 doi: 10.2176/jns-nmc.2024-0077

NMC Case Report Journal 11, 227-231, 2024

Combined Mechanical Thrombectomy for Multiple Cerebral Venous Sinus Thrombosis Involving the Straight Sinus: A Case Report

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Abstract

The proportion of cerebral venous sinus thrombosis involving the straight sinus (StS) is low, and the prognosis is poor. We report a case of multiple sinus thrombosis involving StS in which the patient underwent mechanical thrombectomy (MT) using a stent retriever and an aspiration catheter (combined MT) with a good postoperative course. A 15-year-old girl was admitted to our hospital with rapid loss of consciousness. Magnetic resonance imaging (MRI) revealed thrombosis of the bilateral internal cerebral veins, vein of Galen, StS, torcular herophili (TH), and right transverse sinus (TS), as well as edema mainly in the left thalamus, basal ganglia, and corpus callosum. Systemic heparinization was initiated, and combined MT was performed. Although complete recanalization of the TH and right TS via the left internal jugular vein was achieved, the microwire could not be advanced to the StS. Hence, the approach route was changed to remove the thrombus from the superior sagittal sinus and successfully reach the StS via the right TS. Partial recanalization of the StS was achieved, and venous congestion was improved. Two months after MT, the patient returned to school without neurological deficits. MRI performed 3 months after MT revealed disappearance of the edema and complete recanalization of the StS. In this case, StS catheterization via the left TS was not possible. However, we could reach the right TS, which were recanalized first. Partial recanalization of the StS can be expected a good prognosis under the patency of the TH and TS.

Keywords: cerebral venous sinus thrombosis, straight sinus, mechanical thrombectomy

Introduction

Cerebral venous sinus thrombosis (CVST) has an incidence of four cases per 1,000,000 individuals and accounts for 0.5% of all stroke cases.[1)] CVST carries a 4.3% risk of death and an 18.9% risk of dependence.[2,3)] Systemic anticoagulant therapy is the standard treatment for CVST.[2,4,5)] Although it may be effective in some cases, its efficacy in endovascular treatment needs to be verified.[3-7)] Involvement of the deep venous system is a predictor of death or dependence on CVST and should be considered in endovascular therapy.[2,5)]

In this report, we describe a case of multiple cerebral venous sinus, including straight sinus (StS) thrombosis, treated with mechanical thrombectomy (MT) through the combined use of a stent retriever and an aspiration catheter (combined MT). The patient had a good prognosis.

Case Report

A 15-year-old girl with anorexia (height, 143 cm; weight, 28 kg) presented with headache and vomiting for 6 days. The symptoms worsened, and the patient rapidly lost consciousness and was admitted to our hospital. On arrival, her Glasgow Coma Scale (GCS) score was E4V1M6, and she had motor aphasia and right hemiparesis. Laboratory findings demonstrated that the prothrombin time-international normalized ratio, activated partial thromboplastin time fibrinogen and antithrombin III levels were 1.21, 27.1 s, 215 mg/dL and 117%, respectively. Plain com-

Received March 28, 2024; Accepted June 12, 2024

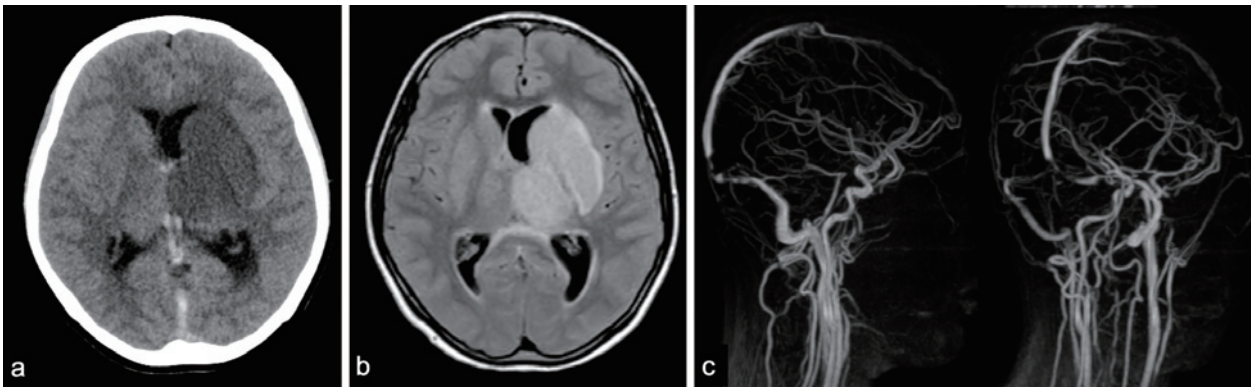

Fig. 1 (a) Computed tomography scan showing hyperdense signals in the internal cerebral veins (ICVs), vein of Galen (VG), straight sinus (StS), and torcular herophili (TH). (b) Fluid-attenuated inversion recovery (FLAIR) reveals high-intensity lesions mainly in the left thalamus, basal ganglia, and corpus callosum. (c) Magnetic resonance venography showing a venous flow defect in the ICVs, VG, StS, TH, and right transverse sinus.

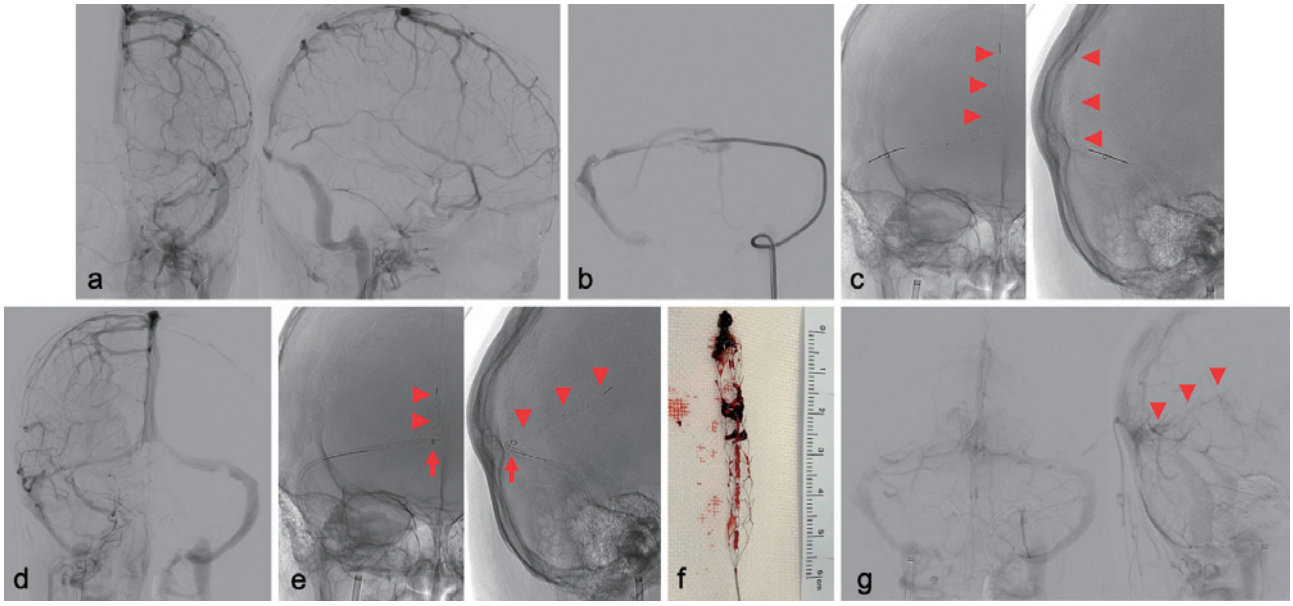

Fig. 2 (a) Left carotid angiogram (CAG) showing venous flow defects of the internal cerebral veins (ICVs), vein of Galen (VG), straight sinus (StS), torcular herophili (TH), and right transverse sinus (TS). (b) Venography from the aspiration catheter at the TH showed recanalization of the right TS. (c) A stent (arrowhead) was deployed in the superior sagittal sinus (SSS). (d) Right CAG of the venous phase revealed recanalization from the SSS to the right TS. (e) A stent (arrowhead) was deployed in the StS, and the aspiration catheter (arrow) followed the TH. (f) A large amount of red thrombus was retrieved. (g) Left vertebral angiogram showing partial recanalization of the bilateral ICVs, VG, and StS (arrowhead).

puted tomography revealed thrombi in the bilateral internal cerebral veins (ICVs), vein of Galen (VG), StS, and torcular herophili (TH) (Fig. 1a). Fluid-attenuated inversion recovery (FLAIR) on magnetic resonance imaging (MRI) revealed edematous lesions mainly in the left thalamus, basal ganglia, and corpus callosum (Fig. 1b). Magnetic resonance venography (MRV) revealed venous flow defects in the ICVs, VG, StS, TH, and right transverse sinus (TS) (Fig. 1c). No intracranial hemorrhage was noted. Anticoagulant therapy with intravenous heparin was initiated immediately, and endovascular treatment was performed.

A 4-Fr diagnostic catheter was inserted into the left femoral artery. A left carotid angiogram (CAG) revealed venous flow defects in the bilateral ICVs, VG, StS, TH, and right TS and venous congestion (Fig. 2a). To improve circulation in the deep venous system, StS MT was performed.

A 6-Fr FUBUKI guiding sheath (Asahi Intec, Aichi, Japan) was positioned in the left internal jugular vein (IJV) via the left femoral vein. Thrombus aspiration was performed from the left sigmoid sinus to the left TS using a 6-Fr SOFIA Flow Plus aspiration catheter (MicroVention,

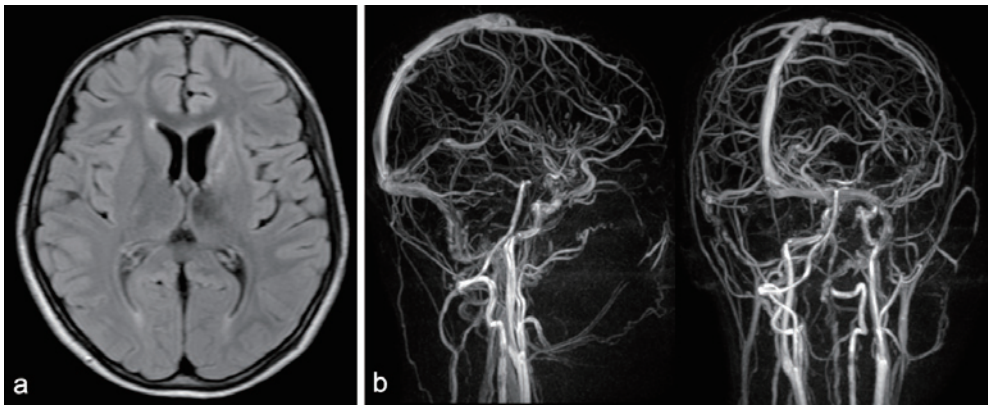

Fig. 3 (a) Fluid-attenuated inversion recovery (FLAIR) at 3 months after mechanical thrombectomy reveals the disappearance of high-intensity lesions. (b) Magnetic resonance venography shows complete recanalization of the straight sinus.

Terumo, Tustin, CA, USA). The aspiration catheter was passed through the TH, and venography of the aspiration catheter at the TH revealed recanalization of the right TS (Fig. 2b). We then attempted to navigate a Marksman microcatheter (Medtronic, Minneapolis, MN, USA) to the StS using a Venture 14 microwire (MIZUHO, Tokyo, Japan) with the aspiration catheter located at the left TS. However, the microwire could not pass through the occluded StS. Subsequently, the guiding sheath was repositioned in the right IJV. The microcatheter was navigated into the superior sagittal sinus (SSS) using a microwire, and the aspiration catheter was located in the right TS. A 6.5 × 45 mm EMBOTRAP III stent retriever (Cerenovus, Johnson & Johnson Medical Devices, CA, USA) was deployed in the SSS (Fig. 2c). The stent retriever was removed, and right CAG of the venous phase revealed recanalization from the SSS to the right TS (Fig. 2d). The microcatheter was navigated into the StS using a CHIKAI Black 0.014-inch microwire (Asahi Intec). The aspiration catheter was placed in the TH, and the stent retriever was deployed from the distal end of the StS to the TH (Fig. 2e) and removed under continuous suction through the aspiration catheter at the TH, which was not advanced because of resistance when entering the StS, and a large amount of red thrombus was retrieved (Fig. 2f). Left vertebral angiography revealed partial recanalization of the bilateral ICVs, VG, and StS (Fig. 2g), and bilateral cerebral angiography revealed improvement in venous congestion. Consequently, the procedure was terminated at this point.

MRI performed 2 weeks after MT revealed complete recanalization of the deep venous system on MRV and reduction in left thalamic edema and bilateral basal ganglia. Thereafter, the patient's level of consciousness recovered to GCS E4V5M6, and right hemiparesis improved. At 26 days after MT, the patient was transferred to a rehabilitation hospital for oral anticoagulant therapy. Two months after the MT, the patient returned to school. MRI performed 3 months after MT demonstrated resolution of the thrombus and edematous lesions (Fig. 3a), and the deep venous system remained recanalized (Fig. 3b).

Discussion

CVST occurs most frequently in the SSS (62%-88%) and the TS (38%-62%), and cases involving StS are relatively rare (18%).[2,3] In deep venous thrombosis, multiple venous sinuses are often occluded. Most cases present with involvement of StS (97%) and VG (88%), whereas the basal vein of Rosenthal is less frequently affected (41%). Furthermore, the superficial venous system is often involved, particularly the TS (69%) and SSS (38%).[9] Patients with deep venous thrombosis, particularly those with large venous infarctions or bilateral edema of the basal ganglia and thalami, exhibit mental status changes such as amnesia, mutism, confusion, or delirium. Severe cases can result in rapid neurological deterioration, leading to coma and death due to increased intracranial pressure.[8] Other studies have reported CVST involving StS as a risk factor for poor prognosis.[10] This patient presented with rapid deterioration of consciousness, and MRI/MRV revealed edematous lesions mainly in the left thalamus, basal ganglia, and corpus callosum, as well as occlusion of the ICVs, VG, StS, TH, and right TS.

Systemic anticoagulant therapy is the standard treatment for CVST. More than two-thirds of patients treated with anticoagulant therapy had partial or complete recanalization. However, this process generally takes weeks or months,[11] and 18.9% of patients were still disabled or died at discharge.[2] Conversely, in different case series and prospective cohorts, 95% of patients undergoing MT have shown rapid complete or partial recanalization, and complete recanalization was associated with a good outcome and lower risk of complications.[12] MT, which can achieve early recanalization, is useful in rapidly progressing cases. The TO-ACT study[4] did not prove the efficacy of endovascular therapy, possibly because it did not evaluate whether

Table 1 Combined mechanical thrombectomy for straight sinus thrombosis

Pt. #	Age (years)	Sex	Symptoms	Affected veins or sinuses	Approach root	Location of the aspiration catheter	Stent retriever and aspiration catheter	Early recanalization	Neurological deficit
1 (2015)[6]	<10	-	Headache, altered mental status, and bilateral lower extremity weakness	VG and StS	Right TS	Proximal StS	Solitaire FR (6 × 30 mm) +054 Penumbra	Complete	None
2 (2017)[7]	42	F	Dizziness, mild tetraparesis, and coma	ICVs, thalamic veins, VG, and StS	Left TS	Proximal StS	Solitaire FR (6 × 30 mm) +5MAX ACE	Complete	None
3 (2022)[3]	51	F	Altered consciousness, disorientation, and urinary incontinence	BVR and StS	Left TS	Proximal StS	Trevo NXT (6 × 37 mm) +REACT 68	Partial	None
4 (Present case, 2023)	15	F	Motor aphasia and right-sided hemiparesis	ICVs, VG, StS, TH, and right TS	Right TS	TH	EMBOTRAP III (6.5 × 45 mm) +6 Fr SOFIA	Partial	None

ICV, internal cerebral vein; BVR, basal vein of Rosenthal; VG, vein of Galen; StS, straight sinus; TH, torcular herophili; SSS, superior sagittal sinus; TS, transverse sinus

early recanalization was achieved, the study population was small, and AngioJet (Boston Scientific, Marlborough, MA, USA) was mainly used for MT. The use of AngioJet was associated with a lower likelihood of a good outcome and a higher risk of complications due to the bulky and rigid device.[12] The Standards and Guidelines Committee of the Society of Neurointerventional Surgery[5] recommends considering endovascular treatment for patients with CVST in the following cases: clinical deterioration despite anticoagulation, contraindications to anticoagulation, coma, deep venous thrombosis, and intracranial hemorrhage.

A literature search identified four cases of StS thrombosis that underwent combined MT, including this case (Table 1).[3,4,6] None of the patients developed intracranial hemorrhage. Cases 1 and 3 were isolated, whereas the other cases were not isolated. Case 2 involved the right TS, whereas this case involved the TH and right TS. This case was assumed to be the most severe. In this case, the catheter was first inserted into the StS from the left TS because the StS usually drains to the left TS. Park *et al.*[13] evaluated the morphology of the TH in a cadaver study and reported that in 58.1%, 35.5%, 3.2%, and 3.2% cases the direction of StS drainage was toward the center of the TH, left TS, right TS, and OS, respectively. However, catheterization from the left TS was not possible. Catheterization from the right TS, which was initially recanalized, was achieved. In cases 1-3, the aspiration catheter was navigated into the proximal StS, whereas in this case, it was located in the TH, as the structure of the TH is diverse, as described earlier, and it was not identified because of the obstruction of the TH itself. In all cases, a ≥6-mm-diameter stent retriever was used, and recanalization was achieved. The adult size for StS diameter is 4.8 ± 1.3 mm.[14] A stent retriever with a diameter of at least 6 mm is preferred for thrombus trapping and anchoring. At the end of the procedure, cases 1 and 2 achieved complete recanalization, whereas case 3, which is an isolated StS thrombosis, and this case achieved only partial recanalization. However, both case 3 and this case showed complete recanalization on early follow-up (2 weeks later) imaging. None of the patients exhibited neurological deficits. This case had a good postoperative course despite partial StS recanalization. Deep venous thrombosis often involves other venous sinuses, such as the SSS and TS. Complete recanalization of these sinuses by MT may have contributed to the improvement of venous congestion and a good prognosis.

We report a case of combined MT for multiple sinus thrombosis involving StS with good outcomes. Catheterizing the StS from the left TS was not possible, but we could reach the right TS, which was initially recanalized. The StS approach should be attempted considering various TH structures. Even if MT resulted in partial recanalization of the StS, complete recanalization of drainage routes such as the TH and TS led to a good outcome.

Acknowledgments

We would like to thank Editage (www.editage.jp) for English language editing.

Informed Consent

The patient consented to use his data in a case report.

Conflicts of Interest Disclosure

The authors declare no conflicts of interest.

References

1) Stam J: Thrombosis of the cerebral veins and sinuses. *N Engl J Med* 352: 1791-1798, 2005
2) Ferro JM, Canhão P, Stam J, Bousser MG, Barinagarrementeria F: ISCVT Investigators. Prognosis of cerebral vein and dural sinus thrombosis results of the international study on cerebral vein and Dural Sinus thrombosis (ISCVT). *Stroke* 35: 664-670, 2004
3) Michiwaki Y, Yamane F, Tanaka T, et al.: Recanalization for straight sinus thrombosis through combined mechanical thrombectomy: a case report. *Surg Neurol Int* 13: 293, 2022
4) Coutinho JM, Zuurbier SM, Bousser MG, et al.: Effect of endovascular treatment with medical management vs standard care on severe cerebral venous thrombosis: the TO-ACT randomized clinical trial. *JAMA Neurol* 77: 966-973, 2020
5) Lee S-K, Mokin M, Hetts SW, et al.: Current endovascular strategies for cerebral venous thrombosis: report of the SNIS standards and guidelines committee. *J Neurointervent Surg* 10: 803-810, 2018
6) Shaikh H, Pukenas BA, McIntosh A, Licht D, Hurst RW: Combined use of Solitaire FR and Penumbra devices for endovascular treatment of cerebral venous sinus thrombosis in a child. *J Neurointervent Surg* 7: e10, 2015
7) Taniguchi S, Harada K, Kajihara M, Kozo F: Combined use of stent-retriever and aspiration thrombectomy for cerebral venous sinus thrombosis involving the straight sinus: a case report. *Interv Neuroradiol* 23: 605-608, 2017
8) Capecchi M, Abbattista M, Martinelli I: Cerebral venous sinus thrombosis. *J Thromb Haemost* 16: 1-14, 2018
9) Pfefferkorn T, Crassard I, Linn J, Dichgans M, Boukobza M, Bousser MG: Clinical features, course and outcome in deep cerebral venous system thrombosis: an analysis of 32 cases. *J Neurol* 256: 1839-1845, 2009
10) Girot M, Ferro JM, Canhão P, et al.: Predictors of outcome in patients with cerebral venous thrombosis and intracerebral hemorrhage. *Stroke* 38: 337-342, 2007
11) Dentali F, Gianni M, Crowther MA, Ageno W: Natural history of cerebral vein thrombosis: a systematic review. *Blood* 108: 1129-1134, 2006
12) Siddiqui FM, Dandapat S, Banerjee C, et al.: Mechanical thrombectomy in cerebral venous thrombosis: systematic review of 185 cases. *Stroke* 46: 1263-1268, 2015
13) Park HK, Bae HG, Choi SK, et al.: Morphological study of sinus flow in the confluence of sinuses. *Clin Anat* 21: 294-300, 2008
14) Larson AS, Lanzino G, Brinjikji W: Variations of intracranial dural venous sinus diameters from birth to 20 years of age: an MRV-based study. *AJNR Am J Neuroradiol* 41: 2351-2357, 2020

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