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Diagnosis of COVID-19 Based on Radiological and Clinical Features: A Narrative Review

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Abstract

Introduction: The diagnosis of COVID-19 is guided by clinical features and radiological findings of ground glass appearance, but the result should be confirmed by RT-PCR with 66-80% sensitivity. This review aimed to evaluate the evidence regarding diagnosis of COVID-19 based on the radiological and clinical features.

Methods A systematic review of the literature was carried out to identify relevant articles using six different databases. Only studies which reported data on pre-defined outcomes were included. Epidemiological studies published in 2020 (from January–March) on the clinical presentation, laboratory findings and treatments of COVID-19 patients were identified from PubMed/MEDLINE and Embase databases. Studies published 2020-2022 were included. Primary outcomes included comorbidities of COVID-19 patients, laboratory results and radiological outcomes.

Results: , the chest CT is widely used to find the infected person through diagnostic imaging. The CT is performed only on the person who has been infected severely. In many positive patients, pulmonary consolidation is observed, and based on that, the infected patients are quarantined. In addition, few patients were observed with a decrease in WBC and lymphocytes. The CT diagnosis employed to the COVID-19 positive patients based on the RT-PCR results. CT imaging is done based on a 4-day interval to monitor the function of the respiratory syndrome. CT scans are usually conducted on a single respiratory phase. To reduce the uncertainties, the patients are advised to hold breath during CT imaging.

Conclusions: COVID-19 can be identified with higher precision using CT than RT-PCR. Further, the diagnosis of infection is possible by identifying the GGO and consolidation along the subpleural area of the lung. Identification of infected patients using CT can be more efficient to enable the prevention of infection transmission.

Keywords: Covid-19 D, Diagnosis, Radiology, Clinical, Accuracy.

Introduction

Coronavirus disease 2019 (COVID-19) caused by SASRS-CoV2 has spread in an exponential rate since December 2019, when it was first identified in Wuhan city, China. Tell now, more than 13,800,00 people were confirmed to have SARS-CoV2 with more than 580,000 reported deaths [1]. In 11 March 2020, the World Health Organization announced COVID-19 as a global pandemic. Since then, extreme unpreceded control measures were applied by most countries in the world including strict social distancing, closure of public gathering places, travelers quarantine, and intensive health education campaigns. Corona viruses are responsible of three known pandemics including severe acute respiratory syndrome coronavirus (SARS-CoV) in 2003 [2], the Middle East respiratory syndrome coronavirus (MERS-CoV) in 2013 [3], and finally the current pandemic of COVID-19. Only 15% of the infected people showed symptoms such as fever, fatigue, headache, dry cough, myalgia, dyspnea, and anosmia. Complications occur in a small percentage of patients (4%) and death is reported in 1.0 - 3.3% of the patients [4, 5].

SARS-CoV2 is a single-stranded RNA enveloped virus that belongs to beta Coronavirus family. The infection of SARS-CoV2 is transmitted mainly through droplets or aerosol that expelled by infected persons during coughing or talking. Other means of transmission include hand-surface transmission, fomites, and less commonly fecal-oral mode of transmission [6]. Thus, social distancing, hand hygiene, and wearing of masks were considered as effective measures to prevent virus transmission. The basic productive number of SARS-CoV2, which represents how many persons will be infected from one patient during its infectious period, ranged from 2-6.47 in most affected countries [7].

The diagnosis of COVID-19 is guided by clinical features and radiological findings of ground glass appearance, but the result should be confirmed by RT-PCR with 66-80% sensitivity [8]. The management of the disease is mainly supportive including antipyretics and antitussive, in addition to oxygen supplementation and respiratory aid in complicated cases [9]. Protocols for the prevention, diagnosis, and treatment of COVID-19 was developed by National Health Commission (NHC) in China and they suggested a combination of protease inhibitors (lopinavir and ritonavir) with INF-α [10]. This review aimed to evaluate the evidence regarding diagnosis of COVID-19 based on the radiological and clinical features.

Methods

A systematic review of the literature was carried out to identify relevant articles using six different databases. Keywords to refine the search included ‘COVID-19’, ‘SARS-CoV2’, ‘Biomarkers’, among others. Only studies which reported data on pre-defined outcomes were included. Epidemiological studies published in 2020 (from January–March) on the clinical presentation, laboratory findings and treatments of COVID-19 patients were identified from PubMed/MEDLINE and Embase databases. Studies published 2020-2022 were included. Primary outcomes included comorbidities of COVID-19 patients, laboratory results and radiological outcomes..

Results and discussion

COVID-19 can be detected using various diagnostic procedures such as chest CT scan, acid detection, epidemiological history, and clinical treatment. Since COVID-19 is highly contagious, finding a rapid and

reliable diagnosis technique is significant. Although the origin of the virus took place in Wuhan, now under control there due to the effective utilization of diagnostic tests to identify the individual before the reproduction rates of infection were increased [10]. At the time of origin, the test procedures are different when compared to the latest clinical practices. For instance, the patients are subjected to a CT scan to find the infection. However, nowadays, the rapid test kits are used to predict the infection though uncertainty is a problem.

IgM and IgG is a simple technique performed to diagnosis the infected person. The test performed on 57 individuals. On comparing, IgG reported 72.7 % of the detection rate. Besides, the nucleic acid test report 87.5 %. Moreover, high-sensitivity C-reactive protein (hs-CRP) nucleic acid negative group observed higher test results compared to the positive group [11, 12].To sum up, the use of IgM and IgG over nucleic acid detection is highly recommended. Furthermore, a combination of all these to predict COVID-19 leads to high reliability and precision. Zhang et al. diagnosed the presence of COVID-19 by identifying the presence of the spike protein. They evaluated six recombinant nucleocapsid and spike proteins using IgM and IgG. They found that rs1 and rs-receptor binding domain-mFc are highly suitable to diagnose theHCoV-19. In the same way, gold immunochromatography assay (GICA) can be used to identify the antibodies [13,14].

Unlike the above method, the chest CT is widely used to find the infected person through diagnostic imaging. The CT is performed only on the person who has been infected severely. In many positive patients, pulmonary consolidation is observed, and based on that, the infected patients are quarantined. In addition, few patients were observed with a decrease in WBC and lymphocytes. The effects of infection in Hubei patients were compared with those from other countries. This comparative determination has aided in correlating the transmission of the virus from one geographic location to another. All patients, irrespective of their origin, suffered from fever, cough, and other respiratory issues. Likewise, the decrease in WBC and lymphocyte count was also seen [15].In traditional clinical procedures, X-ray imaging is performed to identify pulmonary diseases. However, in the case of COVID-19, using X-ray will not help due to the poor imaging characteristics, as shown in Table 1. Thus, CT is used to identify the infected person. Generally, the uncertainty in determination exists owing to false-negative ground-glass opacification (GGO) detection. Moreover, the imaging differs from case to case based on age, infection seriousness, and health status. To identify the infection, a comprehensive diagnosis must be made using distribution pattern, quantity and range, density, shape, interface, internal features of the lesion and adjacent structural changes, CT staging, quantitative CT, and artificial intelligence (AI).

The determination of CoV-2 using CT is not very clear. Furthermore, using CT on children is not specific [16,17].Thus, advanced computer-aided CT and AI are required urgently for screening patients and conducting virus surveillance. Further, analysing the CT images by AI using deep learning reduces the uncertainty in the confirmation of the positive new case. Few notable works incorporated the neuro-network through a deep learning model, which has achieved 82 % accuracy on findings. Song et al. proposed a framework to predict COVID-19 with minimum time using AI technology engines. The designed framework was made of simple Smartphone sensor measurements. The designed framework was comprised of a series of layers, such as input, measurement, sensing, computing, and predicting layers. The implementation of the proposed AI increased the mobility of diagnosis. The reliability was higher since the framework used multiple readings to diagnose. Another reliable method is deep learning.

Deep learning was proposed based on the CT diagnosis system to detect patients with COVID-19 using radiograph imaging. The model was built based on 88 patients' CT images. The DREnet architecture used ground-glass opacity in CT images to assist doctors in determining the infected persons [18]. The CT diagnosis employed to the COVID-19 positive patients based on the RT-PCR results. CT imaging is done based on a 4-day interval to monitor the function of the respiratory syndrome. CT scans are usually conducted on a single respiratory phase. To reduce the uncertainties, the patients are advised to hold breath during CT imaging [19]. The distribution of the

abnormalities are recorded and evaluated by the digital database and the radiologist. The patients are evaluated based on the ground glass opacity, crazy paving, and consolidation. A notable studied derived CT scan observations based on the seriousness of infections. All the patients were hospitalized and discharged after recovery with the mean days of 18. Based on imaging, the infection can be categorized into 4 stages. Further, the CT scan classified the different lobes such as left upper, left lower, right middle, and right lower. During stage 1, the maximum numbers of patients were observed with GGO (75 %), lesions in single lobe (42 %), and Consolidation (42 %). At stage II, consolidation (47 %), GGO (82 %), Crazy paving (53 %), multilobe (77 %), and peripheral lesion (59 %).Followed by at stage III, peripheral (70 %), bilateral multilobe (86 %), GGO (71 %), and consolidation (91 %). At stage IV, peripheral (70 %), bilateral multilobe (80 %), GGO (65 %), consolidation (75 %), and crazy paving pattern (0 %) [18]. As the patients getting cured, the GGO is decreased and the null observation for crazing paving patterns. From the above distribution frequency, it is evident COVID-19 can be diagnosed using GGO, consolidation, and crazy paving pattern. Further, the distribution of pulmonary lesion and the involvement of lesions also helped to detect the COVID-19 with the least precision since many patients were not observed with lesions [20].

Some studies revealed the effectiveness of PCR on CT. To understand this, comparative analysis between both is mandatory. A case report had been generated for 1014 confirmed cases in China. Based on the test dataof1014 suspected cases, the comparison of RT-PCR and CT is prepared. Nevertheless, the time interval between the RT-PCR and CT is approximately 5 days. Ai et al. reported a basic comparison of CT and PCR for 167 patients in China. Based on the comparison they revealed, 155 patients were confirmed with COVID-19 infection by testing using both. On the contrary, 12 patients were tested with false results in PCR compared to CT [21]. Further, the usage of PCR led to false negatives owing to insufficient viral material and laboratory errors. Yet again, immature nucleic acid, insufficient viral load, improper clinical sampling, low detection rate, and manufacturing defects were the other possibilities of errors in RT-PCR. By concluding all, CT is considered as more reliable for comprehensive evaluation and screening. Another study performed a statistical analysis using SPSS version 21.0. 95 % of the confidence interval was observed by the Wilson score method. Some patients with negative RT-PCR were confirmed with the infection by CT scans [22, 23]. Thus, CT is preferred over RT-PCR when the patients carry clinical symptoms such as shortness of breath, cold, fever, and diarrhea the other end, the correlation between RT-PCR and CT was done to make sure the infected patients after complete recovery..

Conclusions

In summary, COVID-19 can be identified with higher precision using CT than RT-PCR. Further, the diagnosis of infection is possible by identifying the GGO and consolidation along the subpleural area of the lung. Identification of infected patients using CT can be more efficient to enable the prevention of infection transmission.

Conflict of interests

The authors declared no conflict of interests.

References

1. worldometer. COVID-19 CORONAVIRUS PANDEMIC. 2020 [cited 2020 14-7-2020]; Available from: https://www.worldometers.info/coronavirus/?utm_campaign=homeAdvegas1?%22.

2. Organization WH. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. http://www who int/csr/sars/country/table2004_04_21/en/index html. 2003.

3. de Groot RJ, Baker SC, Baric RS, Brown CS, Drosten C, Enjuanes L, et al. Commentary: Middle east respiratory syndrome coronavirus (mers-cov): announcement of the coronavirus study group. Journal of virology. 2013;87(14):7790-2.

4. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. The Lancet. 2020;395(10223):507-13.

5. Yang J. Clinical Characteristics, Treatment, and Prognosis of 74 COVID-19 Patients from Cities outside Wuhan: A Descriptive Study.

6. Ong SWX, Tan YK, Chia PY, Lee TH, Ng OT, Wong MSY, et al. Air, surface environmental, and personal protective equipment contamination by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from a symptomatic patient. Jama. 2020;323(16):1610-2.

7. Singhal T. A review of coronavirus disease-2019 (COVID-19). The Indian Journal of Pediatrics. 2020:1-6.

8. Ai T, Yang Z, Hou H, Zhan C, Chen C, Lv W, et al. Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases. Radiology. 2020:200642.

9. Organization WH. Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: interim guidance, 13 March 2020: World Health Organization2020.

10. Kakodkar P, Kaka N, Baig M. A comprehensive literature review on the clinical presentation, and management of the pandemic coronavirus disease 2019 (COVID-19). Cureus. 2020;12(4).

11. Y. Sugishita, J. Kurita, T. Sugawara, Y. Ohkusa. Preliminary evaluation of voluntary event cancellation as a countermeasure against the COVID-19 outbreak in Japan as of 11 March, 2020.

12. X. Jia, P. Zhang, Y. Tian, J. Wang, H. Zeng, J. Wang, L. Jiao, Z. Chen, L. Zhang, H. He. Clinical significance of IgM and IgG test for diagnosis of highly suspected COVID-19 infection.

13. P. Zhang, Q. Gao, T. Wang, Y. Ke, F. Mo, R. Jia, W. Liu, L. Liu, S. Zheng, Y. Liu. Evaluation of recombinant nucleocapsid and spike proteins for serological diagnosis of novel coronavirus disease 2019 (COVID-19). MedRxiv (2020).

14. R. Konrad, U. Eberle, A. Dangel, B. Treis, A. Berger, K. Bengs, V. Fingerle, B. Liebl, N. Ackermann, A. Sing. Rapid establishment of laboratory diagnostics for the novel coronavirus SARS-CoV-2 in Bavaria, Germany. February 2020 Eurosurveillance, 25 (9) (2020), Article 2000173.

15. K.G. Andersen, A. Rambaut, W.I. Lipkin, E.C. Holmes, R.F. Garry. The proximal origin of SARS-CoV-2. Nat. Med., 26 (4) (2020), pp. 450-452.

16. L. Fan, D. Li, H. Xue, L. Zhang, Z. Liu, B. Zhang, L. Zhang, W. Yang, B. Xie, X. Duan. Progress and prospect on imaging diagnosis of COVID-19 Chin. J. Acad. Radiol. (2020), pp. 1-10.

17. H.S. Maghdid, K.Z. Ghafoor, A.S. Sadiq, K. Curran, K. Rabie, A novel ai-enabled framework to diagnose coronavirus covid 19 using smartphone embedded sensors: design study, arXiv preprint arXiv:2003.07434 (2020).

18. Y. Song, S. Zheng, L. Li, X. Zhang, X. Zhang, Z. Huang, J. Chen, H. Zhao, Y. Jie, R. Wang. Deep learning enables accurate diagnosis of novel coronavirus (COVID-19) with CT images. medRxiv (2020).

19. T. Ai, Z. Yang, H. Hou, C. Zhan, C. Chen, W. Lv, Q. Tao, Z. Sun, L. Xia Correlation of chest CT and RT-PCR testing in coronavirus disease 2019. (COVID-19) in China: a report of 1014 cases.Radiology, 10 (2020).

20. Z. Cheng, Y. Lu, Q. Cao, L. Qin, Z. Pan, F. Yan, W. Yang. Clinical features and chest CT manifestations of coronavirus disease 2019 (COVID-19) in a single-center study in Shanghai, China. Am. J. Roentgenol. (2020), pp. 1-6.

21. X. Xie, Z. Zhong, W. Zhao, C. Zheng, F. Wang, J. Liu. Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiology (2020), Article 200343.

22. M. Chung, A. Bernheim, X. Mei, N. Zhang, M. Huang, X. Zeng, J. Cui, W. Xu, Y. Yang, Z.A. Fayad, A. Jacobi, K. Li, S. Li, H. Shan. CT imaging features of 2019 novel coronavirus (2019-NCoV). Radiology. (2020), 10.1148/radiol.2020200230

23. V.M. Corman, O. Landt, M. Kaiser, R. Molenkamp, A. Meijer, D.K. Chu, T. Bleicker, S. Brünink, J. Schneider, M.L. Schmidt. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Eurosurveillance, 25 (3) (2020), 2000045


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