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Variation of the Venous Drainage of Carotid Cavernous Sinus Fistula

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Introduction

There have been many reports of carotid cavernous sinus fistula (CCF) since Travers' [16] report in 1811. Recently, with the advent of major advances in the technology of interventional neurosurgery, endovascular embolization has become the first choice for the treatment for both direct CCF and indirect CCF.

Furthermore, it is necessary to know the vascular structure and haemodynamics preoperatively. We examined 44 CCF cases for the clinical findings, shunt sites and venous drainages.

Material and Methods

44 CCF cases including five traumatic CCF and 39 spontaneous CCF were examined angiographically.5 cases were direct ones and 39 cases were indirect ones.There were 7 men and 37 women.Their age was ranged from 20 to 77 years (mean 61,7 years).

In the CCF, the possible venous drainage was the superior drainage to the sylvian vein, anterior drainage to the ophthalmic vein, posterior drainage to the petrosal sinus and inferior drainage to the pterygoid plexus. Typical cortical drainage to the sylvian vein was originated from the superior anterior cavernous sinus. We had the cases with the atypical cortical drainage and classified them into two groups.

One was the superior reflux variation and another one was posterior reflux variation. Superior reflux variation means the drainage to the sylvian vein originated from the posterior cavernous sinus or ophthalmic vein and drainage to the temporal cortical veins via uncal vein and so on. Posterior reflux variation means the drainage to the posterior fossa veins via the petrosal sinus and petrosal vein and drainage to the perimesencephalic veins originated from the posterior cavernous sinus or inferior petrosal sinus.

Results

The fistulas manifested with chemosis and/or proptosis in 39 cases, the third nerve palsy and/or sixth nerve palsy in 25 cases, the fifth nerve palsy in 4 cases, tinnitus in 3 cases and haemorrhagic infarction in one case.

The shunt was located in anterior cavernous sinus in 3 cases and posterior cavernous sinus in 36 cases.

In the direct CCFs cases, shunt site was located in C4 portion of the ICA in three cases, C5 portion in one and C3-C4 portion in one.

The cortical reflux was recognized in 21 cases out of 44 cases. In these 21 cases, the typical cortical reflux was seen in 10 cases and the atypical cortical reflux in 11 cases.

The superior reflux variation was seen in 8 cases and the posterior reflux variation to in 7 cases.

Among 8 cases of superior reflux variation, the reflux to the sylvian vein originated from posterior cavernous sinus was recognized in one case, the reflux to the sylvian vein originated from the ophthalmic vein in one case, the reflux to the temporal lobe through the uncal vein or the deep sylvian vein in 5 cases and the reflux to the basal vein of

Rosenthal through the deep sylvian veinin 5 cases. Among 7 cases of posterior reflux variation, the reflux to the posterior fossa via the petrosal vein from the superior petrosal sinus was recognized in 2 cases, the reflux to the perimesencephalic vein from the inferior petrosal sinus in 3 cases, and the reflux to the perimesencephalic vein from the posterior cavernous sinus in 3 cases.

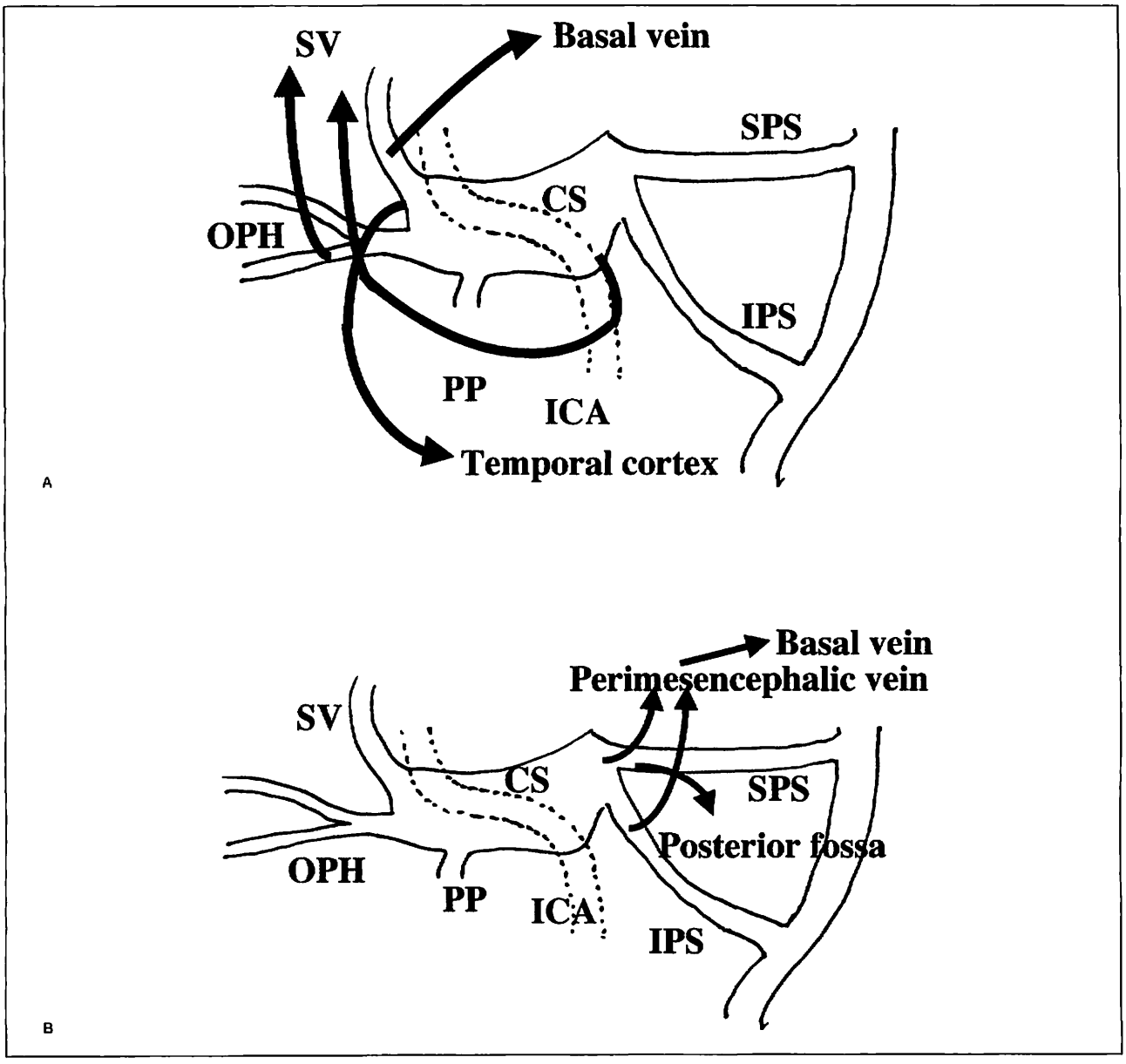

Figure 1 Schematic drawing showing the atypical superior reflux variation (A) and atypical posterior reflux variation (B) (CS: cavernous sinus, ICA: internal carotid artery, IPS: inferior petrosal sinus, OPH: ophthalmic vein, PP: pterygoid plexus, SV: sylvian vein).

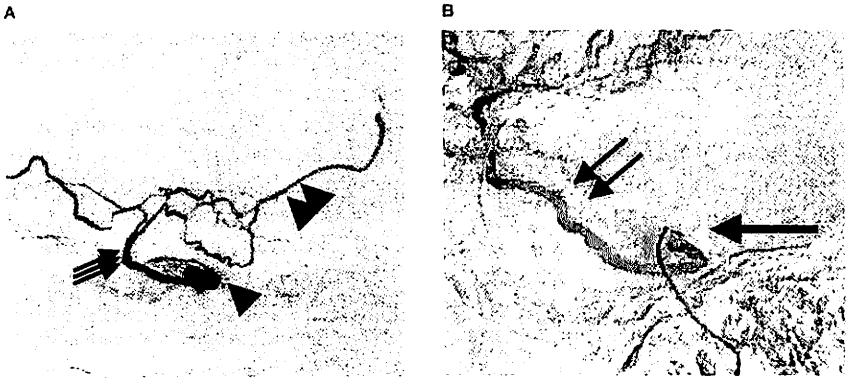

Figure 2 Cavernous sinus venogram on the left side (A: lateral view) showing the deep sylvian vein (triple arrows) originating from the posterior cavernous sinus (single arrow) and draining to the olfactory vein and the basal vein of Rosenthal (double arrowheads). Cavernous sinus venogram on the right side (B: lateral view) showing the superficial sylvian vein (double arrows) originating from the posterior cavernous sinus (arrow).

Representative Cases

Case 1

A 70-year-old woman was admitted with bilateral chemosis for one year. Neurological findings revealed swelling of the right eyelids, conjunctival chemosis on both sides, and the third nerve palsy on the right side.

The angiogram disclosed the dural CCF fed by right meningohypophyseal trunk of the internal carotid artery and right ascending pharyngeal artery and drained to right ophthalmic vein and right superficial sylvian vein.

The shunt site was the posterior cavernous sinus. Additionally, the angiography also showed the dural CCF fed by left meningohypophyseal trunk of the internal carotid artery and left ascending pharyngeal artery.

The drainage routes were the left ophthalmic vein and deep sylvian vein to the olfactory vein and the basal vein of Rosenthal.

Cavernous sinus venogram on the left side showing the deep sylvian vein (triple arrows) originated from the posterior cavernous sinus and drained to the olfactory vein and the basal vein of Rosenthal (figure 2A).

The microcatheter was inserted into the origin of left deep sylvian vein and this portion was occluded with Interlocking detachable coils (IDCs) (Target Therapeutics, Fremont, Calif., U.S.A.).

Afterwards, the microcatheter was advanced the origin of left ophthalmic vein. After occlusion of this artery with IDCs, coil packing of cavernous sinus was achieved and the left dural CCF disappeared. 10 days later, the embolization for right dural CCF was performed. The microcatheter was inserted into the posterior cavernous sinus on the right side.

Cavernous sinus venogram on the right side disclosed the superficial sylvian vein originated from the posterior cavernous sinus (figure 2B) and perimesencephalic vein originated from the posterior cavernous sinus with reflux to the basal vein of Rosenthal.

The coil packing of the right cavernous sinus after the occlusion of the origin of the right superficial sylvian vein and the origin of the right ophthalmic vein with IDCs were performed. The right dural CCF disappeared.

Figure 3 External carotid angiogram on the right side showing the sylvian vein originating from the proximal portion of the ophthalmic vein (arrow).

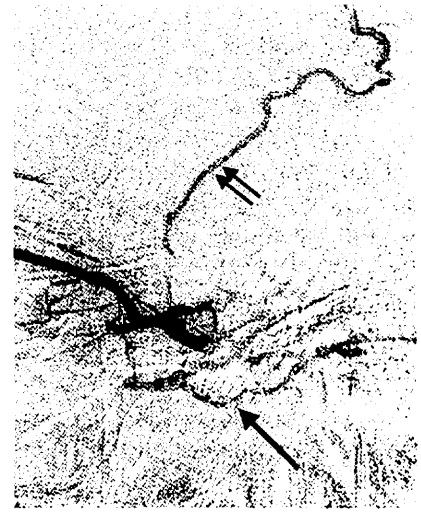

Figure 4 Cavernous sinus venogram on the right side (lateral view) showing the reflux to the temporal cortex (arrow) and the basal vein of Rosenthal via the deep sylvian vein (double arrows).

Figure 5 Common carotid angiogram on the right side (lateral view) showing the reflux to the posterior fossa via the superior petrosal sinus and the petrosal vein (arrow).

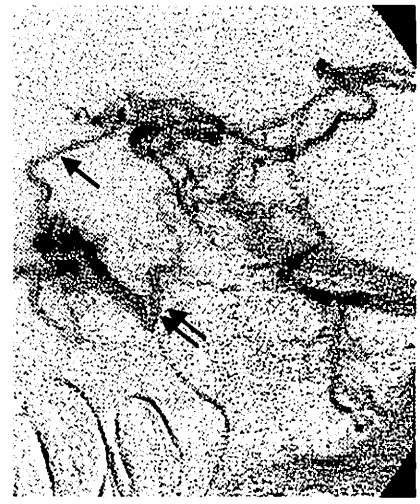

Figure 6 Cavernous sinus venogram on the right side showing the reflux to the perimesencephalic vein originating from the posterior cavernous sinus (arrow) and the inferior petrosal sinus (double arrows).

Case 2

A 60-year-old woman was admitted with a conjunctival chemosis of the right eye and diplopia.

Neurological findings revealed conjunctival chemosis of the right eye and right 6th nerve paralysis. Right external carotid angiogram disclosed the dural CCF fed by right middle meningeal artery,

right accessory meningeal artery and drained to the right ophthalmic vein and the sylvian vein.

The shunt site was posterior cavernous sinus. Right superficial sylvian vein was originated from the proximal portion of the right ophthalmic vein and also drained into the anastomotic vein of Labbe. (figure 3)

Case 3

A 60-year-old woman was admitted with an intermittent right orbital pain for eight months.

Neurological findings revealed the conjunctival chemosis of the right eye and right exophthalmos. Cerebral angiogram disclosed the right dural CCF fed by the bilateral meningohypophyseal trunks of the ICA, the bilateral ascending pharyngeal arteries, the right artery of the foramen rotundum, the right accessory meningeal artery, and the right middle meningeal artery.

The drainege route were the right superior ophthalmic vein, right superficial sylvian vein, and the right deep sylvian vein to temporal cortex and basal vein of Rosenthal.

The shunt site was posterior cavernous sinus.

Cavernous sinus venogram (figure 4) on the right side disclosed the reflux to the temporal cortex and the basal vein of Rosenthal via the deep sylvian vein.

The coil packing of cavernous sinus was performed after occlusion of the origin of the right ophthalmic vein and the right sylvian vein with IDCs.The dural CCF disappeared.

Case 4

A 78-year-old woman was admitted with a conjunctival chemosis of the right eye for two weeks.

Neurological findings revealed the conjunctival chemosis of the right eye, the right 6th nerve palsy and the right retroocular synchronous bruit with pulse.

Cerebral angiogram disclosed the dural CCF fed by the bilateral middle meningeal arteries, the bilateral accessory middle meningeal arteries, the bilateral arteries of foramen rotundum, and the meningohypophyseal trunks of the ICA and drained to the right ophthalmic vein and right sylvian vein. The shunt site was posterior cavernous sinus.

The common carotid angiogram on the right side disclosed the reflux to the posterior fossa via the superior petrosal sinus and the petrosal vein (figure 5).

Embolization from the bilateral external carotid artery systems with PVA particles was performed.Afterwards, the patient was followed up.

Case 5

A 71-year-old woman was admitted with the right exophthalmos and the right conjunctival chemosis for six months.

Transarterial embolization was performed. The symptom dissolved.

But the right exophthalmos and the right conjunctival chemosis appeared again 3 months ago.

Neurological findings revealed the right exophthalmos and the right conjunctival chemosis.

Cerebral angiograms revealed the dural CCF fed by the right artery of the foramen rotundum, the right accessory meningeal artery, the right middle meningeal artery and the left meningohypophyseal trunk of the ICA and drained to the right ophthalmic vein.

The shunt site was the posterior cavernous sinus.

The right cavernous sinus venogram disclosed the reflux to the perimesencephalic vein originated from the posterior cavernous sinus and the inferior petrosal sinus (figure 6).

The transvenous embolization with IDCs of the posterior cavernous sinus was performed followed by transarterial embolization with PVA particles to the right accessory meningeal artery.

Discussion

To date, a lot of CCF cases were reported in the literature.

About 65,5% of the reported CCF cases were traumatic, and 23,3% were dural. 10-60% of indirect CCF dissolved spontaneously[3,9,11,13,18].

Most cases presented the conjunctival chemosis and/or proptosis. 56 cases with intracranial haemorrhage (about 1,6%) were reported in the literature.

Most cases with intracranial haemorrhage (76,8%) were traumatic CCF with high flow shunt, and only 9 cases (16,1%) including our case were dural one with low flow shunt[2,5,7,10,14,17].

Although some authors described the therapeutic indication of CCF were progressive visual disturbance, aggravation of secondary glaucoma, intolerable eye pain or tinnitus, progressing cranial nerve palsy and the cortical reflux[1,6], only 1,6% of CCFs present with intracranial haemorrhage.

The sylvian vein or sphenoparietal sinus flows into anterior cavity of cavernous sinus generally.

But there are some anomalous origin of the sylvian vein and some cortical reflux to the temporal lobe through the uncal vein. We termed these variations "the superior reflux variation".

Moreover, there are some cortical refluxes to the posterior fossa through the superior petrosal sinus and the petrosal vein and some perimesencephalic veins originated from the posterior cavernous sinus or the inferior petrosal sinus.

We termed these refluxes "posterior reflux variation". The affer-

ent and efferent veins are the ophthalmic vein, the sphenoparietal sinus, the sylvian vein, the superior petrosal sinus and the inferior petrosal sinus.

In the atypical cortical reflux we named in this paper, the perimesencephalic veins originated from the posterior cavernous sinus or the inferior petrosal sinus and the routes to the basal vein of Rosenthal seemed to exist normaly, but were hard to be demonstrated in usual angiography.

With advance of the interventional neuroradiology, occlusion of the fistula with the detachable balloon by the transarterial approach for traumatic CCF s and the feeder embolization with the particles and/or coils by the transarterial approach and/or the coil embolization by the transvenous approach for indirect CCFs become to be the treatment of choice.

Transvenous embolization for indirect CCF is the main treatment because it is curative and safe. But the flow diversion might induce the venous infarction or intracranial haemorrhage when the main drainage was occluded and the shunt was remained without complete packing of the cavernous sinus. Sinuluoto [12] reported slight residual flow through the fistula does not appear to be a definite indication to place more coils because the small residual fistula had closed completely by follow-up angiography in his cases who had minimal residual flow at the termination of the procedure.

On the other hand, 3 cases with the complication by flow diversion with incomplete occlusion were reported in the literature.

Halbach [4] reported a case of a direct CCF draining to the cortical vein, superior ophthalmic vein, and inferior petrosal sinus with Ehlers-Danlos syndrome. 4 days after marked reduction in fistula flow to the superior ophthalmic vein, but slight increase cortical venous drainage by transvenous balloon occlusion, the patient developed the fatal pontine haemorrhage, presumbly from diversion of arterialized fistula drainage to the fragile, collagen-deficient posterior fossa veins.

Nakahara [8] reported one case with brainstem infarction by flow diversion to the posterior fossa in which the shunt and the drainage to the superior petrosal sinus was remained due to the incomplete occlusion out of his 40 spontaneous CCFs. Teng [15] reported one case of the traumatic CCF treated with transvenous coil embolization via superior ophthalmic vein approach developed the brain stem edema by venous hypertension 5 days after the procedure with smaller and remaining fistula flow. In the case with the posterior variation and the shunt site in the posterior cavernous sinus, it is necessary to occlude the posterior component after occlusion of the ophthalmic vein and the sylvian vein. In the case with the superior reflux variation, we should pay attention to the existence of anomalous origin of the sylvian vein and the reflux to the temporal cortex during the embolization. Attention should be paid to the shunt site and the venous drainage as flow diversion could cause the deterioration of the flow pattern by incomplete occlusion in the cases of transarterial embolization with detachable balloon for the direct CCFs and transvenous embolization with coils for the indirect CCFs.

Conclusions

We recognized the atypical cortical reflux such as "the superior reflux variation" and "the posterior reflux variation" in the cortical reflux of CCFs.

Attention should be paid to the shunt site and the venous drainage pattern during the embolization for the CCFs.

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