

BRAIN DAMAGE IN COVID-19. CASE REPORTS AND SUMMARY OF DATA IN LITERATURE

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ABSTRACT

SARS-CoV-2 (severe acute respiratory syndrome), rapidly escalated to a pandemic and has a significant impact on the quality of human life and activity, affecting millions of people.

The presentation resumes data regarding the neurological impairment of patients affected by COVID-19; although the data was observational and limited, this examination would help us to broaden our understanding on the association between COVID-19 and the stroke. In order to support such observations I will present two cases of patients diagnosed with COVID-19 that have shown neurological damage, but with different altogether outcomes.

The first case analysed, the age and comorbidities of the patient determined an unfavourable evolution, partly also due to tardiness in getting admitted. The apparition of the stroke after the serological negative bias SARS-CoV-2 denotes the complications recently emerged after the severe infection with COV-2, therefore while the viral infection remitted, the physical and pathological tumult determined the emergence of complications with unfavourable evolution. Although similar in certain ways to the first case, the second patient that also presented multiple unfavourable factors, such as old age, severe comorbidities and beyond that - multiple hospital admissions, recent neurosurgical intervention- clinical, immune-serum and biological evolutions have been favourable.

Cerebrovascular events are somewhat common findings in COVID-19 infected patients and they could bare a multifactorial etiology. In order to better understand the impact of cerebrovascular events in COVID-19 infection, more precise and prospective data are needed.

Keywords: COVID-19, SARS-CoV-2, stroke, comorbidities, evolution.

Introduction

SARS-CoV-2 (severe acute respiratory syndrome) or the disease produced by this new Coronavirus denominated COVID-19 by World Health Organization, rapidly escalated to a pandemic and has a significant impact on the quality of human life and activity. At a global level, according to National Center for Surveillance and Control of Communicable Diseases/12.07.2021, 187.511.690 cases have been confirmed, of which 4.063.474 deaths. (1) SARS-CoV-2 has transformed into a medical emergency, demonstrating that it determined dangerous multi-organic damages, not only at

pulmonary level but, throughout time it has been noticed that it has an impact on the entire vascular economy of the body. Due to the hypoxia it generates, a brain damage emerges. The virus made us conscious again on the fact that the oxygen can be a medicine for the human body and subsequently it must be used under optimum conditions. (2)

Being mainly a respiratory disease, with a major dynamic pulmonary damage, it is clinically associated with headache, fever, non-productive cough, fatigue, shortness of breath, dyspnea, thoracic pain or pressure, myalgia; signs of interstitial pneumonia or other pathological modifications which are

characteristic to SARS-CoV-2 infection at radiography (X-ray) or pulmonary Computed tomography (CT) scan. (3) The symptomatology may evolve in an unforeseeable manner, from easy forms to serious forms of disease. Slight neurological modifications can appear from the very beginning, from the loss of smell and/or taste, to an unfavourable evolution of the disease which leads to drowsiness, change of consciousness state, confusion, temporal and spatial disorientation, psycho-motor agitation, behaviour disorders, hallucinations, motor deficits, lack of tactile attention, ataxia up to a well-defined clinical delineation - myelitis or damages of the peripheral nervous system, encephalitis, encephalopathy, stroke either ischemic or haemorrhagic). (4, 5)

So far, researches seem to indicate the fact that COVID-19 may increase the risk to have a thrombotic or haemorrhagic event. Patients affected by SARS-CoV-2 develop the increase of the risk of rennet formation by abnormal coagulation of blood. Thrombosis emerges when a rennet is formed and it blocks a blood vessel - an artery or vein. Blockage of the blood flow may provoke various complications: stroke, transitory ischemic attack, pulmonary embolism, heart attack. (6)

Meanwhile, the specialists have discovered more data on the patients affected by COVID-19 and their susceptibility to suffer strokes have been demonstrated. Patients with cardiac pathology (hypertension, atrial fibrillation), metabolic diseases (diabetes mellitus) present severe symptoms of COVID-19 and have unfavourable evolutions. Recent studies confirm the fact that people with complicated cases of COVID-19 are more prone to a vascular disease (stroke), compared to persons presenting mild forms of disease. (7, 8)

Such universal statistic data have been confirmed by the pathology presented by various patients infected with COVID-19 in the Clinics of Infectious Diseases and Neurology in Constanta. In order to support such observations throughout this article, I will present two cases of patients diagnosed with COVID-19 who presented neurological damage.

Case presentation nr.1:

The first case is a 70-year-old patient, with personal pathological antecedents known as diabetes mellitus type II with chronic treatment, who was recovered for a period of 23 days at the Hospital of Infectious Diseases for fever, dry cough, asthenia, capricious appetite, general influenced status. On admission, the real-time polymerase chain reaction (RT-PCR) for SARS-CoV-2 was positive.

On admission, the SpO₂ was 92% in free air (corrected with 15l/min O₂ - on facial mask), and at thoracic and pulmonary CT on admission (day 1) presents condensations suggestive for pulmonary lesions of SARS-CoV-2-type with severity-score 11 (6 for right pulmonary, 5 for left pulmonary) - moderate form (Figure no.1a). Treatment according to the National Protocol with antiviral medication was instituted (Favipiravir 200mg 8 tablets x 2/day on the first day, then 3 tablets x2 /day), antibiotics (Ceftriaxone 2g intravenously every 12 hours), anticoagulant (Dalteparine of 0.6 ml, 1 vial/day), non-steroidal anti-inflammatory (Paracetamol 1 gram every 12 hours, for 7 days), mucolytic (Acetylcysteine 200 mg 1tablet x2/day), therapy with oxygen, but the evolution was not favourable; after days of specific treatment and therapy with oxygen, the general status damaged, the patient desaturated (SpO₂=76% with additional oxygen of 15l/min flow), the flow raises to 35l/min with SpO₂=95-96%) and was transferred to the intensive care unit with dyspnoea, polypnea, tachycardia. The therapy is changed, being added antiviral medication (Remdesivir 200 mg intravenously in the first day, then 100 mg intravenously / day), corticosteroid anti-inflammatory (Dexamethasone 8mg intravenously every 12 hours), immunosuppressant (Tocilizumab – 800 mg, one dose intravenously). The dynamic thoracic and pulmonary CT in the seventh day of admission presents bilateral fibrosis-alveolo-interstitial modifications in the context of SARS-CoV-2 lung disease in marked progression, with current severity score of 21 (11 for previous examination) and severe damage; bilateral pleural and pericardial discharge in small novo-quality (Figure no.1b). The therapy was sustained, it

necessitated non-invasive oxygen therapy with continuous positive airway pressure (CPAP) mask, with SpO₂=92-95% aerosols with Nitroglycerine. Hyperimmune Plasma was administered in the 8th day of admission. The therapy with antiviral medication was continued, associated with antibiotics (Meropenem 1g intravenously every 8 hours, Moxifloxacin 400 mg intravenously / day), antifungal (Fluconazole 400 mg/day in first day and then 200 mg/day, intravenously), steroidal anti-inflammatory (Dexamethasone), anticoagulant, platelet anti-aggregatory agent, mucolytic, bronchodilator, aerosols, inhibitors of protons pump, therapy with vitamins of B and C groups, diuretic, electrolytic rebalancing and metabolic support. In the 15th day of hospital admission, the thoracic and pulmonary CT re-evaluation indicates pulmonary lesions of SARS-CoV-2-type in discrete remission, with severity score and unchanged damage degree (Figure no.1c). In the 19th day of hospital admission, the RT-PCR SARS-CoV-2 test is still positive. The dynamic health status aggravated, presented facial asymmetry, deviation of right corner of the mouth, dysarthria, temporal and spatial confusion, decrease of saturation in oxygen up to 89-90% (she needed an additional flow up to 40l/min) and it raised the suspicion of stroke in the 23rd day of hospital admission. The patient was transferred at the Emergency Clinical Hospital in Constanta for a neurological evaluation. Neurological objective at the presentation: the patient is conscious, she presents mixed aphasia, right central facial paresis, right hemianopsia, she preferentially looks towards the right side, upper limb=1/5, lower limb=2/5 right motor deficit, right Babinski and score of Glasgow Coma Scale (GCS)=14 points. At the presentation in the Emergency Clinical Hospital in Constanta, a cerebral CT scan was performed in the 23rd day of disease, underlining left acute ischemic stroke, infratentorial sequellar lesion (Figure no.2). To note that the RT-PCR for SARS-CoV-2 performed in the 25th day after hospital admission is negative, and the pulmonary X-ray presents confluent alveolar opacities in half of the right pulmonary field and in the left basal field. The evolution maintained unfavourable under treatment with cerebral depletion, solutions of hydro-electrolyte rebalancing, statine,

painkillers, antiemetic, platelet anticoagulant, vitamins, diuretic, antibiotics. The patient's status aggravated and in the 26th day of hospitalization she died.

During her hospital admission, the evolution of biological data were synthesized in the table nr 1.

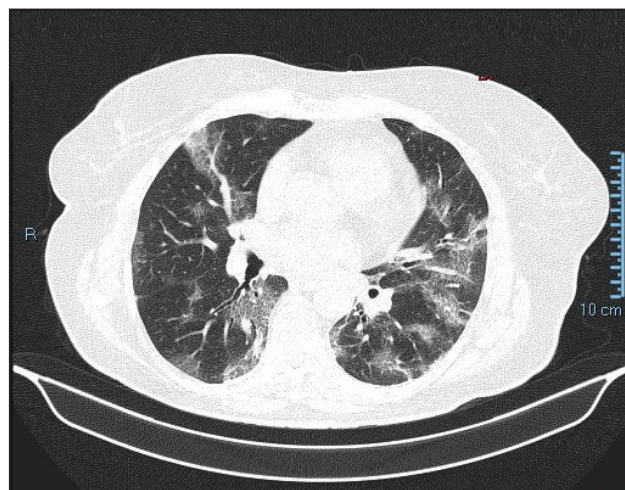


Figure 1a - Pulmonary CT scan native in the first day of hospital admission: bilateral pulmonary condensations suggestive for lesions of SARS-CoV-2 type with severity score of 11 (6 right lung, 5 left lung) and moderate damage.

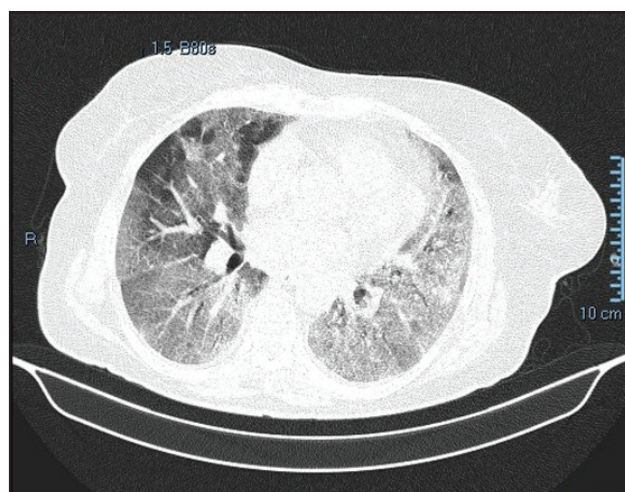


Figure 1b - Pulmonary CT scan native in the 7th day of hospital admission compared to the investigation performed in the first day of hospital admission, highlights bilateral pulmonary fibro-alveolar-interstitial modifications in the context of SARS-CoV-2 pneumonia in marked progression, with current severity score of 21.

Table 1 - Biological data in patient no. 1

Parameter/ Normal value (NV)	Day 1	Day 6	Day 8	Day 12	Day 14	Day 17	Day 19	Day 22	Day 23
White blood cells (NV: 4-10/10*9/L)	3.60	3.74	10.92	12.46	13.46	17.03	18.14	20.5	17.2
Haemoglobin (NV: 11.7-16.1/ g/L)	12.7	11.8	13.3	12.1	12.3	13.3	12.3	12.1	10.8
Platelets (NV: 150-400 / 10*9/L)	147	233	190	204	162	161	157	188	170
Erithrocyte sedimentation rate (NV: 6-12/ mm/1hour)	36	100	22	2	4	2	6	48	43
C reactive protein (NV: 0-5/ mg/L)	45	297	91	4	2	2	2	216	-
Ferritine (NV: 10-280 ng/ml)	432.60	>1200	-	-	-	-	-	1058.10	-
Troponin HS1 (NV: 4.9-29/ ng/L)	3.3	-	-	<1.5	-	-	3.5	-	-
Fibrinogen (NV: 196-372/ mg/dl)	483	814	115	90	61	82	181	648	-
International Normalized Ratio (INR) (NV: 0.79-1.25)	0.94	-	1.38	1.26	1.22	1.35	1.04	1.20	1.18
PT (sec) (NV: 9.8-12.1 / sec)	10.0	-	14.5	13.3	12.9	14.2	11.0	12.7	-
PT (%) (NV: 70-130 / %)	110.5	-	55.8	63.7	66.7	57.6	90.9	68.3	-
APTT (sec) (NV: 21.2-28.6/sec)	-	-	21.3	18.4	16.8	18.5	17.1	-	-
Alanine amino-transferase (NV: 0-40/ U/L)	30.3	-	33.8	61.1	38.4	34.1	28.2	-	18
Aspartat amino-transferase (NV: -37/ U/L)	20	-	28	72	81	53	33	-	18
Lactatdehidrogenase (NV: 240-480 / U/L)	600	1178	-	1900	1830	1820	1605	1473	-
Urea (NV: 15-45/ MG/DL)	37	-	31	52	46	44	43	20	29
Creatinine (NV: 0.6-1.2/ MG/DL)	0.76	-	0.57	0.655	0.63	0.64	0.48	0.48	0.33
Glycemia (NV: 70-105/ mg/dl)	97.5	-	153.1	207.5	270.4	280.7	137.3	-	243
D-DIMER (NV: 0-0.5 / ug FEU/ml)	-	-	21.00	3.51	2.35	-	1.06	4.48	-

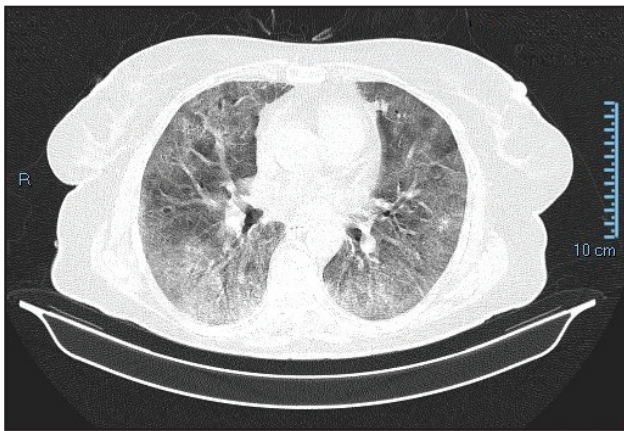


Figure 1c - Pulmonary CT scan native in the 15th day of hospital admission compared to the investigation performed in the 7th day of hospital admission, highlights pulmonary lesions of SARS-CoV2 type in discrete remission in left pulmonary area.

The old patient with comorbidities evolved unfavourably due to tardive presentation in hospital and associated diseases. The apparition of the stroke after the serological negative bias SARS-CoV-2 denotes that the complications recently emerged after the severe infection with COVID-19, therefore while the viral infection remitted, the physical and pathological tumult determined the emergence of complications with

unfavourable evolution.



Figure 2 - Cranio-encephalic CT scan highlights acute stroke on the territory of the left middle cerebral artery.

Case presentation nr 2:

The second case is a 83-years-old patient, known with Parkinson's Disease, II Hoehn and Yahr (H&Y) phase, atrial fibrillation, arterial hypertension III degree at very high risk, hypertensive heart disease, mitral insufficiency, having performed surgical operation of neoplasm prostate and colon in 2018, chemotherapy and

Table 2 - Biological values in patient no 2

Parameter/ Normal value (NV)	Day 1	Day 2	Day 3	Day 5	Day 6	Day 7
White blood cells (NV: 4-10/10 ⁹ /L)	7.19	5.87	6.60	2.43	6.55	6.76
Haemoglobin (NV: 11.7-16.1/ g/L)	12.2	10.8	10.8	12.4	11.0	11.3
Platelets (NV: 150-400 / 10 ⁹ /L)	39	263	298	211	271	179
Erythrocyte sedimentation rate (NV: 6-12/ mm/1hour)	-	5	10	-	10	5
C reactive protein (NV: 0-5/ mg/L)	23	13	11	3	2	2
Fibrinogen (NV: 196-372/ mg/dl)	148	160	175	108	119	135
INR (NV: 0.79-1.25/INR)	-	1.07	1.05	1.03	0.99	-
PT (sec) (NV: 9.8-12.1 / sec)	-	11.1	210.9	10.7	10.3	-
PT (%) (NV: 70-130 / %)	-	87.2	91.8	96.7	107.7	-
APTT (sec) (NV: 21.2-28.6/sec)	19.6	21.2	20.5	22.3	19.2	19.5
Alanine amino-transferase (NV: 0-40/ U/L)	105.3	117	105.5	59.1	51.2	38.7
Aspartat amino-transferase (NV: 0-37/ U/L)	57	69	76	54	45	38
Lactatdehidrogenase (NV: 240-480 / U/L)	1291	1165	1261	1185	1383	1120
Urea (NV: 15-45/ MG/DL)	35	40	47	43	45	33
Creatinine (NV: 0.6-1.2/ MG/DL)	0.94	0.94	1	0.77	0.82	0.89
Glycemia (NV: 70-105/ mg/dl)	87.2	113.3	132.2	122.4	116.2	115.7

radiation therapy in 2012, colon polypectomy in 2020, is being admitted in the Neurology Department of the Emergency Clinical Hospital in Constanta, for blurred vision and walking disorder, for a period of three days. During the hospital admission, the patient was made a Magnetic resonance imaging (MRI) of the brain with contrast, which evidenced expansive intra-nevraxial temporo-parieto-occipital right formation, with subfalcine affliction and right uncal herniation, the imagistic aspect suggesting a multiform glioblastoma (Figure no.3); neurological surgery is recommended. In the 3rd day of hospital admission, the patient was transferred to Bagdasar Arseni Hospital in Bucharest, where a neurological surgery was performed. After the neurological surgery, the patient was transferred (after 14 days of hospitalization) at the Emergency Clinical Hospital in Constanta in the Neurological Surgery Department (glioblastoma operated); from a neurosurgical perspective, the general status is good during the hospital admission, with no changes. At the moment of the transfer, the patient is traced with SARS-CoV-2 infection, while the native cerebral CT scan and with contrast substance highlights cerebral post-surgical modifications (Figure no. 4), and the native CT scan of the thoracic area indicated alveolar infiltration with tendency of confluence and consolidation – the imagistic point of view beeing compatible to a viral pneumonia

COVID-19, which can be classified as CORADS 5, severity score: 22 from 25; bilateral pleurisy; moderate cardiomegaly (Figure no. 5a). After 5 days of hospitalization in the Department of Intensive Care COVID at the Emergency Clinical Hospital in Constanta, the patient is transferred to the Infectious Disease Hospital in Constanta.

Here the patient was admitted for 12 days. On the day of hospital admission at the Department of Intensive Care - infectious diseases, all vital functions were changed and the patient needed multi-organic and multifunctional rebalancing. The radiological thoracic and pulmonary examination performed in the second day of hospital admission indicates: bilateral pulmonary condensations which are suggestive for SARS-CoV-2 lesions, with severe damage. In the 8th day of hospitalization, the radiological pulmonary examination indicates: discretely improved radiological aspect of pulmonary lesions with maintenance of severe damage. The RT-PCR SARS-CoV-2 test which was performed in the 9th day of hospitalization is negative. The Pulmonary CT scan in the 10th day of hospitalization indicates: bilateral pulmonary condensations which are suggestive for SARS-CoV-2 lesions in various stages of evolution, with severity score 20 and severe damage; free bilateral pleurisy in small quantity (Figure no. 5b). Due to specific therapy of the pathological phases which were covered, associated with a continuous flow of oxygen, the patient's

condition evolved favourably, performing an immunological serum conversion after specific treatment.

During hospitalization at the Infectious Disease Hospital in Constanta the patient received treatment with antiviral medication (Remdesivir 200 mg intravenously in the first day, then 100 mg intravenously/day for 4 days; then the antiviral medication was changed and the patient received it on the 6th day -Favipiravir 200mg 8 tablets x 2/day, then 3 tablets x2 /day for 5 days), antibiotic (Meronem 1g intravenously every 8 hours), immunosuppressant (Anakinra 1vial/day), anticoagulant (Clexane 0,6 ml 1vial every 12 hours), corticosteroid anti-inflammatory (Dexamethasone 8mg intravenously every 12 hours), anticonvulsant (Phenytoin 1 tablet every 8 hours), platelet anti-aggregatory agent (Aspirin 1 tablet/day), antifungal (Fluconazole 1vial/day), inhibitors of protons pump, probiotic, mucolytic, bronchodilator, antihypertensive, therapy with vitamins of B and C groups, aerosols and electrolytic rebalancing and metabolic support.

All biological data dynamically obtained during the period of hospitalization at the Infectious Disease Hospital in Constanta are specific to the infection with SARS-CoV-2 (Table 2)

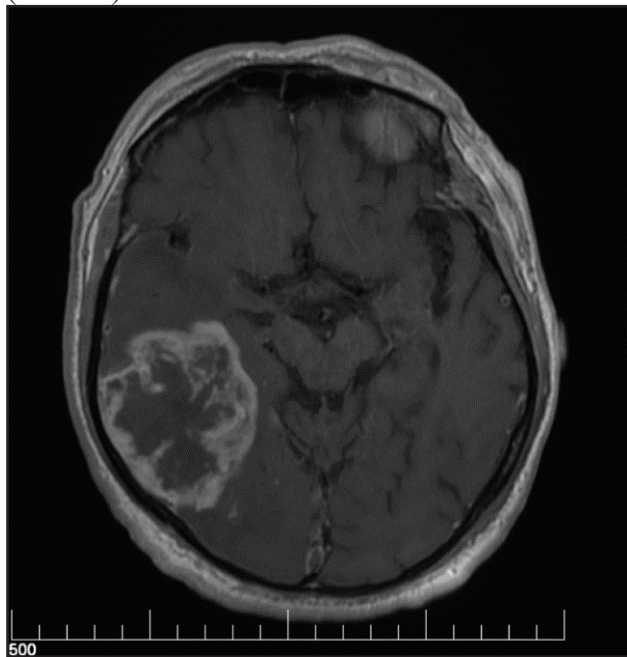


Figure 3 - Cranio-cerebral MRI with contrast agent: Expansive intra-neuraxial temporo-parieto-occipital right formation, with subfalcine affliction and right uncus herniation, the imagistic aspect suggesting a multiform glioplastoma.

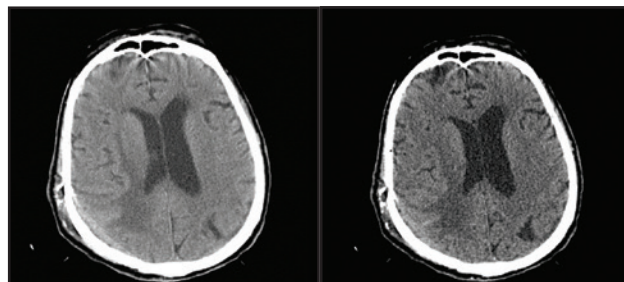


Figure 4 - Cerebral CT scan native and with contrast agent, taken 14 days after surgery, indicates cerebral postsurgical modifications.



Figure nr 5a - CT scan of the thoracic area (at the moment of the transfer at the Emergency Clinical Hospital in Constanta , after 14 days of hospitalization at Bagdasar Arseni Hospital in Bucharest) indicated alveolar infiltrations with tendency of confluence and consolidation - imagistically compatible to a viral pneumonia COVID-19, which can be classified as severity score of 22 from 25, and bilateral pleurisy.

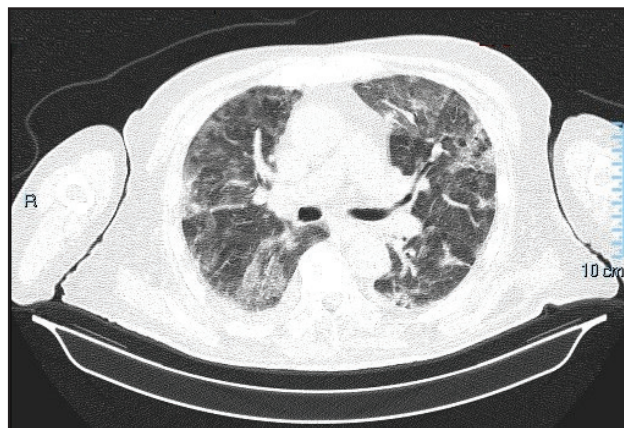


Figure nr 5b - The native CT scan of the thorax in the 10th day of hospitalization at IDHC, indicates: bilateral pulmonary condensations which are suggestive for SARS-CoV-2 lesions in various stadia of evolution, with severity score 20 and severe damage; free bilateral pleuresia in small quantity.

Although the patient presented multiple unfavourable factors, such as old age, severe comorbidities (Parkinson's Disease, II H&Y phase, atrial fibrillation, arterial hypertension III degree at very high risk, hypertensive heart disease, mitral insufficiency, having performed surgical operation of neoplasm prostate and colon in 2018, chemotherapy and radiation therapy in 2012, colon polypectomy in 2020), multiple hospital admissions, recent neurosurgical intervention (glioblastoma), clinical, immune-serum and biological evolutions have been favourable.

Discussion

These presentations resume data regarding the neurological impairment of patients affected by COVID-19; although the data was observational and limited, this examination would help us to broaden our understanding on the association between COVID-19 and the stroke. Currently, there is another uncertainty on the relation between the stroke and COVID-19, not being clear if it is casual or not. The average time to develop a stroke in the current revision is of 10 days for the process of determining the infection of SARS-CoV-2. It is said that it may reflect an impact of the infection, inflammation and extreme activity of cytokines on the systemic and neurological deterioration. Although in most of the studies the cytokine levels were not measured, C-reactive protein levels, lactate dehydrogenase, ferritin, and D-Dimer test have proved to be very high for both cases analysed.

The first case described in my presentation, is a 70-year-old patient, with associated pathology such as diabetes mellitus Type II undergoing chronic treatment, who was presented 23 days after COVID-19 symptom onset (fever, dry cough, asthenia, dyspnea, general influenced status), had temporal and spatial confusion, facial asymmetry, deviation of right corner of the mouth, dysarthria and incoordination. The brain CT shows acute stroke on the territory of the left middle cerebral artery. D-dimer level was 4.48/ug FEU/ml, the INR was 1.18 at the time when the stroke symptoms occurred. The patient's status aggravated and in the 26th day of hospitalization she died.

According to Beyrouti R, the recent data surfacing from the pandemy's epicentre in Wuhan, China, neurological complications have been declared in 36% of the total of 214 patients with COVID-19. Acute cerebrovascular disease (mainly ischaemic stroke) appears to be more common among 88 patients that suffer from severe COVID-19, rather than the patients with non-severe disease (5.7% vs 0.8%). The mechanisms, the phenotype and proper management of ischaemic stroke that is associated with COVID-19 remain unsure. The authors also describe different characteristics of six consecutive patients evaluated during two week and two days at the National Hospital for Neurology and Neurosurgery, Queen Square, London, UK, that suffered acute ischaemic stroke and COVID-19. All these patients presented large vessel occlusion with highly elevated D-dimer levels. Out of the six, three patients suffered multiterritory infarcts, two had concurrent venous thrombosis, and, in two cases, ischaemic strokes occurred despite administration of anticoagulation. (9)

Out of the six patients presented by Rahma Beyrouti, the case of a 53-year-old woman strikes some resemblance to the first case described in my presentation, regarding age, symptoms and outcome, the patient in cause was taking warfarin for a valvular atrial fibrillation (AF), was presented 24 days after COVID-19 symptom onset (cough, dyspnoea), had acute confusion, drowsiness and incoordination. The brain CT confirmed the acute large left cerebellar and the right parieto-occipital infarcts. D-dimer level was 7750 µg/L, the INR was 3.6 at the time when the stroke symptoms occurred. After external ventricular drainage for hydrocephalus, the patient was given therapeutic low-molecular-weight heparin anticoagulation. She died following cardiorespiratory deterioration due to COVID-19 pneumonia. (9)

Ischaemic stroke is known to be a complication of COVID-19, generally in case of severe disease, what is yet to be understood are the phenotype and the mechanisms. Related observations point toward the idea that acute ischaemic stroke accompanying COVID-19 infection could have distinct characteristics, including implications for diagnosis and

treatment. (9)

On the other side, the SARS-CoV-2 infection is very likely to affect both patients suffering from cancers and those that just get diagnosed with it and in need to start specific therapy. Cancer patients are considered a very vulnerable potential target to SARS-CoV-2 infection and more prone to a more severe COVID-19 symptomatology, which might be due to the systemic immunosuppressive state that is a consequence of tumor growth and indirectly because of the effects of anticancer treatment. Also, due to the confirmed nosocomial transmission of SARS-CoV-2 among patients admitted in different healthcare units, patients suffering of cancer could be predisposed to getting infected by SARS-CoV-2 because of direct contact with either COVID-19 patients or different contaminated areas, as they need regular visits to hospitals to receive anticancer therapy. (10)

The second case described in my presentation is a 83 year old patient who was presented in the Neurology Department of the Emergency Clinical Hospital in Constanta for blurred vision and walking disorder, for a period of three days. Through native and contrast MRI of the brain, an expansive intra-nevrxial temporo-parieto-occipital right formation was highlighted, with subfalcine affliction and right uncal herniation, the imagistic aspect suggesting a multiform glioblastoma. Neurological surgery is recommended. After the operation, the patient was diagnosed with SARS-CoV-2 infection. But after 12 days of hospitalization in the Infectious Disease Hospital in Constanta, under treatment the patient's evolution turned out to be favorable.

In a paper written by Reinier Alvarez, a case of a 60 year old patient was presented, with a left insular and frontal operculum glioblastoma. The patient presented to his primary care physician with a 4-months history of right-sided tinnitus and hearing intermittent loud noises that he described as "bells and whistles." Magnetic resonance imaging revealed a patchy infiltrative signal abnormality within the left insular region and portions of the left frontal operculum, suggestive of neoplastic disease. 10 days after being referred to the neurosurgery section, the patient was found to be COVID-19 positive.

Meanwhile, treatment was postponed, until the SARS-CoV-2 result would come out as negative. In the interim, the patient had developed an intratumoral hemorrhage with progressive expressive aphasia. The recommended surgical approach was to perform an awake craniotomy, as the tumor was causing dominant hemisphere language symptomatology. By performing this intervention, a near-total gross resection was achieved, with the use of airborne-level personal protective equipment and a surgical drape to protect the surgeon from the direction of potential aerosolization. The postoperative course was uneventful and notable improvement in speech was obvious with diminished expressive aphasia. On postoperative day 4, the patient has been discharged at home, with a corticosteroid taper. Negative RT-PCR SARS-CoV-2 tests had been confirmed 3 weeks postoperatively, nonetheless at that time, repeat imaging was consistent with tumour recurrence. (11)

Both the patient described in my presentation and the one described in Reiner Alvarez's article share certain aspects, as an older age, glioblastoma diagnosis and the SARS-CoV-2 infection, but regardless of the aforementioned, and most importantly share a favourable clinical evolution.

A clear link between the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and cerebrovascular disease has been reported. Therefore, neurological manifestations are not odd for a patient infected with SARS-CoV-2. The unknown is whether this association is either causal or incidental. Several factors can contribute as potential etiopathogenic mechanisms leading to diverse cerebrovascular clinical manifestations, such as: angiotensin-converting enzyme-2 receptor dysregulation, uncontrollable immune reaction and inflammation, coagulopathy, COVID-19-associated cardiac injury with subsequent cardio-embolism, complications due to critical illness and prolonged hospitalization. (12)

Conclusions

One of the common findings in patients infected with the novel SARS-CoV-2 virus, are cerebrovascular events which could bare a

multifactorial etiology. A better understanding is provided by accurate and prospective data, so that the impact of cerebrovascular events in COVID-19 infections can be further analysed.

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