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Case report of a fulminant non-aneurysmal convexity subarachnoid hemorrhage after COVID-19

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ABSTRACT

We report on a case of a fulminant non-aneurysmal subarachnoid hemorrhage after COVID-19 in a patient without previous medical history or known previous illness despite a COVID-19 infection one month prior. We saw rarefied vessels in the area of the left middle cerebral artery besides a massive left frontal hemorrhage on cranial imaging. We concluded that these rarefied vessels are the expression of an RCVS, which fits the history of progressive headaches for one month. The RCVS might be caused by the COVID-19 infection and is related to the hemorrhage. Unfortunately, due to preoperative entrapment, brain death occurred a few days later.

1. Introduction

Respiratory symptoms in combination with fever, cough, and fatigue are the most common symptoms of COVID-19 infections [1].

Central nervous system (CNS) involvement in patients suffering from coronavirus disease 2019 (COVID-19) has been reported in several studies and can lead to neurological symptoms such as headache, dizziness, hypogeusia, or hyposmia [2,3]. Severe neurological conditions like stroke and vascular events have also been observed [2,4].

Intracranial hemorrhage occurs in about 4.4% of COVID-19 patients and typically affects elderly persons with comorbidities and anticoagulation [5]. Nearly 80% of those hemorrhages are associated with ischemic stroke [6]. Brain herniation is the consequence in very few cases (0.7%). Some authors propose a higher incidence of aneurysmal and non-aneurysmal subarachnoid hemorrhage (SAH) in patients with COVID-19. It is debated whether an increase in incidence is a coincident finding or a confident correlation [7,8].

We report on a case with a fulminant non-aneurysmal subarachnoid hemorrhage in a patient without previous medical history or known previous illness despite a COVID-19 infection one month prior.

2. Case report

A 56-year-old patient with no previous medical history presented with a Glasgow Coma Scale (GCS) of 3. The last contact with relatives was the evening before. One month ago, he suffered from mild respiratory symptoms, and COVID-19 was diagnosed. The relatives reported that the patient had reported progressive headaches after the COVID-19 illness with episodes of most severe holocephalic headaches (thunderclap headache). A treatment or evaluation prior to this admission for headache did not happen.

At admission, COVID-PCR was weakly positive (ct value: 37), and d-dimer was elevated (2.14 μg/ml (reference < 0.5)). Coagulation parameters (PTT, INR, CT) and thrombocyte were within normal limits. The CT scan documented a massive, left frontal hemorrhage causing a dramatic midline shift which we thought was most likely an intracerebral hemorrhage (Fig. 1). No vascular malformation and no perfusion alterations were detected by CT angiography (CTA). But rarefied vessels on the left side in the area of the anterior and middle cerebral artery were seen (Fig. 2). Immediate surgery revealed not the suspected intracerebral hemorrhage but a massive space-occupying subarachnoid hemorrhage. The cortex appeared pale. No intracerebral hemorrhage was found (Fig. 3). Histologically, an old hematoma with additional fresh portions was confirmed, while there was no evidence of vascular

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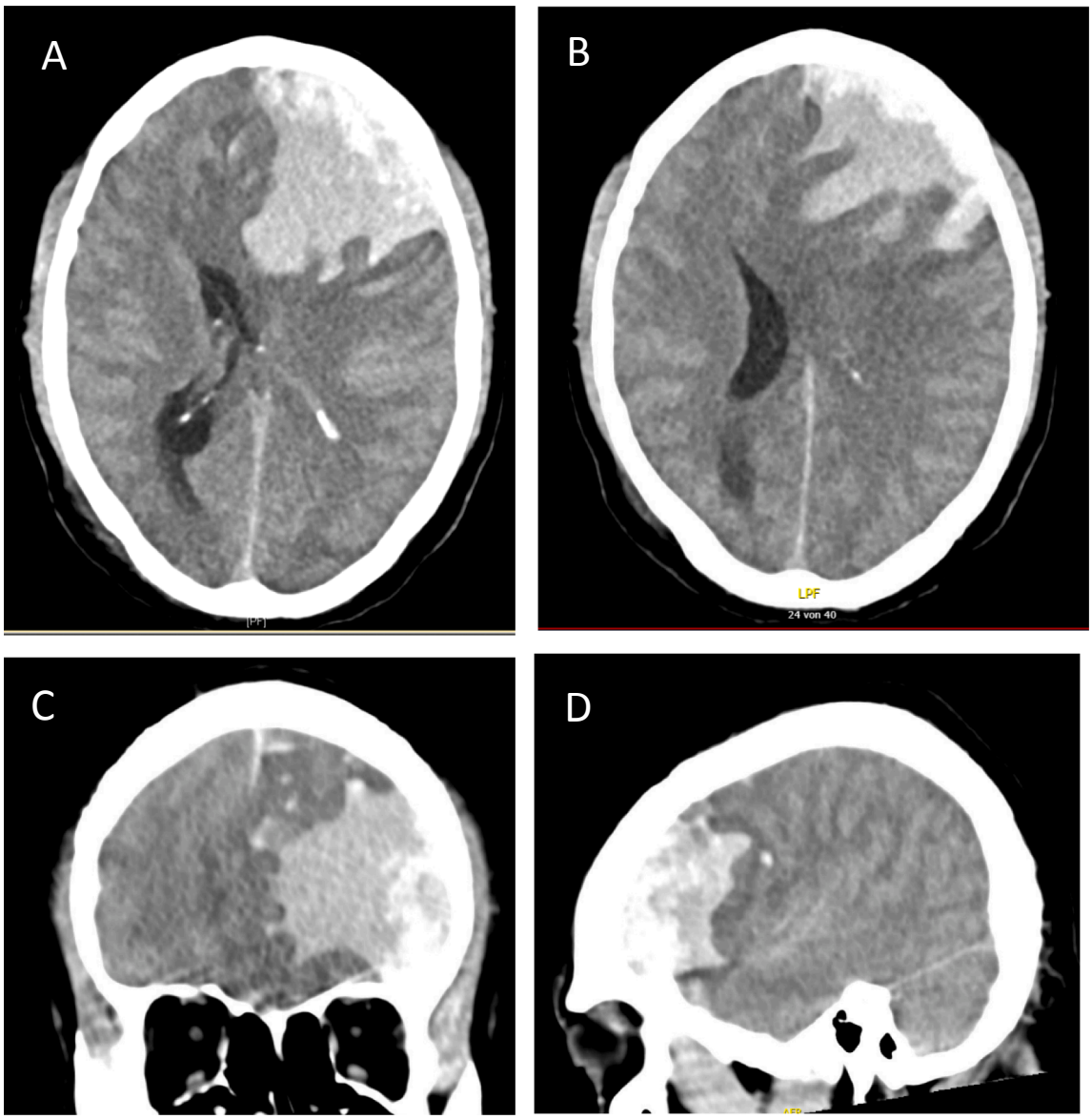

Fig. 1. Preoperative CT scan of the brain on admission. Axial (A,B), coronal (C) and sagitall (D) cross-section image showing a massive left frontal hemorrhage with consecutive midline displacement. Imaging suggested intracerebral hemorrhage.

disease, vascular malformation, or neoplasia. Postoperative CT demonstrated complete removal of the hemorrhage but massive strokes in the anterior, middle and posterior cerebral artery supply zone as a result of the preoperative entrapment (Fig. 4). Brain death was diagnosed three days after surgery.

3. Discussion

COVID-19 usually affects the CNS mildly with the leading symptoms of headache and/or hyposmia [3]. Additionally, vascular events like thrombosis of the cerebral venous sinus and reversal cerebral vasoconstriction syndrome (RCVS) are described in COVID-19 patients. It is suggested that thrombosis is mediated by a cytokine storm or by endothelial damage. Resulting cascade activation is leading to hypercoagulation [9–11]. Hypercoagulation might lead to ischemic stroke and increased risk of a secondary intracerebral hemorrhage [5,12,13]. However, intracranial hemorrhage is rare in patients with COVID-19 and is typically associated with risk factors such as arterial hypertension and anticoagulation therapy [4–7].

In our case, ischemic stroke was not observed on the primary ct scan. The initially elevated d-dimer levels in our patent may indicate a thrombosis of cerebral venous, but this could not be confirmed by CT angiography. A sinus vein thrombosis could cause a subarachnoid or intracerebral hemorrhage [14,15].

Furthermore, a higher incidence of aneurysmal SAH in COVID-19 patients is suspected by some authors [7,16]. Acute onset of thunderclap headache is typical for SAH. Four weeks after recovery from a COVID-19 infection, this patient suffered from progressive headaches for about one month with episodes of most severe holocephalic headaches (thunderclap headache).

Recurrent thunderclap headache is typical for RCVS caused by constriction of cerebral arteries [17]. Global or segmental vasoconstriction is not directly caused by COVID-19 but COVID-19 is attributed for down-regulation of angiotensin-converting enzyme (ACE)-2 receptors, leading to sympathetic hypertonia of the cerebral vessels and/or over activation of the classic renin-angiotensin axis resulting in

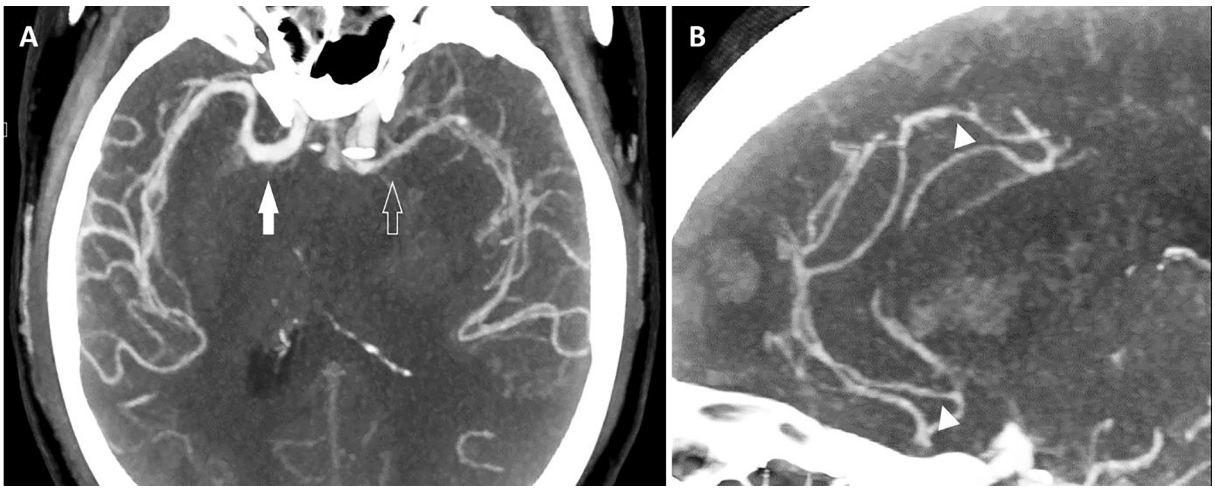

Fig. 2. CT angiography (CTA) scan of the brain on admission. (A) Axial cross-section image with multiplanar reconstruction (MPR) of the CTA showing abnormal narrowing of the left middle cerebral artery (open arrow) compared to the normal width of the right middle cerebral artery (solid arrow). (B) Sagittal MPR, revealing segmental narrowing and dilatation of the anterior cerebral arteries with a string-of-beads appearance (arrowheads).

vasoconstriction [18]. RCVS can lead to complications like posterior reversible encephalopathy syndrome (PRES), seizures, ischemic stroke, intracerebral hemorrhage, and convexity subarachnoid hemorrhage (cSAH) [19]. cSAH is described as a typical subtype of non-aneurysmal SAH and is commonly caused by RCVS in 60-year-old patients or younger [20]. Administration of Nimodipine and Aspirin may be used for the treatment of RCVS [19].

Our patient died because of a massive cerebral infarction caused by intracranial hypertension following massive cSAH.

To sum up, we saw rarefied vessels in the area of the left middle cerebral artery besides a massive left frontal hemorrhage on cranial imaging. We concluded that these rarefied vessels are the expression of an RCVS, which fits the history of progressive headaches for one month. The RCVS might be caused by the COVID-19 infection and is related to the hemorrhage.

To avoid the development of RCVS and hypercoagulability in patients with or after recovery from COVID-19 a regular headache history should be taken and if symptoms occur oral anticoagulation, antiplatelet therapy, or prophylaxis of vasospasm with Nimodipine should be considered, depending on the individual risk profile and cranial imaging [19,21–23].

4. Conclusion

COVID-19 is suggested to raise the risk of hemorrhage after stroke and the incidence of aneurysmal SAH. The described case shows, that RCVS and cSAH are possible complications after COVID-19 infection with potentially fatal outcomes. We conclude that even in the case of mild course of COVID-19, especially young patients should be advised that recurrent headache and particularly thunderclap headache is a typical symptom of RCVS which can lead to seizure, stroke or convexity subarachnoid hemorrhage. Early detection of RCVS rises the possibility for successful treatment.

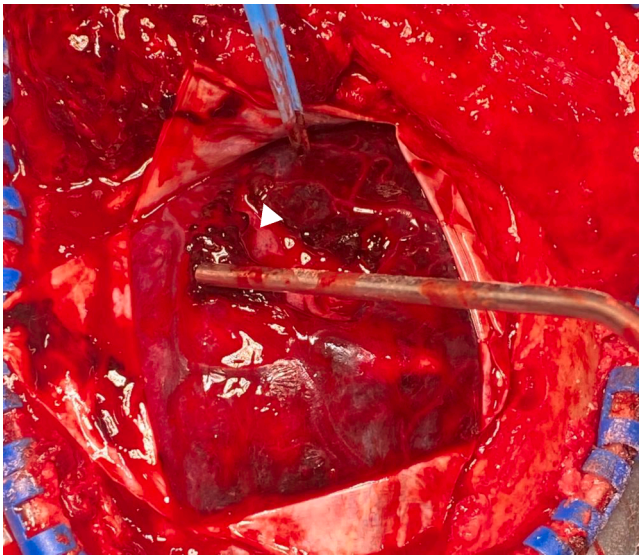

Fig. 3. Image of intraoperative findings showing massive subarachnoid hemorrhage rather than the intracerabral hemorrhage suspected on imaging. The cortex can be identified in depth (arrowhead).

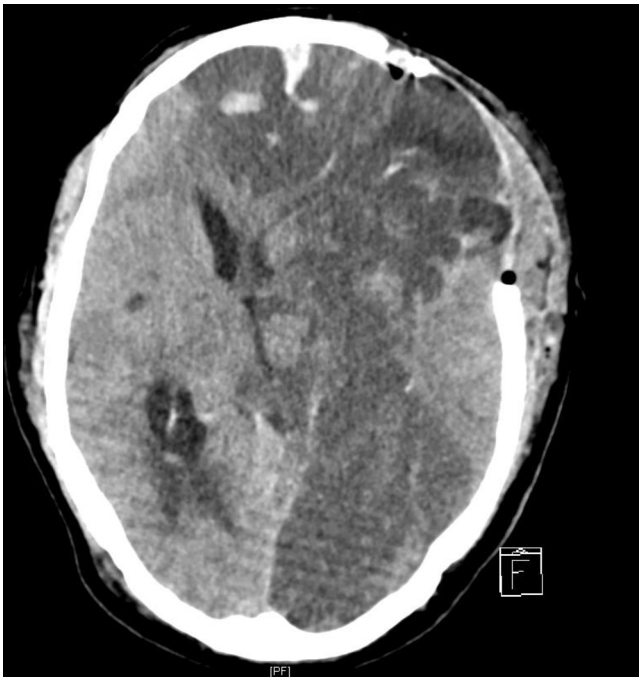

Fig. 4. Postoperative CT scan of the brain. Axial cross-section image showing complete removal of subarachnoid hemorrhage but anterior, middle, and posterior cerebral artery stroke.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] W.-J. Guan, Z.-Y. Ni, Y. Hu, et al., Clinical characteristics of coronavirus disease 2019 in China, N Engl J Med 382 (18) (2020) 1708–1720, https://doi.org/10.1056/NEJMoa2002032 [published Online First: 28 February 2020].

[2] J.R. Lechien, C.M. Chiesa-Estomba, Siati DR de, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease (COVID-19): a multicenter European study. European archives of oto-rhino-laryngology official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery 2020;**277**(8):2251–2261. 10.1007/s00405-020-05965-1 [published Online First: 6 April 2020].

[3] C. Huang, Y. Wang, X. Li, L. Ren, J. Zhao, Y.i. Hu, L.i. Zhang, G. Fan, J. Xu, X. Gu, Z. Cheng, T. Yu, J. Xia, Y. Wei, W. Wu, X. Xie, W. Yin, H. Li, M. Liu, Y. Xiao, H. Gao, L.i. Guo, J. Xie, G. Wang, R. Jiang, Z. Gao, Q. Jin, J. Wang, B. Cao, Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China, The Lancet 395 (10223) (2020) 497–506, https://doi.org/10.1016/S0140-6736(20)30183-5.

[4] I.J. Koralnik, K.L. Tyler, COVID-19: a global threat to the nervous system, Ann. Neurol. 88 (1) (2020) 1–11, https://doi.org/10.1002/ana.25807.

[5] S. Dogra, R. Jain, M. Cao, S. Bilaloglu, D. Zagzag, S. Hochman, A. Lewis, K. Melmed, K. Hochman, L. Horwitz, S. Galetta, J. Berger, Hemorrhagic stroke and anticoagulation in COVID-19, J. Stroke Cerebrovasc. Dis. 29 (8) (2020) 104984, https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.104984.

[6] J.M. Trejo-Gabriel-Galán, Ictus como complicación y como factor pronóstico de COVID-19, Neurologia (Barcelona, Spain) 35 (5) (2020) 318–322, https://doi.org/10.1016/j.nrl.2020.04.015 [published Online First: 6 May 2020].

[7] A.B. Cezar-Junior, I.V. Faquini, J.L.J. Silva, et al., Subarachnoid hemorrhage and COVID-19: Association or coincidence? Medicine 99 (51) (2020) e23862, https://doi.org/10.1097/MD.0000000000023862.

[8] L.L.C. de Castillo, J.D.B. Diestro, K.H.D. Ignacio, et al., Concurrent Acute Ischemic Stroke and Non-Aneurysmal Subarachnoid Hemorrhage in COVID-19. The Canadian journal of neurological sciences, in: Le journal canadien des sciences neurologiques 2020:1–2, 2020, https://doi.org/10.1017/cjn.2020.242 [published Online First: 5 November.

[9] X. Qi, K.A. Keith, J.H. Huang, COVID-19 and stroke: A review, Brain Hemorrhages 2 (2) (2021) 76–83, https://doi.org/10.1016/j.hest.2020.11.001.

[10] C.B. Medicherla, R.A. Pauley, A. de Havenon, et al., Cerebral Venous Sinus Thrombosis in the COVID-19 Pandemic, J. Neuro-Ophthalmol. the official journal of the North American Neuro-Ophthalmology Society 40 (4) (2020) 457–462, https://doi.org/10.1097/WNO.0000000000001122 [published Online First: 28 October 2020].

[11] K. Dakay, J. Cooper, J. Bloomfield, et al., Cerebral Venous Sinus Thrombosis in COVID-19 Infection: A Case Series and Review of The Literature, J. Stroke Cerebrovasc. Dis. the official journal of National Stroke Association 30 (1) (2021), https://doi.org/10.1016/j.jstrokecerebrovasdis.2020.105434.

[12] A. Vogrig, G.L. Gigli, C. Bnà, M. Morassi, Stroke in patients with COVID-19: Clinical and neuroimaging characteristics, Neurosci. Lett. 743 (2021) 135564, https://doi.org/10.1016/j.neulet.2020.135564.

[13] G. Ntaios, P. Michel, G. Georgiopoulos, et al., Characteristics and Outcomes in Patients With COVID-19 and Acute Ischemic Stroke: The Global COVID-19 Stroke Registry, Stroke 51 (9) (2020) e254–e258, https://doi.org/10.1161/STROKEAHA.120.031208 [published Online First: 9 July 2020].

[14] M. Girot, J.M. Ferro, P. Canhão, et al., Predictors of outcome in patients with cerebral venous thrombosis and intracerebral hemorrhage, Stroke 38 (2) (2007) 337–342, https://doi.org/10.1161/01.STR.0000254579.16319.35 [published Online First: 4 January 2007].

[15] K. Afifi, G. Bellanger, P.J. Buyck, S.M. Zuurbier, C. Garcia-Esperon, M.A. Barboza, P. Costa, I. Escudero, D. Renard, R. Lemmens, N. Hinteregger, F. Fazekas, J. Jimenez-Conde, E. Giralt-Steinhauer, S. Hiltunen, A. Arauz, A. Pezzini, J. Montaner, J. Putaala, C. Weimar, M. Schlamann, T. Gattringer, T. Tatlisumak, J. M. Coutinho, P. Demaerel, V. Thijs, Correction to: Features of intracranial hemorrhage in cerebral venous thrombosis, J. Neurol. 267 (11) (2020) 3299–3300, https://doi.org/10.1007/s00415-020-10082-4.

[16] S. Basirjafari, M. Rafiee, B. Shahhosseini, et al., Association of pediatric COVID-19 and subarachnoid hemorrhage, J. Med. Virol. 93 (2) (2021) 658–660, https://doi.org/10.1002/jmv.26434 [published Online First: 28 September 2020].

[17] A. Ducros, Reversible cerebral vasoconstriction syndrome, The Lancet Neurol. 11 (10) (2012) 906–917, https://doi.org/10.1016/S1474-4422(12)70135-7.

[18] C. Vieira, L. Nery, L. Martins, L. Jabour, R. Dias, A.C. Simões e Silva, Downregulation of Membrane-bound Angiotensin Converting Enzyme 2 (ACE2) Receptor has a Pivotal Role in COVID-19 Immunopathology, Curr. Drug Targets 22 (3) (2021) 254–281, https://doi.org/10.2174/1389450121666201020154033.

[19] T. Mansoor, A.A. Alsarah, H. Mousavi, et al., COVID-19 associated reversible cerebral vasoconstriction syndrome successfully treated with nimodipine and aspirin, J. Stroke and Cerebrovascular Diseases the official journal of National Stroke Association 30 (7) (2021), https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.105822 [published Online First: 12 April 2021].

[20] S. Kumar, R.P. Goddeau, M.H. Selim, A. Thomas, G. Schlaug, A. Alhazzani, D. E. Searls, L.R. Caplan, Atraumatic convexal subarachnoid hemorrhage: clinical presentation, imaging patterns, and etiologies, Neurology 74 (11) (2010) 893–899, https://doi.org/10.1212/WNL.0b013e3181d55efa.

[21] W. Miesbach, M. Makris, COVID-19: coagulopathy, risk of thrombosis, and the rationale for anticoagulation, Clin. Appl. Thromb. Hemost. 26 (2020), https://doi.org/10.1177/1076029620938149.

[22] A.A.R. Mohamed-Hussein, K.M.E. Aly, M.-E.A.A. Ibrahim, Should aspirin be used for prophylaxis of COVID-19-induced coagulopathy? Med. Hypotheses 144 (2020) https://doi.org/10.1016/j.mehy.2020.109975.

[23] J.S. Rico-Mesa, D. Rosas, A. Ahmadian-Tehrani, A. White, A.S. Anderson, R. Chilton, The Role of Anticoagulation in COVID-19-Induced Hypercoagulability, Current Cardiology Reports 22 (7) (2020), https://doi.org/10.1007/s11886-020-01328-8.