

# Original Article: A Review of the Effect of Brain imaging- Short Review

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## ABSTRACT

Stroke, delirium, brain inflammation, encephalopathy or even confusion and neuromuscular disorders are part of the list of observed pathologies. The people who conducted this research emphasize that many people who experience these neurological symptoms are under 50 years of age and seemed to be in good health before the infection. American doctors believe that corona virus can lead to sudden stroke in young people, and according to scientific research, one third of corona patients suffer from neurological disorders within six months. Rapid reduction of brain gray matter has been observed in people with Covid-19. A new study has shown that even mild cases of Covid-19 can cause brain shrinkage and rapid gray matter loss. The study, published in the journal nature, examined brain scans of people before contracting the coronavirus and in the months after. This is the first case of its kind that has a longitudinal approach and examines changes over time. In this study, 785 people underwent two brain scans with a gap of about three years from each other. Among this group, 401 people were infected with the corona virus, most of which were mild cases that did not require hospitalization. The studied subjects were in the age range of 51 to 81 years. Of this group of people who got infected with the coronavirus, compared to people who never got infected, the level of gray matter loss in their brains was accelerated.

## Introduction

Researchers at the National Institute of Health in the United States also concluded last year that the disease "Covid-19" leads to small bleedings in the brain of patients.

Scientists have published the results of their research on the effect of the corona virus on the brain in the scientific publication "New England Journal of Medicine". They examined the tissues

of the structure known as the "olfactory bulb" and the brain stem of 19 patients who died due to corona.

By conducting magnetic resonance imaging (MRI) on tissues belonging to 19 patients who died due to "Covid-19", scientists found that these tissues were damaged in an unusual way. According to the researchers of the American National Institute of Health, the reason for the damage to the tissues of the "olfactory onion"

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and the brain stem was small bleedings in these tissues due to the rupture of small vessels. Based on the observations made, about four to five percent of the patients who are suffering from the Covid-19 disease have suffered strokes, and on the other hand, about 25 to 30 percent of the patients who have problems related to the brain and nerves are infected with the corona virus.

People who have underlying risk factors and cerebrovascular problems are more exposed to the brain effects of Covid-19, and of course, this virus itself can lead to neurological diseases in people who do not have a history of brain disease. The main method of corona virus attack on the patient is by activating the immune and coagulation systems; In the first stage, the immune system becomes overactive and causes inflammation in all tissues of the body, including the brain and its vessels, with inflammation and cytokine storm, and this inflammation can cause serious and even irreversible damage to the brain and its vessels. What has caused the double concern of neurologists is that the conditions caused by the Covid-19 epidemic and the refusal of patients to be hospitalized cause an increase in mortality and stroke complications due to late referral to medical centers, which is an important factor in increasing the number of deaths.

In addition to the effect it has on the pulmonary system and is associated with fever, cough and shortness of breath, Covid-19 causes severe respiratory disorders and in its severe forms, it can involve the central and peripheral nervous system in 30% of cases. There are patients who return to the hospital after recovering from corona a month or even longer after being discharged with a stroke, which was caused by delayed blood clotting in the cerebral vessels.

Diffusion through blood and diffusion through nerve terminals such as taste and smell disorders can be the cause of brain and nervous system involvement in this disease. Patients with this disease have shown some neurological symptoms, such as decreased level of consciousness, seizures, strokes, and disorders

of smell and taste, headache, dizziness, and muscle pain, and some of the patients have cerebral vascular involvement and complications in the brain and nerves, and at least 15 The percentage of people infected with corona refer to hospitals with symptoms of headache, dizziness and confusion.

#### *The effect of corona on brain tissue*

In a study by Eric Song and his colleagues at Yale University, they used independent and different approaches to identify the capacity of SARS-CoV-2 to infect the brain and invade neurons. They first used human brain organoids and observed clear evidence of metabolic changes in infected neurons and their neighboring neurons.

However, no evidence for type I interferon responses was detected. They showed that neuronal contamination can be achieved by blocking ACE2 with an antibody or using cerebrospinal fluid from patients with Covid-19. In the next part of the study of the effect of corona on the brain, it is mentioned that they used mice that expressed human ACE2 and showed the neural invasion of SARS-CoV-2 in vivo. Finally, in the autopsies of patients who had died due to Covid-19, the researchers also observed SARS-CoV-2 in cortical neurons and found pathological features related to infection and immune cell infiltration. The results show the capacity of corona to affect the brain and it seems that this virus can directly involve this tissue.

#### *Neurological manifestations of Covid-19 disease*

The studies conducted indicate the presence of neurological symptoms in patients with the disease of Covid-19. These manifestations are divided into several groups based on their symptoms, such as non-specific symptoms, specific symptoms, impaired consciousness and skeletal muscle problems. A study that examined neurological symptoms in patients with Covid-19 showed the disease of the nervous system with a prevalence of 36.4% in 214 patients. Most of the neurological symptoms occurred in the early stages of the disease.

Headache, dizziness with or without nausea, cerebrovascular disease, impaired consciousness and muscle problems are neurological manifestations reported in these studies. After muscle pain, headache is one of the most common neurological symptoms in patients with Covid-19.

21 studies have reported headache with a prevalence of three and a half to 34% among patients with Covid-19. In general, the prevalence of headache was 10.9% in the population of 6486 people from 21 studies. A review of past studies shows that headache is the most common symptom during disease exacerbation in patients with Covid-19. In another study, dizziness was the most common central nervous system manifestation with 16.8%, followed by headache with 13.1%. Dizziness and headache are often observed in the initial disease as typical symptoms of the disease of Covid-19. Dizziness has been reported in six studies with an overall prevalence of 8-77% among 1,888 people.

#### *The effect of corona life habits on brain biology*

"People develop habits throughout life," says Dr. Emma Yinel, a renowned behavioral neuroscientist. For example, we see our friends on certain days of the week and exercise on certain afternoons.

Disruption of this order can create a very difficult situation." According to him, "being in an unknown situation affects the biology of the brain". A mental health crisis appears to have emerged during the coronavirus pandemic. According to a report provided by the US Centers for Disease Control and Prevention (CDC) as of June 2020, almost one-third of US adults suffer from anxiety or depression.

This figure is almost twice as high for young people, a population that has seen a significant increase in the prevalence of mental health disorders in the last decade. It is estimated that more than 60% of people aged 18 to 24 are at risk of depression or anxiety. These estimates show a sharp increase in the rate of depression compared to the statistics that were published before the corona pandemic.

The increase in depression statistics along with the implementation of quarantine laws, the closing of universities and schools and the implementation of social distancing has caused major disruptions in daily life and has changed the way people live, work, study and interact.

"The term pandemic brain has suddenly caught on," says Dr. Yinel. The interesting part is that different people have different experiences with it. We know that those with chronic anxiety disorder or chronic stress and worry experience changes in the parts of the brain involved in decision-making and concentration.

But we need to do more research to find out if the experience of living during the pandemic was able to make changes in the structure of people's brains." The first round of results of this study was published on June 15, 2022. The results showed the prevalence of short-term and long-term symptoms in these people. While the condition of many of these patients indicates their recovery, the majority of them still have neurological symptoms after six months.

56 people who were infected with moderate to severe corona virus and had neurological symptoms were selected for this study from October 2020 to October 2021. These people underwent a neurological examination and cognitive evaluation and recorded their symptoms through a questionnaire.

In addition, an optional brain scan was taken from some of them. Baseline measurements were taken several months after their initial infection and repeated three and six months later. At the time of the first examination, 89% of participants reported fatigue and 80% reported headaches. Other common neurological symptoms included memory impairment, insomnia, and decreased concentration. 80% of the participants stated that these symptoms affected their quality of life.

When participants returned for their six-month assessment, only a third reported complete improvement in symptoms. Another two-thirds of participants still had persistent

neurological symptoms, although most reported that their symptoms had decreased in severity. The most common symptoms of corona in six months were memory impairment and decreased concentration. Interestingly, those who had persistent symptoms after six months reported that they had no history of neurological disease before contracting Covid-19. The researchers also noticed some new symptoms in these people, which surprised them.

Seven percent of participants showed an unknown set of symptoms, including cognitive deficits, tremors, and difficulty maintaining balance. These people did not have any neurological problems before contracting the disease of Covid-19, but now they have suffered from disharmony of their bodies and possible disharmony of their thoughts. Researchers are still investigating the extent to which the severe coronavirus directly penetrates the brain, but researchers believe that it is likely that these delayed neurological symptoms caused by the infection triggered an inflammatory autoimmune response in the brain.

Also, another new study has shown that even mild cases of Covid-19 can cause brain shrinkage and rapid gray matter loss. This study was published in the journal Nature and scanned the brains of people before contracting the coronavirus and in the months after. This is the first case of its kind that has a longitudinal approach and examines changes over time. In this study, 785 people underwent two brain scans with a gap of about three years from each other.

Among this group, 401 people were infected with the corona virus, most of which were mild cases that did not require hospitalization. The studied subjects were in the age range of 51 to 81 years.

Of this group of people who got infected with the coronavirus, compared to people who never got infected, the level of gray matter loss in their brains was accelerated. According to researchers, each person loses between 0.2 and 0.3 percent of their gray matter in the natural aging process. But the study found that compared to uninfected participants, those

infected with Covid-19 lost between 0.2 and 2 percent more gray matter in several brain regions. Scientists have published the results of their research on the effect of the corona virus on the brain in the scientific publication "New England Journal of Medicine".

They examined the tissues of the structure known as the "olfactory bulb" and the brain stem of 19 patients who died due to the corona virus. Scientists performed magnetic resonance imaging (MRI) on the tissues belonging to 19 patients who died due to the infection. They found that these tissues were abnormally damaged by "Covid-19". According to the researchers of the American National Institute of Health, the reason for the damage to the tissues of the "olfactory onion" and the brain stem was small bleedings in these tissues due to the rupture of small vessels.

#### *Corona's relationship with stroke and blood clots*

Corona's relationship with stroke may result from a combination of factors, including complications from the infection or pre-existing conditions. Here are answers to some frequently asked questions about Covid-19 and its relationship to stroke. During the studies conducted, it was observed that up to 4.9% of Covid-19 patients suffer from acute ischemic stroke during their first hospitalization.

The reason for the increased risk of stroke is the presence of a number of factors caused by the coronavirus, such as increased blood clotting, diabetes and high blood pressure. Doctors and researchers alike who have worked on Covid-19 patients have noted that severe cases of the disease involve rapid blood clot formation, which in turn increases the risk of stroke as well as heart attacks and heart failure.

In a study conducted at Baylor St. Luke, conducted by Baylor College of Medicine, researchers found that more than half of hospital evaded routine blood clot screenings. Studies conducted in November 2020 show similarities between Covid-19 and antiphospholipid syndrome (APS), itself an autoimmune disease that causes abnormalities in blood clotting. In both cases, the patient's

immune system releases antibodies that cause blood clots to form rapidly in large vessels, veins, and even the most microscopic capillaries.

### *What is the cause of seizures in old age?*

Scientists at Yale University in America have announced that the corona virus can use these cells for its reproduction by affecting brain cells and hijacking them. Scientists have announced in this research that brain cells are one of the favorite targets of the corona virus. Akiko Iwasaki, the director of this research, said: Our findings have shown that the corona virus can attack brain neurons.

We have seen neurons infected with Covid-19 in the brains of corona patients. When we studied the infected neurons, we saw that these cells were very active from a metabolic point of view (cell fuel). This point shows that the virus does not destroy brain cells after infecting them, but uses them for its reproduction by changing the function of these cells.

In fact, the virus enslaves brain cells. He added: When this happens, these cells can cause a decrease in oxygen in the cells adjacent to the brain. Since the virus infects brain cells, it can cause significant damage to that cell and its neighboring cells. Before that, the scientists of the University of California had announced the direct attack of the corona virus on brain cells. American scientists have announced that the corona virus has the ability to directly attack the brain.

This attack can lead to symptoms such as headache, confusion and distress, and delirium of the patient. Andrew Josephsen, the director of this research from the University of California, said in this regard: We used very precise technology to conduct research. It is very important for scientists to know what effects the corona virus can have on the brain. Researchers say that it will not be surprising at all that the corona virus can cause the blood membrane of the brain to rupture. In fact, the blood membrane surrounds the brain cells and, in addition to supplying blood to these cells, prevents foreign and pathogenic factors from

entering them. Now it seems that Covid-19 can destroy this membrane and attack brain cells.

Researchers believe that the corona virus probably enters the brain through the nose and through the nerve related to the sense of smell. This nerve is very important in the function of the sense of smell. Therefore, loss of sense of smell is one of the common symptoms among those infected with the corona virus. The part of the brain that is responsible for the sense of smell communicates with other parts of the brain and sends them messages.

These areas are responsible for learning, memory and emotions. The olfactory part of the brain uses chemicals such as dopamine, which plays an important role in our pleasure and motivation, to communicate with other parts. Probably, the corona virus changes the level of dopamine in the blood. Also, this virus probably affects the amount of brain chemicals such as serotonin and acetylcholine. All these chemicals are effective in processes such as concentration and attention, learning, memory and behavior. These changes in chemicals lead to changes in behavior, fatigue and cognitive changes that are common in patients with corona. This issue leads to complications such as stress, worry and anxiety, and depression in patients with Covid-19.

### **Discuss**

The virus uses the machinery of the brain cells to block the way of oxygen to the neighboring cells and they starve and die. Scientists say that more research is needed to determine the effect of Covid-19 on the brain. Corona virus targets lung cells more than anywhere else. But it also affects the kidney, liver and blood vessels. Half of the patients report neurological symptoms, including headache, confusion, and delirium, indicating that the virus is attacking the brain.

A new study suggests the first clear evidence that in some patients, the coronavirus attacks brain cells and tricks them into producing copies of itself. The virus also seems to gobble up all the oxygen around it, starving neighboring cells to die.

It is not clear how the virus reaches the brain or when it causes this series of destruction. Brain infection may be rare, but some people may be susceptible because of their genetic background, or the size of the virus, or other reasons. If the brain becomes infected, it can have fatal results, says Akiko Iwasaki, an immunologist at Yale University who led the study. The study was recently published online, but has not yet been approved by experts for publication. But many researchers said that it was accurate and shows that the virus can affect brain cells in many ways.

Scientists have relied on imaging of the brain and the patient's symptoms to show the effects on the brain, but we do not have much evidence to say that the virus attacks the brain, although we know that this possibility is possible and likely Dr. Mikael Zandi, assistant neurologist at the National Hospital of Neurology and Neurosurgery in England says so. This information can provide us with more documents. Dr. Zandi and his colleagues published research in July showing that Covid-19—a disease caused by the coronavirus—causes severe neurological symptoms, including nerve damage.

In the new study, Iwasaki and his colleagues examined the brain infection in these ways: in brain tissue from patients who died of the disease, in mouse brains, and in artificial brains (clusters of brain cells in a laboratory dish that is similar to the three-dimensional structure of the brain. Other pathogens include the Zika virus, which seems to involve the brain. Immune cells go to the damaged tissues to clean the brain by destroying the infected cells.

Corona virus works more stealthily and exploits brain cells to multiply. But it does not destroy them. Instead, it blocks oxygen from nearby cells, causing them to shrivel up and die. The researchers found no evidence of how the immune response corrects the problem. It's a type of hidden infection, Ms. Iwasaki said. This virus has many ways to escape. These findings are consistent with other observations in organoids infected with the coronavirus.

So says Alison Mottery, a neuroscientist at the University of California, San Diego who works

on the Zika virus. The coronavirus seems to rapidly reduce the number of synapses, the connections between nerve cells. Dr. Motri says: "Days after the infection, we saw a prominent and important reduction in the amount of synapses. We still do not know if this state is reversible or irreversible. The virus infects a cell through a protein on its surface called ACE2 contaminates. This protein is revealed in the body, especially the lungs, and explains why they are attacked by the virus. Previous studies based on protein levels showed that the brain has very small amounts of ACE2 and may not be infected with the virus.

But Dr. Iwasaki and her colleagues looked more closely and saw that the virus can enter the brain cells through a corridor. Iwasaki says: It is very clear that the virus manifests itself in neurons and needs to enter the neuron. His team studied two groups of mice, one of which displayed the ACE2 receptor only in the brain, and the other had the receptors only in lung cells. (Certain genetic manipulations in brain cells can cause the manifestation of this protein.)

When the virus entered these mice, the mice with the infected brain quickly lost weight and died within six days. A mouse with an infected lung did not suffer from any of the above. Despite the cautionary predictions of the mouse tests, the results still suggest that viral infection in the brain may be more fragile than lung infection. The virus may enter the brain through the olfactory bulb, which is responsible for smell control, or through the eyes, or even through the bloodstream.

It is not clear how the pathogen is transmitted in order to fully explain the symptoms of the disease. Dr. Motri says: I imagine this is a case and there is little information in front of the clinical documents.

Researchers will need to analyze many samples to estimate what normal brain infection looks like and whether it is present in mild patients or patients with long-term effects of the Covid-19 syndrome, most of whom have neurological symptoms. 40 to 60% of patients with Covid-19 have mental and nervous symptoms. This is said by Dr. Robert Stevens, a

neurologist at Johns Hopkins University. But all the symptoms are not caused by the virus invading the brain.

It may be the result of widespread inflammation in the body. For example, inflammation in the lungs may release molecules that make the blood sticky and block the blood vessels with clots, leading to a stroke. There is no need for the brain cells themselves to be infected with the virus to produce such results. But in some people, it may be the low blood oxygen in the infected brain cells that causes a stroke. He continues: Different groups of patients may be involved in different ways.

We may see a combination of these complications. Some psychological symptoms such as confusion and delirium may not be easily resolved in patients who are sedated under artificial respiration. Dr. Stevens says: Doctors need to avoid giving too many painkillers and sedatives to these patients. Also, the research about the new corona virus refers to ACE2 cell receptors, which is the main way to enter various cells in the body, and this receptor is present in many parts of the body, and Covid-19 affects the brain through these receptors and the use of their protein. The usual and well-known symptoms of Covid-19 such as fever, cough, fatigue and respiratory distress are still there, but every day more and more people are showing secondary symptoms of corona, which can help in early diagnosis of this disease.

For example, the loss of the sense of smell or vision problems were proposed as secondary symptoms of corona. The corona virus has a crown-like shape from the outside and this crown consists of needles that have proteins necessary to access human cells. The human receptor is also the ACE2 protein, which it exists in the body to interact in a system called renin-angiotensin, this system, which includes hormones and internal substances, actively participates in the regulation of blood pressure.

Therefore, it even interferes with the work of the kidneys. Covid-19 affects the brain because we have ACE2 receptors in some of our neurons, the connection of this receptor is the key to understanding the lethality of the corona

virus. As various studies have shown, people with blood pressure disorders are the group that has the highest probability of dying from the corona virus, and this issue can be justified by the effect of the renin-angiotensin system from the corona virus.

Losing the sense of smell was the first symptom of the corona virus that doctors all over the world noticed, which they attributed to the neurological tendency of the new corona virus. Loss of memory, fatigue and difficulty in concentration have been announced as symptoms of the corona virus. But scientists think that those who have not been infected with the corona virus have experienced some kind of increased fatigue, impaired decision-making, and reduced concentration and accuracy due to the epidemic.

Experts believe that the unpredictable conditions of life during the Covid-19 era and the impact it has had on people's regular daily schedule have led to a phenomenon called "pandemic brain". Experts at the University of Texas, Leicester and Nottingham Medical Center are concerned that Covid-19 can cause long-term damage to the brain and central nervous system several years after infection.

Therefore, experts want to investigate whether the virus can lead to cognitive decline, Alzheimer's, Parkinson's or other forms of dementia. Currently, there is no evidence that the coronavirus will cause Alzheimer's in the future, but scientists have already found that the virus is able to enter the brain. There is the first evidence that shows that the corona virus can infect brain neurons through mucous membranes after passing through the nose.

Previous studies indicate that Covid-19 can cause delirium, stroke and even paralysis. Dr. Gabriel D. Erasquin, the study's senior author from the University of Texas, believes that the impact of the coronavirus is not limited to these short-term acute symptoms, but chronic diseases.

Scientists from more than 30 countries will participate in this research to monitor the condition of about 40,000 people. The first results of the analysis will appear in 2022.

Scientists have already mentioned the worst long-term effects of the corona virus. Experts have found that those who have the corona virus suffer from symptoms such as "head fog", inability to concentrate, heart muscle inflammation, kidney damage, and urinary problems months after infection. Patients also had strokes and seizures.

## Conclusion

The new corona virus SARS-CoV-2 - the causative agent of corona disease (Covid-19) - is one of the main viruses that primarily targets the human respiratory system and leads to severe respiratory disease. This virus is spreading rapidly all over the world. Recently, there have been speculations that the central nervous system (CNS) may be involved during infection with this virus and cause or exacerbate respiratory failure.

Considering that the ACE2 protein is present in the central nervous system in a large amount, there are many reports of the SARS-CoV-2 virus's affinity for the central nervous system and the ability of this virus to invade the nerves, which requires the identification of possible complications in the central nervous system during the infection period. It is due to Covid-19 disease.

Symptoms of Covid-19 infection usually appear after a period of about five days. The most common symptoms of this disease are fever, cough, fatigue, headache and shortness of breath. In severe cases, patients may suffer from pneumonia (severe lung infection), acute respiratory distress syndrome, acute heart problems and failure of several organs in the body. Infections caused by the corona virus are also accompanied by neurological symptoms such as seizures accompanied by fever, changes Mental status and encephalitis are associated.

After nasal infection, the corona virus enters the nervous system through the olfactory bulb and causes inflammation and demyelination of the nerve fibers (damage and destruction of the myelin sheath around the nerve fibers). Reports indicate that in a significant number of patients who suffer from severe disease, there is involvement of the central nervous system and

neurological manifestations. In their investigations, experts found significant differences in the MRI scans of people before and after contracting the disease of Covid-19.

According to them, even after contracting a mild form of the disease, the overall size of the brain was slightly reduced and there was less gray matter in the parts related to smell and memory. Experts do not know whether these changes are permanent or not, but they emphasize that the brain can recover. The results of this study were published in the journal nature.

British experts stated: We were examining mild infection to see the differences in the brains of patients and the extent of these changes compared to people who were not infected with the coronavirus, and the results were very surprising. In this review of medical records of 500,000 People from about 15 years ago and the data related to their scans before the epidemic were studied, and during the epidemic, brain scans were taken again from a number of these patients who had the following conditions:

- 401 participants 4.5 months after contracting corona infection, 96% of them had a mild form of the disease.
- 384 participants who did not suffer from Covid-19 disease.

By comparing the results, English experts found out:

- The overall size of the brain of people infected with coronavirus was reduced between 0.2 and 2 percent.
- The amount of gray matter was reduced in the olfactory areas associated with smell and areas associated with memory.
- People who had just recovered from Covid-19 had some difficulty in doing complex mental tasks.

Autopsy studies have identified the presence of the corona virus in people's brains, but how it got there has been somewhat of a mystery. The results of previous studies show that the ACE2 receptor, which the virus usually uses to



enter cells, is difficult to detect in the brain, unlike the cells lining the nose, mouth, and lungs.

Now, Chiara Zorzullo at France's Institut Pasteur and colleagues have found that the coronavirus appears to open up a surprising way to enter cells that lack the ACE2 receptor through cells with the ACE2 receptor. They conducted experiments with the corona virus and two different types of cells in a laboratory container; One, SH-SY5Y, was used to model human brain cells, and the other, Vero E6, was used to model cells that cover body surfaces, including the nose. The model brain cells alone could not be infected with the coronavirus because they lack the ACE2 receptor, but when they were placed in the same dish as the nose model cells that have these receptors, they were easily infected.

Using high-powered electron microscopy, the researchers observed that the virus, upon entering the model's nasal cells, stimulated the cells to grow tiny tubes called tunneling nanotubes to communicate with the model's brain cells. By magnifying closely, they observed that the virus uses these tunnels to move between two types of cells; Nanotubes are already known to transport specific structures and other viral particles between distant cells. "I think this is a very interesting study because it provides a nice, neat mechanism by which the virus can be transferred from one cell to another while bypassing the need for ACE2 receptors," said Frederic Monier of the University of Queensland in Australia. "

However, because the experiments were limited to cells in a dish, more studies are needed to confirm a similar mechanism inside the human brain, according to Meunier. Zorzolo says his group is setting up "organ-on-a-chip" experiments to better mimic the interactions between nose and brain cells. He added: "If tunneling nanotubes are approved for the transmission of the corona virus from the nose to the brain, we may be able to produce drugs to block them."

The virus that causes the disease of Covid-19 may cause neurological manifestations by

releasing cytokines, circulating the virus in the body or direct invasion of the virus through multiple ACE2 receptors in the olfactory epithelium. Olfactory disorder may be caused by damage to the olfactory epithelium. Fever is believed to be caused by cytokines or hypothalamic dysfunction. Seizures may also be due to an excessive increase in cytokines, the severity of the disease, or the involvement of the brain parenchyma; especially the middle temporal lobe.

In addition, altered mental status may be the result of multiple organ failure, severe infection, or involvement of part of the brain stem. Also, headache is caused by irritation of the meningeal fluid. Of course, it should be noted that these reviews are limited to current information and limited reports. Corona can be diagnosed through corona throat test.

The studies conducted indicate the presence of neurological symptoms in patients with Covid-19 disease. These manifestations are divided into several groups based on their symptoms, such as non-specific symptoms, specific symptoms, impaired consciousness and skeletal muscle problems.

A study that examined neurological symptoms in patients with Covid-19 showed the disease of the nervous system with a prevalence of 36.4% in 214 patients. Most of the neurological symptoms occurred in the early stages of the disease. Headache, dizziness with or without nausea, cerebrovascular disease, impaired consciousness and muscle problems are neurological manifestations reported in these studies. The initial manifestations of the disease of Covid-19 are usually respiratory symptoms. However, doctors have identified neurological symptoms as one of the early symptoms at the time of diagnosis. Non-specific symptoms may make diagnosis difficult when they occur alone.

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