacities and consolidations , In early stages of the disease chest radiographs were least sensitive for detecting any abnormalities , The ground glass opacities and densities which were observed on CT scan of chest had an correlate which was extremely difficult to detect on a chest radiograph (CXR).

Conclusion : CXR scoring was considered to be less sensitive than CT Scan , COVID-19 generally manifested a spectrum of pure ground glass , mixed ground glass opacities to consolidations in bilateral peripheral , best practice , Parameters for communication of diagnostic imaging findings.

Keywords :COVID-19,X-Ray,CT scan,Pneumonia,Ground Glass Opacities & Consolidation

INTRODUCTION

A disease in 2019 known as COVID-19 emerged from China and spread to the whole world[1]. Patient diagnosis : COVID-19 infection was confirmed by RT-PCR ,Reverse transcription polymerase chain reaction , on nasopharyngeal and throat swabs[2] . The scoring : lung involvement scoring was done by giving a score from 0-4 to the lung on the basis of the involvements the score was considered to be 0,1,2,3 and 4 and the score was distributed as 0= least or no involvements , 1= more than 25 involvements , 2= in between 25-50, 3= in between 50-75, 4= more than 75% involvement[3]. RALE classification : In march 2020 the system was introduced to radiology , which was used to identify the severity of the findings in the covid-19 patients ,. Scoring on the CXR : The method was introduced to assess the involvements and pathologies in covid-19 patients .

CRX : it was considered to have least sensitivity in early stage of covid-19 to detect the abnormalities , but was found active in progressive stage covid-19 patients to find the abnormalities . **CT scans** were found effective in detecting the abnormalities in the lungs during COVID-19 , and CT was considered to be effective in early stage detection as well [4]. As it was believed that CXR is least active in detecting abnormalities in early stages of COVID-19 so for that a follow-up was needed for the patients of covid-19 [5]. Differential Disease finding : findings on Ct images were found similar to other findings or viral diseases which were responsible for the cause of pneumonia in patients , because of the similar origin or coronaviridae virus family[6] . The literature was focused on CT computed tomography findings as CT has been believed to be more sensitive than chest x-ray radiographs , CT was considered to be the primary imaging modality in the COVID-19 outbreak but the chest x-ray remained the first line imaging investigation for evaluating the acute respiratory illness in some patients , it was believed that considering CT as the first line modality would lead to a burden on radiology departments and challenges in posing , pertaining to sterilization of CT suite and infection control[7]. The coronaviruses identified are six , out of which four cause symptoms like common cold due the (SARS) virus and the (MERS) virus which are two strains[8] . The epidemiological suspects of COVID-19 infection found on the CXR of the patients, performed at emergency department of that hospital were reviewed respectively. The most effected patients were found to be of age group 60-79 years old The RALE score was found to be slightly higher in Male patients than in female patients[9]. The chest x-rays of the in-hospital (376) patients and had gone through RTPCR were included in the study . Then the radiologist of experience greater than 10 years, categorised the radiographs into covid-19 negative or positive on the basis of image patterns[10]. The severity of abnormalities on the radiographs was outputted by a trained convolutional Siamese neural network-based algorithm , used the weakly supervised pre training on large number of anterior-posterior images from CheXpert[11] . For clinical variables the radiographs data of a month was taken to review which were examined by the radiologists to identify the abnormalities and involvements and on the basis of that a score of severity was given[12] . The study identified the abnormalities and findings on the Computed tomography scans of Covid-19 patients, The change in the (GGO) into consolidation and subsequent resolution of the airspace changes were demonstrated[13]. The serial and baseline chest radiographs with RT-PCR were reviewed and if available the correlation with concurrent CT examination was performed[14]. The patient presented to the Emergency department of that hospital with confirmation of COVID-19 on RT-PCR were identified by the abnormalities and lung involvements found in the quadrants on the CXR which were studied by the radiologists[15].

Abbreviations

AP	Anterior posterior	CO	Consolidation
AUC	Area under the curve	COVID-19	Coronavirus disease 2019
AI	Artificial intelligence	ED	Emergency department
BMI	Body mass index	EC	Ethics committee
CDC	Centers for disease control and prevention	GGO	Ground glass opacity
CXR	Chest radiography	HR	Hazard ratio
CR	Chest radiography	mRALE	Modified radiographic assessment of lung edema
CT	Computed tomography	NPV	Negative predictive value
CC	Complete concordance	PPV	Positive predictive value
PXS	Pulmonary x-ray severity	RT-PCR	Real time reverse transcriptase polymerase chain reaction
RALE	Radiographic assessment of lung edema		

RESEARCH METHODOLOGY

This is the retrospective comparative study in which we included thirty articles in medicine using PUBS, BMJ, AJR and Google scholar , out of thirty studies 23 were prospective and 7 studies were Retrospective , In these studies we have found that RT-PCR test results were considered as the reference standard and RALE scoring is evaluated on CXR's of patients who were positive for corona virus and have lung abnormalities and pathologies , The imaging technique have a big role in the diagnosis of the corona virus disease , Computed Tomography is considered to be most effective method for early lung abnormality detection while as the CXR is found to be least sensitive in the diagnosis or detection of pulmonary abnormalities and other pneumonias caused by the virus ,scoring system was used to determine the intensity of the disease.

Method: reverse transcription polymerase chain reaction test is considered to be an important diagnostic tool for detecting the corona virus disease , the results of reverse transcription polymerase chain reaction test were considered to be medium for correlation with chest x-ray findings , the chest x-ray that were taken of the patients from the initial time to discharge time of the patient who were having the respiratory syndrome a scoring was done on the basis of the lung involvements and the abnormalities and pathologies found .

RESULTS AND DISCUSSION

In December 2019 the outbreak of a pneumonia of unknown cause started from the city of Wuhan in Hubei , province of China, it was later confirmed to be a virus which was originally called 2019 Novel coronavirus and on Feb , 11, 2020 the disease was named COVID-19 by WHO**,** it was considered that corona virus has a different origin and it was it was also believed that the virus was found in the sea food and the virus is extremely contagious and spreads easily from one to another person

Imaging features

According to many studies the latest diagnostic criteria or the identification of the virus via-nucleic acid detection through RT-PCR and throat swabs were considered as desired technique for locating the lung involvements of the corona positive patients , False negative results after virus detection were there which were there because of some issues with the settings , which include the least availability of the kits , which were used as the initial test tool for the diagnosis of the corona virus disease and happened also because of the technical problems in sampling and because of any issues with the laboratory and due to the non-proper technique used for the testing of the nucleic acid out of the clinical material .

Radiography of chest

In many studies we have found that chest radiography was not practiced on routinely basis as it was found that chest radiography is not sensitive for detecting COVID-19 in the early stage, the chest radiography was considered to be sensitive only after the disease had progressed from early stage .

The pathologies that were observed on the chest radiographs after progressive stage were opacities and consolidations , in some of the studies we have observed that no obvious abnormalities were found on the chest radiographs after showing positive symptoms . In early stages of the disease chest radiographs were least sensitive for detecting any abnormalities like increased area left basilar opacity which was possibly seen atleast after 9^{th} or 10^{th} day of the disease progress .

Computed tomography of chest

In several studies we have found that COVID-19 typically presents with Ground glass opacities (GGO) and consolidations in a peripheral , posterior lower lung distribution or diffuse, The ground glass opacities and densities which were observed on CT scan of chest had an correlate which was extremely difficult to detect on a chest radiograph (CXR) . The CT scans were performed in supine position , The scans included the upper and the inferior portions of lungs or the thoracic portion and then the taken images were reconstructed with (1.5 - 1mm ST) as found in most of the studies. CT computed tomography scan is recommended because it is very sensitive for detecting the lung involvements at early stages in COVID-19 positive patients .

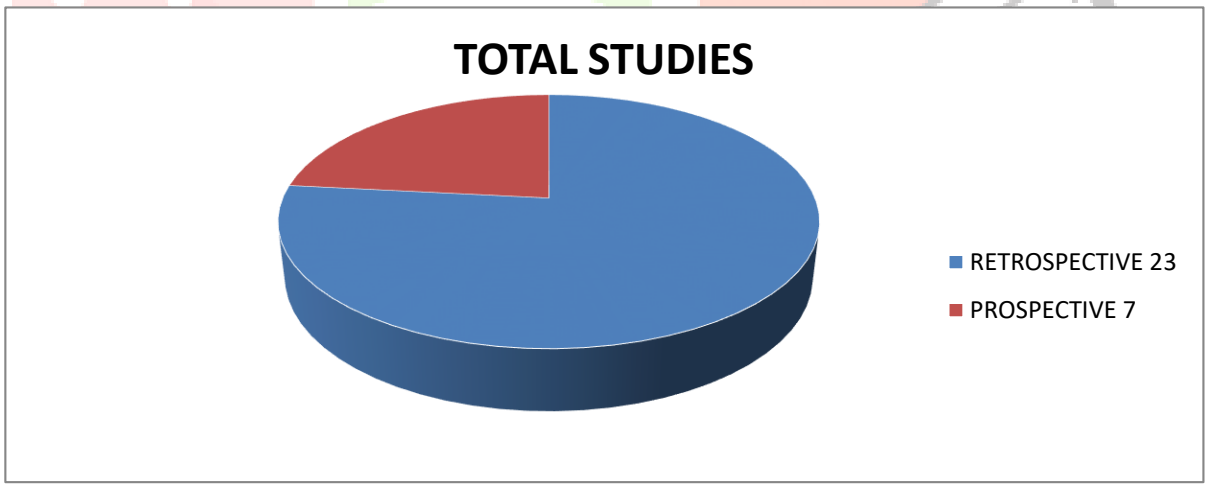
In one of the study, according to an association of the radiology branch the computed tomography scans of the corona positive patients were divided , into the different stages which include ,the Early stage ,the advance stage , the severe stage , on the basis of involvement of lungs or pathologies found .

In early stage the computed tomography has shown single of multiple scattered patchy , conglomerate ground glass opacities(GGO) , The ground glass lesions were also found in peripheral and sub peripheral areas of lung . The crazy paving pattern was given due to the intra and interlobular septal thickening which was present in ground glass opacities (GGO)

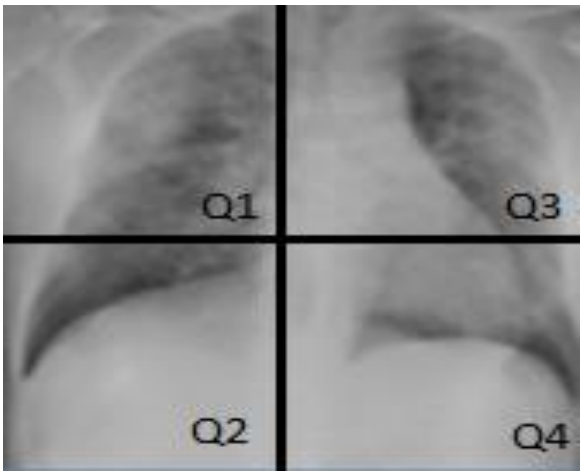
In Advance stage , new lesions similar to the earlier lesions were found in dense and extent state .

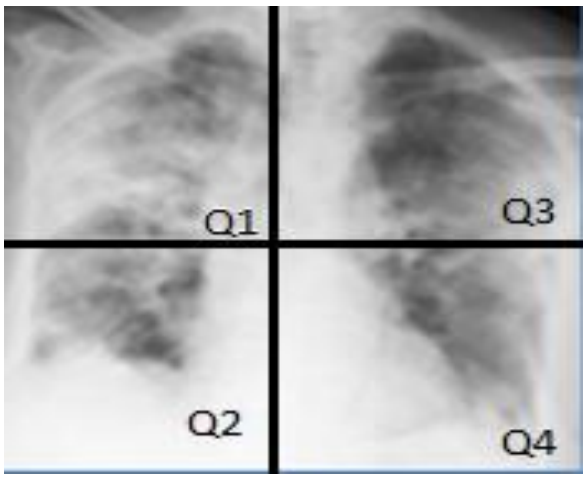
Severe stage , in disease progressive state , consolidation of lungs of varying density is seen , the patchy ground glass opacity were considered as Non-Consolidated areas of the lungs , with thickened plura . The “white out lung” appearance was considered as the major lung involvement .

This Retrospective study was conducted to evaluate the severity of Chest X-Ray at the time of COVID-19 and to compare the RALE score with RT-PCR . In this study we Reviewed at least Thirty articles on the basis of data provided in the articles in medicine using RSNA, AJR , BMJ , PUBS and PubMed out of thirty studies twenty three were retrospective and seven studies were prospective, In this retrospective study we have found that the only patients were included who were adult and were presented to the emergency department with corona virus disease.



QUADRANTS FOR RALE SCORING OF RADIOGRAPHS





Consolidation and density scoring in the Radiographic Assessment of Lung Oedema (RALE

Consolidation	
Consolidation score	**Extent of alveolar opacities**
0	**None**
1	**≤25%**
2	**25%-50%**
3	**50%-75%**
4	**≥75%**
Density	
Density score	**Density of alveolar opacities**
1	**Hazy**
2	**Moderate**
3	**Dense**
Final RALE score	
Upper Quadrant	Upper Quadrant
Cons x Den=Q 1 Score	**Cons x Den=Q 3 Score**
Lower Quadrant	Lower Quadrant
Cons x Den=Q 2 Score	**Cons x Den=Q 4 Score**
Total RALE =Q1+Q2+Q3+Q4	

Radiographic Findings on Chest Radiographs

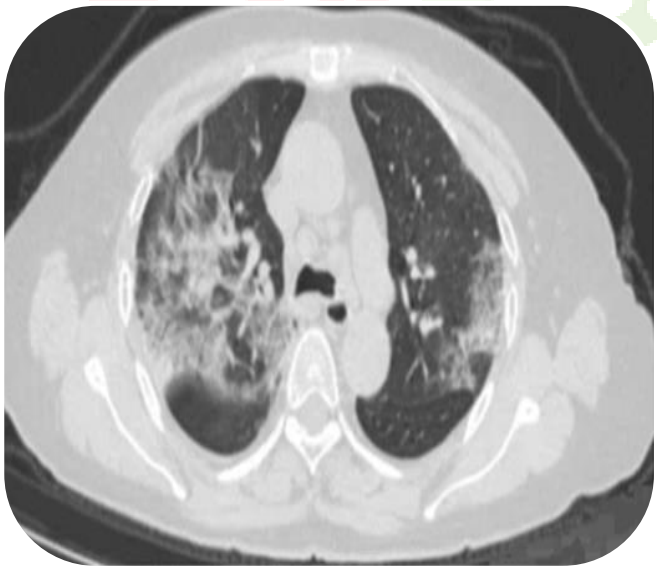
RADIOGRAPHIC CHARACTERISTIC	
NORMAL CHEST RADIOGRAPHS	LUNG ABNORMALITY FEATURES ON CHEST X-RAY
UPPER ZONE PREDOMINANT	RETICULAR -NODULAR OPACITIES
MIDDLE ZONE PREDOMINANT	PATCHY OPACITIES
LOWER ZONE PREDOMINANT	CONSOLIDATION
PERIPHERAL PREDOMINANT	PLEURAL EFFUSION
Perihilar predominant	

CT IMAGES FINDINGS AND PATHOLOGIES IN PATIENTS WITH COVID-19 PNEUMONIA

The lymph node is enlarge in this computed tomography image

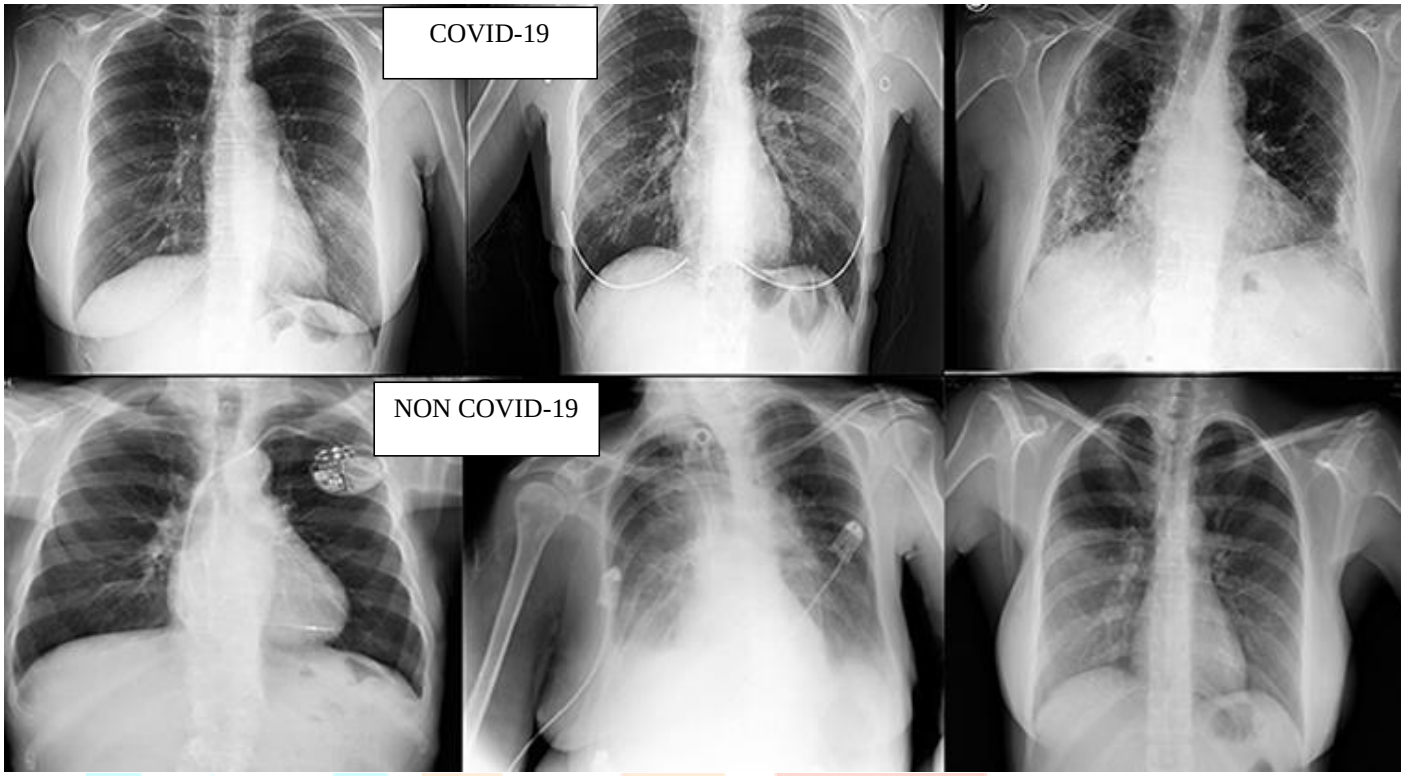
Lung computed tomography view , showing multi-focal crazy-paving pattern and

Computed tomography showing the Parenchyma of Lung



The enlarged lymph node shown in computed tomographic scan

Comparison of different chest X-ray of normal & COVID-19 patient's lungs



DISCUSSION

According to many studies we have found that a disease was emerged among the people in china and other parts of the world , which lead the patients suffer from a kind of pneumonia with several other respiratory abnormalities which lead the patients having breathlessness and coughing , the virus responsible for this pneumonia and other chest related abnormalities was considered to be corona virus which was of the different origin and later subsequently named as the (COVID19 virus) by the WHO and the lower portions of the respiratory system were found to be involved the most and it was considered a tough task to find differences between the CXR taken , to differentiate in symptomatic and non symptomatic corona virus patients , the study defines that an algorithm from (AI) can be used on CXR for finding the differences between the corona and the non corona abnormalities in lungs or simply the pneumonia in lungs , this data set testing and differentiating system showed good results in the (AUC). In this study we found that the outcome of the patients who were found corona virus positive , was done by artificial intelligence data set system .

The excellent results out of the artificial intelligence data set system and the score which was given by the radiologists to get known to the outcome of the diagnosis , played a vital role for the resource , constrained data set setting , at the time when corona was at its peak , the artificial intelligence also helped by getting the severity score and the clinical data of the corona positive patients for the identification of the patients who were considered to be at a rik of progression in severity and with this we can use the limited equipements and the sources accordingly .

The identification of key image findings in corona virus disease and the improvement of the effective patient management and the treatment , the findings in CXR was considered important , the patients who were severe , their findings on chest computed tomography were the bilateral , multilobar , involvements , sub segmental consolidation opacities, and the most commonly found indication was find to be ARDS , which gave the actual reason for shifting the patient to (ICU) and the same was find to be the

mortality among patients in (ICU)[20], It was found that RALE scoring can predict the death of the patients having corona virus and AI Scores derived from Chest x-rays , although most of the literature had focused on the use of chest CT in patients with COVID-19 infection for assessing the severity , complications and outcome of ,but according to the study the use of Chest x-ray was considered of low radiations as the radiations in computed tomography were higher , the CXR was considered easy to handle and easily to be sterilized , severity score out of AI algorithm is as robust a predictor of adverse patient outcome in patients with COVID-19 pneumonia as subjective RALE Score [21]

In this study we have reasoned the detection of a form of pneumonia of unknown origin and the causative agent was considered to be a Novel Virus of the family coronaviridae and the disease associated with this virus was termed as COVID-19 , for this an algorithm system was used on chest radiographs, The AI system proved to be a game changer in predicting adverse outcomes , for resource- constrained settings especially for the countries with a shortage of radiological expertise and also helped in identifying the patients at higher risk of an adverse outcome so the limited resources can be allocated accordingly . The desired standard for the diagnostic criteria of the virus were RT-PCR and throat swabs via Nucleic acid detection , The chest radiographs were considered to be least sensitive for detecting COVID-19 in early stages , The correlate of Ground Glass Opacities and Densities was very difficult to be detected on a chest x-ray so Computed Tomography scan was recommended as it was found to be sensitive for early stage lung involvement detection in COVID-19 patients .

CONCLUSION

CXR was suggested s the initial tool for the diagnosis of the severity of the corona virus , which was possible only due to the scoring systems including the RALE scoring system and the CXR scoring system , Although CXR scoring may be less sensitive than CT Scan , It is acknowledged that for patients with unexpected finding that could be attributed to COVID-19, The radiologists should follow the best practice , Parameters for communication of diagnostic imaging findings , The staff for examining should be notified to initiate (SOP's) for potential exposure .

Acknowledgment

I thank almighty Allah, for all his blessings , I would like to thank my supervisor **Mr. Arshad Alam** Khan for his valuable help , I would also like to thank my co-supervisor **Ms.Ashita Jain** whose support, guidance, help and views helped me a lot throughout my study period .

REFERENCES

[1] 1.Chamorro EM, Tascón AD, Sanz LI, Vélez SO, Nacenta SB. Radiologic diagnosis of patients with COVID-19. Radiología (English Edition). 2021 Jan 1;63(1):56-73. https://scholar.google.com/scholar?cites=11303051106331023197&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

2.Moroni C, Cozzi D, Albanesi M, Cavigli E, Bindi A, Luvarà S, Busoni S, Mazzoni LN, Grifoni S, Nazerian P, Miele V. Chest X-ray in the emergency department during COVID-19 pandemic descending phase in Italy: Correlation with patients' outcome. La radiologia medica. 2021 May;126(5):6618 https://doi.org/10.1007/s11547-020-01327-3 https://scholar.google.com/scholar?cites=8119564795094566940&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

3.Kaleemi R, Hilal K, Arshad A, Martins RS, Nankani A, Tu H, Basharat S, Ansar Z. The 0patients with COVID-19 presenting to the emergency department of a tertiary care hospital in Pakistan. PLoS One. 2021 Jan 5;16(1):e0244886. https://doi.org/10.1371/journal.pone.0244886 https://scholar.google.com/scholar?cites=2485372348720312908&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

4.Wasilewski PG, Mruk B, Mazur S, Półtorak-Szymczak G, Sklinda K, Walecki J. COVID-19 severity scoring systems in radiological imaging–a review. Polish Journal of Radiology. 2020;85:e361. https://doi.org/10.5114/pjr.2020.98009
https://scholar.google.com/scholar?cites=16462040260497432450&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
5.Cleverley J, Piper J, Jones MM. The role of chest radiography in confirming covid-19 pneumonia. bmj. 2020 Jul 16;370. http://dx.doi.org/10.1136/bmj.m2426https://scholar.google.com/scholar?cites=14475537418461932549&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
6.Yang W, Sirajuddin A, Zhang X, Liu G, Teng Z, Zhao S, Lu M. The role of imaging in 2019 novel coronavirus pneumonia (COVID-19). European radiology. 2020 Apr 15:1-9. https://doi.org/10.1007/s00330-020-06827-4
https://scholar.google.com/scholar?cites=6598210955425181470&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
7.Palwa AR, Zafar SI, Nisar U, Halim A, Riaz S, Nayyar B. SPECTRUM OF CHEST X-RAY FINDINGS IN COVID-19 POSITIVE PATIENTS UTILIZING MODIFIED RALE SCORE FOR SEVERITY ASSESSMENT. PAFMJ. 2020 Sep 3;70(2):S494-500.
https://scholar.google.com/scholar?cites=10552551605524533572&as_sdt=2005&sciodt=0,5&hl=en
https://scholar.google.com/scholar?cites=8119564795094566940&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
8.Rousan LA, Elobeid E, Karrar M, Khader Y. Chest x-ray findings and temporal lung changes in patients with COVID-19 pneumonia. BMC Pulmonary Medicine. 2020 Dec;20(1):1-9. https://doi.org/10.1186/s12890-020-01286-5
https://scholar.google.com/scholar?cites=3371329690622780366&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
9.Cozzi D, Albanesi M, Cavigli E, Moroni C, Bindi A, Luvarà S, Lucarini S, Busoni S, Mazzoni LN, Miele V. Chest X-ray in new Coronavirus Disease 2019 (COVID-19) infection: findings and correlation with clinical outcome. La radiologia medica. 2020 Aug;125:730-7. https://doi.org/10.1007/s11547-020-01232-9
https://scholar.google.com/scholar?cites=14804095624286829568&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
10.Smith DL, Grenier JP, Batte C, Spieler B. A Characteristic Chest Radiographic Pattern in the Setting of the COVID-19 Pandemic. Radiology: Cardiothoracic Imaging. 2020 Sep 3;2(5):e200280. https://doi.org/10.1148/ryct.202020028
https://scholar.google.com/scholar?cites=8433330497141687845&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-
11.Li MD, Arun NT, Gidwani M, Chang K, Deng F, Little BP, Mendoza DP, Lang M, Lee SI, O'Shea A, Parakh A. Automated assessment and tracking of COVID-19 pulmonary disease severity on chest radiographs using convolutional siamese neural networks. Radiology: Artificial Intelligence. 2020 Jul 22;2(4):e200079. https://doi.org/10.1148/ryai.2020200079
https://scholar.google.com/scholar?cites=5055667000560704421&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
12.Kwon YJ, Toussie D, Finkelstein M, Cedillo MA, Maron SZ, Manna S, Voutsinas N, Eber C, Jacobi A, Bernheim A, Gupta YS. Combining Initial Radiographs and Clinical Variables Improves Deep Learning Prognostication in Patients with COVID-19 from the Emergency Department. Radiology: Artificial Intelligence. 2020 Dec 16;3(2):e200098. https://doi.org/10.1148/ryai.2020200098
https://scholar.google.com/scholar?cites=3566451389687028852&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
13.Ng MY, Lee EY, Yang J, Yang F, Li X, Wang H, Lui MM, Lo CS, Leung B, Khong PL, Hui CK. Imaging profile of the COVID-19 infection: radiologic findings and literature review. Radiology: Cardiothoracic Imaging. 2020 Feb 13;2(1):e200034. https://doi.org/10.1148/ryct.2020200034
https://scholar.google.com/scholar?cites=4249711248896066062&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19
14.Wong HY, Lam HY, Fong AH, Leung ST, Chin TW, Lo CS, Lui MM, Lee JC, Chiu KW, Chung TW, Lee EY. Frequency and distribution of chest radiographic findings in patients positive for COVID-19. Radiology. 2020 Aug;296(2):E72-8. https://doi.org/10.1148/radiol.2020201160
https://scholar.google.com/scholar?cites=6418434276155450 27&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

15.Toussie D, Voutsinas N, Finkelstein M, Cedillo MA, Manna S, Maron SZ, Jacobi A, Chung M, Bernheim A, Eber C, Concepcion J. Clinical and chest radiography features determine patient outcomes in young and middle-aged adults with COVID-19. Radiology. 2020 Oct;297(1):E197-206. https://doi.org/10.1148/radiol.2020201754 https://scholar.google.com/scholar?cites=7606797573324369691&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

16.Zhang R, Tie X, Qi Z, Bevins NB, Zhang C, Griner D, Song TK, Nadig JD, Schiebler ML, Garrett JW, Li K. Diagnosis of coronavirus disease 2019 pneumonia by using chest radiography: Value of artificial intelligence. Radiology. 2021 Feb;298(2):E88-97. https://doi.org/10.1148/radiol.2020202944 https://scholar.google.com/scholar?cites=7742020920769630074&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

17.Mushtaq J, Pennella R, Lavalle S, Colarieti A, Steidler S, Martinenghi CM, Palumbo D, Esposito A, Rovere-Querini P, Tresoldi M, Landoni G. Initial chest radiographs and artificial intelligence (AI) predict clinical outcomes in COVID-19 patients: analysis of 697 Italian patients. European radiology. 2021 Mar;31(3):1770-9. https://doi.org/10.1007/s00330-020-07269-8 https://scholar.google.com/scholar?cites=16804751096545377230&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

18.Nagarajan B, Autkar G, Monga A, Toshniwal N. Lung Manifestations of COVID-19 on Chest Radiographs—Indian Experience in a High-Volume Dedicated COVID center. SN Comprehensive Clinical Medicine. 2021 Jan;3(1):16-21. https://doi.org/10.1007/s42399-020-00643-z https://scholar.google.com/scholar?q=related:98_CmjveAdIJ:scholar.google.com/&scioq=Lung+Manifestations+of+COVID-19+on+Chest+Radiographs%E2%80%94Indian+Experience+in+a+High-Volume+Dedicated+COVID+center&hl=en&as_sdt=0,5

19.Hosseiny M, Kooraki S, Gholamrezanezhad A, Reddy S, Myers L. Radiology perspective of coronavirus disease 2019 (COVID-19): lessons from severe acute respiratory syndrome and Middle East respiratory syndrome. American Journal of Roentgenology. 2020 May;214(5):1078-82.doi.org/10.2214/AJR.20.22969 https://scholar.google.com/scholar?cites=17929895042687751755&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

20.Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients. American Journal of Roentgenology. 2020 Jul;215(1):87-93. doi.org/10.2214/AJR.20.23034 https://scholar.google.com/scholar?cites=6784596390702194l0&as_sdt=2005&sciodt=0,5&hl=en&scioq=spectrum+of+chest+x+ray+findings+in+COVID-19

21.Ebrahimian S, Homayounieh F, Rockenbach MA, Putha P, Raj T, Dayan I, Bizzo BC, Buch V, Wu D, Kim K, Li Q. Artificial intelligence matches subjective severity assessment of pneumonia for prediction of patient outcome and need for mechanical ventilation: a cohort study. Scientific Reports. 2021 Jan 13;11(1):1-0. https://doi.org/10.1038/s41598-020-79470-0 https://www.nature.com/articles/s41598-020-79470-0

22.Majeed AI, Raza F, Riaz SK, Kanwal J. The Essential Role Of Conventional Radiography In Covid-19; Perspective Of A Developing Country. Journal of Ayub Medical College, Abbottabad: JAMC. 2021 Apr 1;33(2):267-73. https://europepmc.org/article/med/34137543J Ayub Med Coll Abbottabad 2021;33(2):267–73

23.Antonio GE, Wong KT, Tsui EL, Chan DP, Hui DS, Ng AW, Shing KK, Yuen EH, Chan JC, Ahuja AT. Chest radiograph scores as potential prognostic indicators in severe acute respiratory syndrome (SARS). American Journal of Roentgenology. 2005 Mar;184(3):734-41 https://www.ajronline.org/doi/abs/10.2214/ajr.184.3.01840734AJR 2005;184:734–741

24.Joseph NP, Reid NJ, Som A, Li MD, Hyle EP, Dugdale CM, Lang M, Betancourt JR, Deng F, Mendoza DP, Little BP. Racial and ethnic disparities in disease severity on admission chest radiographs among patients admitted with confirmed coronavirus disease 2019: a retrospective cohort study. Radiology. 2020 Dec;297(3):E303-12. https://pubs.rsna.org/doi/abs/10.1148/radiol.2020202602 https://doi.org/10.1148/radiol.2020202602

25.Borakati A, Perera A, Johnson J, Sood T. Diagnostic accuracy of X-ray versus CT in COVID-19: a propensity-matched database study. BMJ open. 2020 Nov 1;10(11):e042946. https://bmjopen.bmj.com/content/10/11/e042946.abstract doi:10.1136/bmjopen-2020-042946

26.Setiawati R, Widyoningroem A, Handarini T, Hayati F, Basja AT, Putri AR, Jaya MG, Andriani J, Tanadi MR, Kamal IH. Modified Chest X-Ray Scoring System in Evaluating Severity of COVID-19 Patient in Dr. Soetomo General Hospital Surabaya, Indonesia. International Journal of General Medicine. 2021;14:2407. doi: 10.2147/IJGM.S310577 https://www.ncbi.nlm.nih.gov/pmc/articles/pmc8200150/

27. Durrani M, Inam ul Haq UK, Yousaf A. Chest X-rays findings in COVID 19 patients at a University Teaching Hospital-A descriptive study. Pakistan journal of medical sciences. 2020 May;36(COVID19-S4):S22. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7306947/doi: https://doi.org/10.12669/pjms.36.COVID19-S4.2778

28.Yoon SH, Lee KH, Kim JY, Lee YK, Ko H, Kim KH, Park CM, Kim YH. Chest radiographic and CT findings of the 2019 novel coronavirus disease (COVID-19): analysis of nine patients treated in Korea. Korean journal of radiology. 2020 Apr 1;21(4):494-500. https://synapse.koreamed.org/articles/1144173 eISSN 2005-8330 https://doi.org/10.3348/kjr.2020.0132

29.Jabaudon M, Audard J, Pereira B, Jaber S, Lefrant JY, Blondonnet R, Godet T, Futier E, Lambert C, Bazin JE, Bastarache JA. Early changes over time in the radiographic assessment of lung edema score are associated with survival in ARDS. Chest. 2020 Dec 1;158(6):2394-403. https://www.sciencedirect.com/science/article/pii/S0012369220318742 https://doi.org/10.1016/j.chest.2020.06.070

30.Warren MA, Zhao Z, Koyama T, Bastarache JA, Shaver CM, Semler MW, Rice TW, Matthay MA, Calfee CS, Ware LB. Severity scoring of lung oedema on the chest radiograph is associated with clinical outcomes in ARDS. Thorax. 2018 Sep 1;73(9):840-6. https://thorax.bmj.com/content/73/9/840.abstract http://dx.doi.org/10.1136/thoraxjnl-2017-211280