

Narrative Review Article: What are the radiological criteria for identifying the Corona virus in CT scan images?

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ABSTRACT

Doctors in New York, for the first time in the United States, examined lung scans of patients infected with the Corona virus in China. They believe that with the help of CT scan, certain patterns in the lungs can be identified as indicators of the infection of the Covid-19 virus. According to them, this method helps to quickly identify the patient and isolate him in the early stages of the disease, even before the symptoms appear. On the other hand, with the help of CT scan, the degree of destruction of lung tissue can be checked more easily. This is while X-ray scanning does not provide this possibility for doctors. Adam Bernheim, one of the assistant professors at the Mount Sinai School of Medicine, says: CT scan images are a very accurate identification tool because the internal organs of the body can be seen in three dimensions. In the same way, many diseases can also be identified. This research was published in the Journal of Radiology, during which researchers examined the scans of 94 patients in 4 health centers in 4 states of China. These patients were hospitalized between January 18 and February 1, and all of them had traveled to Wuhan (the center of the outbreak of the Corona virus) or had contact with someone infected with the virus. Radiologists reviewed the scans of these people and took notes based on the time of symptoms and the time of CT scan. This method showed that it is possible to track the destruction of lung tissue faster by CT scan. The researchers of this project have decided to use the CT scan along with the test kits of the US Centers for Disease Control and Prevention.

Introduction

Ground glass opacity (GGO) densities are very common in CT scans of Corona virus patients. GGOs usually occur bilaterally [1-3], but may first be unilateral and then become bilateral [4-6]. These

findings usually involve the back and the periphery of the lung, and with the severity of the disease [5-7], they can progress towards dense consolidation [8-11]. These findings are one of the most common manifestations in the CT scan images of Corona patients [12-16]. Linear opacities and crazy-paving opacities may

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also be seen in CT scan images of patients with Corona virus [17-25].

Covid-19 diagnostic methods based on PCR-based molecular methods

The molecular study of Covid-19 is based on PCR, an enzymatic method to produce a large number of target genes [26-30]. This method is widely used to amplify small amounts of genetic material in order to provide a sufficient sample for laboratory studies [31-35]. Due to the existence of a wide range of applications, as well as the high sensitivity and specificity of this technique, the PCR-based diagnostic method has become a common and reliable method for detecting the Corona virus. In general, the RNA of the Corona virus is transferred to cDNA by reverse transcription. After that [36-40], PCR is performed and the PCR product is identified through specific diagnostic methods or tools. Meanwhile, gel electrophoresis and gene sequencing are the conventional methods after PCR to detect Corona viruses; But due to the time-consuming process and high cost, these methods are not usually used in clinical samples. Currently, RT-PCR is a popular method for detecting Corona viruses due to its high specificity [41-45].

In addition, Real-Time RT-PCR is much more sensitive than conventional RT-PCR methods and can help in rapid diagnosis of infection. Some patients show unusual symptoms of Covid-19 in the early stages of infection or disease; therefore, molecular studies are needed to identify the causative agent in order to confirm the transmission of the virus through respiratory, mouth and feces [46-50].

For the molecular study of Covid-19, different samples such as throat and rectal swabs are used to perform Real-Time RT-PCR. In Zhang et al.'s study on patients with Covid-19, the results of throat and rectal swab tests from these patients

show that the virus was detected in both samples. In this study, 50% of throat swabs and 25% of rectal swabs were positive for the diagnosis in the initial sampling [51-58].

Over the following days, the rate of positive rectal swabs (75%) versus positive throat swabs (50%) increased, suggesting that the higher number of positive throat swabs in the early days of infection indicates that the Covid-19 infection is in the early stages of infection. The beginning is more in the throat, and with the passage of time of the disease, the rate of infection is seen more in the rectal swabs [59].

In Qian et al.'s study, rectal and throat swabs were obtained from 91 patients with confirmed Covid-19 [60-68], who were asymptomatic, and it was found that in these patients, the positive number of rectal swabs was higher than that of throat swabs, even it was observed that some of these people have negative throat swabs but their rectal samples are positive [69-75]. After repeating various tests, it was found that anal swab samples play a more important role in detecting the virus in asymptomatic patients than throat samples [76].

In the RT-PCR test conducted by Peng and his colleagues on various patient samples, including blood, urine, anal and throat swabs, the presence of the Covid-19 virus was observed in all samples, and it indicates the presence of the virus in all samples. The point is that this virus can infect people through the respiratory, digestive, urinary and blood systems [77].

For this reason, it is recommended to evaluate different individual samples to diagnose Covid-19, especially in people who have no symptoms [78-82]. In the study conducted by Chu and his colleagues on sputum and throat swab samples from 2 suspected patients, both samples were positive for the presence of the virus, which indicates that in addition to respiratory droplets, transmission also occurs through sputum [83].

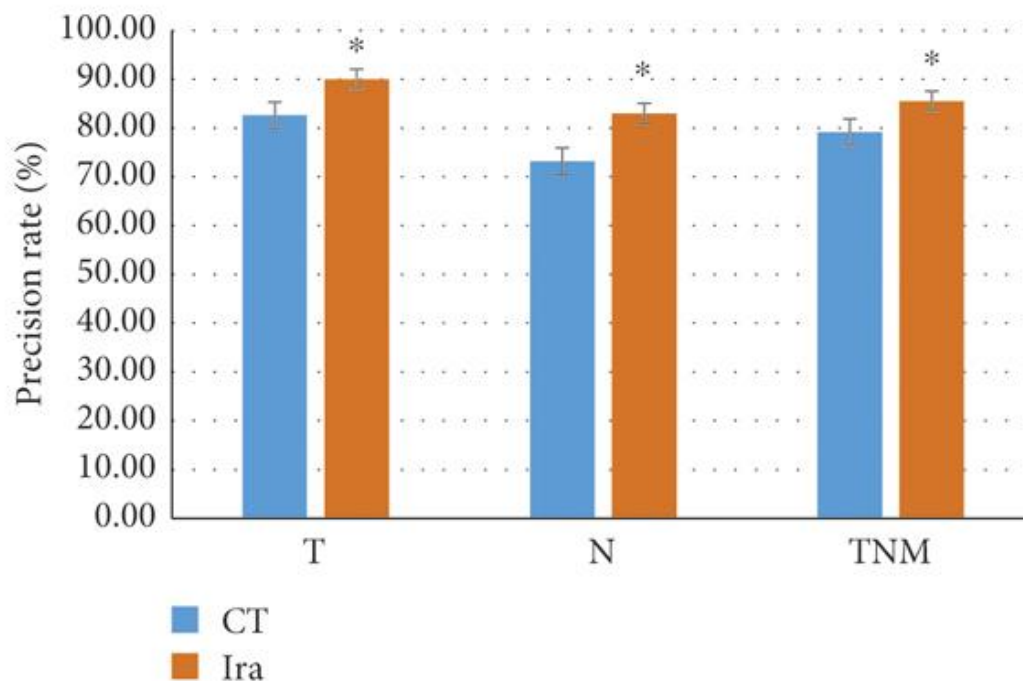


Figure 32. Adoption of Computed Tomography Images under Iterative Reconstruction

Cell, nucleus and genome

All human bodies are made of different cells. Cells are located in all tissues of the body, from fat tissue to bones and skeleton. Inside most cells of the body there is a nucleus [84-89]. The nucleus is the control center of the cell's activities and can be considered the brain of the cell [90-98]. Inside the cell nucleus is the genome. Genome can be considered as a set of instructions that causes the creation of a human being and its set of functions. In fact, the genome is the order of human creation [99].

Chest pain in Corona patients

Chest pain or a feeling of discomfort in the chest may not be a symptom of Corona alone, but it often occurs as a result of current symptoms. In terms of the intensity and type of pain that a person can feel, it may be very painful, mild, or causing difficulty in movement symptoms or even breathing in some cases [100-105]. When Corona spreads in the body through the bloodstream, it can cause pulmonary embolism,

which causes deep pain if the blood clot breaks and spreads to the lungs, and in severe cases, restricts blood flow [106].

Due to having an incubation period of 2 to 14 days, the similarity of its symptoms with the common cold, and the high ability to transmit it between different people, Covid-19 has spread all over the world and is currently considered a major health problem. Therefore, using appropriate and efficient diagnostic methods is one of the most important control options for this disease [107].

The results of the published research show that the diagnostic kits and methods of Covid-19, which are designed based on serological, molecular and CT scan techniques, are considered to be the most common diagnostic methods around the world. Although these methods have false positive and negative results in some situations. Meanwhile, false results from CT scan methods are less reported than other methods. Different diagnostic methods such as serological, molecular and radiological can help

health centers in diagnosing Covid-19; Today, molecular and radiographic methods are used as the main methods for diagnosing the disease of Covid-19. Radiology technique is known as one of the most suitable methods for detecting viral infection due to its high speed and accuracy and less false negative answer in this field [108].

Therefore, considering the high prevalence of Covid-19 and taking into account the incubation period of 2 to 14 days for this disease, correct and timely diagnosis of this disease in the early stages of the disease will play an important role in controlling the spread of the disease and treating patients [109-111].

Therefore, it is very important to use effective methods in diagnosing the infection of Covid-19 and it is very vital in saving the lives of patients and preventing the transmission of the infection to other people and its widespread spread in human societies. Due to the fact that sometimes the virus is detected in the blood and anal swabs, but not found in the throat swab, as a result, these patients can act as carriers and transmit the infection to other people, so it is suggested that for correct and timely diagnosis several diagnostic methods should be used for this disease, especially in asymptomatic patients, and different samples of the patient should be evaluated. It is also recommended that due to the lack of effective treatment and vaccine, the best way to deal with this disease is to avoid contamination and prevent its spread through protective measures and personal hygiene.

What are chest CT scans?

In X-ray (radiography), radiation is used to produce a 2-dimensional image. Usually in hospitals using fixed equipment by radiographers, they can also be done in portable devices. In CT scanning, a computer is used to merge 2-D X-ray images and convert them into a 3-D image. They require highly specialized

equipment and are performed by a radiographer in a hospital. In ultrasound scans, high-frequency sound waves are used to produce images. These can be done in hospitals or other medical facilities such as a doctor's office.

Recent research has shown that the sensitivity of CT scan to detect the Covid-19 infection is 98%. While the sensitivity of the RT-PCR method is 71%. In a study published in the radiology journal, CT scan of the chest was performed in addition to laboratory tests on more than 1000 patients to diagnose Corona disease. The results of this research indicated that CT scan should be used as a primary screening tool for the Corona virus.

In general, in connection with diseases for which there is no specific medicine or vaccine, such as the infection caused by the virus that causes the Corona disease, it is necessary and vital to diagnose the disease in the early stages and quickly separate the infected person from the healthy population. According to the latest guidelines published by the Chinese government, the diagnosis of the Covid-19 virus should be confirmed by the molecular method of reverse transcription polymerase chain reaction (RT-PCR) or gene sequencing on respiratory or blood samples as the main indicator in the hospital.

However, the limitations of sample collection and its transfer as well as the performance of the kit, the sensitivity of the RT-PCR molecular method in throat swap samples in the initial tests has been reported as 30-60%. In the current public health emergency, the low sensitivity of RT-PCR means that a large number of patients with Covid-19 are not being detected quickly and may not receive appropriate and necessary medical care. Also, due to the highly contagious nature of the virus, there is a greater risk of contracting the population [112].

Parameters	Number of lesions detected by PET/CT scan			
	Lymph Node groups	Spleen	Bone marrow	Other extra-nodal organs
True positive	312	79	54	100
False positive	4	1	1	4
False negative	3	0	0	0
True negative	181	20	45	796

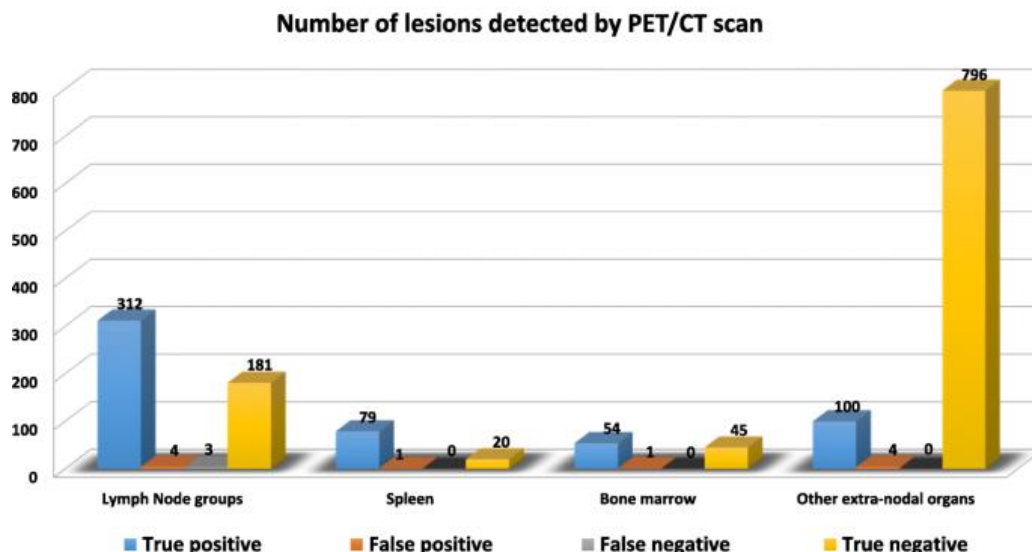


Figure 33. PET/CT and contrast-enhanced CT: making a difference in assessment

Early diagnosis of the Covid-19 virus is very important for medical care and disease control. CT scan of the chest compared to RT-PCR can be a more reliable, practical and quick method for diagnosing and evaluating the Corona disease, especially in areas where this disease has spread [113].

Advantages and disadvantages of CT scan in diagnosing Corona disease

CT scan provides high-quality and accurate images of the patient's bones and internal organs. By performing a CT scan of the lungs, radiologists can detect the presence of dark spots or bright spots in the patient's lungs. In the diagnosis of Covid-19, a CT scan of the lungs of a patient suspected of infection can show hazy abnormalities that accumulate in the outer parts of the lungs. These abnormalities are more commonly known as vitreous opacities. With these images, doctors can partially detect the Covid-19 infection that has penetrated deep into

the lungs. This infection may not be detected by PCR test.

The advantages of CT scan in the diagnosis of Corona disease include the following

- Easily accessible and fast scanning with immediate results;
- More sensitive than some PCR tests and may remain positive as infection evolves.

One of the important disadvantages of CT scan in the diagnosis of Corona disease is that it can produce false negative results, especially in the early stages of infection. In turn, this may give people false reassurance and cause them to avoid proper isolation. Finally, the risk of infecting other members of the community increases. False positive results may also occur. The results of CT scan of other diseases can be similar to the results of CT scan of lungs of Covid-19.

When can we be sure of the results of the lung CT scan in Corona disease?

Even when PCR tests are available, imaging tests for Covid-19 are useful under the following conditions: CT scan can be a suitable solution to diagnose suspicious cases. Things that are not shown in the PCR test. In some CT scan centers, some Corona patients whose first PCR test was negative have been diagnosed with infection in the CT scan test. Imaging tests, especially CT, can help detect complications of Covid-19 in known cases. Such as revealing the severity of the disease, checking for other infections, showing

blood clots in the lungs (pulmonary embolism) and showing signs of heart failure.

The role of CT scan in the future

Radiology researchers are seriously investigating possible long-term effects of Covid-19, such as possible scarring of the lungs. Imaging research could help identify how Covid-19 affects blood vessels in the lungs. Finally, it explains why low oxygen occurs in Corona patients. Studies on CT scans of the lungs can help the medical community understand and combat possible complications that appear in people infected with the Corona virus [114].

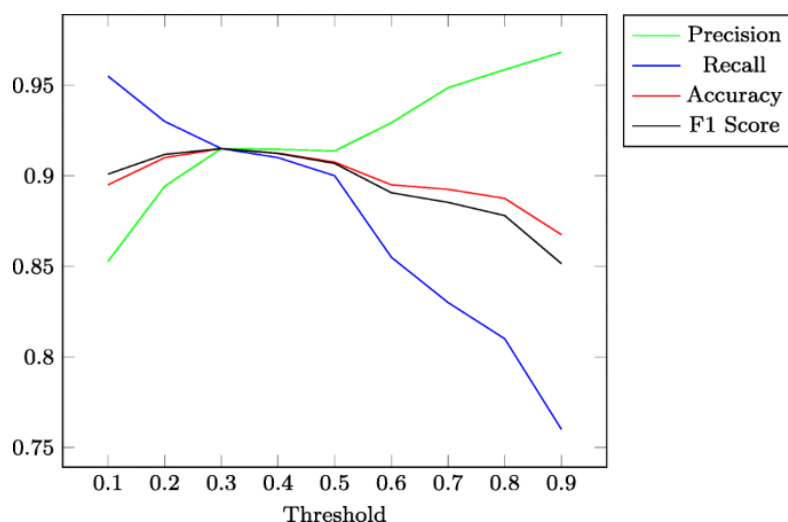


Figure 34. Automatic detection of COVID-19 from chest CT scan and chest X-Rays images

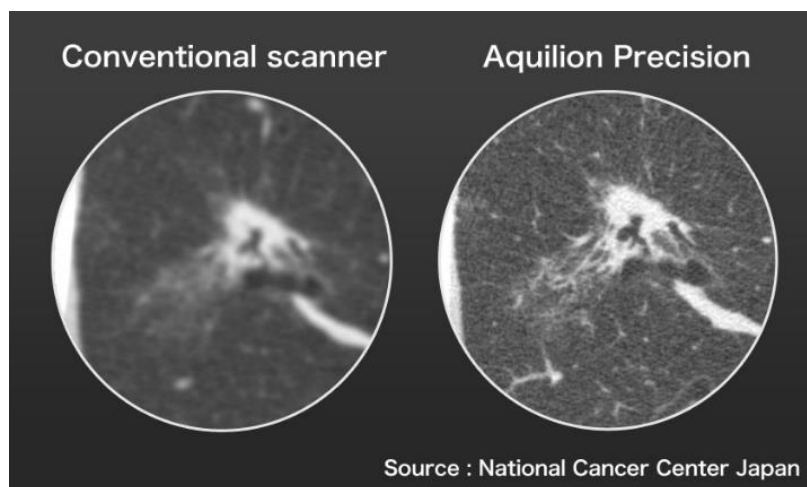


Figure 35. Ultra High-Resolution CT

Limitations of CT and chest X-ray in the diagnosis of Covid-19

The American College of Radiology (or ACR) has advised its nearly 40,000 practicing radiologists that CT and X-rays should not be used as a first-line tool to diagnose or screen for Covid-19.

There are three main reasons for recommending ACR

- A CT or chest X-ray cannot accurately differentiate between Covid-19 and other respiratory infections such as seasonal influenza. Unlike swab tests that lead to specific diagnoses of Covid-19, imaging findings are not accurate enough to confirm Covid-19. They can only refer to the symptoms of infection. These symptoms can be caused by other reasons, including seasonal influenza, which is very common in some seasons of the year.
- A significant percentage of patients with Covid-19 have a normal CT scan and chest image. For those patients, a normal imaging result can falsely convince them that they are healthy. If they believe they are healthy, they expose others to the Corona virus.
- Because Covid-19 is highly contagious, the use of imaging equipment on Covid-19 patients poses a serious risk to health care providers and other patients. CT scan is a big and complicated machine. They should be thoroughly cleaned between the CT of the next potential Covid-19 patient. But even with thorough cleaning, there is a

risk that the virus will remain on the surface of the CT scan room. In addition, the transfer of potential Covid-19 patients into the CT scan room increases the risk of spreading the virus in medical centers. It also means that fewer CT scanners are available for other vulnerable patients who need imaging tests.

Conclusion

By conducting a study, researchers compared the diagnostic power of CT scan with RT-PCR test in the diagnosis of Covid-19 patients. This study was conducted by reviewing the files of 569 patients who were admitted to one of Kermanshah hospitals from July to March 2021. The results of this study showed that 84% of people had a positive CT scan and nearly 85% of people had a positive RT-PCR result. In this study, the sensitivity, specificity and accuracy of CT scan were reported as 88.7%, 64.8% and 80.1% respectively. The sensitivity of CT scan was nearly 90% in people under 60 years old and 83% in people over 60 years old.

Also, the accuracy of this test was reported to be 84.7% in women and 78.7% in men. Finally, the investigations of this study indicated that the accuracy of CT scan in patients with Covid-19 is high. Of course, CT scan cannot definitely diagnose or rule out Covid-19. The findings of this study have been published in the journal of Mazandaran University of Medical Sciences in the form of a scientific article entitled "Investigation of the diagnostic power of CT scan compared to RT-PCR test in the diagnosis of Covid-19 patients" in August of this year.

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