Complete Cure of Superior Sagittal Sinus Dural Arteriovenous Fistulas by Transvenous Embolization through the Thrombosed Sinus in a Single Therapeutic Session

A Case Report

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Key words: transvenous embolization, thrombosed sinus, superior sagittal sinus, dural arteriovenous fistulas

Summary

Endovascular treatment often fails to completely eliminate dural arteriovenous fistulas (dural AVFs) involving the superior sagittal sinus (SSS). We report a successful case of dural AVF involving the SSS using transvenous embolization through the thrombosed sinus in a single therapeutic session.

Introduction

Dural arteriovenous fistulas (AVFs) involving the superior sagittal sinus (SSS) are rare¹⁻⁶. Because of their midline location and multiple arterial supply, endovascular treatment often fails to eliminate SSS dural AVF completely, necessitating its combination with craniotomy⁷⁻¹⁰.

We present a case of complete cure in only one therapeutic session of dural AVF involving the SSS using transvenous embolization through the thrombosed sinus. We report the clinical and radiological features, and also discuss the therapeutic techniques in this case.

Case Report

History and Radiographic Findings

A 68-year-old man presented with sudden onset of generalized seizure.

On admission, his Glasgow Coma Scale was E1V1M2. His CT scan demonstrated multiple subcortical hemorrhages (Figure 1).

Cerebral angiography revealed a dural AVF mainly fed by bilateral superficial temporal arteries (STA), middle meningeal artery (MMA) and occipital artery (OA), and located in the SSS with reflux into cortical veins (Figure 2A). The posterior part of SSS was thrombosed and the fistulous portion existed anterior to the thrombosed sinus (Figure 2B). The fistula was classified as a type II b fistula according to Cognard et Al.¹¹. Angiograms of the right internal carotid artery (ICA) demonstrated severe venous stasis (Figure 3A,B).

We planned transvenous embolization through the thrombosed sinus.

Intervention

The patient was intubated and ventilated artificially under general anesthesia with barbiturates because he was in status epilepticus.

A 4F catheter was placed via the left femoral artery into the right external carotid artery (ECA) to allow road-mapping during the transvenous procedure. A long 7F sheath was placed in the right femoral vein. A heparin bolus of 5000U was given to increase the activated clotting time to a minimum 250 seconds. A 7F guiding catheter (Guider; Boston Scientific)

Figure 1 Head CT scan on admission demonstrating multiple subcortical hemorrhages.

was placed with the tip in the right jugular bulb. Through this guiding catheter, a 4F guiding catheter (Cerulean G40; Medikit) was placed over a 0.035-inch Terumo hydrophilic guidewire (Terumo Corp) in the right transverse sinus.

Through the 4F guiding catheter, a microcatheter (Prowler Plus; Cordis) was advanced over a microguidewire (GT wire 16; Terumo Corp) into the thrombosed sinus. The shape of the thrombosed sinus was determined by investigation using angiography via the 4F catheter in ECA or via the microcatheter in the sinus by slow injection. The microguidewire was advanced into the proposed thrombosed sinus with slow rotation, followed by the microcatheter. The tip of the microguidewire was frequently checked from the anteroposterior view, lateral view and oblique view, to ensure that migration into the cortical vein did not occur. When strong resistance was felt at the tip of the microguidewire or it bent sharply, it was pulled back to avoid perforation, and then advanced again to explore a different route. Finally, the fistulous portion of the SSS was reached through the thrombosed sinus.

The fistulous portion of the SSS was packed tightly using mechanical detachable coils (IDC; Boston Scientific) from the anterior end to the

posterior end until the dural arteriovenous was completely eliminated (Figure 4A,B). During embolization, venous drainage was frequently checked with angiography via the 4F catheter in ECA. In particular, the entrance of the cortical vein that showed reflux was embolized tightly. Final angiograms showed complete occlusion of dural AVF (Figure 5A) and normalization of cerebral venous drainage (Figure 5B).

Postprocedural Course

After the patient awakened from general anesthesia, the postoperative course was uneventful. Six weeks later, a follow-up angiogram confirmed that the dural AVF had resolved and normalization of cerebral venous drainage. Magnetic resonance imaging (MRI) demonstrated multiple subcortical hemorrhages in the subacute stage, but no complications related to the treatment were recognized (Figure 6A,B). The patient was discharged with a good performance status.

Discussion

Dural AVFs in the region of the SSS are rare^{1-8,10}. Their frequency is reported to be between 8% and 13% of all dural AVFs⁷. Dural AVFs in the SSS with cortical drainage have a greatly increased risk of hemorrhage³⁻⁵. The incidence of bleeding caused by rupture of draining veins or by venous hypertension is higher than in dural AVFs arising in other locations^{3,5}. Therefore, these lesions should be treated aggressively and require complete occlusion. Therapy should be chosen on an individual basis, considering the angiographic appearance of the lesions and the feasibility of safe endovascular access^{8,11}.

Cognard et al. classified venous drainage of dural AVFs¹¹. Our case was classified as a type II b fistula, according to the classification, because the fistula involved the SSS and there was reflux into cortical veins only and not another sinus. Because of the risk of bleeding associated with cortical reflux, complete occlusion or at least suppression of the cortical venous reflux is mandatory¹¹. This may sometimes be achieved by arterial embolization^{1,4,5,8}, but sinus occlusion may be necessary and can be accomplished by surgical resection of the sinus or transvenous sinus occlusion⁷⁻¹⁰.

Many reports have described the priority of

Figure 2 A) Lateral view of angiogram of the right ECA (arterial phase). Dural AVF fed by STA, MMA and OA was located in the SSS with reflux into cortical veins. B) Lateral view of angiogram of the right ECA (venous phase). The posterior part of SSS was thrombosed (between arrows). The fistulous portion existed anterior to the thrombosed sinus.

treatment for dural AVFs with sinus thrombosis. Houdart et Al. reported sinus packing combined with craniotomy after failure of transvenous embolization for four cases of SSS dural AVFs with sinus thrombosis⁹. Kong et Al. proposed that transarterial embolization, not transvenous embolization, should be selected when the venous drain to dural sinus is not re-

cognized, and that sinus packing combined with craniotomy should be selected when transarterial embolization is unsuccessful¹². Kakarla et Al suggested that surgical treatment is indicated when endovascular access is difficult¹³.

Transvenous embolization offers an obvious advantage over surgical access, avoiding the

Figure 3 A) Anteroposterior view of angiogram of the right ICA. B) Lateral view of angiogram of the right ICA. The angiograms of the right ICA demonstrated severe venous stasis.

Figure 4 A) Anteroposterior view of angiogram of the right ECA. B) Lateral view of angiogram of the right ECA. The fistulous portion of the SSS was completely packed using mechanical detachable coils.

need for craniotomy and surgical exposure of the sinus. In the present case, as the fistulous portion of the SSS did not have normal sinus function, we decided that it could be occluded safely. Complete occlusion was accomplished in a single therapeutic session by transvenous embolization for several reasons: the microcatheter could reach sufficiently distal beyond the fistulous portion of the SSS with strong support of the 4F guiding catheter; the fistulous portion was embolized tightly, especially at the entrance of the cortical vein in order to eliminate cortical reflux; and the fistulous portion could be sufficiently occluded in the long segment to prevent recanalization.

Injury to the thrombosed sinus during recanalization is an important complication in transvenous embolization¹⁴, and care should be taken to avoid perforation of the cortical veins draining the fistula because they have thin, weak walls¹⁴. To prevent perforation, the microguidewire and the microcatheter should be advanced gently. When strong resistance is felt at their tip, they should not be advanced. If perforation occurs, heparinization should be reversed and it is necessary to plug the perforation point with coils when it occurs by microcatheter. One case of perforation of the sinus wall and extravasation of contrast agent during

transvenous embolization for SSS dural AVF has been reported, but with no clinical deficit¹⁵.

Urtasun et al reported the treatment of four cases of SSS dural AVF with sinus thrombosis¹⁵. Among them, transvenous embolization was successful in three cases, but none resulted in complete occlusion of dural AVF. Only one case treated with sinus packing combined with craniotomy resulted in complete occlusion of dural AVF. Therefore, to our knowledge, this is a very rare case report that describes the complete cure of superior sagittal sinus dural arteriovenous fistulas by transvenous embolization through the thrombosed sinus in a single therapeutic session. Urtasun et al also reported the treatment of 13 cases of transverse and/or sigmoid dural AVF with sinus thrombosis. Among them, ten cases resulted in complete cure of dural AVF by transvenous embolization¹⁵. It is thought that the manipulation of microcatheters is more difficult and that the risk of injury to the sinus and cortical veins is higher in SSS dural AVF than in transverse and/or sigmoid dural AVF, because SSS dural AVF is located more distally than transverse and/or sigmoid dural AVF.

It is reported that sinus packing combined with craniotomy for dural AVFs that have limited angiographic access has a high success

Figure 5 A) Lateral view of angiogram of the right ECA. Final angiogram showing complete occlusion of dural AVF. B) Lateral view of angiogram of the right ICA. This view shows normalization of cerebral venous drainage. Venous stasis was not observed.

rate^{9,12}. Therefore, when endovascular access is difficult, we should not persist with embolization, but select surgical treatment. Although sinus packing combined with craniotomy is emphasized to be a safe procedure^{9,12}, it should be

performed carefully because several complications have been reported, including a subdural and intracerebral hematoma with intraventricular extension, resulting in neurologic deficit¹⁵.

It is important to minimize the number of

Figure 6 Head MRI on discharge. A) T1-weighted image. B) T2-weighted image. Head MRI demonstrated multiple subcortical hemorrhages in subacute stage, but no complications related to the treatment were recognized.

therapeutic sessions in order to reduce the occurrence of complications, especially when patients have a poor neurological status. In the present case, complete cure in a single therapeutic session was accomplished. However, if transvenous embolization is unsuccessful, sinus packing combined with craniotomy should be selected in another therapeutic session^{9,12}. This stepwise therapeutic strategy is a time-consuming procedure and increases the number of therapeutic sessions and the likelihood of complications. Therefore, it is desirable to evaluate whether transvenous embolization is successful before treatment to minimize the number of therapeutic sessions. However, it is not easy to predict whether transvenous embolization for dural AVF with sinus thrombosis will be suc-

cessful only from preoperative angiographic findings. MRI may be a good tool for prediction because it can evaluate sinus thrombosis by detecting the time for thrombus formation^{16,17}. Unfortunately, we could not examine MRI in this case because our patient had a poor neurological status before treatment.

Conclusions

We reported a complete cure of SSS dural AVF by transvenous embolization through the thrombosed sinus in a single therapeutic session. However, when endovascular access is difficult, we should not persist with embolization, but select surgical treatment, including sinus packing combined with craniotomy.

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