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Cerebral Venous Sinus Thrombosis Successfully Treated with Mechanical Thrombectomy under Intracranial Pressure Monitoring: A Case Report

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Abstract

A 54-year-old man with no medical history presented to our hospital with vomiting, left hemiplegia, and seizures. On arrival, he was experiencing generalized tonic-clonic seizures, which required him to be intubated and deeply sedated. Contrast-enhanced computed tomography revealed extensive venous sinus obstruction from the superior sagittal sinus to the bilateral sigmoid sinus and cerebral edema with intracranial hemorrhage. An intracranial pressure (ICP) monitor was immediately placed intracranially, and mechanical thrombectomy (MT) was performed under ICP monitoring. MT was immediately terminated when the venous sinus was partially recanalized enough to decrease the ICP; then, anticoagulation therapy was initiated. Postoperative follow-up angiography revealed that venous sinus obstruction and intracranial venous perfusion improved over time. Although he had intracranial hemorrhage-induced left hemiplegia and sensory deficits, his condition improved with rehabilitation, and the patient was eventually discharged home. The indication criteria and techniques for MT for cerebral venous sinus thrombosis are yet to be established. As in this case, in patients with impaired consciousness due to intracranial hemorrhage or epilepsy, preoperative ICP monitor placement is deemed useful to evaluate venous perfusion during MT and decide the treatment goal.

Keywords: cerebral venous sinus thrombosis, mechanical thrombectomy, ICP

Introduction

Medical treatment with anticoagulants has been determined as the first-line treatment for cerebral venous sinus thrombosis (CVST).[1-3] However, the indication criteria and techniques for mechanical thrombectomy (MT) are yet to be established; thus, careful consideration of its indication must be provided for each case, especially concerning the extent of recanalization that needs to be targeted.

In this study, we present a case of CVST associated with impaired consciousness due to intracranial hemorrhage and epilepsy, which eventually resulted in a good functional outcome after decompression under intracranial pressure (ICP) monitoring despite partial recanalization with MT.

Case Report

A 54-year-old male patient with no medical history presented to our hospital with vomiting. He was previously admitted to another hospital for the aforementioned complaint. One week after admission, he was referred to our hospital due to left hemiplegia and seizures. On arrival, he manifested generalized tonic-clonic seizures and was considered status epilepticus. He was subsequently intubated and sedated deeply in order to control his seizures. Head plain computed tomography (CT) revealed a subcortical and subarachnoid hemorrhage in his right frontal and pa-

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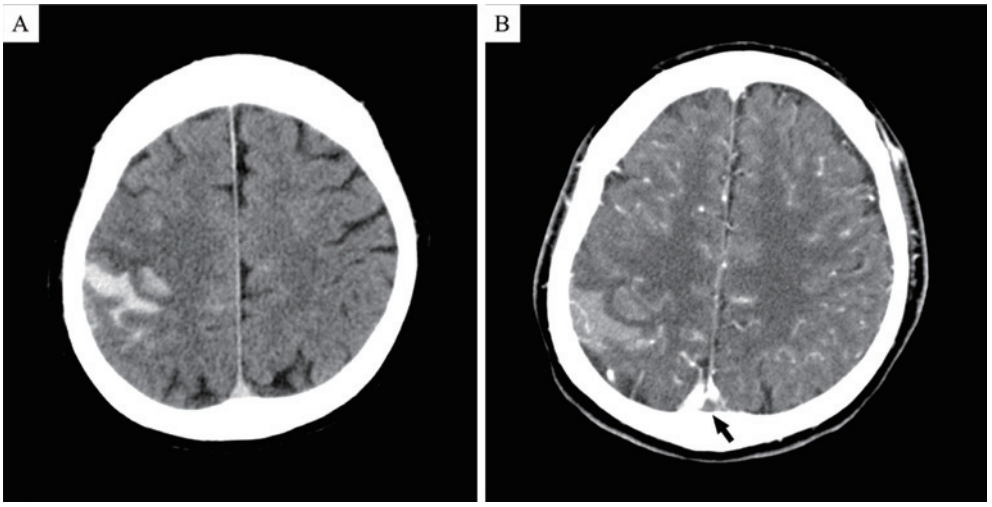

Fig. 1 Plain computed tomography (CT) and contrast-enhanced CT (axial view) on arrival.
A) Subcortical and subarachnoid hemorrhage is observed in the right frontal and parietal lobes. The sulcus surrounding the hematoma has been narrowed with cerebral edema.
B) Contrast defects suggestive of thrombus are noted in the superior sagittal sinus (SSS) (arrow).

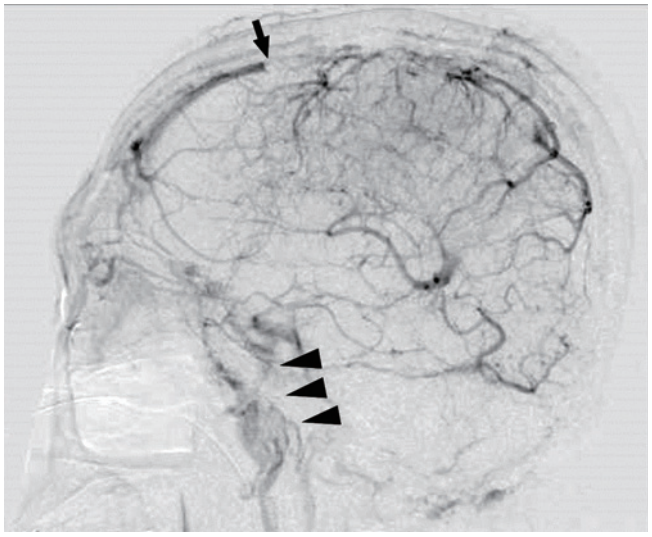

Fig. 2 Pretreatment cerebral angiography (lateral view).
The superior sagittal sinus (SSS) is occluded anteriorly (arrow), and no venous sinus is contrasted distal to the occlusion. Cortical venous perfusion is markedly delayed, and a perfusion pathway from the pterygoid venous plexus through the internal jugular vein is grown (arrowhead).

rietal lobes and narrowing sulci, which indicate cerebral edema (Fig. 1A). Contrast-enhanced CT revealed contrast defects, which suggest the presence of a thrombus in the superior sagittal sinus (SSS) (Fig. 1B) and venous sinus obstruction from the anterior half of the SSS. His blood tests showed a high D-dimer level of 6.36 μg/mL. Intracranial hypertension due to CVST was thus suspected; however, the patient was under deep sedation, and assessing his level of consciousness was difficult. Therefore, he was immediately attached to an ICP monitor with ICP Express (Integra LifeSciences, Princeton, New Jersey, USA) intracranially. Although the ICP was as high as 25 cmH_2O immediately after implantation, the hematoma volume was not large; it was also determined that cerebral edema due to impaired venous perfusion caused the increase in ICP. Following heparin administration, cerebral angiography was performed to evaluate the hemodynamics related to venous return.

Bilateral internal carotid angiography (ICAG) revealed extensive venous sinus obstruction from the anterior half of the SSS to the bilateral transverse sinus (TS) and sigmoid sinus (SS) (Fig. 2). Furthermore, there was a noted marked delay in cortical venous perfusion, with the pterygoid venous plexus as their main drainage route. To rapidly improve venous perfusion, MT for CVST was performed. A 9-French (Fr) long sheath was inserted into the right femoral vein, and 8-Fr FUBUKI guiding catheter (Asahi Intecc Co., Ltd., Aichi, Japan), AXS Catalyst 6 distal access catheter (Stryker Neurovascular, Kalamazoo, Michigan, USA), Trevo Trak 21 microcatheter (Stryker Neurovascular), and CHIKAI 0.014-inch microguidewire (Asahi Intecc Co., Ltd.) were used as the coaxial system. First, the FUBUKI guiding catheter was implanted into the right internal jugular vein, which then guided Trak 21 to the right SS and TS (Fig. 3A). Furthermore, we attempted to remove the thrombus via a direct aspiration first pass technique (ADAPT)[4] using the Catalyst 6 distal access catheter. A large amount of red thrombus was then retrieved, and partial recanalization of the right SS and TS was achieved. Subsequently, partial recanalization was obtained from the right TS to the confluence of the sinus by repeating the ADAPT and performing the stent retriever assisted vacuum-locked extraction (SAVE) technique[5] using the Trevo NXT 6 × 37 mm stent (Stryker Neurovascular)

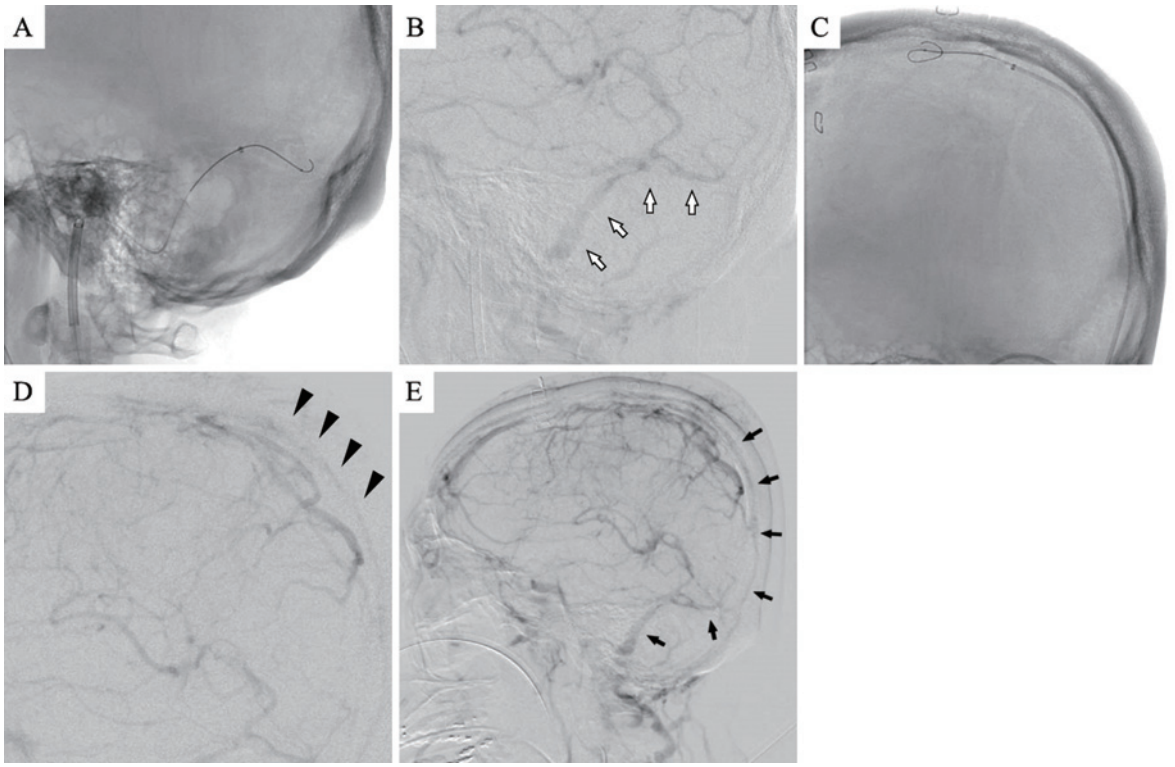

Fig. 3 Cerebral angiography during mechanical thrombectomy (MT) (lateral view).
A) Guiding microcatheter from the right sigmoid sinus (SS) to the transverse (TS).
B) Deploying the stent retriever (Trevo NXT 6 × 37 mm). TS and SS are partially recanalized (white arrow).
C) Guiding microcatheter into the parietal superior sagittal sinus (SSS). The microguidewire was bounced back by thrombus and could not be passed to the frontal SSS.
D) Following undergoing MT using the a direct aspiration first pass technique (ADAPT) and stent retriever assisted vacuum-locked extraction (SAVE) techniques, partial recanalization of the parietal SSS is observed (arrowhead).
E) Internal carotid angiography at the end of treatment. Cortical veins have returned to partially reopened venous sinuses (arrow), and perfusion delay is improved.

(Fig. 3B). At this point, the ICP was noted to remain high at 20 cmH_2O. Next, the catheters were advanced to the SSS. The parietal occlusion could be passed, but the frontal occlusion could not be passed (Fig. 3C). However, since preoperative CT showed cerebral edema mainly in the parietal lobe, we thought it would be effective to first perform thrombectomy of the parietal SSS. The ADAPT and SAVE techniques were then repeated to retrieve the thrombus, and partial recanalization of the parietal SSS was observed (Fig. 3D). In the same way, MT was undergone from parietal SSS to the confluence of the sinus. Although the frontal SSS occlusion could not be reopened until the end, the ICAG showed partial recanalization from the cortical vein to the parietal recanalized SSS to the right IJV (Fig. 3 E), and ICP was noted to decrease to 5-10 cmH_2O at the time. Furthermore, improving the venous perfusion delay was attained. The treatment goal was achieved, and MT was thereafter terminated.

As per on the follow-up cerebral angiography performed the day after MT, it was confirmed that partial recanalization of the cerebral venous sinuses from parietal SSS to the right IJV and improvement in cortical venous perfusion were maintained (Fig. 4A). The ICP averaged 9 cmH_2O. After that, ICP remained between 5 and 15 cmH_2O on average (Fig. 5), and cerebral angiography on the 4th postoperative day confirmed that cerebral venous perfusion was not impaired. Five days postoperatively, the ICP monitor was removed, and the patient was then extubated. Ten days postoperatively, angiography revealed that the anterior SSS occlusion was released (Fig. 4B). Anticoagulation therapy was continued with heparin (target APTT ≥ 40 s or twice the normal pretreatment values). After extubation, it was switched to warfarin, and PT-INR was controlled between 2.0 and 3.0.

The postoperative clinical outcome was good. He was eventually discharged home following rehabilitation transfer for his left upper extremity paralysis and sensory disturbance of the left fingers. At the time of discharge, his modified Rankin scale (mRS)[6] was 1.

Cerebral angiography was performed 3 and 12 months after discharge. The venous sinus remained open; however, the wall irregularity from the posterior SSS to the conflu-

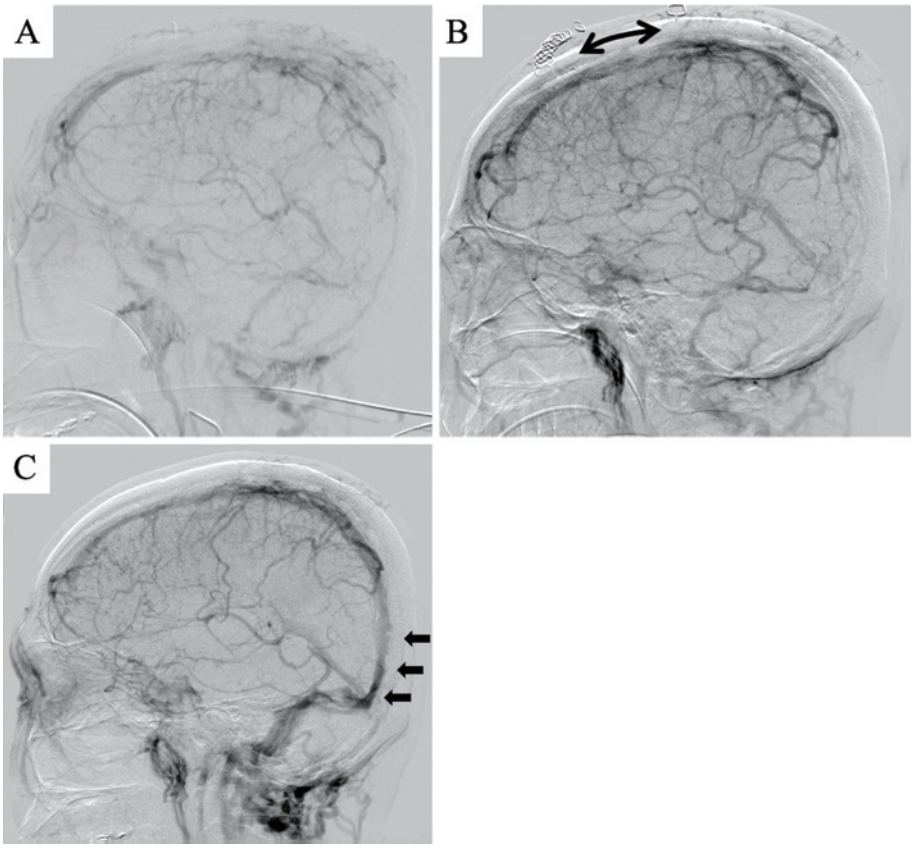

Fig. 4 Follow-up cerebral angiography.
A) Postoperative day (POD) 1. The venous sinus has maintained partial recanalization.
B) POD10. The anterior superior sagittal sinus (SSS) occlusion has been reopened (double arrow).
C) One year after discharge. The venous sinus has recanalized almost completely. The wall irregularity has remained from the posterior SSS to the confluence (arrow).

ence of the sinus has remained (Fig. 4C). Therefore, anticoagulation therapy with warfarin was continued up until the present.

Discussion

Anticoagulation therapy has been used as the first-line treatment for CVST;[1-3] however, its prognosis remains poor in 13.6% of patients treated with anticoagulation alone, and the fatality rate is 8.3%, with impaired consciousness, intracranial hemorrhage, and large thrombi being reported as poor prognostic factors.[7] The fatality rate of patients with severe CVST admitted in the intensive care unit, such as the present case, is reported to be 34.2%;[8] thus, more aggressive treatment strategies should be considered. The efficacy of endovascular therapy has not yet been established. However, endovascular treatment, including thrombus aspiration or retrieval, has been recommended as an effective option to rapidly reopen the occluded venous sinus and decrease ICP buildup in patients with severe clinical symptoms or those who do not respond to heparin or other anticoagulants.[9,10] A systematic review of 17 studies of endovascular treatment of CVST reported complete and partial recanalization rates of 69% and 26.3%, respectively. The final clinical outcome was mRS0 and mRS1-2 in 34.7% and 41.3%, respectively.[11]

In this case, the patient had status epilepticus requiring deep sedation, which made neurological evaluation difficult. Therefore, as a priority for treatment, he was attached to the ICP monitor. Consequently, the ICP increased, and immediate decompression was performed. The hematoma of the subcortical hemorrhage was not large, and cerebral edema due to extensive CVST was considered as the main cause of the increased ICP. Therefore, decreasing the ICP by improving venous perfusion was deemed urgent, and endovascular therapy was selected in addition to anticoagulation. Decompression craniotomy and hematoma removal were planned considering the possibility that the ICP could not be improved.

In MT-treated CVST, there have been no reports of ICP monitoring as an indicator of achieving treatment goals during MT as in the present case. In a previous single-center case series of 20 cases of severe CSVT, ICP monitors were implanted preoperatively in 7 cases, but they were

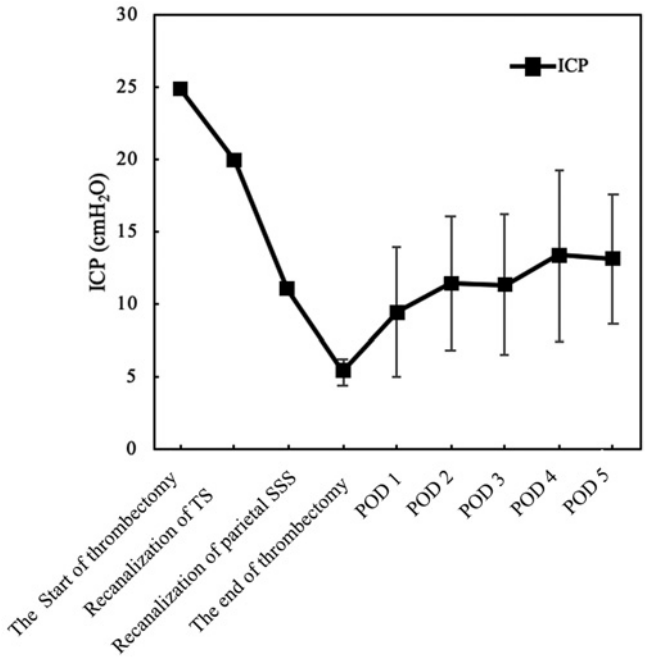

Fig. 5 Transition of intracranial pressure (ICP). ICP remained between 20 and 25 cmH_2O prior to the start of treatment, but it dropped to 11 cmH_2O when the parietal superior sagittal sinus (SSS) was recanalized and cortical venous return was improved by mechanical thrombectomy (MT). The ICP remained at an average of 5 to 15 cmH_2O until the ICP monitor was removed on postoperative day (POD) 5.

primarily placed to determine whether external ventricular drainage or decompression surgery before MT is needed.[12] It has been reported that higher recanalization rates tended to follow better clinical outcomes. On the other hand, as the reported complication rate for catheterization for CVST is 6.3%,[11] prolonged treatment that aim for a high recanalization rate may increase the risk of catheter-related complications and miss the timing of conversion to external decompression surgery. In this present case, extensive venous sinus obstruction was observed in the SSS and bilateral TS and SS, and complete recanalization was expected to be difficult. However, once the parietal SSS was reopened, the intracranial hypertension improved rapidly, leading to the end of the treatment and avoidance of a fatal clinical course. It can be considered that, even with partial recanalization, if intracranial hypertension can be rapidly improved by recanalized main venous drainage routes, the risk of a fatal outcome can be reduced. Therefore, we believe that preoperative implantation of ICP monitor is useful as an objective indicator to confirm the degree of venous perfusion delay and to terminate the MT at the appropriate time, as well as to determine whether external ventricular drainage or decompression surgery before MT is needed. Particularly in patients with impaired consciousness or required sedation and with extensive CVST, which is less likely to be recanalized completely by MT, prior ICP monitoring should be actively considered.

Acknowledgments

TH and TS contributed to the conception and design of this study. All authors contributed to data collection; TH, TS, ST, and HK have contributed to the writing and revision of this manuscript.

Conflicts of Interest Disclosure

The authors declare no conflict of interest.

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