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Neurological and Pulmonary Radiological Abnormalities of Corona Virus Disease 2019, Are They Different between Adult and Pediatric Patients? Observational Study

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Abstract

Background: Corona virus disease-2019 (COVID-19) became a world pandemic causing millions of deaths worldwide. Adults and pediatrics can be infected. Corona virus disease-2019 affects different body organs including central nervous system not only lung.

Aim of Study: This study aimed to describe the imaging findings of corona virus neurological and pulmonary complications developed in infected adults and pediatrics. The two groups were observed regarding the possible pathophysiology, radiological findings, mean computed tomography (CT) chest severity score and clinical outcome.

Patients and Methods: This observational study included 50 patients 36 were adults and 14 were pediatrics. Only patients with positive COVID-19 polymerase chain reaction tests, who presented with neurological complications were included. All patients were examined by CT chest, different neuroimaging modalities were used according to patient's neurological presentations. CT chest was assessed for extent of ground glass or consolidative patches to obtain CT severity score. The neurological complications detected were classified according to the possible underlying pathophysiology into: A-complications due to: (A) Cerebro-vascular diseases, (B) Auto immune mechanisms and (C) Direct virus effect.

Results: The neurological complications detected in adults were mainly due to A-cerebro vascular diseases: Stroke seen in 44.4% of patients followed by sinus thrombosis in 25%, then intracranial hemorrhage in 19.4%, followed by B-auto immune mechanisms totally seen in 30.55% of patients and less frequently due to C-direct virus effect: As anosmia seen in 11.1 % of patients. While in pediatrics, the neurological diseases detected were only due to autoimmune mechanism seen in 100% of patients. The mean CT severity score was higher in adults (7.36) compared to pediatrics (5.21). In the adult group 54.8% of patients were improved up to total recovery of presenting neurological symptoms and signs, while the percent was higher in the pediatric group 85.7% indicating better clinical outcome in pediatrics.

Conclusion: COVID-19 associated neurological abnormalities showed an increased prevalence among both adult and pediatric patients. The pattern and possible pathophysiology of neurological affection differed between both groups but pediatric patients showed a better clinical outcome.

Key Words: *COVID-19 – Pulmonary – Neurological – Radiological – Abnormalities.*

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Introduction

BY September 2020; more than 216 million people were infected with COVID-19, with more than 933,000 deaths worldwide. In April, in the United States, the pediatric age group (<18 years) represented 2,572 (1.7%) of 149,082 diagnosed patients, with infants (<1 year) constituting 15% of pediatric COVID-19 cases **[1]**.

COVID-19 not only affected the respiratory system but also has been reported to involve other organs such as: The heart, kidneys, liver, and central nervous system (CNS) **[2]**. Multiple organ involvementis explained by viral entry through the angiotensin-converting enzyme 2 receptors, which are abundantly presented not only on vascular endothelial cells of the lungs but also in other organs **[3]**.

Regarding neurological complications, variable clinical syndromes have been documented, including both CNS and peripheral nervous systems (PNS) **[4]**.

The different neurological symptoms may result from either the direct effect of the virus or systemic inflammatory reaction, ischemic insult, autoimmune processes or a combination of these. Anosmia and dysgeusia are very common in the early phase of the infection **[4]**. This supported the theory, which suggested that the viral spread to CNS occurs through the olfactory tract **[5]**.

Manifestations of cerebrovascular diseases were reported in patients infected with COVID-19 and showed increased frequency with time. The active SARS-CoV-2 may be associated with para-infectious autoimmune neurologic manifestations including: Hemorrhagic necrotizing encephalopathy, Guillain-Barre, Miller-Fisher syndromes, encephalitis and acute demyelinating encephalomyelitis (ADEM) [4].

Affection of cranial nerves may happen as mono-neuropathy or polyneuritis cranial is, bilaterally or unilaterally, with or without peripheral nerves affection and with or without CNS affection [6].

In most of the cases with CNS/PNS affection, cerebrospinal fluid (CSF) investigations for SARS-CoV-2 RNA were found to be negative, signifying that immunological reactions were the commonest pathophysiological mechanism behind CNS/PNS affection in COVID-19 [6].

Severe COVID-19 infection were not common in most children and adolescents; however, life-threatening neurologic involvement was reported in patients developing multisystem inflammatory syndrome in children (MIS-C),a relatively rare, hyper inflammatory, severe illness temporally associated with SARS-CoV-2 infection, and presumably post-infectious [7].

Previous reports found a higher incidence of neurologic complications in patients with severe respiratory diseases [8]. Acute lung injury increases the risk of brain injury as it leads to hypoxemia and/or proinflammatory mediator development that connect both the brain and the lungs [9].

This observational study described the imaging findings of different neurological and pulmonary complications developed in (COVID-19) infected adults and pediatrics. Comparison between two groups regarding the possible pathophysiology, pattern of neurological and pulmonary abnormalities, mean CTchest severity score as well as patients" clinical outcome.

Aim of the work:

This study aimed to describe the imaging findings of COVID-19 neurological and pulmonary abnormalities developed in infected adults and pediatrics. The two groups were observed regarding the possible pathophysiology, radiological findings, mean computed tomography (CT) chest severity score and clinical outcome.

Patients and Methods

This observational study, with approval from the ethics committee of our University, included 50 patients who were divided into two groups as follows: The adult and pediatric groups, including patients under the age of 16 years. The adult group involved 36 patients, of whom 23 (63.9%) were males and 13 (36.1%) were females. Their age ranged from 19 to 91 years old. The pediatric group included 14 patients, of whom 11 (78.6%) were males and 3 (21.4%) were females. Their age ranged from 3 to 16 years old. Our inclusion criteria were the following: (1) Hospitalized patients who were positive for COVID-19 via real-time polymerase chain reaction from September 2020 to September 2021 and (2) The presence of neurologic symptoms developed during the hospital stay.

Exclusion criteria: Previous history of neurological disorders. All patients underwent non contrast CT examination of chest, while neuro imaging modalities differed according to patients' neurological presentations. They included brain CT, brain MRI, MRV of the brain, MR examination of the orbits, petrous bone and of the spine (Table 1). The electronic medical records were reviewed to extract clinical, laboratory and demographic data. Clinical data collected: Patients symptoms and signs related to respiratory system affection including distress, O_2 therapy and fever as well as those of neurological complications like weakness, disturbed conscious level, and convulsions. These data were assessed during their hospital stay at time of presentation as well as after management to detect the relation of severity of lung affection (represented by CT severity score) to respiratory distress and need of O_2 therapy, in addition to detection of patients" neurological clinical outcome post COVID infection.

Table (1): Types of neuro imaging modalities used in adult and pediatric groups.

Imaging modalities	Adult	Pediatric
CT	11	0
MR	25	14
MR brain	13	10
MRV	9	0
MR spine	11	10
MR orbit	1	0
MR petrous	1	0

Clinical assessment of patients:

Regarding the symptoms of respiratory system affection, 19 patients (52.8%) in the adult group suffered from distress and required oxygen therapy, and 11 patients (30.6%) presented with fever. Distress was detected only in 2 patients (14.3%) in the pediatric group contrary to the fever, which was detected in all patients (100%).

We found that the most common neurological presentation in the adult group was weakness that was seen in 15 patients (41.7%) with persistent of symptoms among 4 of them during hospital stay, followed by proximal muscle weakness (5 of them improved) and disturbed conscious level (three of them died and two had history of chronic illness) both detected in 6 patients (16.7%), and anosmia in 4 patients (11.1%); three of them restore their smell sensation before hospital discharge and one gradual recovery of smell was reported. Other less frequent presentations included one patient with tinnitus (improved before discharge) and one patient with persistent decreased visual acuity (2.8%).

The most common neurological presentation in the pediatric group were convulsions in 7 patients (one of them died) (50.0%), followed by disturbed conscious level in 4 patients (one of them died) (28.6%),then one-sided weakness and proximal muscle weakness each detected in 3 patients (21.4%). 13 patients of them presented variable degrees of recovery up to total resolution of symptoms during hospital stay.

Of adult patients, 50% had underlying diseases, including diabetes and hypertension are seen in 10 patients (27%), ischemic heart disease in 4 patients (11.11%), hypothyroidism in 2 patients (5.6%), breast cancer 1 patient (2.8%) and cardiomyopathy in 1 patients (2.8%). None of the pediatric patients had underlying illness.

Image acquisition:

CT Chest parameters:

Non contrast CT chest was performed in all patients using 16 channels MSCT (Simens). Reconstructed axial, coronal, and sagittal images were done.

The CT Scanning parameters were as follows: slice thickness = 1-2mm, FOV = 350mm x 350mm, tube rotation = 0.6-0.9s, and detector collimation = 1mm. The irradiation dose parameters were as follows: 120-130kvp and 100-200mA, according to the patient age and weight.

Neuro imaging:

Brain CTparameters:

CT examinations were obtained on 64 – section multi-detector row CT scanners. Studies were axially acquired (120 kV/auto-milliampere-seconds) at 5- and 1.25-mm-thick slicesfrom the level of the skull base to the vertex for non-contrast head CTs.

MR neuroimaging:

Brain, orbits, petrous and spinal cord MR imaging were performed on 1.5T (Achieva) scanners with standardized protocols.

- Brain MRI sequences: Axial diffusion-weighted imaging, axial T2-weighted-Fluid-Attenuated Inversion Recovery (T2FLAIR), axial T2WI, axial susceptibility weighted imaging, and sagittal T1WI. Intravenouscontrast was used in a subset of studies. TR: 488, TE: 15, Flip: 69, RFOV: 83%, FOV: 230/102, THK:6.7/1.3.
- Technique of MRV examination of the brain: Time of flight MRV with 3D reconstruction.
- MR of the orbit: Axial T1 and T2WI (fat saturated) FOV for the orbits and coronal (from chiasm through the orbits), coronal STIR post contrast axial and coronal T1 fat saturated.
- MR of petrous boneused sequences: Axial T 1 WI, T2WI, coronal T1 and T2WI and post contrast axial and coronal T1WI as well as axial CIS 3D of the petrous bone.
- Spine MR: Sagittal T1, T2, axial T1 and T2WI, post contrast axial and sagittal T1WI.

Image interpretation:

1- Chest CT:

Evaluationof the following: (1) The presence and/or absence of groundglass opacities (GGOs) and/or consolidation; (2) Crazy paving pattern; (3) CT severity score; (4) Predominant zonal distribution; (5) Lobar involvement; and (6) significant chest radiological signs.

Chest CT Severity was assessed by 2 thoracic radiologists based on a previously published grading system, the Chest CT severity (CCS) score [10] . Briefly, the 5 lung lobes were individually assessed for the degree of involvement by GGOs and consolidation. A score of 0 indicates no involvement; 1- Minimal involvement (1%-25%); 2- Mild involvement (26%-50%); 3- Moderate involvement (51%-75%) and 4- Severe involvement (76%-100%). The summation of the individual lobe scores yields the total CCS score. Only scans with the greatest severity were selected in patients with multiple chest CT scans, and all were performed approximately 7-12 days after the initial onset of respiratory symptoms.

2- *Neuro imaging:*

- Images of the brain: Were evaluated for the followings for each patient: (1) T2/FLAIR white matter signal abnormality: Non confluent punctate and/or confluent white matter lesions with and/or without restricted diffusion and/or microhemorrhage; (2) Enhancement: Lepto-meningeal, parenchymal, and cranialnerves; (3) Acute ischemic infarcts: Vascular territory, small/watershed zone, and cardio-embolic; (4) intracranial hemorrhages: parenchymal, subarachnoid, and microhemorrhage; (5) Acuteleuco-encephalopathy; (6) Posterior reversible encephalopathy syndrome; and (7) Hypoxic-ischemic-encephalopathy.

• MRV of the brain: Checked for evidence of sinus thrombosis with filling defect along major and visualized dural venous sinuses.

• MR images of both orbits: Carefully assessed for abnormal signal intensity within the optic nerve or abnormal post contrast enhancement suggestive of optic neuritis, as well as abnormalities in the extra ocular muscles or in the retro orbital fat.

• MR examination of the petrous bone: Evaluated for abnormal enhancement of the vestibule-cochlear nerve, inner ear structures, middle ear cavities or mastoid air cells.

• MR examination of the spine: Evaluated for intra medullary areas of altered signal or areas of abnormal enhancement within the cord, within the conusmedullaris or cauda equine nerve roots to diagnose transverse mylities, demyelinating insult as well as Guillain-Barredisease. All scans were reviewed by 3 neuro-radiologists in consensus.

Our hypothesis regarding the possible pathophysiology of neurological complications categorizing into:

A- Cerebero vascular disease manifestations: Including strokes, sinus thrombosis and intra cranial hemorrhagic complications.

B- Manifestations related to para infectious autoimmune diseases including: Transverse myelitis, ADEM, encephalitis Guillain-Barre disease, chronic demyelinating peripheral polyneuropathy, cranial nerve affection.

C- Manifestations due to direct virus effect: Including anosmia (olfactory nerve affection).

Statistical analysis:

Data were coded and entered using the Statistical Package for the Social Sciences version 28 (IBM Corp., Armonk, NY, USA). Data were summarized using mean, standard deviation, median, minimum and maximum in quantitative data and frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Mann-Whitney test [11] (Chan, 2003a). The Chi-square (X^2) test was performed to compare categorical data. The exact test was used instead when the expected frequency is <5 [12] (Chan, 2003b). Correlations between quantitative variables were done using the Spearman correlation coefficient [13] (Chan, 2003c). p-values of <0.05 were considered statistically significant.

Results

Radiological evaluation:

Chest CT examination:

CT image analysis revealed pathological findings in 29 patients (80.6%) while 7 patients (19.4%) in the adult group did not show significant abnormality in their chest CT examination. In the pediatric group, 13 patients (92.2%) showed pathological findings and 1 patient (7.1%) showed normal chest CT examination.

The most common pattern of lung affection in the two groups was ground glass followed by consolidation. The ground glass and consolidative patches were mostly multiple affecting both lungs in the majority of patients and showing mainly peripheral location (Table 2).

Table (2): Radiological findings in CT examination of chest.

	Pediatric		Adult	
	Count	%	Count	%
CT chest:				
Abnormal	13	92.9	29	80.6
Normal	1	7.1	7	19.4
Ground glass:				
Positive	13	92.9	29	80.6
Negative	1	7.1	7	19.4
Consolidation:				
Positive	3	21.4	18	50.0
Negative	11	78.6	18	50.0
Laterality:				
Unilateral	2	14.3	1	2.8
Bilateral	11	78.6	28	77.8
Negative	1	7.1	7	19.4
Multiple patches:				
Multiple	13	92.9	29	80.6
Single	0	0	0	0
Negative	1	7.1	7	19.4
Peripheral location:				
Peripheral	13	92.9	29	80.6
Central	0	0	0	0
Negative	1	7.1	7	

Some less common patterns of lung affection in COVID-19 infection were detected in the adult group as follows: Crazy paving pattern in 15 patients (41.7%) (Figs. 1,2), atoll sign in 8 patients (22.2%) (Figs. 1,2), Bull's eye in 4 patients (11.1%) (Fig. 2), architectural distortion in 3 patients (8.3%), and tree on bud (Fig. 1) and peri lobular fibrosis in 2 patients (5.6%).

Atoll and Bull's eye signs, architectural distortion and peri lobular fibrosis werenot detected in the pediatric group; however, a crazy paving pattern was seen in 2 patients (14.3%) and tree on bud in 1 patient (7.1 %).

The mean value of CT severity score was 7.36 in the adult and 5.21 in the pediatric group.

Other findings detected in chest CT of adult patients were pulmonary embolism in 1 patient (2.8%), pleural effusion in 1 patient (2.8%), mediastinal lymph nodes in 2 patients (5.6%) and cardiomegaly in 4 patients (11.11%), whereas pulmonary embolism, pleural effusion and cardiomegaly were not detected in any patient in the pediatric group while mediastinal lymph nodes were seen in 1 patient (7.1 %).

Neuroimaging:

According to the patients' neurological presentations, imaging modalities used were: In the adult group, 25 patients (69.4%) were assessed by MRI and 11 patients (30.6%) by CT.

In the pediatric group, 14 patients (100%) were assessed by MRI and none by CT.

The most common neurological abnormalities of adult and pediatric groups were different as follows.

The neurological diseases diagnosed in adults were mainly due to cerbero vascular diseases: strokeseen in 16 patients (44.4%) (Figs. 1,2,3), followed by sinus thrombosis in 9 patients (25%), intracranial hemorrhage in 7 patients (19.4%) (Figs. 1,4), followed by auto immune mechanisms (totally seen in 11 patients 30.55%) as following: Guillain-Barrein 6 patients (16.7%), transverse myelitis and chronic demyelinating peripheral polyneuropathy each in 2 patient 2 (5.6%), encephalitis in 1 patient (2.8%) and cranial nerve affection (including: Optic neuritis, and vestibule cochlear neuritis) each in 1 patient (2.8%)and less frequently due to direct virus effect: As anosmia (with a gyral area of abnormal signal) seen in 4 patients (11.1%).

In the pediatric group, the neurological diseases detected were only due to autoimmune mechanism as following: ADEM in 6 patients (42.9%) (Fig. 5), acute necrotizing encephalitis in 4 patients (28.6%) (Fig. 6), Guillain-Barre in 3 patients (21.4%) and transverse myelitis in 1 patient (7.1 %) (Fig. 7).

The clinical outcome differed between both groups. In the adult group 54.8% of patients were improved up to total recovery of their neurological symptoms and signs, while the percent was 85.7% in the pediatric group.

The relation between the mean CT severity score and age was assessed and revealed a statistically significant relationship (p-value=0.001) (Table 3, Fig. 8).

Table (3): Correlation between CT severity score and age.

	CT severity score
Age:	
Correlation Coefficient	0.451
p-value	0.001
N	50

Statically significant relation was found between CT severity score and O_2 requiremment in adult (p-value=0.003). This relation could not be assessed in pediatrics due to small number of patient's required O_2 therapy in this group.

No significant relationship was found between the age group and improvement of the clinical condition (p=0.090) (Table 4).

Table (4): Correlation between improved prognoses in two groups.

	Pediatric		Adult		p-value
	Count	%	Count	%	
Improved	12	85.7	17	54.8	0.090

Statistically significant relationship was detected between the presence of underlying diseases and CT severity score in adults (p-value=0.005) (Table 5, Fig. 9).

Table (5): Relation between chronic disease and CT severity score.

	Adult					p-value
	CT severity score					
	Mean	Standard deviation	Median	Minimum	Maximum	
Chronic disease:						
Yes	10.06	5.51	10.00	2.00	18.00	0.005
No	4.67	6.74	2.50	0.00	20.00	

The relationship between the presence of underlying illness and the occurrence of stroke, intracranial hemorrhage and sinus thrombosis was assessed and revealed a statistically significant relationship between chronic illness and stroke only (*p*=0.044) (Table 6).

Table (6): Relation between chronic disease and presence of neurological complication.

	Adult				*p*-value
	Chronic disease				
	Yes		No		
	Count	%	Count	%	
Stroke:					
Yes	11	61.1	5	27.8	0.044
No	7	38.9	13	72.2	
Hemorrhage:					
Yes	3	16.7	4	22.2	1
No	15	83.3	14	77.8	
Sinus thrombosis:					
Yes	7	38.9	2	11.1	0.121
No	11	61.1	16	88.9	

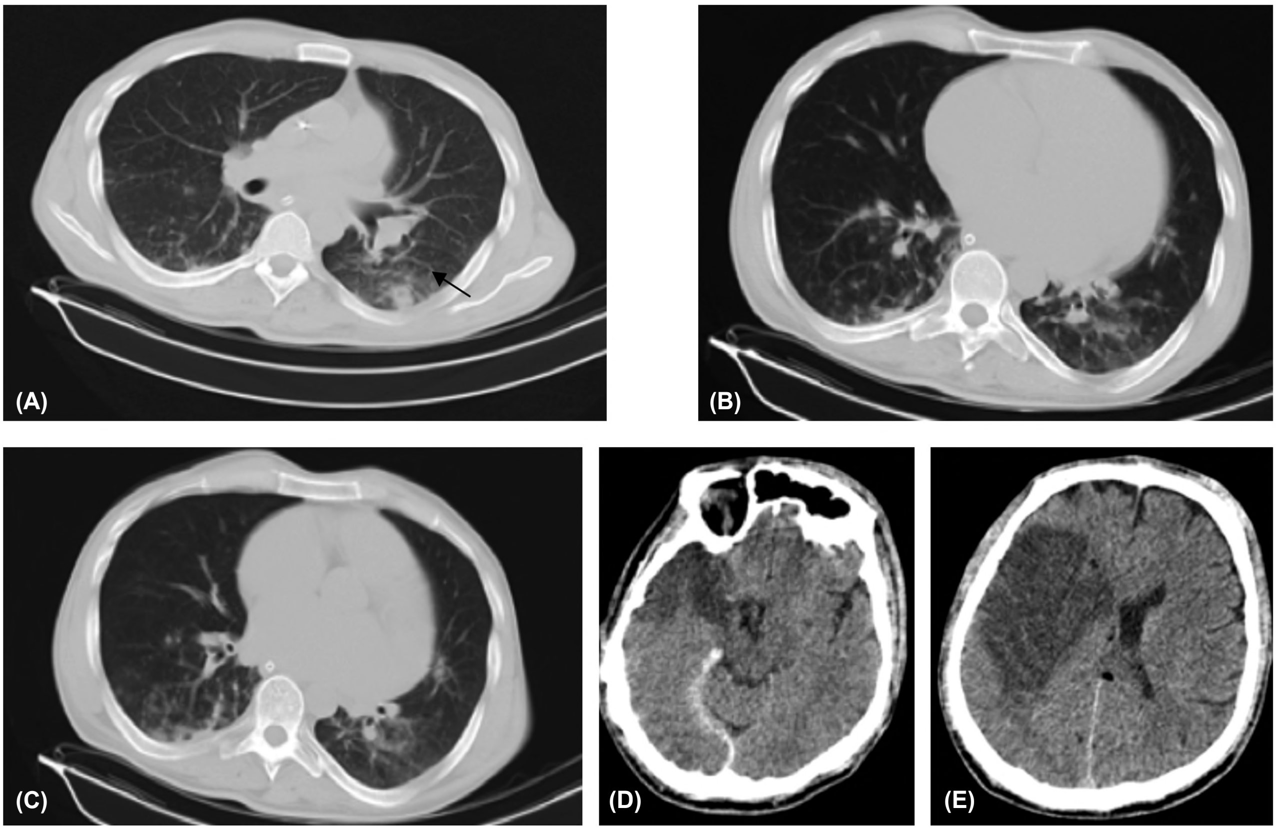


Fig. (1): 33 years old male patient with dyspnea followed by left sided weakness and disturbed conscious level after 3 days (A,B,C) Axial CT chest lung window, CT severity score 8, with atoll sign, arrow in (A), crazy paving pattern in (B) and tree in bud pattern in (C). (D,E) Axial CT cuts of the brain showing right sided tentorial leaflet subdural hemorrhage in (D) and right fronto parietal acute ischemic infarction along right MCA territory (E).

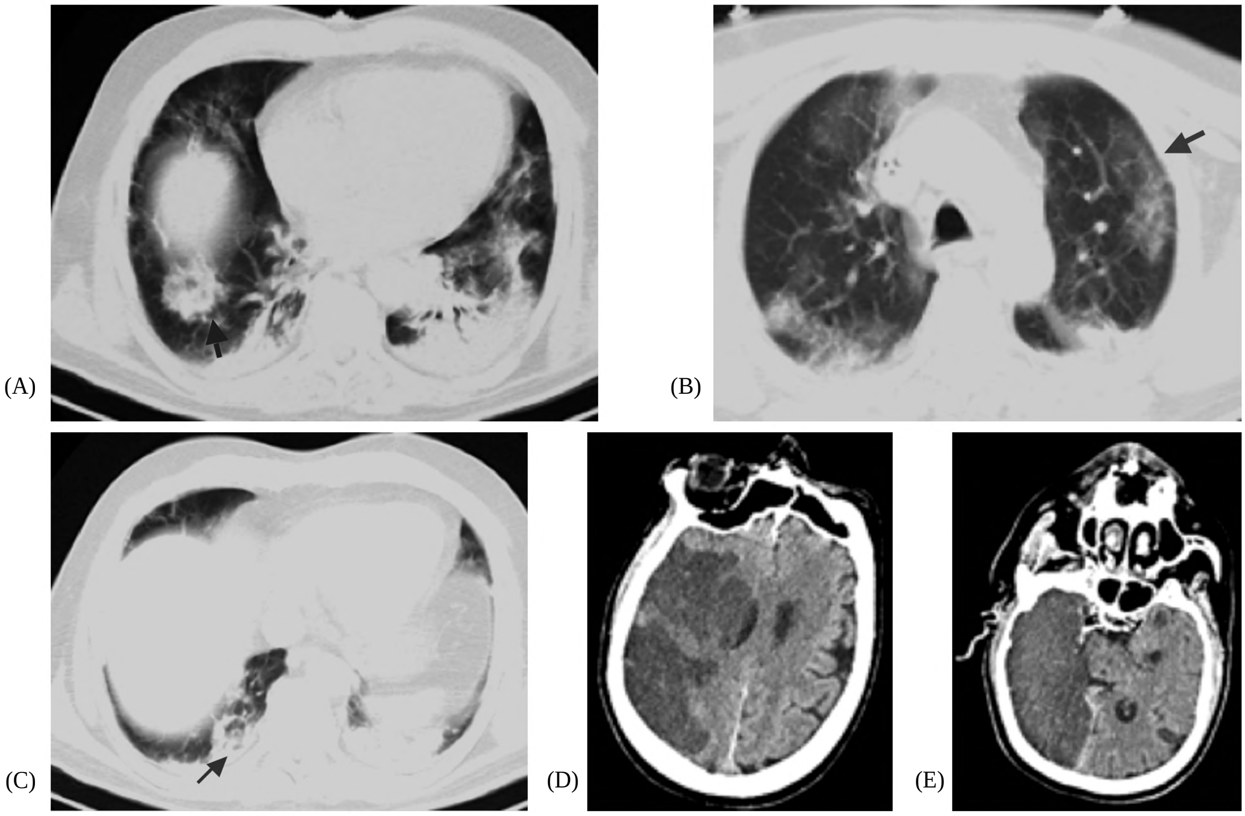
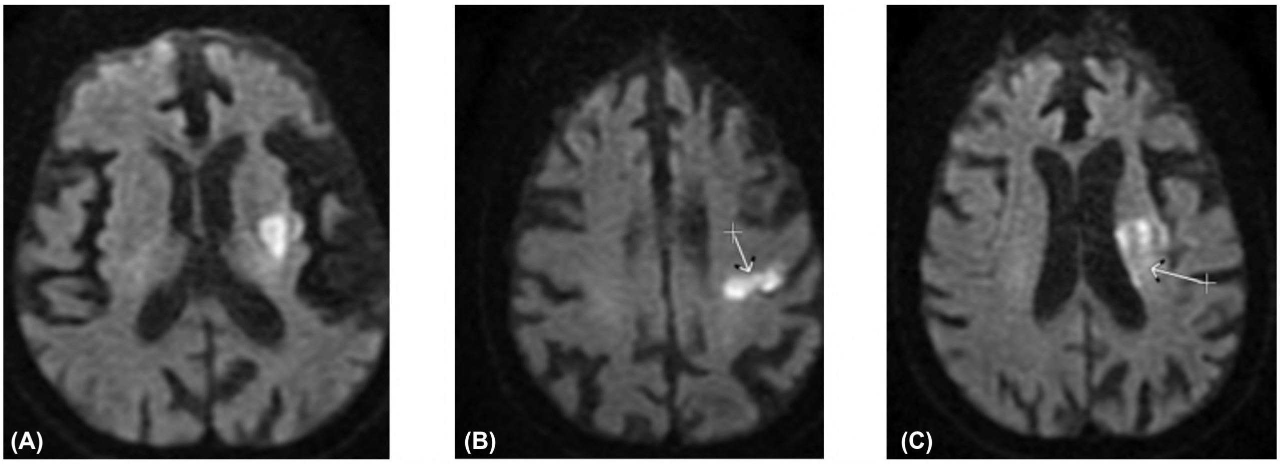


Fig. (2): 60 years old male patient with progressive dyspnea, respiratory distress followed by left sided weakness and disturbed conscious level. (A,B and C) Axial CT chest lung window, CT severity score 19, showing a toll sign in (A), crazy paving pattern in (B) and bull's eye sign in (C). (D,E) Axial CT of the brain showing right fronto-temporo-parietal large acute ischemic infarction along right MCA territory.



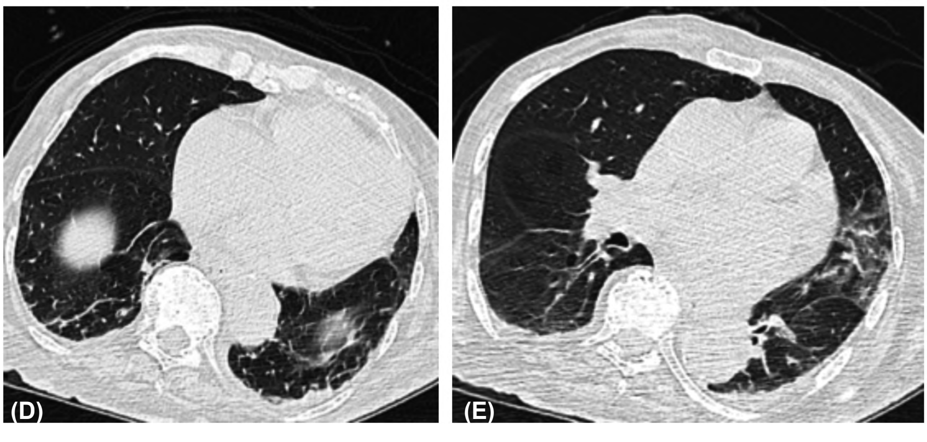
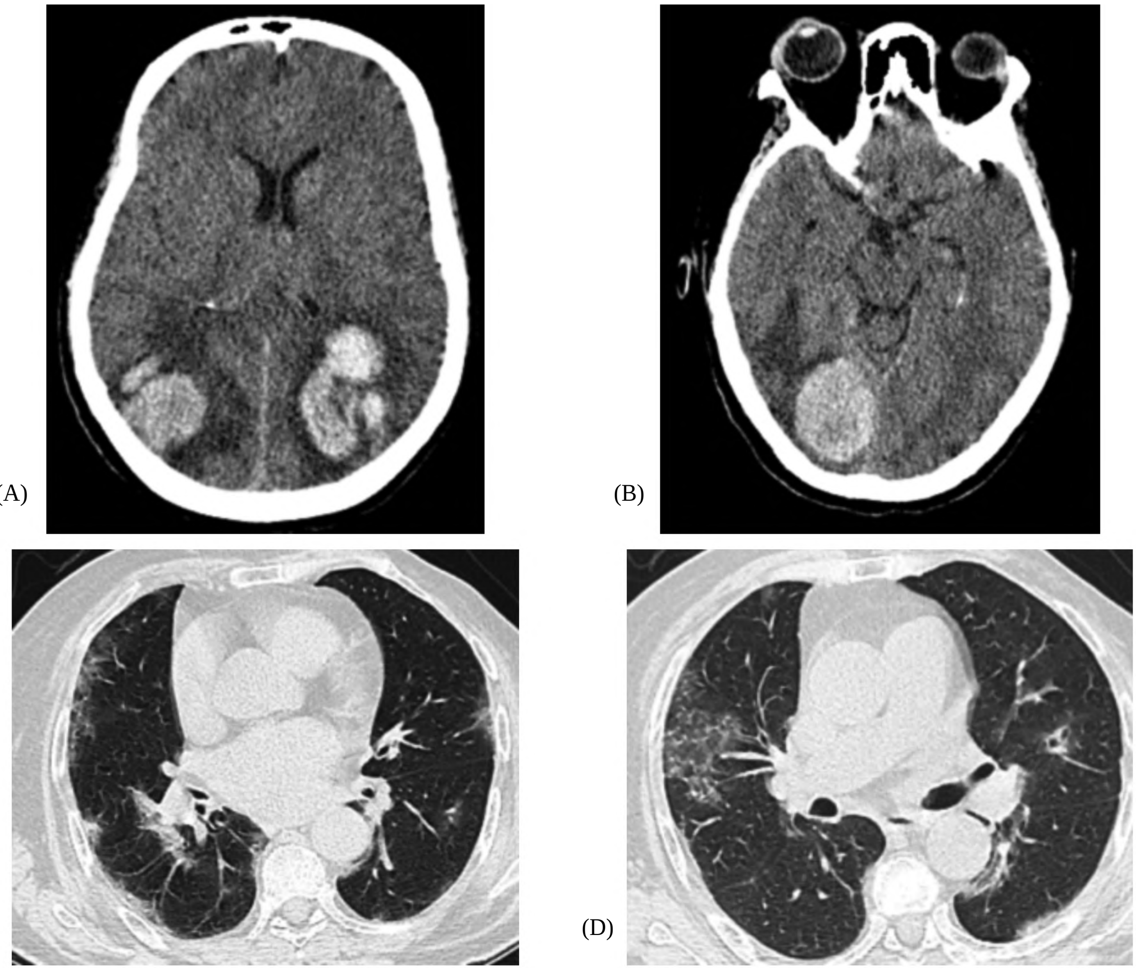


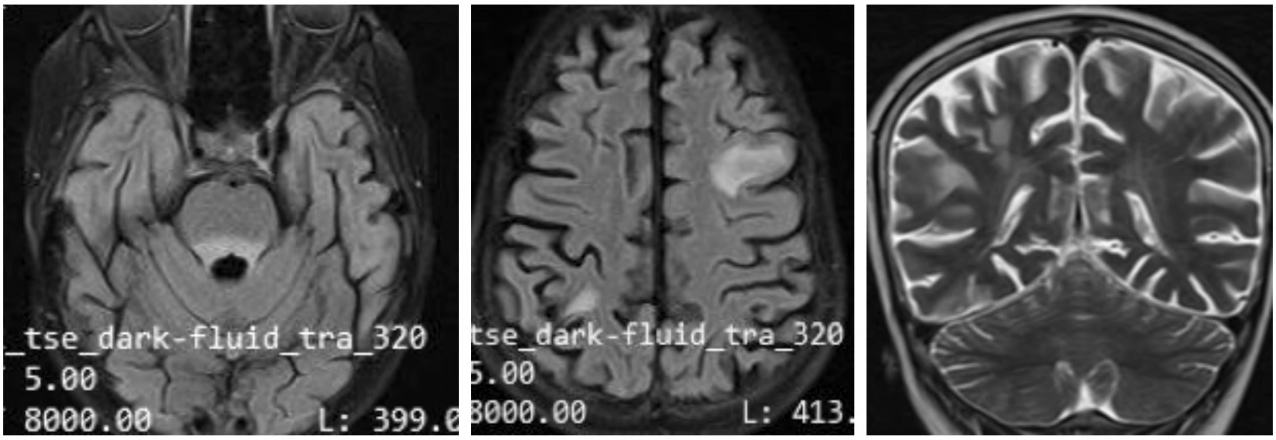
Fig. (3): 91 years old male with COVID 19 infection, radiologically and laboratory confirmed, followed by disturbed conscious level and right sided weakness. (A, B, and C) Axial DWI MRI study of the brain showing multiple left parietal and left lentiform foci of restricted diffusion, denoting presence of acute ischemic infarcts. (D,E) Axial CT chest lung window, CT severity score 6, showing bilateral patchy faint ground glass opacities more at the left side with bilateral basal atelectatic lung bands as well as minimal pleural reaction.



(A) (B)

(C) (D)

Fig. (4): (a,b) Axial CT brain in 55 years old female patient, post COVID 19, presented by disturbed conscious level, showing multiple bilateral cerebral hemorrhagic infarcts. (C,D) Axial CT chest lung window, CT severity score 10, showing bilateral patchy faint ground glass opacities with crazy paving at the right side.



(A) (B) (C)

Fig. (5): 7 year old female child with COVID 19, laboratory proven, followed by convulsions and decreased conscious level, diagnosed with ADEM. CT images of chest (not shown) revealed no significant abnormality and CT score 0. (A,B) Axial FLAIR, (C) coronal T2WI, showing patchy area of high signal intensity in the posterior aspect of the pons (A) and multiple subcortical and periventricular white matter patchy areas of high signal intensity in T2 and FLAIR (in B and C).

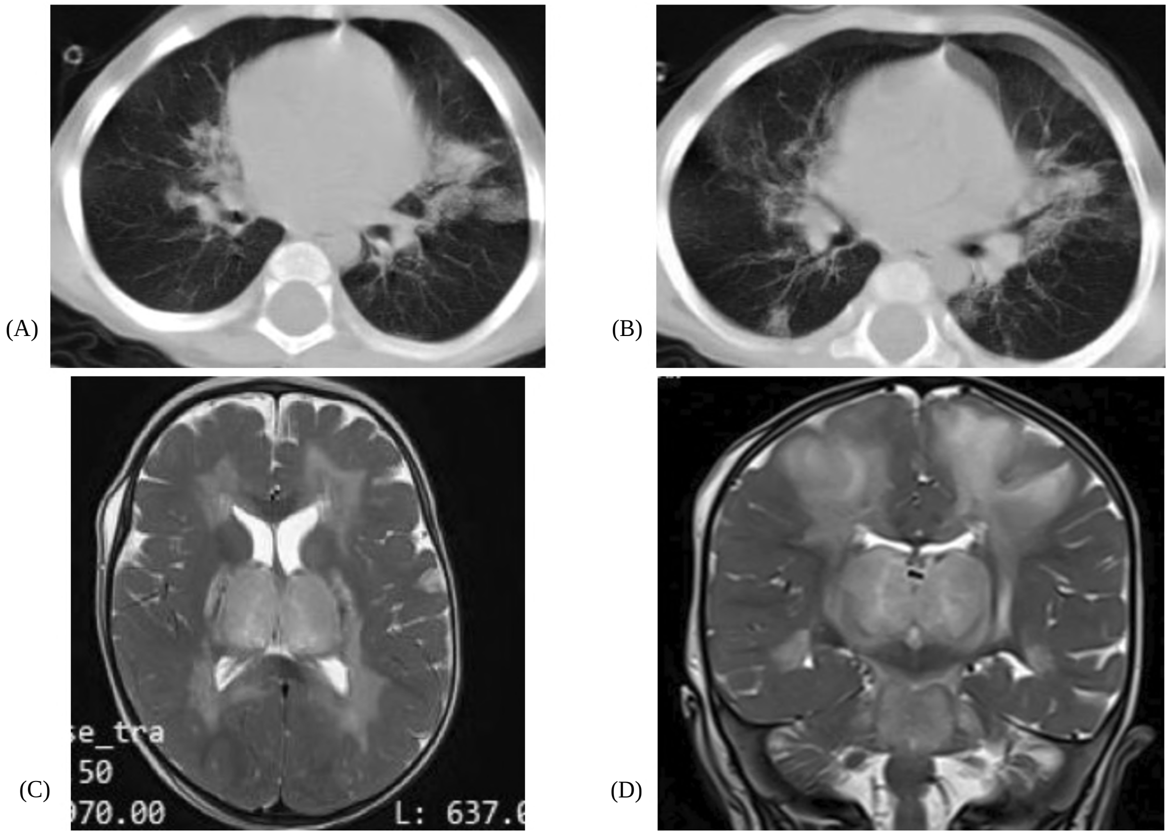


Fig. (6): 1 year old male boy presented by COVID 19, radiologically and laboratory proven, followed by disturbed conscious level, diagnosed with ANEC (Acute necrotizing encephalitis). CT score of 10. (A,B) Axial CT chest showing scattered areas of airspace consolidation. (C,D) Axial and coronal T2WIs, MRI brain images showing swollen thalami with abnormal high T2 signal within the periventricular white matter.

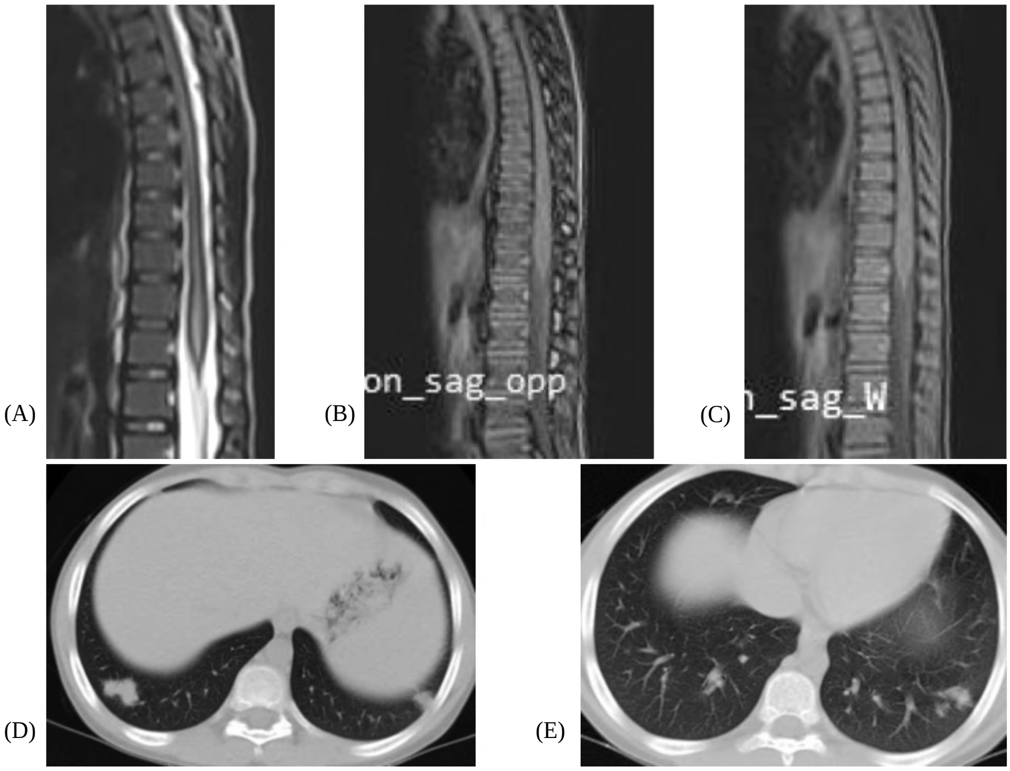


Fig. (7): 8 year old male boy with COVID 19, radiologically and laboratory proven, followed by bilateral lower limb weakness with sensory level ,diagnosed with transverse myelitis. CT score of 8. (A) Sagittal T2WIs, (B,C) Sagittal post contrast T1 WIs with and without fat suppression, showing diffuse swelling of the lower part of the lumbar spinal cord and the conusmedullaris with intramedullary abnormal high T2Ws signal and diffuse enhancement in the post contrast series. (D,E) Axial CT chest showing peripheral multifocal areas of airspace consolidation.

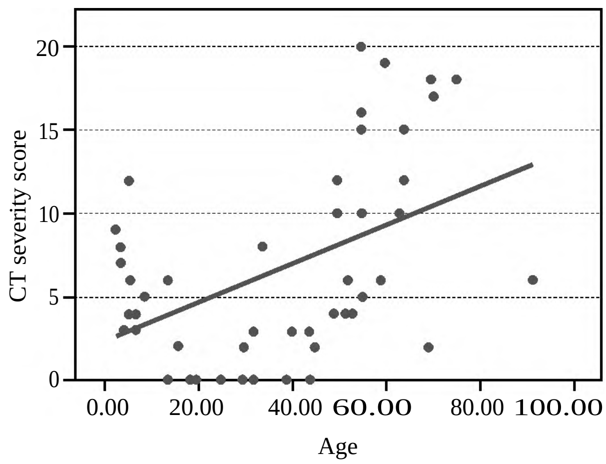


Fig. (8): Relation between CT severity score and age.

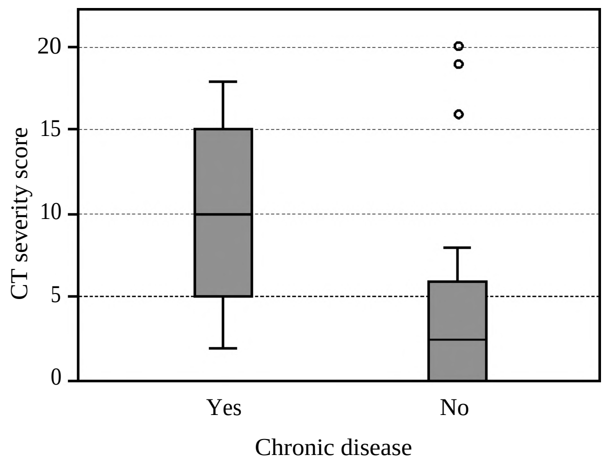


Fig. (9): Relation between CT severity score and presence of chronic diseases.

Discussion

Our results are related to other similar studies as following:

Most adults and pediatric patients, were males, which matched with previous reports that the male sex is associated with severe COVID-19 disease **[14]**. This could be explained by sex-specific features of the innate and adaptive immune systems that may account for increased defense against COVID-19 in females **[15]**.

We noticed that the incidence of oxygen therapy requirement was more in adult patients than in pediatric patients. Fever was the most common clinical presentation in children seen in (100% of patients). This went well with previously described in other research that clinical symptoms were mild in children with fever and dry cough being the most common symptoms **[16]**.

Matching with previous reports, the most common pattern of lung complicationin our COVID-19 infected adults and children were multiple bilateral peripheral patchy areas of ground glass and consolidation **[17]**.

Other less common CT signs of COVID-19 had been reported in our patients, the most common was a crazy paving pattern followed by an atoll sign and Bull's eye sign, then architectural distortion. These signs denoted severe lung complications mainly in our adult patients, the mean CT severity score in adult patients was higher than in the pediatric group, as well as chest complications, such as pulmonary embolism and pleural effusion,which were seen only in our adult patients. These findings supported the results of previous research, which documented that children are known to have less severe lung complications compared to adults **[18]**.

We agreed with Aref Saeed G, et al., **[19]** in that severity of lung affection detected by CT severity score had statistically significant relation with respiratory distress and O_2 requirement in adults.

The most common underlying pathophysiological mechanism causing neurological complications seen in the adults was cerbero vascular affection. This is similar to other study conducted by Lang M, et al., **[20]**. This might be explained by the association of COVID 19 infection with vigorous inflammatory response accompanied by coagulopathy, elevated D-dimer levels, and the frequent presence of antiphospholipid antibodies, which may explain the high prevalence of thromboses seen in these patients **[21]**.

The study conducted by Kim PH, et al., **[22]** differed from our results as they reported that olfactory bulb abnormality (caused by direct virus spread) was the most common neuroimaging finding, followed by white matter abnormality (due to automimmune mechanism), acute/subacute ischemic infarction (due tocerbero vascular affection) and encephalopathy.

We reported six cases of different cranial nerves affection: Four with olfactory bulb affection resulting mostly from (direct virus spread to CNS), one showed affection of the optic nerve and the other of the vestibule-cochlear nerve (most likely due to immunological reactions). This went well with-Finsterer J, et al., who reported that any cranial nerve can be involved in COVID-19, but they differed from us as they documented that cranial nerves VII, VI, and III were the most frequently affected, but our study did not show any case with affection of these nerves.

All neurological complications detected in pediatric group were due to autoimmune mechanism with no cases of cebero vascular affection or direct virus spread. This differed from the report of Govil-Dalela T and Sivaswamy L [23], wherein cases of stroke (cerbero vascular affection) and anosmia (direct virus spread to CNS) were reported among children as well as among adults. They also reported cases of ADEM and acute necrotizing encephalitis among adults and none among children. However, in our study, cases of ADEM and acute necrotizing encephalitis were only in the pediatric group. They agreed with us that Guillain-Barre could affect both adult and pediatric groups. This was the only study that compared neurological complications between adults and children.

We found that 85.7% of our pediatric group showed improvement in their neurological abnormalities, this coincides with the study conducted by Principi N and Esposito S [24], in which almost all children with COVID-19 and neurological manifestations described a complete recovery.

We reported a significant relationship between CT chest severity score and age, Statsenko Y, et al. [15] reported that age appeared as a strong risk factor for COVID-19 severity and poor clinical outcomes, Reasonably, age-related co-morbidities are the leading reason for the increased mortality observed in the elderly Wang J, et al., [25].

A significant relationship was found between the presence of chronic disease and stroke development in patients withCOVID-19, which was most probably due to the increased risk of thromboembolic events in patients who suffered from chronic illness, especially diabetes and hypertension.

The main limitations of our study were: Small sample size of the pediatric group and neuro imaging assessment of some adult patients with CT, which has a low sensitivity for white matter disease compared to MRI, which may underestimate the results in those patients.

Conclusion:

COVID-19 associated neurological abnormalities showed an increased prevalence among both adult and pediatric patients. The pattern and possible patho physiology of neurological affection differed between both groups but pediatric patients showed a better clinical outcome.

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المضاعفات الإشعاعية العصبية والرئوية لمرض فيروس كورونا ٢٠١٩، هل تختلف بين المرضى البالغين والأطفال ؟ دراسة مبنية على الملاحظة

أصبح مرض فيروس كورونا ٢٠١٩ (COVID-19) جائحة عالمياً تسبب فى وفاة الملايين فى جميع أنحاء العالم.

هدفت هذه الدراسة إلى وصف نتائج التصوير لمضاعفاتها العصبية والرئوية التى تم تطويرها لدى البالغين والأطفال المصابين. تمت ملاحظة المجموعتين فيما يتعلق بالفيزيولوجيا المرضية المحتملة، والنتائج الإشعاعية، ودرجة شدة الصدر بالتصوير المقطعى المحوسب (CT) والنتيجة السريرية، وكانت المضاعفات العصبية المكتشفة لدى البالغين ناتجة بشكل أساسى عن أمراض الأوعية الدموية الدماغية : السكتة الدماغية التى شوهدت فى ٤٤.٤٪ من المرضى. عن طريق تجلط الجيوب الأنفية بنسبة ٢٥٪، ثم نزيف داخل الجمجمة بنسبة ١٩.٤٪، يليه آليات المناعة الذاتية B التى لوحظت بالكامل فى ٣٠.٥٥٪ من المرضى وأقل تكراراً بسبب تأثير الفيروس C المباشر : مثل فقدان الشم فى ١١.١٪ من المرضى. بينما فى طب الأطفال، كانت الأمراض العصبية المكتشفة ناتجة فقط عن آلية المناعة الذاتية التى لوحظت فى ١٠٠٪ من المرضى. كان متوسط درجة شدة التصوير المقطعى المحوسب أعلى عند البالغين (٧.٣٦) مقارنة مع الأطفال (٥.٢١). فى مجموعة البالغين، تم تحسين ٥٤.٨٪ من المرضى حتى الشفاء التام من الأعراض والعلامات العصبية، بينما كانت النسبة أعلى فى مجموعة الأطفال ٨٥.٧. تشير النسبة المئوية إلى نتائج سريرية أفضل لدى الأطفال، وأظهرت التشوهات العصبية المرتبطة بفيروس COVID-19 انتشاراً متزايداً بين المرضى البالغين والأطفال على حدٍ سواء. اختلف النمط والفيزيولوجيا المرضية المحتملة للعاطفة العصبية بين المجموعتين، لكن مرضى الأطفال أظهروا نتائج سريرية أفضل.