

## Endovascular Technique of a Stent Device Combined With a Direct Aspiration Catheter for Endovascular Treatment and Pathological Examination of Clots in Cerebral Venous Sinus Thrombosis

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### Abstract

The initial treatment of cerebral venous sinus thrombosis (CVST) is intravenous heparin, however, a novel endovascular technique combining a stent retriever and an aspiration catheter has achieved rapid, safe, and effective revascularization. A 21-year-old man was transferred to our emergency department and diagnosed with CVST. Because of venous congestion due to massive thrombosis and clinical deterioration, endovascular intervention was opted for. A combination technique using a stent device (Solitaire) and a direct aspiration catheter (Penumbra) was used, which achieved recanalization with good antegrade venous flow. The combination therapy is safe and effective for CVST because of the favourable prognosis and low risk of complications reported in all 4 patients to date. Pathological examination of clots suggested that venous vasculitis is implicated in thrombus formation, fever, and raised white blood cell and C-reactive protein counts seen in CVST.

**Keywords:** Cerebral venous sinus thrombosis; Novel endovascular technique; Solitaire stent; Penumbra reperfusion catheter

### Introduction

Anticoagulation therapy for cerebral venous sinus thrombosis (CVST) is generally effective. However, diagnosis of CVST is a challenge for physicians and in some patients diagnosis may be delayed, resulting in a poor outcome, even death [1,2]. The International Study on Cerebral Vein and Dural Sinus Thrombosis, [1] a multinational, multicentre, revealed that 2.2% of patients became severely disabled (modified Rankin Scale 4 or 5) and 8.3% died.

Due to the high morbidity and mortality rate, alternative aggressive treatment strategies such as endovascular mechanical thrombectomy became the focus of subsequent clinical trials [3]. A novel endovascular technique has been used for access to and treatment of deep venous sinus thrombosis using a combination of a stent retriever and an aspiration catheter [4-6].

The cause of the fever and the raised white blood cell count and C-reactive protein level seen in patients with CVST have not been fully investigated in previous reports. The case reported here contributes to the literature because we could retrieve a sufficient number of clots of adequate size for pathological examination. The results offer further of the pathophysiological mechanism(s) involved in thrombus formation.

### Case Report

A 21-year-old man presented with a 10-day history of mild headache and nausea. After onset of severe headache accompanied by confusion, he was transferred to the emergency department at our hospital. His temperature was 37.5°C and other vital signs were within normal limits.

### Investigations

Magnetic resonance venography (MRV) clearly showed a signal defect from the posterior SSS to the right TS (Figure 1A). Susceptibility weighted imaging showed severe venous congestion, mainly of the

right hemisphere (Figure 1B). There was no evidence of ischemic stroke or intracranial haemorrhage.

Blood tests revealed elevated white blood cell count (11300/ $\mu$ L), C-reactive protein level (1.43 mg/dL), and D-dimer (3.6  $\mu$ g/dL). In addition, laboratory tests showed a parallel reduction in plasma anti-thrombin III (ATIII) activity (36%) and antigen concentrations (11.6 mg/dL).

The above findings suggested cerebral venous thrombosis due to ATIII deficiency.

### Treatment

Because of the venous congestion due to massive thrombosis and clinical deterioration, a decision was made to proceed with endovascular intervention.

Digital subtraction venography demonstrated occlusion from the posterior SSS to the right TS and a stenosed left TS (Figure 1C and 1D). An 8F guide catheter (Brite Tip; Cordis, Johnson and Johnson, Fremont, CA) was positioned via the distal left internal jugular vein. A Marksman catheter (ev3, Irvine, CA) placed coaxially within a Cerulean DD6 catheter (Medikit Co., Ltd, Tokyo, Japan) was then navigated into the left TS using a 0.014-inch micro-guidewire (Chikai).

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A 6 × 40 mm Solitaire device (ev3/Covidien, Irvine, California, USA) was deployed (Figure 1E) within the posterior SSS for 10 min without suction to minimise blood loss. The Cerulean DD6 catheter was connected to a Penumbra aspiration system (Penumbra Inc., Alameda, California, USA), and the Solitaire device was removed under continuous Penumbra suction system. A large amount of thrombus was removed by the Solitaire stent retriever and the Penumbra aspiration catheter (Figure 1F). Post-thrombectomy venography demonstrated improvement in antegrade venous drainage (Figure 1G). A thrombus of the right TS was probably removed by the aspiration system.

### Outcome and follow-up

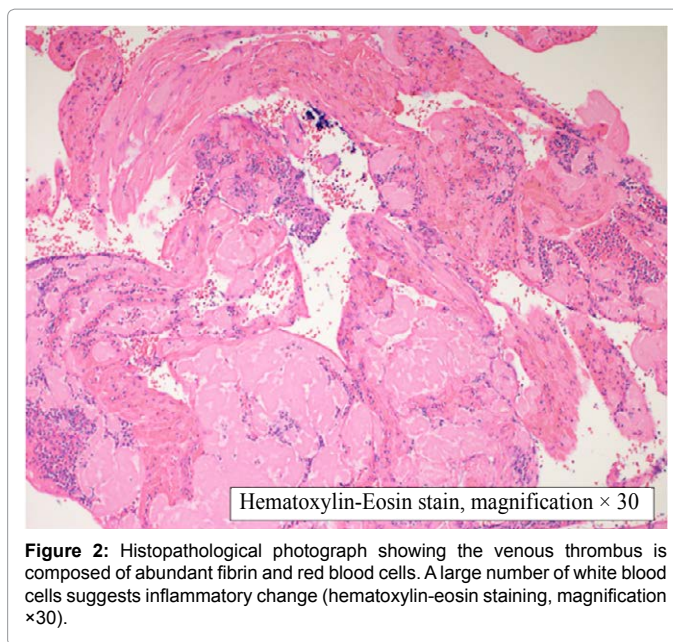
Follow-up MRI/MRV performed 2 weeks later showed resolution of the thrombosis and venous congestion and normal venous drainage (Figure 1H and I). The postoperative course was uneventful, and he was discharged with no neurological deficit.

### Pathological examination

The histopathological diagnosis of the removed clots was venous thrombi (i.e., red clots) based on the presence of abundant fibrin and red blood cells. A large number of white blood cells suggested inflammatory change, such as venous vasculitis (Figure 2).

### Discussion

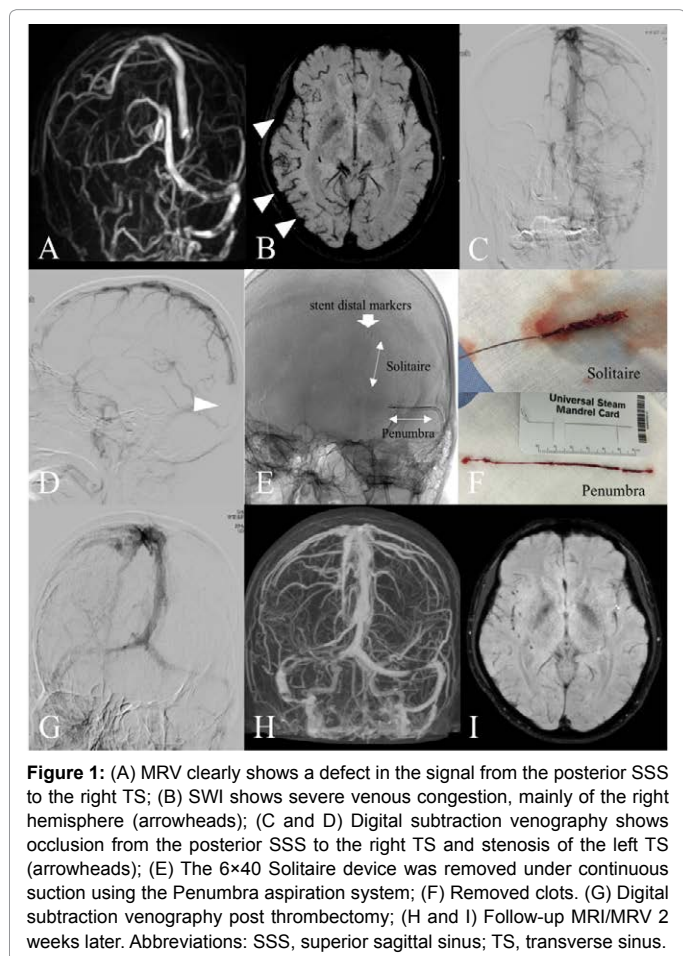
CVST is a rare disorder with an estimated annual incidence of 3-4 cases per million and is reported to account for only about 0.5% of all



patients presenting with stroke-like symptoms. The initial treatment of choice is intravenous heparin, with mechanical thrombectomy often used as a second-line treatment. But, if a hypercoagulable state has developed, the medical strategies may be ineffective and urgent implementation of mechanical thrombectomy needs to be considered.

Mechanical thrombectomy was first used to treat CVST in the 1990s, [7] Endovascular treatment should be chosen when features suggestive of poor prognosis, such as coma and clinical deterioration, are evident [1,8]. Mechanical thrombectomy can be performed by balloon angioplasty, stenting, a rheolytic catheter, a stent retriever, or an aspiration catheter. Recent studies reported that mechanical thrombectomy using the Solitaire stent device is safe and effective for CVST and can significantly improve clinical symptoms. However, review article reported [9] a mortality rate was 27% for multimodal approaches to endovascular treatment for CVST resulted in partial or complete restoration of flow in all cases, although it did not include the combination therapy using a stent retriever and an aspiration catheter reported here. This review also highlighted the need for improved recanalization strategies. Our review of the literature revealed 3 cases [4-6] where a stent device combined with a direct aspiration catheter was used as endovascular treatment of CVST (Table 1). Including our case, all 4 cases were efficiently recanalized with a low complication rate and a favourable prognosis.

A previous study [10] in an animal model showed that, during the initial stage, the intravascular thrombus has a laminated structure, with layers of aggregated and degranulated thrombocytes, and infiltration of leukocytes and layers of fibrin. After 5-10 days, the thrombus takes on a homogeneous hyaline structure. At a later stage (8-20 days), the thrombus becomes organised with the growth of fibroblasts and capillaries and the appearance of endothelium-coated gap junctions. The combination device can help to retrieve a sufficient amount of clots for pathological examination, and so can aid our understanding of the pathophysiology of thrombus formation. The clots removed in the present case were identified as venous thrombi (i.e., red clots), based on the presence of abundant fibrin and red blood cells, along with a large number of white blood cells suggesting inflammatory change.



Case	Author (year)	Sex/Age, years	Symptoms	MR images (complications)	Occluded vessel	Cause	Device	Prognosis
1	Raychev (2014)	F/27	Generalised seizure Headache Left-sided weakness	Brain oedema Small ICH	SSS	Oral contraceptives	Solitaire FR Penumbra	Left hand and foot weakness (mRS=1)
2	Shaikh (2015)	Unknown/pre-teenage	Headache Altered mental status Bilateral lower extremity weakness	Brain oedema	Vein of Galen SS	Infection: Ulcerative colitis	Solitaire FR Penumbra	No deficit
3	Mascitelli (2016)	F/17	Lethargy Headache Proptosis Chemosis Nuchal rigidity No movement of left lower extremity Febrile	Brain oedema	SSS SS Bilateral TS	Infection: Oral infection	Trevo Penumbra	Mild lower extremity weakness

**Abbreviations:** SSS: Superior Sagittal Sinus; SS: Straight Sinus; TS: Transverse Sinus; ICH: Intracranial Haemorrhage.

**Table 1:** Reported cases using the combination of a stent retriever and an aspiration catheter for cerebral venous thrombosis.

## Conclusion

We propose that the combination of a stent retriever and an aspiration catheter is a safe and effective treatment for CVST. In addition to the conventional factors of circulatory disease and coagulation disorder, venous vasculitis was also an important factor involved in thrombus formation, fever, and the raised white blood cell count and C-reactive protein level in CVST.

**Competing interests:** No conflict of interest present.

**Ethics approval statement:** The report was approved by the institutional review board (No. 1620), and the treatment was provided in accordance with the principles set forth in the Declaration of Helsinki.

**Contributors:** All authors were involved in patient's intervention, and all authors participated in manuscript preparation.

**Patient consent:** Obtained

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