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Direct trans-orbit puncture for embolization of the intra-orbital or cavernous arteriovenous fistula

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Keywords: Arteriovenous fistula; Puncture; Superior orbital fissure; Embolization.

Abstract

Background and objective: To report indications, complications, and treatment effects of direct trans-orbit puncture for embolization of the intra-orbital or cavernous arteriovenous fistula.

Methods: Five cases of intra-orbital or cavernous arteriovenous fistula, which was failed to be treated with conventional endovascular access, were treated using direct trans-orbit puncture for ONYX embolization.

Results: The inferior ophthalmic vein was punctured in 2 cases and cavernous sinus was punctured in three. Onyx embolization with or without a combination of coils was performed successfully in the 5 cases of intra-orbital or cavernous arteriovenous fistula and resulted in complete obliteration of the fistulas. At angiographic and clinical followed-up, visual acuity was found in 1 case and good recovery without any sequelae in 4 cases and no fistula recanalization was observed.

Conclusion: Direct trans-orbit puncture for embolization could be an alternative option for the intra-orbital or cavernous arteriovenous fistula after failures of the conventional endovascular approach.

Introduction

Transvenous embolization through the inferior petrosal sinus or facial vein reaches the cavernous sinus is a common pathway for embolization of cavernous dural arteriovenous fistula. [1-4] But in some cases, venous sinus thrombosis, venous tortuosity, stenosis or occlusion or residual fistula after transvenous embolism and other reasons would make venous approach can not be successful accessed. [5, 6] In such circumstances, direct surgical exposure of superior ophthalmic vien is also an option, we have successfully implemented a number of cases of such surgery. [7] However, surgical exposure of the superior ophthalmic vein will be very difficult when the superior ophthalmic vein was not significant dilated. [8] In such cases, we chose direct trans-orbit puncture for Onyx embolization and our experiences were reported in this study.

Materials and methods

During a 3-month period, we had treated 5 cases [3 male and 2 females; ages 36-57 years (mean 51.8 years)] of intra-orbital or cavernous arteriovenous fistula using direct trans-orbital puncture for Onyx embolization. Conjunctival hyperemia and edema were observed in all 5 cases and additional epilepsy in 1 case, diplopia in 1 cases and blindness on the lesion side in 1 case (Table 1).

Table 1: The clinical data of 5 patients

Cases	Age (years)/Sex	Symptoms	Feeding arteries	Draining veins	Embolization material	Result	Complications	Follow-up time (months)
1	49/F	Diplopia, chemosis, epilepsy	Bilateral middle meningeal artery, meningeal branch of internal carotid artery	The superficial middle cerebral vein	Onyx	Complete	No	5
2	68/M	Conjunctival edema, blindness	The left ophthalmic artery branch	The superior ophthalmic vein	Onyx	Complete	No	5
3	36/M	Diplopia, conjunctival hyperemia	Meningeal branch of bilateral internal carotid artery	The superficial middle cerebral vein	Combination of Onyx and coils	Complete	No	4
4	49/M	Conjunctival hyperemia, blurred vision	Meningeal branch of internal carotid artery	The superior ophthalmic vein	Onyx	Complete	visual acuity declined	2.5
5	57/F	Conjunctival hyperemia	The bilateral middle meningeal artery, meningeal branch of bilateral internal carotid artery	The superior ophthalmic vein	Combination of Onyx and coils	complete	No	2.5

Treatment failures for cavernous sinus dural ateriovenous fistulas

Symptoms of proptosis and conjunctival edema deteriorated in 1 case after embolization via direct surgical accesses to the superior ophthalmic vein in local hospital. One case presented with sudden aggravation of the eye and conjunctival hyperemia symptoms after embolization via the infterior petrosal sinus in other hospital and residual fistula was found on post-treatment angiogram. In one case, the femoral vein-infterior petrosal sinus approach and direct surgical exposure of the facial vein were attempted to access the cavernous sinus dural fistula in other hospital but all failed. And in the other two cases, bilateral inferior petrosal sinus and facial vein approach were attempted and failed. All diagnosis was based on six-vessel angiography, 4 cases of cavernous sinus dural arteriovenous fistula and 1 case of intra-orbital arteriovenous fistula.

Cerebral angiography examination

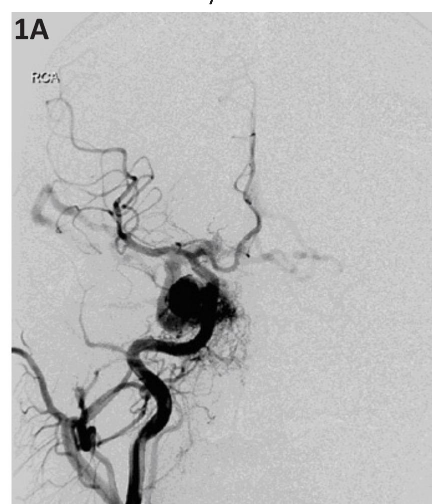
Meningeal branches of both internal carotid artery and external carotid artery were involved in the blood supply in 3 cases. Four fistulas involved one side of the cavernous sinus and one involved bilateral cavernous sinus. Three cases had the superior ophthalmic vein drainage, the other two cases had superficial middle cerebral vein drainage. The inferior petrosal sinus on the lesion side was invisible in all cases.

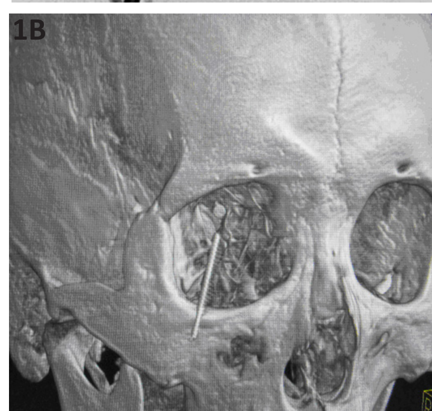
Embolization Technique

All procedures were performed under general anesthesia. A 6F guiding catheter was navigated into the involving carotid artery, which was used to create angiographic roadmaps of the cavernous sinus and ophthalmic veins.

A rotational skull image was reconstructed using Siemens DSA machine (Artisfloor, Siemens, German). The image demonstrated the osseous anatomy of the orbit, which defined the location of the superior and inferior orbital fissures in relation to the optic foramen. The working angles were the ipsilateral oblique, which allowed the overlap of the lateral third of the inferior orbital rim and medial aspect of the superior orbital fissure, and direct lateral projections, which could evaluate the depth of needle.

An 18-gauge puncture needle (Argon Medical Inc, USA) was used for the direct trans-orbital puncture. The entry point for the 18-gauge needle was the lateral third of the inferior orbital rim. We elevated the eyeball superiorly with the index finger of the left hand, while the needle was advanced with the right hand. The needle was directed along the line of the lateral third of the inferior orbital rim and medial aspect of the superior orbital fissure under X-ray film. Care was taken to avoid a trajectory toward the optic canal. Biplanar roadmap fluoroscopic guidance was used to direct the needle toward the medial aspect of the superior orbital fissure (Figure 1). The lateral projection provided the depth of the needle avoiding puncture too deeply into the internal carotid artery.





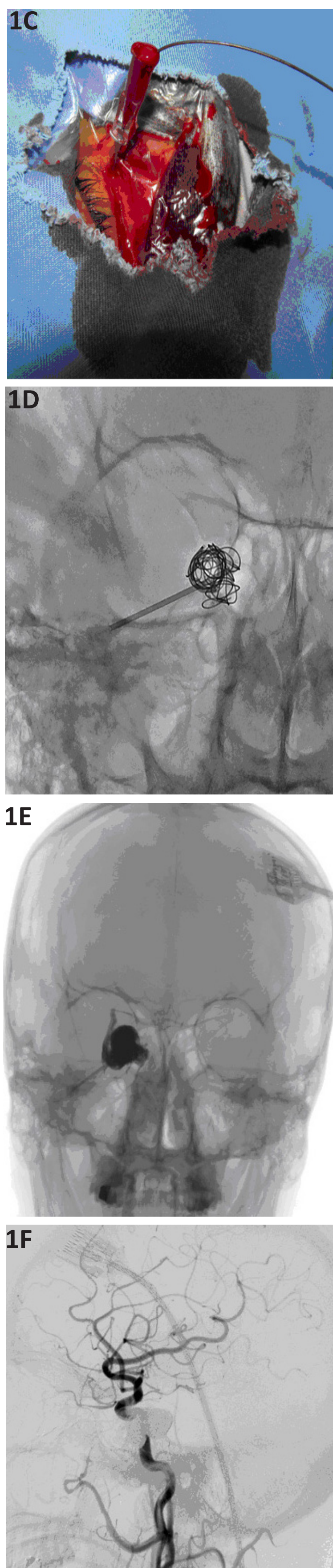


Figure 1: (A) Right carotid artery angiogram, frontal view, the right cavernous sinus dural arteriovenous fistula supplied by meningeal branches of the internal carotid artery and external carotid artery and drained by the superficial middle cerebral vein. **(B)** Three-dimensional skull reconstruction images. **(C)** Puncture needle into the superior orbital fissure and micro-catheter inserted through the needle. **(D)** Coils delivered prior to Onyx injection. **(E)** Frontal view of unsubtracted angiogram. **(F)** Right internal carotid artery angiography, lateral view, showed complete occlusion.

Once blood return was observed at the hub, angiography was performed via the needle using 5-ml syringe to confirm the draining vein of the fistula. An Enchelon-10 micro-catheter (ev3, Micro Theraputics.Inc, USA) was advanced over a Sliverspeed-14 micro-guidewire (ev3, Micro Theraputics.Inc, USA) through the needle posteriorly into the superior ophthalmic vein and into the cavernous sinus. Super-selective venogram via the micro-catheter was used to confirm the micro-catheter tip adjacent to the fistulous connection. Onyx embolization was performed under road-map or injected directly into the Onyx filling the cavernous sinus. Coils can be used as an adjunct to reduce fistula volume prior to Onyx embolizaiton.

Results

Puncturation of the cavernous sinus was performed in 3 cases and superior ophthalmic vein in 2 cases. Complete embolization was achieved in all 5 cases.

Complications

The internal carotid artery was punctured in our first patient due to the deep advancement of the needle. A 4×20mm HyperGlide balloon (ev3, Micro Theraputics. Inc, USA) was advanced to the cavernous carotid artery and inflated to block the internal carotid artery as while the needle was withdrawed slowly into the cavernous sinus, and Onyx was injected into the cavernous sinus until the fistula was completely obliterated.

An intra-orbital arteriovenous fistula supplied by branches of the left ophthalmic artery and drained via the superior ophthalmic vein was diagnosed in 1 patient. The superior ophthalmic vein was punctured and Onyx was slowly injected to completely occlude this fistula. The symptoms of left eye swelling and proptosis deteriorated after treatment.

A visual acuity decline (visual acuity 0.3) occurred in 1 patient after treatment of a residual fistula.

Outcome

All 5 patients developed intra-obital hematoma and eye swelling immediately after treatment. But these symptoms with recovered significantly during subsequent 3-5 days after conservative treatment. At angiographic and clinical followed-up (2.5 to 5 months), visual acuity was found in 1 case and good recovery without any sequelae in 4 cases and no fistula recanalization was observed.

Discussion

Cavernous sinus dural arteriovenous fistula has a benign the natural history than that of other intracranial parts, but when patients had increased intra-ocular pressure, cortical venous drainage, intracranial hemorrhage or neurological dysfunction, diplopia, intracranial murmur, severe headache, the treatment will be needed. [9] Intra-orbital arteriovenous fistula, the incidence is very low, timely treatment will also be needed for symptoms such as proptosis, chemosis.

The traditional treatment of cavernous sinus dural arteriovenous fistula is intravenous approach. Cavernous sinus dural arteriovenous fistula is difficult to cure intra-arterial embolization due to the complex feeding arteries, multi-bilateral blood supply and often involving the bilateral cavernous sinus, and arterial approach is usually used to relieve symptoms. [10] Neurosurgical treatment of the disease, radiation therapy and conservative treatment (neck compression or orbital pressure), in

addition to comprehensive treatment, such as skull fenestration puncture sinus [11], these management have also been used for treatment of cavernous sinus fistula. Under several circumstances, such as dilated ophthalmic vein drainage, failures of artery approach failure and conventional intravenous approach, direct trans-orbit puncture [12] may be a good option to avoid complications, such as eye and cranial nerve injury, hemorrhage, carotid artery injury, associated surgical treatment [13] and to achieve complete embolization.

There are some complications associated to direct trans-orbit puncture. The extracranial complications include retrobulbar hematoma, periorbital cellulitis, eye and optic nerve damage, tackle nerve injury and cranial nerve injury and intracranial complications include carotid artery injury, subarachnoid hemorrhage, and cerebrospinal fluid leakage. [13-15] Retrobulbar hematoma is generally from the intra-orbital puncturation and a rich vascular plexus bleeding. We injected Onyx routinely while withdraw the needle, this may reduce retrobulbar vascular plexus bleeding. To our experience, retrobulbar hematoma will be gradually absorbed in 5-7 days after treatment and does not affect vision. We did not encounter periorbital cellulitis and antibiotic was not given in out patients. Puncture of eye ball and ophthalmic nerve can be avoided by familiar with the orbital anatomy and slow puncturation under fluoroscopic guidance. Most common intracranial complication is penetration of the internal carotid artery. If the internal carotid artery is pierced, using HyperGlide balloon temporary closure of the internal carotid artery, then slowly withdraw the needle into the cavernous sinus and obliterate the fistula and cavernous sinus completely to block the penetration point of the internal carotid artery. Subarachnoid hemorrhage was caused by deep puncturation. To avoid this complication, the depth of needle advancement under fluoroscopy each time should be 1mm as long as the strict control of the depth of the needle. **A**pplication of liquid embolic agent combining coil embolization for cavernous sinus dural fistula is a safe, effective and economical treatment mordality. And a combination of Onyx and coil can promote a the higher anatomical cure rate, the lower rate of recurrence and complication rates[16], can improve the anatomy of the fistula closure rate, reduce the amount of coil, reducing the cost of treatment and cranial nerve palsy caused by over packing with coils.

Conclusions

Direct trans-orbit puncture for embolization could be an alternative option for the intra-orbital or cavernous arteriovenous fistula after failures of the conventional endovascular approach.

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