Role of penumbra mechanical thrombectomy device in acute dural sinus thrombosis

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Abstract

Background: In dural venous sinus thrombosis (DVST), the mortality ranges 5–30%. Deep venous system involvement and septic dural sinus thrombosis have a higher mortality rate. In acute occlusion, collateral flow may not be established, which may result in significant edema and mass effect. Endovascular interventions may be considered as a treatment option in appropriate high-risk patients with DVST. Materials and Methods: Eight patients with magnetic resonance imaging (MRI)-confirmed dural sinus thrombosis, who did not respond to the conventional standard medical treatment, were subsequently treated with mechanical thrombectomy using the Penumbra System®. In all cases, medical treatment including anticoagulants were continued following the procedure for a minimum period of 1 year. Results: Recanalization of the dural sinus thrombosis was achieved in all 8 cases. There were no immediate or late endovascular-related complications. One death occurred due to an unrelated medical event. At 6 months, there was notable improvement in the modified Rankin Score (mRS), with 5/8 (62%) patients achieving mRS of 2 or less. The follow-up ranged between 3 months and 26 months (mean: 14.5 months), and there were no new neurological events during the follow-up period. Conclusion: Cerebral venous sinus thrombosis is a rare but life-threatening condition that demands timely diagnosis and therapy. In cases of rapidly declining neurological status despite standard therapy with systemic anticoagulation and anti-edema measures, mechanical thrombectomy could be a lifesaving and effective option. In this study, good outcomes were observed in the majority of patients at long-term follow up.

Key words: Dural sinus thrombosis; neurointervention; recanalization; thrombectomy

Introduction

Cerebral venous sinus thrombosis (CVST) was first described by Ribes in 1825.[1] The mortality and morbidity from CVST in various prospective studies range between 8.8% and 44.4%.[2] Conditions predisposing to dural sinus thrombosis include puerperium, trauma, malignancy, disseminated intravascular coagulation, hypercoagulable states, infections, medications (e.g., synthetic steroids and contraceptive hormones), connective tissue disorders, and dehydration.[3] In contrast to arterial infarction, CVST commonly occurs in the young. The absence of pathognomonic features can delay diagnosis. Headache is the most common symptom (80–90%), other common presentations are focal or generalized seizures, focal...
neurological deficits, and alteration in sensorium. Occlusions in the superficial venous system are better tolerated and has a better prognosis than thrombosis in the deep venous system because of the extensive collateral supply. The treatment is aimed at opening up of the occluded sinuses by systemic anticoagulation and giving antiedema measures in the acute phase. Surgical decompression may be the option in cases with a large infarct volume and midline shift. In cases where there is no significant improvement following systemic anticoagulation, direct thrombolysis and mechanical thrombectomy can be considered.

Here, we review the techniques and indications for endovascular treatment of CVST and long-term results in 8 cases of dural venous sinus thrombosis (DVST) that underwent mechanical thrombectomy with Penumbra device with or without concurrent balloon angioplasty and chemical thrombolysis.

Materials and Methods

Out of the 243 cases of acute CVT treated in a quaternary level teaching hospital over a period of 4 years, 8 underwent mechanical thrombectomy using the Penumbra system, with or without concurrent balloon angioplasty and chemical thrombolysis. The ages ranged from 20–40 years, with all the patients being females. In all 8 patients, the common presenting feature was headache [Table 1]. In 5/8 patients, there was involvement of the superficial venous system, and in the rest there was involvement of the superficial and deep system. Seven out of 8 cases had venous infarct on the magnetic resonance imaging (MRI) before endovascular thrombectomy was performed [Figure 1].

All patients were initially managed medically, systemic anticoagulation (intravenous unfractionated heparin) was started to keep the target PTT >1.5 times the control. Anticonvulsants were started in patients who presented with seizures and also were given prophylactically to others with large venous infarcts involving the cerebral cortex. All patients were treated for raised intracranial pressure with acetazolamide (Dose ranging from 250 mg thrice a day to 500 mg thrice day), intravenous dexamethasone, and hypertonic (3%) saline. These patients were taken up for endovascular thrombectomy after clinical and radiological worsening.

In 5 out of 8 cases, balloon angioplasty was concurrently used along with the Penumbra System (Penumbra, Alameda, USA). In the remaining 3 cases, however, Penumbra mechanical clot retrieval was performed in conjunction with balloon angioplasty and chemical thrombolysis. The clinical outcome was measured based on the modified Rankin score (mRS).

Transarterial cerebral angiography was not routinely performed to survey the DVST detail, except when required. Penumbra mechanical clot retrieval was done with additional balloon angioplasty and chemical thrombolysis were carried out on as required basis. A 6F Envoy guide catheter (Codman & Shurtleff, Inc, Raynham, MA, USA) was first advanced through the femoral vein and placed at the base of the skull. The blocked dural sinuses were approached using an anteroposterior, lateral, or a combination of both projections. Using a 300 cm 0.014 in microwire, a 0.32” Penumbra reperfusion microcatheter was advanced retrogradely into the anterior two-thirds of the superior sagittal sinus. To disrupt the thrombus, 5 mg tPA, or 2L Urokinase was administered or a 3–5 mm balloon angioplasty was performed up to 2–3 times from the distal to the proximal end of the occlusion to sufficiently extract the thrombus. Then using a Penumbra reperfusion catheter–separator combination, thrombus extraction was performed [Figures 2-5]. In cases where there was no significant angiographic recanalization of the sinus after 2 or 3 passes of the Penumbra device along with thrombolysis/angioplasty, the procedure was discontinued.

Medical management was continued in all patients. A repeat magnetic resonance venography (MRV) was performed if the patient showed no significant clinical improvement after 2–3 days. After discharge, the patient was followed up with, mRS score assessment and fundal examination.

Recanalization of the dural sinus thrombosis was achieved in all 8 cases. Three showed complete recanalization, whereas 4 showed partial recanalization. There were no hemorrhagic events during or after the procedure in any of
Follow MRI was not done as patient was pregnant. Thrombolysis was done by angioplasty (A) with a 3 mm × 6 cm balloon (arrow) followed by mechanical thrombectomy (B) with a Penumbra catheter system (arrow). No significant recanalization of SSS, right transverse sinus, and right sigmoid sinus. Penumbra + 5 mm × 20 mm balloon plasty, followed by Urokinase, balloon venoplasty, Penumbra. No significant recanalization of the SSS, right transverse sinus, and right sigmoid sinus. No procedure related complication, nosocomial pneumonia. Repeat MRI not done post intervention, however Modified Rankin Score of 1 at 3 month follow-up.

Discussion

Venous sinus thrombosis is a rare and potentially life-threatening condition, with a 30-day fatality rate of 3.4% in a multicentre international prospective study. Intravenous anticoagulation with heparin, followed by oral anticoagulation is the front-line treatment. When
the clinical condition fails to respond despite standard medical management, endovascular therapy can be undertaken. All 8 patients described here were young, otherwise healthy individuals with severe and progressive neurological symptoms in spite of standard medical therapy.

Before the era of mechanical thrombectomy devices, endovascular chemical thrombolysis was performed by infusion of Urokinase or tPA.[7-10] Dentali et al.[10] found that local thrombolysis was associated with a non-negligible incidence of major bleeding complications, including intracranial bleeding, potentially affecting patient outcome. In this study, Urokinase was used because it was readily available and less expensive than tPA. In only one case tPA was used.

The use of mechanical thrombectomy with or without concurrent chemical thrombolysis has been reported using other devices, such as balloon angioplasty, the Angiojet Rheolytic catheter (Possis Medical, Minneapolis, Minnesota, USA), the Merci Retriever device (Concentric Medical, Mountain View, California, USA), and the Solitaire FR retrieval device (Covidien, Irvine, CA, USA), with each having their own inherent limitations.[11] In 3 out of 8 cases, thrombolysis was combined with balloon angioplasty and mechanical thrombectomy to aid in clot retrieval.

Here, we report possibly the largest series using the Penumbra system for mechanical thrombectomy in DVST. The Penumbra system is a modification of the manual proximal aspiration technique and consists of a dedicated reperfusion catheter connected to a pump, which applies continuous aspiration. A microwire with an olive-shaped tip called the separator is used to clear the tip of the reperfusion catheter from clot fragments to avoid obstruction. The PS has shown safety and efficacy in the mechanical treatment of acute ischemic stroke due to thromboembolism.[8,12] In this report, the procedures...
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Table 2: Patient follow up (showing the Modified Rankin Score over 2 years)

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Modified Rankin Score at discharge</th>
<th>Modified Rankin Score at 3 months</th>
<th>Modified Rankin Score at 6 months</th>
<th>Modified Rankin Score at 12 months</th>
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Figure 5 (A-D): Thrombolysis was done by balloon angioplasty (A) using a 3 mm × 4 cm balloon (arrow) followed by mechanical thrombectomy (B) using a Penumbra thrombectomy device (arrow). Post-thrombolysis venogram (C) shows minimal recanalization of the anterior superior sagittal sinus (arrow) and angiogram (D) showed no flow in the anterior superior sagittal sinus but a patent posterior segment of superior sagittal sinus.

utilized a 0.41 or 0.32 inch Penumbra system reperfusion catheter based on the ease of the wire to traverse the thrombus. Balloon angioplasty augmentation was performed in cases where the Penumbra system separator did not macerate the clot independently to allow optimum aspiration using the reperfusion catheter.

While most cases did not demonstrate significant recanalization in the immediate post-thrombolysis imaging, they showed improvement in their clinical course after the procedure as well as significant resolution in the follow-up imaging [Figures 3D and 6]. There were no intra procedural complications and no procedure-related complications postoperatively. The mean follow-up period in this study was 14.5 months, which is unique compared to other similar studies.\(^6\) None of the patients had recurrent dural sinus thrombosis during the follow-up period. A multicentre randomized controlled trial may be required to measure the clinical efficacy on a large sample size.

Conclusion

Cerebral venous sinus thrombosis is a rare but life-threatening condition that demands timely diagnosis and therapy. In cases of rapidly declining neurological status despite standard therapy of systemic anticoagulation, mechanical thrombectomy appears to be a safe and effective method when used alone or in combination with catheter-directed chemical thrombolysis.

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Conflicts of interest

There are no conflicts of interest.

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