REVIEW ARTICLE

FINDINGS OF COMPUTER AIDED CHEST TOMOGRAPHY FOR DETECTION OF PANDEMIC IN YOUNG AND ADULTS. A SYSTEMIC REVIEW

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ABSTRACT

OBJECTIVES: In this study, we aim to explore all literature that was done on the Covid patients with regards to CT imaging. We aim to explore the variations in CT imaging which occurs at different time intervals with changes in the frequency of CT features. **METHODOLOGY:** For this study, we follow the Preferred Reporting Items guideline for conducting this systematic review analysis (PRISMA) 16. We search electronic articles from January to April on PUB Med, online Willey library, and Science Direct site by using keywords related to CT imaging and Corona virus. **RESULTS:** After pooling data, we observed that bilateral involvement was found in 76.8% of studies, 68.4% GCO, and 62.2% ratio was occupied by peripheral distribution in different studies. 48.7% of studies were concerned about the GCO consolidation, 33.2% observed consolidation, 27.7% ratio of crazy paving pattern, and 25% of studies observed mixed central and peripheral distribution. Only 15.2% of studies observed unilateral involvement and 9.2% of studies were concerned with the nodular opacity feature whereas a very little amount of literature was found on lymphadenopathy (2.4%). **CONCLUSION:** This systematic literature review has some limitations. We did not find studies that have the same interval between CT imaging and symptoms onset. Some researchers performed CT after 2 weeks of symptoms and some performed before 2 weeks.

Introduction

Coronavirus emerged from the city of Wuhan in the last months of 2019. Pathological findings revealed that it is a single-stranded RNA virus which mutates rapidly with 2.2 basic reproductive number.[1] Recently studies examine that 6 species of Coronavirus can form human disease.[2] Generally, the four species including 229E, OC43, NL63, and HKU1 are common which induce common cold symptoms.[2] The rest two species MERS-COV and SARS-COV are caused by the animals and can engage persons in fatal illness.[3] The high prevalence of Coronavirus in different regions of the world depicts that it could be occasionally effected the human species due to its cross-species infection features.[3,4]

On December 31, 2019 world health organization received information about the virus from Wuhan which creates respiratory distress for unknown reasons. The clinical symptoms of viruses were closed to pneumonia-like fever, cold, and cough, which create hurdles to identify the actual virus which increases the mortality rate. In CT imaging of the patients, pulmonary opacities were also observed.[5] After the analysis of bronchoalveolar lavage fluid under the electronic microscope, it came to know

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that a crown like a virus emerging from viral spike peplomers.[6] This virus was observed for the first time so newly came virus labeled as 2019 novel Coronavirus. Studies on the effected patients reflect that the contagious disease rapidly spread from effected patient to normal and sometimes asymptomatic which causes a delay in the examination process. Generally, a wide perception is that it could be transmitted from respiratory droplets and close contact but recently studies depict that it may be caused by the digestive tract.[7] The majority of the patients had mild symptoms but in many countries old patients with poor immune systems and co morbidities were severely affected by this deadly virus.[8]

There is no vaccination of this deadly virus found yet. Only early detection and control of its transmission in form of isolated infected persons can be helpful to stop this deadly virus.[9] Unfortunately, a large number of suspected cases need more time for laboratory examination which causes a wide spread of this disease. A low number of examination kits and a high rate of suspected patients in some regions becomes another issue that causes the wide spread of this virus because of no quarantine administration of the suspected person.[10]

CT imaging plays a massive role in the examination of infected cases of novel Coronavirus 19. It is considered as the imaging modality which screens out the changes in effected patients and depicts the effectiveness of treatment with time.[9] It helps to highlight the patients with negative reverse transcription-polymerase chain reaction (RT-PCR) but in the case of a novel Coronavirus, its effectiveness is still questioned.[10,11] This screening method helps to examine the severity of disease among patients.[12-15] CT features of affected patients might help create a distinction between novel Coronavirus and other viruses which cause pneumonia among patients.

In this study, we aim to explore all literature that was done on the Covid patients with regards to CT imaging. We aim to explore the variations in CT imaging which occurs at different time intervals with changes in the frequency of CT features.

Search Strategies

For this study, we follow the Preferred Reporting Items guideline for conducting this systematic review analysis (PRISMA) 16. We search electronic articles from January to April on PUB Med, online Willey library, and Science Direct site. We use keywords like Diagnostic Imaging, Diagnostic X-Ray, Diagnostic X-Ray Radiology, Medical Imaging, X-Ray Computed Tomography, CT, X-Ray Computer Assisted Tomography, CT X-Ray, X-Ray CAT Scan, X-Ray Computerized Tomography, COVID-19, 2019-n CoV, to Coronavirus, SARS-CoV-2, Wuhan Coronavirus, Novel Coronavirus, 2019 novel Coronavirus, Coronavirus disease 2019 virus, COVID-19 virus, 2019-nCoV infection, Coronavirus disease-19 to search relevant articles. With the help of keywords, we analyze the title, abstract aims, and objectives to extract the relevant data. Articles and case studies with complete demographic information and complete medical symptoms of patients confirmed after RT-PCR were included for this research. Information in the form of posters, case studies without CT imaging, letters to editors, and articles with copied information was excluded from this study. Articles which were written in other than English language were not included for this research. On the behalf of keywords we found seven hundred sixty-two articles. The evaluation of our selected data was further done into two phases first we select the data based on abstract and title. Secondly, we examine the inner text of articles and include if they were eligible to fill the inclusion criteria of our study. For keywords we used Bolian operators.

Methodology

At the initial stage of collecting data, we found seven hundred and sixty-two articles with selected keywords. In the first screening, we excluded 162 duplicate articles and further screen out the rest of 598 articles. Later on, we omitted 502 articles with poor information on CT imaging and 92 articles were further gone through the screening process. At the last stage, we found 12 articles that fulfilled the inclusion criteria and had adequate data on our topic. Student t test was applied to find significant p value at 0.05%

We kept demographic information of patients like mean age and rang, the sample size in tabular form. We also observed the CT findings regarding parenchymal, parenchyma features district, bronchovascular changes, pleural involvement, and extrapleural findings of all selected researches.

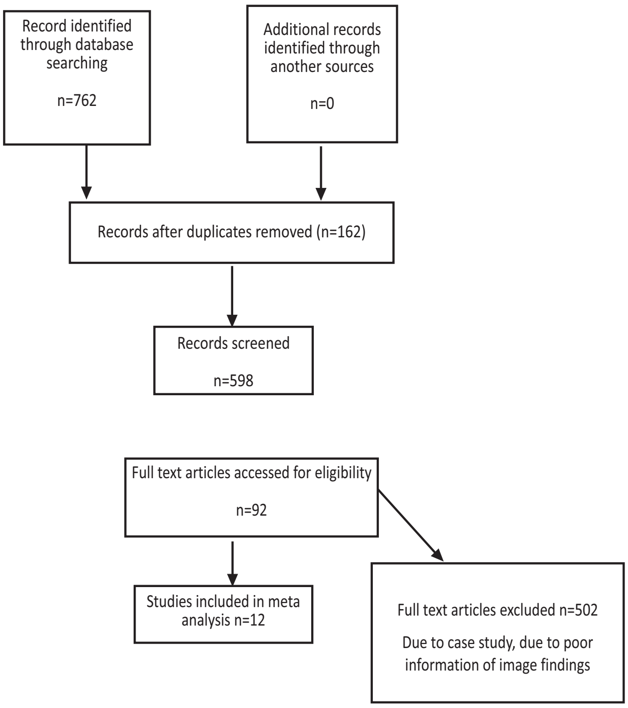

Figure 1: Prisma selection of meta analysis

Results

At first sight, we noted the initial symptoms of our selected studies. During analysis the main symptoms of Covid infected patients were fever and dry cough, decrease in the count of white blood cells and lymphocyte, and increase the frequency of C-reactive protein among the affected patients.

The information of the author, number of patients, and CT findings of the affected patients were mentioned in (Tab.1,2,3).

In pool analysis we observed that CT findings have a significant relationship with each other. (Tab.4)

In a study by Xu et al, he observed 100% subpleural lesion which depicts the existence of peripheral distribution among 100% cases. In another study of Yoon et al, he observed 35% of GCO prevalence which was further added to crazy paving prevalence in 10% cases. In his study, he observed many features of crazy paving patterns except the interlobular septal thickness. In the study of Liu et al, he includes pregnant and nonpregnant groups and represents them in decimal numbers and we rounded down the decimal numbers. In the study of Wang et al, he reported 9.1% and 5.5% single and multiple lesions uncommon in

Author Name	No. of cases	Chest findings of patients					
		Halo signs	GCO	Lymphadenopathy	Nodular opacities	Consolidation and GCO	Consolidation
Chung at al[6]	21	-	57	0	0	29	0
Wang et al[24]	114	-	27.3	-	-	45.4	27.3
Xie et al[11]	5	-	60	-	-	40	0
Wang et al[26]	138	-	-	-	-	-	-
Yoon et al[20]	9	-	45	-	10	50	5
Huang et al[12]	41	-	-	-	-	-	-
Shi et al[23]	81	-	65	6	6	-	-
Liu et al[25]	55	-	-	-	-	-	-
Yuan et al[27]	27	-	67	0	7	30	19
Song et al[15]	51	-	77	6	-	59	55
Xu et al[21]	90	-	72	-	1	-	13
Zhao et al[22]	80	-	71	-	1.3	-	27.8
Li and Xia	51	-	28	11	-	28	-
Lu et al	11	-	11	-	3	7	6
Han et al	108	-	65	-	-	44	-

Table 1:

Author Name	No. of cases	Chest findings of patients					
		Crazy paving	Central distribution	Normal radiology	Central and peripheral distribution	Peripheral distribution	Pleural effusion
Chungatal	21	19	Not mentioned	14	Not mentioned	33	0
Wangetal.	114	Not mentioned	Not mentioned	26	Not mentioned	Not mentioned	9
Xieetal.	5	Not mentioned	0	N/A	0	100	Not mentioned
Wangetal.	138	Note mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Yoonetal.	9	10	20	Not mentioned	20	60	Not mentioned
Huangetal.	41	Note mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Shietal	81	10	Not mentioned	Not mentioned	Not mentioned	54	5
Liuetal.	55	not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Yuanetal	27	Not mentioned	0	0	74	26	4
Songetal	51	75	10	0	2	86	8
Xuetal	90	12	not mentioned	23	Not mentioned	51	4
Zhaoetal.	80	Not mentioned	not mentioned	Not mentioned	Not mentioned	Not mentioned	1.3
Li and Xia40	51	36	Not mentioned	Not mentioned	Not mentioned	Not mentioned	36
Lu at al17	11	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned	Not mentioned
Han et al18	108	43	Not mentioned	49	Not mentioned	Not mentioned	Not mentioned

Table 2:

Author Name	No. of cases	Chest findings of patients	
		Bilateral involvement	unilaterial involvement
Chungatal	21	76	10
Wangetal	114	85.4	N/A
Xieet al	5	100	0
Wangetal	138	100	N/A
Yoonetal	9	N/A	N/A
Huangetal	41	98	N/A
Shietal	81	79	N/A
Liuetal.	55	N/A	N/A
Yuanetal	27	85	15
Songetal	51	86	14
Xuetal	90	59	N/A
Zhaoetal	80	95	5

Table 3:

Variables	Pool Mean	Pool Standard deviations	p value
GCO	53.775	21.14	0 .000028
Lymphadenopathy	1.91	3.67	0 .023928
Nodular opacities	4.04	3.7	0 .001277
Consolidation and GCO	36.9	15.3	0 .001216
Consolidation	17	17.7	0.422449
Crazy paving	29.2	24	0 .105974
Central distribution	7.5	9.57	0.202
Normal radiology	18.6	18.5	0.417821
Central and peripheral distribution	26.25	34.4	-
Peripheral distribution	58.5	26.65	0 .003607
Pleural effusion	8.4	11.5	0 .40873
Bilateral involvement	86.34	12.88	< .00001
Unilateral involvement	8.8	6.3	0.319537

Table 4: Pool analysis of CT findings

one lung during performing unilateral imaging. On the other hand, 85.4% of cases of this study had bilateral involvement of lesions.

We found a large amount of literature on GCO (27.3-80%)[6,10,15,17,18,19,20,21,22,23,24,27,40] consolidation (0-55%)[6,10,15,19,20,21,22,24,27] and their combined density frequency (29-61%)[6,10,15,19,20,24,27]. We observed 0-10 % frequency of nodular opacity[6,20,23,27,10] to 75% of crazy paving pat-terns[6,15,19,20,21,23] results with huge diversity in results. Unilateral involvement, central distribution, and normal imaging were less common among the studies (0 to 25%, 0-20%, and 0-23% respectively)[6,10,19,21,22,27] as compared to bilateral involvement and peripheral distribution (59 to 100% and 26- 100% respectively)[6,10,12,15,19-27]. After pooling data, we observed that bilateral involvement was found in 76.8% of studies, 68.4% GCO, and 62.2% ratio was occupied by peripheral distribution in different studies. 48.7% of studies were concerned about the GCO consolidation, 33.2% observed consolidation, 27.7% ratio of crazy paving pattern, and 25% of studies observed mixed central and peripheral distribution. Only 15.2% of studies observed unilateral involvement and 9.2% of studies were concerned with the nodular opacity feature whereas a very little amount of literature was found on lymphadenopathy (2.4%).

Discussion

In the majority of selected studies, bilateral involvement was observed in CT imaging along with the peripheral involvement, mixed GGO, and consolidation, consolidation, crazy paving pattern. We further observed that selected articles were more concerned with mixed central and peripheral distribution, unilateral involvement, nodular opacities, pleural effusion, central distribution, and lymphadenopathy of the symptomatic patients. In the majority of the studies, CT imaging reports of the patients revealed that GCO was a hazy grey area that was caused by partial air displacement. All the studies observed that the mechanism of GCO without bronchovascular obscuration happened after the alveoli partial filling of interstitial thickening.[28] In one study autopsy reports revealed the formation of pulmonary edema and hyaline membrane formation inside the affected patients.[29] Another study reported that the formation of the hyaline membrane can be a pathological description of GCO.[30] The density of lesion in all studies had variations which may be due to the interval between the CT scan and onset symptoms of the patient.

Song et al studies revealed that patients have more lesion consolidation if they had a longer time interval between CT imaging and symptoms onset. The occurrence of lesions can be observed within the 2 weeks after the examination of the symptoms and gradually increased the GCO after two weeks.[15] The study of Pan et al31 and Shi et al[23] noted the progression of GCO within 1-3 weeks of COVID symptoms along with consolidation. Consolidation exhibits more density than the GCO because they reflect alveolar air that is occupied with fluids, cells, and tissues which results in bronchovascular obscuration.[28] In Covid patients, studies observed secretion of cellular fibromyxoid in alveoli that eventually results in lesion consolidation among patients.[29]

Halo is another feature observed among the studies. It is a mass or consolidative nodule around the peripheral ground-glass opacity (GCO).[28] It is considered one of the major reasons for pneumonia and is highly associated with viral infections.[32] After the pooling of collected data, we observed that halo signs are less common among adult patients and widely occurred in pediatrics.[29,33,34]

In all studies, another frequent feature among Covid patients was irregular opacity less than 3 cm diameter nodular opacities. Usually, it is highly observed among pneumonia patients.[35] Among adult patients, we observed a 9.2% frequency in selected studies.

We observed that majority of the studies have consensus that interstitial lymphocyte infiltration may decrease the interlobular and intralobular septal thickening. After rapid occurrence of Covid symptoms among patients researchers observed an increase in reticular opacity.[29] In a study by Shi et al study,[23] this high reticular opacity frequency affects 33% of patients while Song et al[15] observed a comparatively large amount of continuity among 67% of his study patients. Association of reticular opacity and GCO formed crazy paving patterns in the patient's lungs.[28] This happens due to alveolar edema and interstitial inflammation that arises after lung injury.[11,36] During studies, we observed that 27% of studies report the ed the prevalence of crazy paving patterns with variation in the frequency of patterns due to a long time interval between CT imaging and symptoms onset.

Lymphadenopathy is another feature of lungs CT which occupied great importance for critically ill patients of Covid 19 because it may increase the risk of superinfection if combine with pleural effusion and numerous lung nodules.[37,13] In selected studies, we did not observe any information regarding lymphadenopathy. In Covid infection, pleural effusion is considered as an indicator for the poor condition of patients. In one study of Shi et al little frequency of pleural effusion (5%). Usually, it is less observable of the pleural thickening. Xi Liu et al[38] autopsy report observed pleural thickness in CT imaging. So the total ratio of these two features was slightly less (only 3.5%).

In recent years, unilateral chest imaging was performed for the SARS and MERS affected patients.[39] But in Covid CT imaging shifts from unilateral imaging to bilateral imaging due to the demand for complete observations of patient condition. In a recent systematic review, Salehi et al[33] observed bilateral imaging among 919 studies of novel Coronavirus and the percentage of this practice was 87.5%. Axial or peripheral distribution is highly associated with novel Coronavirus-infected pneumonia cases. In a recent study of Salehi et al, he observed a 76% frequency of peripheral distribution among the patients of 9 studies.

Conclusion

This systematic literature review has some limitations. We did not find studies that have the same interval between CT imaging and symptoms onset. Some researchers performed CT after 2 weeks of symptoms and some performed before 2 weeks. So there must be a specific time interval to perform CT imaging to prevent the variations among results. Variations among results create obstacles to identify the linear time interval for CT imaging which may be helpful to decrease mortality ratio of Covid patients.

Conflict of interest: There was no conflict of research during studies.

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