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Case Report

Combined transarterial and transvenous embolization of anterior cranial fossa dural arteriovenous fistula

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Received : 08 June 2023
Accepted : 25 July 2023
Published : 04 August 2023

DOI
10.25259/SNI_487_2023

Quick Response Code:

ABSTRACT

Background: Excessive glue injection into the drainage vein in patients with dural arteriovenous fistula (dAVF) can result in venous obstruction. We performed transarterial embolization (TAE) combined with transvenous embolization (TVE) with coils to prevent the glue from migrating into the normal cortical veins.

Case Description: A 57-year-old man was pointed out to have a Borden Type III anterior cranial fossa dAVF during a check-up for putaminal hemorrhage. Because a left frontal normal cortical vein drained into the pathological drainage vein, excessive glue injection into the drainage vein may have caused venous obstruction. We performed TVE with coils at the foot of the draining vein to prevent excessive migration of glue into the drainer, followed by TAE with glue. With this technique, complete obliteration of the shunt without venous ischemia was obtained.

Conclusion: The combined treatment of TAE and TVE is effective in preventing venous ischemia caused by unintended migration of glue cast into the drainage vein.

Keywords: Anterior cranial fossa, Combined treatment, Dural arteriovenous fistula, Transarterial embolization, Transvenous embolization

INTRODUCTION

Anterior cranial fossa dural arteriovenous fistula (ACF dAVF) is a rare condition that accounts for approximately 10% of all dAVF cases. Retrograde drainage of the cortical veins is the most common drainage pattern and is characterized by a malignant course that most often presents with hemorrhage, which is reported to occur in 60–90% of cases.[2,3,5,7,12,14] Accordingly, even if these lesions are discovered incidentally, they should be treated aggressively. Over the last decade, several studies have reported favorable outcomes of transarterial embolization (TAE) and transvenous embolization (TVE) for these lesions.[6,8,11,13,19,20] The high cure rates and safety of TAE and TVE are comparable to those of surgical treatment.[13,19,20] However, some technical problems of TAE and TVE remain unresolved. During TAE using liquid embolic materials, it is essential to create a sufficiently penetrated cast into the draining vein to obtain complete occlusion of shunts. In the early stages of the glue injection, we often notice uncontrollable glue fragmentation due to the blood flow from feeding arteries connected with the shunt, and this glue migration may cause venous infarction.[6]

Accordingly, TAE carries the unavoidable risk of glue migration into the distal part of the draining vein until the shunt is completely filled with glue. In particular, TAE by Onyx often creates a relatively long cast into the draining vein; this cast may obstruct the orifice of normal cortical veins.

We report a patient with ACF dAVF successfully treated by glue embolization combined with TVE using coils. The affected drainage vein and the normal cortical veins in the left frontal lobe merged to form a common trunk and finally drained into the superior sagittal sinus (SSS). To avoid venous outflow impairment, the amount of glue injected into the drainage vein should be minimized. We performed TAE combined with TVE to prevent the migration of glue into the normal cortical vein. We controlled the blood flow by prefilling the foot of the drainage vein with a coil to prevent fragmentation of the glue. To the best of our knowledge, this is the first case report of a combined TAE and TVE technique for ACF dAVF. We addressed the safety and efficacy of our concept and discussed the technical aspects.

CASE REPORT

A 57-year-old man presented with a sudden onset of mild right upper and lower extremity paralysis. A magnetic resonance imaging (MRI) scan revealed a left capsular hemorrhage and scattered infarctions in the right middle cerebral artery and the patient was treated conservatively. Magnetic resonance angiography incidentally revealed findings suggestive of ACF dAVF, which was confirmed by cerebral angiography [Figure 1]. The dAVF was fed bilaterally from the ophthalmic arteries through the anterior ethmoidal branches. The shunt pouch was formed in the left cribriform plate. Drainage occurred through the arterialization of the left frontal cortical veins to the anterior third of the SSS. The venous drainage patterns were Cognard Type 4 and Borden Type 3, with cerebral cortical venous regurgitation. The patient refused a craniotomy for the surgical interruption of the dAVF and preferred an endovascular approach. We planned TAE with n-butyl-2-cyanoacrylate (NBCA); however, precise evaluation of angiograms revealed that the drainage vein had a laminar flow [Figure 2a, yellow arrows], which was the confluence of the normal cortical vein perfused from the left frontal lobe. Computed tomography angiography (CTA) revealed that both merged to form a common trunk that drained into the SSS [Figure 2b, yellow arrows]. If unintentional fragmentation or elongation of the glue cast extends into the confluence, there is a risk of ischemia in the left frontal lobe. Accordingly, we performed TAE in combination with TVE of the origin of the draining

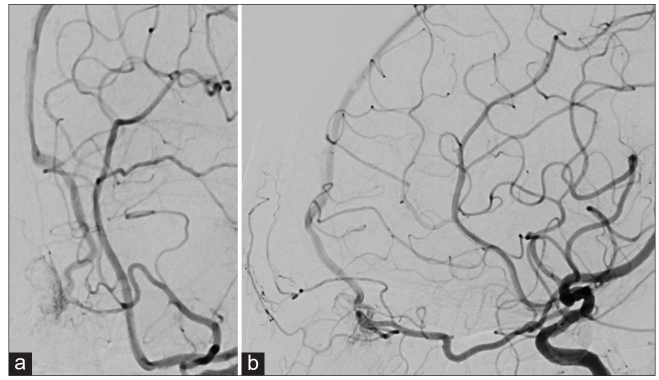

Figure 1: (a) Left oblique and (b) lateral projections of the left internal carotid artery angiogram show the dural arteriovenous fistula at the anterior cranial fossa feeding by the left ophthalmic artery and venous reflux in the left frontal cortical veins drained into the anterior third of the superior sagittal sinus.

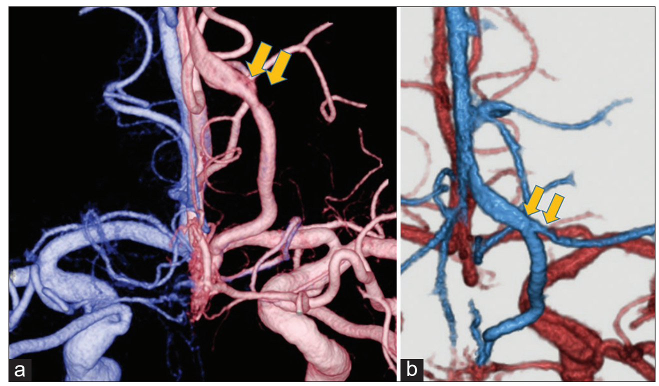

Figure 2: (a) A fusion image of a three-dimensional bilateral internal carotid angiogram shows the anterior cranial fossa dural arteriovenous fistula with a drainage vein associated with a laminar flow (yellow arrow). (b) Computed tomography angiography reveals that it is the confluence of the affected drainage vein and the normal frontal cortical vein (yellow arrow). Both veins merge and form a common trunk that drains into the superior sagittal sinus.

vein to prevent the unexpected migration of glue into the normal cortical vein.

The endovascular procedures were performed under general anesthesia using transfemoral artery and transinternal jugular vein approaches [Figure 3a]. Parent Plus45 at 28 cm (Medikit, Tokyo, Japan) was placed into the right internal jugular vein under ultrasound guidance [Figure 3b]. A 7-French (Fr) introducer was placed in the right femoral artery. After systemic heparinization (intravenous injection at 4000 units, followed by continuous intravenous infusion of 1000 units/hour, to maintain an activated clotting time twice the patient's baseline level), a 6-Fr guiding catheter (Roadmaster STR [90 cm]; Goodman, Aichi, Japan) was inserted into the right internal carotid artery (ICA). Distal transvenous access was retrogradely obtained across the internal jugular vein, and an intermediate catheter, TACTICS PLUS (Technocrat, Aichi, Japan), was advanced into the SSS and carefully inserted into the left frontal cortical vein [Figure 3c]. An Excelsior SL-10 (Stryker, Fremont, California, USA) was advanced over the microwire near the foot of the vein. An SL-10 position was positioned immediately adjacent to the fistula. Subsequently, the arterial approach was initiated. A 7-Fr Roadmaster (Goodman, Aichi, Japan) was placed in the right ICA. Following TACTICS PLUS (Technocrat) insertion into the ICA cavernous portion, a microcatheter Marathon (Covidien, Irvine, CA, USA) was immediately advanced adjacent to the fistula [Figures 3d and e]. Transvenous outlet occlusion was done with a total of 9 cm of three i-ED coils (Kaneka, Osaka, Japan) placed at the foot of the vein [Figures 4a-d]. Left internal carotid angiography revealed a still opacification of the draining vein, but the flow was significantly decreasing; therefore, we thought that fragmentation of the NBCA would prevent splattering into the normal veins. A low concentration of NBCA (14%) was injected under careful inspection using continuous fluoroscopy [Figures 4e and f]. We confirmed the glue penetration of the fistulous point without extending to the confluence of the normal frontal cortical vein and completed the occlusion of the shunt [Figures 4g and h]. The final left ICA angiograms showed complete occlusion of the ACF dAVF [Figures 5a and b] with the preservation of the left frontal cortical vein [Figures 5c and d, yellow arrows]. There were no postoperative complications and no venous ischemia was identified on follow-up MRI. The patient was discharged without complications and lived his daily life in a manner similar to that before at the 3-month follow-up visit.

DISCUSSION

Intracranial hemorrhage has been reported as the most common presentation of ACF dAVF.[4,15,17] Even in cases found incidentally, this condition warrants definitive treatment because of the high risk of hemorrhage. Open surgical clipping or ligation with bipolar electrocautery at the fistulous connection point has been the first-line treatments for ACF dAVF.[1,9,12] Lawton *et al.* listed three reasons for the unsuitability of endovascular therapy.[9] First, since the ophthalmic artery is the feeding artery, TAE risks occluding the central retinal artery. Second, the embolizing material may not reach the shunt sufficiently, resulting in a low cure rate. Third, the tortuous nature of the ophthalmic artery makes it difficult to access the area near the shunt. Recent advances in endovascular treatment technology have

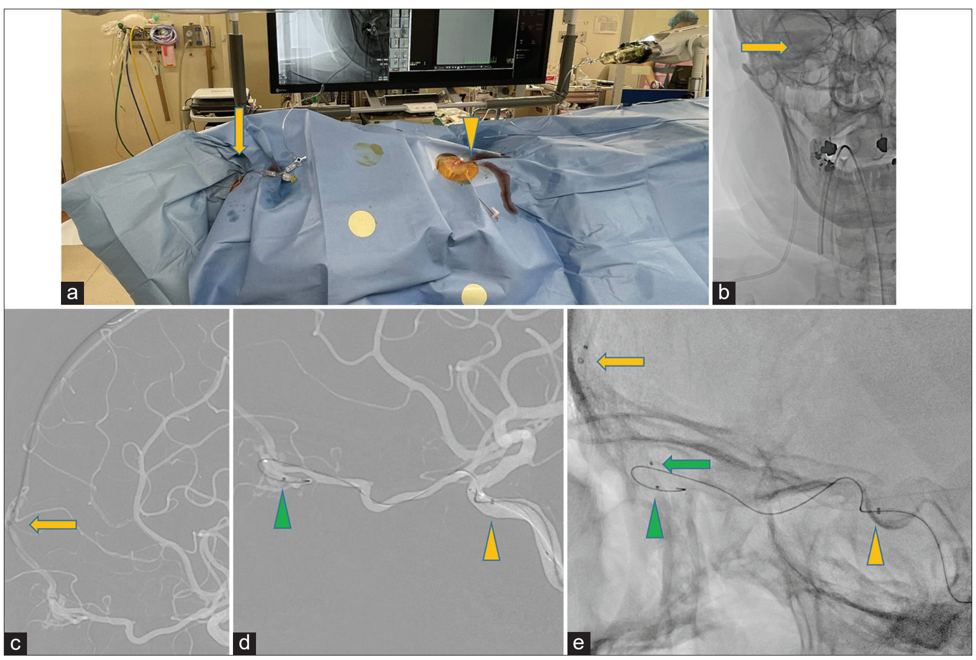

Figure 3: (a) The procedure is performed under general anesthesia using transfemoral artery (yellow arrow head) and transvenous internal jugular vein (yellow arrow) approaches. (b) Parent Plus45 (28 cm) is placed into the right internal jugular vein (yellow arrow). (c) Retrograde transvenous access from the right internal jugular vein to the superior sagittal sinus, and an intermediate catheter TACTICS PLUS reaches to the bifurcation base of the left frontal vein (yellow arrow). (d and e) TACTICS PLUS insertion into an internal carotid artery cavernous portion (yellow arrowhead), with Marathon being advanced over a microwire to the adjacent fistulae (green arrowhead). Excelsior SL-10 being advanced over a microwire to the foot of the vein (green arrow) supported by TACTICS PLUS at the base of the left frontal vein (yellow arrow).

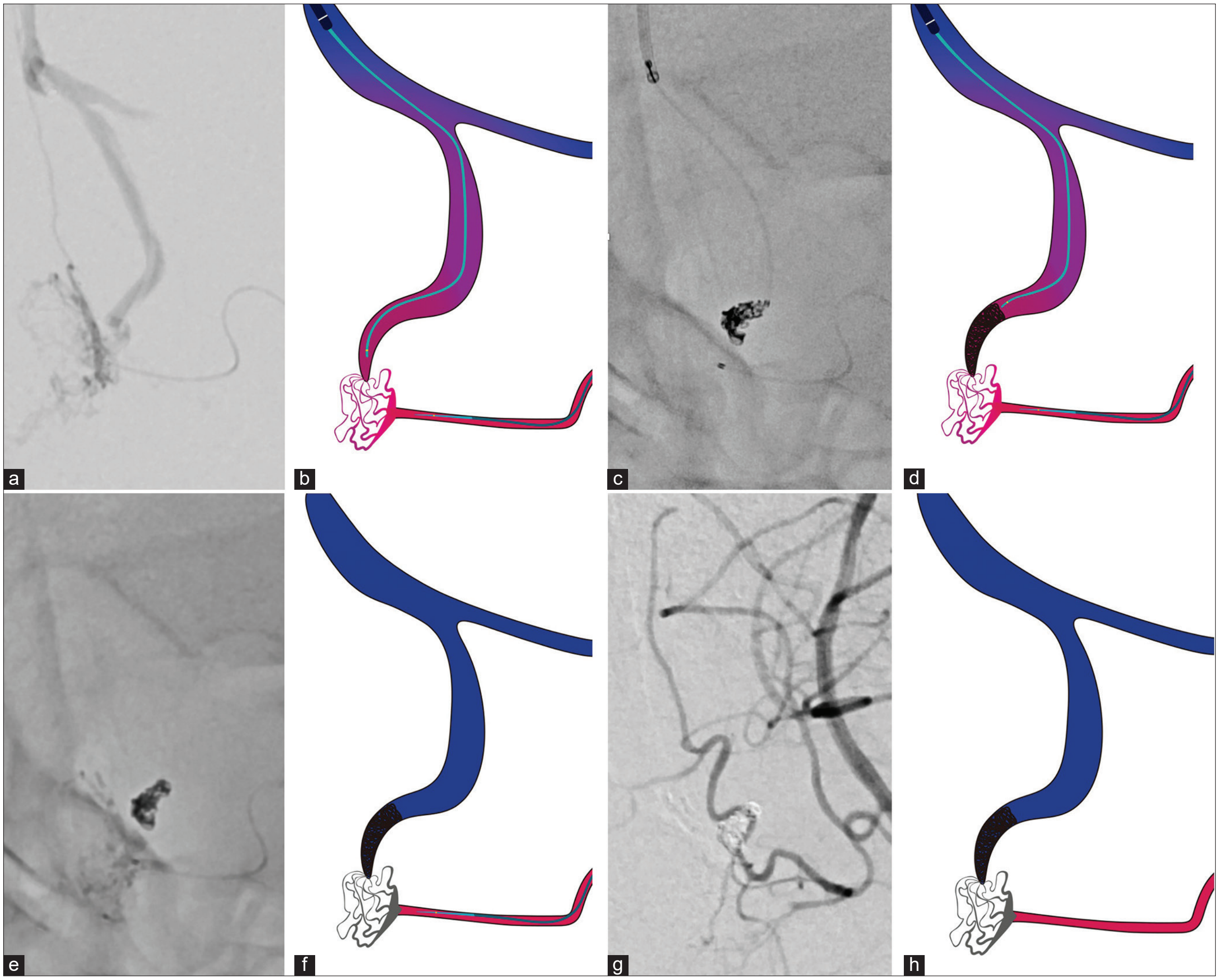

Figure 4: A series of angiograms and illustrations during the procedure. (a and b) Selective angiogram from the microcatheter placed in the left anterior ethomoidal artery. Note the tip of the microcatheter for transvenous embolization placement near the shunt. (c and d) Coils are placed in the foot of the vein for flow control. (e-h) Low-concentration n-butyl-2-cyanoacrylate (14%) is injected from the arterial side without fragmentation into the venous drainage. Note the glue penetration of the fistulous point without extending to the confluence of the normal frontal cortical vein.

resolved these problems and first-line treatment is shifting to the endovascular approach.[13] Over the past decade, several studies have described the feasibility of TAE using liquid embolic materials as a curative treatment for high-grade dAVF. The previous reports have suggested that the positioning of the tip of the microcatheter is an important factor in obtaining complete obliteration of the fistula,[3] that is, if the tip can be positioned immediately adjacent to the fistula, a complete closure is to be expected at a high rate. Disadvantages of the TAE included central retinal artery occlusion due to unexpected backflow of glue around the tip of the microcatheter, and excessive outflow glue migrations in situations where the blood flow from feeding arteries is uncontrolled. Some studies have emphasized the need for flow reduction in high-flow feeders before NBCA injection to minimize the risk of glue fragmentation and incomplete obliteration.[18] Particularly with high-flow shunts, blood flow control is difficult, and the unexpected dispersal of embolic material is problematic. To prevent these complications, various techniques have been reported, such as the wedged microcatheter technique,[18] occluding the ICA at the origin of the ophthalmic artery with a balloon, or using a dual-lumen balloon catheter for stable glue injection, reducing blood flow. The largest published cohort of TAE in the treatment of intracranial dAVFs is from the Japanese Registry of Neuroendovascular Therapy, consisting of 858 TAE procedures with an overall complication rate of 6.9%.[6] In this large cohort, complications related to TAE were more

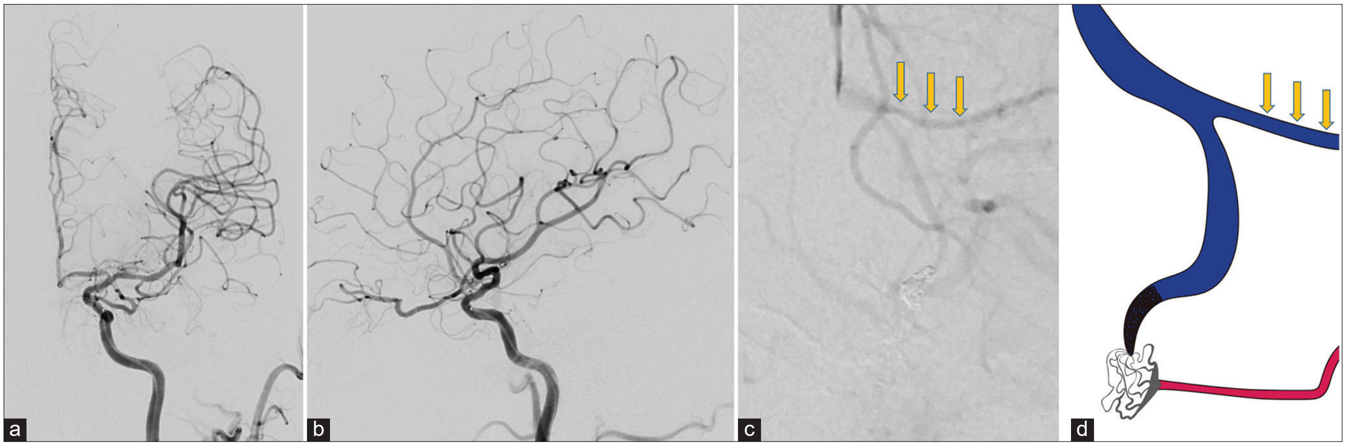

Figure 5: (a) Frontal and (b) lateral projections of the left internal carotid artery angiogram obtained at the end of session show the complete occlusion of the anterior cranial fossa dural arteriovenous fistula. Magnified oblique view of the left internal carotid angiogram(c and d) show the complete occlusion of the shunt with the preservation of the left frontal cortical vein (yellow arrows).

common during treatment of dAVFs of the ACF (17.4%). The most common complications of TAE were arterial ischemic events (2.3%) followed by venous obstruction (venous occlusion with nonhemorrhagic deficits [0.6%] and venous occlusion with hemorrhage [0.5%]). Arterial ischemia is the primary complication of TAE of a dAVF, but occlusion due to unintentional migration of embolic material to the drainer side should also be considered the next most important concern resulting in symptomatic brain edema.[10]

In our case, preoperative CTA revealed that the affected and normal veins in the left frontal lobe had merged to form a common trunk, and the distance from the shunt point to the confluence was <2 cm. By reducing drainage flow from the shunt by TVE with coils, it was possible to prevent the glue from extending from the drainage vein to the confluence. Coil embolization alone does not completely eliminate the reflux itself; however, reducing the flow was enough to control the glue penetration. The purpose was to provide flow control as an adjuvant to TAE.

We should also discuss the disadvantages of TVE for ACF dAVF. Precise preoperative angiographical evaluation was essential; excessively long cortical distances and tortuosity are contraindications to the use of the venous approach.[10,16]

Navigation in the tortuous vein may cause venous perforation, resulting in intracranial hemorrhage. In our case, the venous pathway was relatively short and superficial and we achieved a dense filling of the shunt while preserving normal venous perfusion in the left anterior lobe. As mentioned above, the distance to the confluence of the frontal cortical vein was within 2 cm, glue would have easily reached the confluence without coiling in the drainage vein. To the best of our knowledge, there have been no reports of TAE intentionally performed with TVE for venous flow control. Embolization can be safely and efficiently performed by pinching the shunt pouch from the arterial and venous sides. This technique is useful to form a more stable plug in the shunt and avoid migration into normal veins and sinuses.

Our study has some limitations. This was a case report from a single center. Thus, the future studies with a larger number of patients are required to validate this technique. Moreover, this method has an increased cost and angiography time. It is preferable not to use this method, particularly if the venous pathway is tortuous. Because coiling microcatheters are generally stiff for this purpose, coils cannot be used if catheterization of tortuous veins is required.

CONCLUSION

We reported a patient with ACF dAVF in whom TAE combined with TVE was useful in preserving a normal cortical vein that drained into the pathological draining vein. During the injection of the glue, this technique was effective in preventing unintended migration of the glue cast into the drainage vein, causing venous ischemia, which is a complication of TAE.

Declaration of patient consent

The authors certify that they have obtained appropriate patient consent.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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How to cite this article: Sugihara M, Fujita A, Ikeuchi Y, Hori T, Kohta M, Tanaka K, *et al*. Combined transarterial and transvenous embolization of anterior cranial fossa dural arteriovenous fistula. Surg Neurol Int 2023;14:277.