

Tentorial artery embolization in tentorial dural arteriovenous fistulas

Willem Jan van Rooij · Menno Sluzewski ·
Guus N. Beute

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Abstract

Introduction The tentorial artery is often involved in arterial supply to tentorial dural fistulas. The hypertrophied tentorial artery is accessible to embolization, either with glue or with particles.

Methods Six patients are presented with tentorial dural fistulas, mainly supplied by the tentorial artery. Two patients presented with intracranial hemorrhage, two with pulsatile tinnitus and one with progressive tetraparesis, and in one patient the tentorial dural fistula was an incidental finding. Different endovascular techniques were used to embolize the tentorial artery in the process of endovascular occlusion of the fistulas.

Results All six tentorial dural fistulas were completely occluded by endovascular techniques, confirmed at follow-up angiography. There were no complications. When direct catheterization of the tentorial artery was possible, glue injection with temporary balloon occlusion of the internal carotid artery at the level of the tentorial artery origin was effective and safe.

Conclusion Different endovascular techniques may be successfully applied to embolize the tentorial artery in the treatment of tentorial dural fistulas.

Keywords Tentorial dural fistula · Tentorial artery · Embolization

Introduction

Tentorial dural fistulas almost invariably derive portions or all of their vascular supply from dural arteries originating from the internal carotid artery [1–4]. The meningo-hypophyseal trunk originates from the posterior aspect of the cavernous segment of the carotid artery (C5) and supplies the tentorial dura by the tentorial artery of Bernasconi and Cassinari. The dural branches arising from the C4 segment of the internal carotid artery are known collectively as the inferolateral trunk. Lateral clival dural branches may arise from the petrous portion of the internal carotid artery.

Normally these small dural branches are not visible on angiography but when pathologic conditions such as dural arteriovenous fistulas or meningiomas are supplied, these small branches may become hypertrophic and amenable to catheterization and embolization [4].

In the present study we report our experience with embolization of the tentorial artery in six patients with tentorial dural fistulas using different techniques.

Patients and methods

Between 1995 and 2005, 64 patients with intracranial dural arteriovenous fistulas were treated with endovascular or combined endovascular and surgical techniques. Of these patients, 11 harbored tentorial dural fistulas and 6 of these patients were treated with embolization of the tentorial artery. The characteristics of the six patients are summarized in Table 1. There were four men and two women aged 37–78 years. Two patients presented with intracranial hemorrhage, two with pulsatile tinnitus and one with progressive tetraparesis, and in one patient the tentorial dural fistula was an incidental finding. All six tentorial dural fistulas were cured by endovascular techniques.

W. J. van Rooij (✉) · M. Sluzewski
Department of Radiology, St. Elisabeth Ziekenhuis,
Hilvarenbeekseweg 60,
5022 GC Tilburg, The Netherlands
e-mail: radiol@knmg.nl

G. N. Beute
Department of Neurosurgery, St. Elisabeth Ziekenhuis,
Tilburg, The Netherlands

Table 1 Patient and treatment characteristics of six patients with tentorial dural fistula and embolization of the tentorial artery with different techniques

Patient no.	Gender	Age (years)	Clinical presentation	Arterial supply	Embolization technique	Result
1	M	37	Intracerebral hemorrhage	Tentorial artery	Coil	Complete cure
2	M	52	Intraventricular hemorrhage	Tentorial artery	Glue with balloon occlusion of ICA	Complete cure
3	M	43	Incidental	Inferolateral trunk Occipital artery Middle meningeal artery Tentorial artery	None Glue Glue Glue with balloon occlusion of ICA	Complete cure
4	M	70	Pulsatile tinnitus	Occipital artery Tentorial artery	Glue Particles with balloon occlusion of ICA	Complete cure
5	F	78	Tetraparesis (perimedullary venous drainage)	Tentorial artery	Balloon occlusion of ICA at origin of tentorial artery	Angiographic cure, clinical improvement
6	F	50	Pulsatile tinnitus	Tentorial artery left Tentorial artery right	Glue with balloon occlusion of ICA None	Complete cure

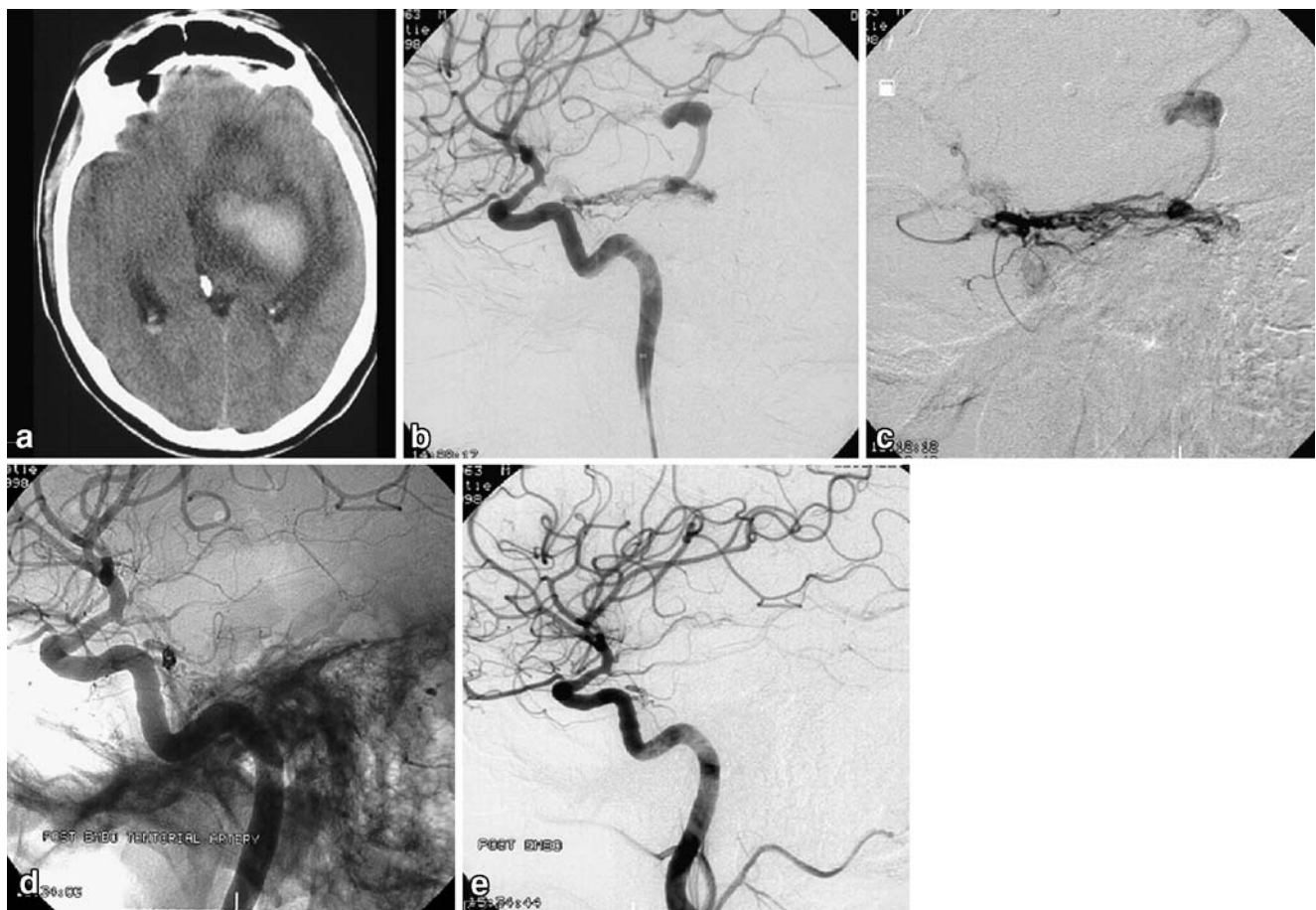


Fig. 1 Patient 1: 37-year-old man with intracerebral hematoma and tentorial dural fistula. **a** CT scan shows large deep hematoma. **b** Right internal carotid angiogram demonstrates tentorial dural fistula supplied exclusively by a hypertrophic and multiple tentorial artery. **c** Contrast

agent injection through a microcatheter into the proximal common trunk of the tentorial artery shows the fistula. Note reflux into the internal carotid artery. **d, e** Native and subtracted angiograms show coil in proximal tentorial artery and occlusion of the fistula

Case 1

A 37-year-old man suddenly collapsed and CT scanning showed a large deep intracerebral hematoma. After 2 weeks the hematoma was partially resorbed (Fig. 1a) and he was referred to our institution. Angiography revealed a right tentorial dural fistula with exclusive arterial supply by the hypertrophic and multiplied tentorial artery (Fig. 1b). A microcatheter (Excelsior 10, Boston Scientific, Fremont, Calif.) was navigated into the proximal common trunk of the tentorial artery. When contrast agent was injected, reflux was noted into the internal carotid artery (Fig. 1c) and glue injection was judged too dangerous. At that point it was decided to deposit a small coil (GDC 10 Ultrasoft 2 mm, 4 cm) in the common trunk. This completely occluded the tentorial artery and thus the supply to the fistula (Fig. 1d,e). Follow-up angiography 3 months later confirmed lasting complete occlusion of the dural fistula.

Case 2

A 52-year-old man was admitted with an intraventricular hemorrhage. Angiography revealed a tentorial dural

Fig. 2 Patient 2: 70-year-old man with pulsatile tinnitus and tentorial dural fistula. **a** Tentorial dural fistula supplied by the tentorial artery and the inferolateral trunk. **b** Microcatheter in the origin of the tentorial artery. **c** Road map image after glue injection and withdrawal of the microcatheter. The occlusion balloon is still in place. Glue has penetrated deep into the vein. **d** Complete closure of the fistula



fistula with arterial supply from the tentorial artery and the inferolateral trunk and draining into a lateral brain stem and cerebellar vein (Fig. 2a). No other dural supply was involved. A microcatheter (Excelsior 10, Boston Scientific) was positioned in the tentorial artery (Fig. 2b). An occlusive balloon (Sentry 15 mm, Boston Scientific) was positioned in the internal carotid artery (ICA) in front of the origin of the tentorial artery (Fig. 2c) for the following reasons: first, the balloon stabilized the microcatheter, second, flow control was obtained, and third, reflux into the ICA was prevented. After flushing the microcatheter (and fistula) with 5% glucose solution, a mixture of 30% glue (Histo-acryl, Braun, Melsungen, Germany) and 70% iodinated oil (Lipiodol, Guerbet, Roissy, France) was slowly injected and penetrated deep into the draining vein (Fig. 2c). Complete occlusion of the fistula (Fig. 2d) was confirmed at follow-up angiography 3 months later.

Case 3

A 43-year-old man was referred to our institution for angiography. On a MRI performed for headaches, dilated

abnormal vessels in the right cerebellopontine angle were noted. Angiography showed a dural fistula with supply from the tentorial artery, lateral clival dural branches (Fig. 3a), middle meningeal artery and occipital artery (Fig. 3b) and draining into dilated lateral brain stem veins. The supply from the occipital artery and middle meningeal artery was embolized with glue but there was no penetration into the veins. A microcatheter (Excelsior 10, Boston Scientific) was positioned in the tentorial artery with control of flow and reflux by an occlusion balloon (Fig. 3c). Subsequently, a mixture containing 30% glue was injected and penetrated into the draining veins. This resulted in complete occlusion of the fistula, confirmed by angiography 3 months later (Fig. 3d).

Case 4

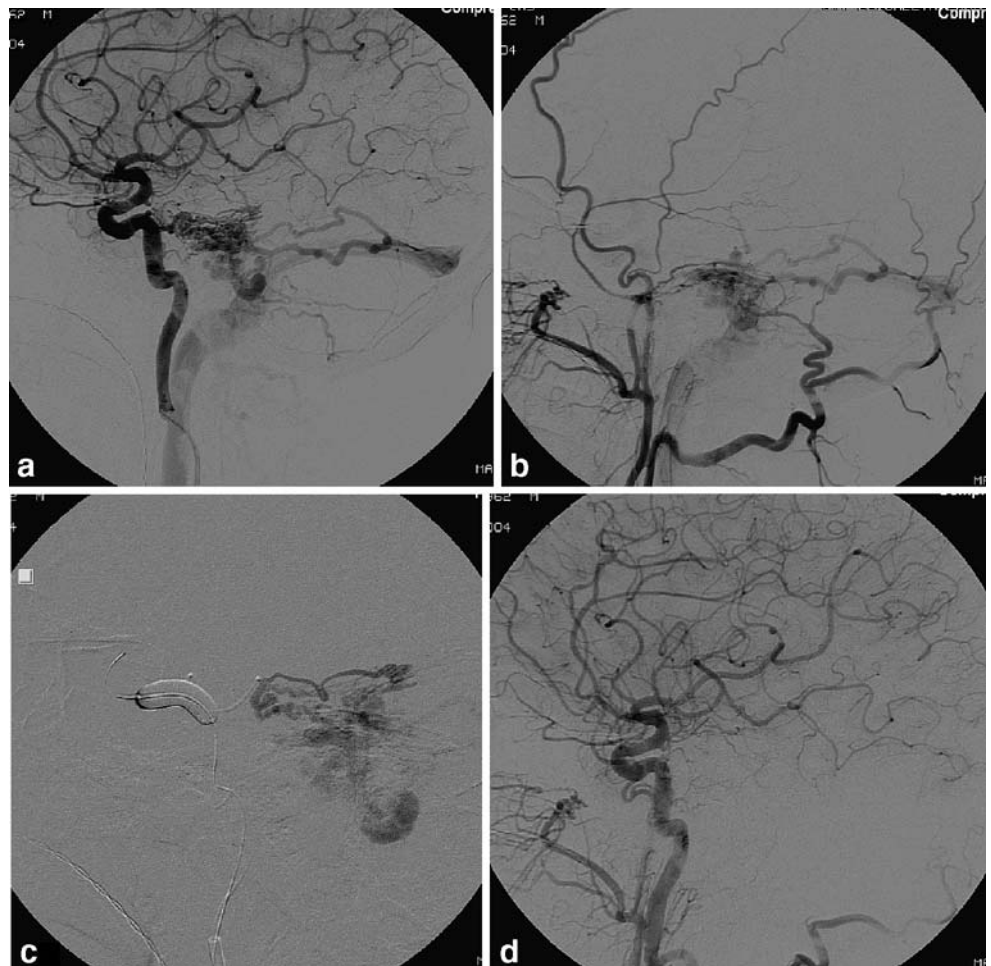
A 70-year-old man was referred to our institution with a tentorial dural fistula diagnosed on angiography performed for pulsatile tinnitus. The arterial supply was via the tentorial artery, the occipital artery and the middle meningeal artery and drainage via the basal vein of Rosenthal into

the vein of Galen (Fig. 4a,b). The supply from the occipital artery was embolized with glue (Fig. 4c). This resulted in partial penetration of the venous drainage with the remaining supply from the tentorial artery. Selective catheterization of the tentorial artery was impossible. The ICA was temporarily occluded with a balloon (Sentry 15 mm, Boston Scientific) just distal to the origin of the tentorial artery after administration of 5,000 U heparin. Via a microcatheter (TurboTracker, Boston Scientific) positioned just in front of the origin of the tentorial artery, particles (Contour SE 150–250, Boston Scientific) were injected until the artery was occluded (Fig. 4d). After a vigorous flush of the ICA with saline through the guiding catheter to redirect remaining particles into the external carotid artery, the balloon was deflated. Complete occlusion of the fistula was confirmed at follow-up angiography 3 months later (Fig. 4e). The pulsatile tinnitus was cured immediately after embolization.

Case 5

A 78-year-old woman with a history of cardiac disease presented with gradually progressive tetraparesis. MRI

Fig. 3 Patient 3: 43-year-old man with an incidentally discovered tentorial dural fistula. **a, b** Tentorial dural fistula supplied by the tentorial artery (**a**), occipital artery and middle meningeal artery (**b**). **c** Angiogram via a microcatheter in the tentorial artery and balloon occlusion of the ICA. From this point glue was injected with deep penetration into the veins. **d** Follow-up angiogram 3 months later demonstrates complete closure of the fistula



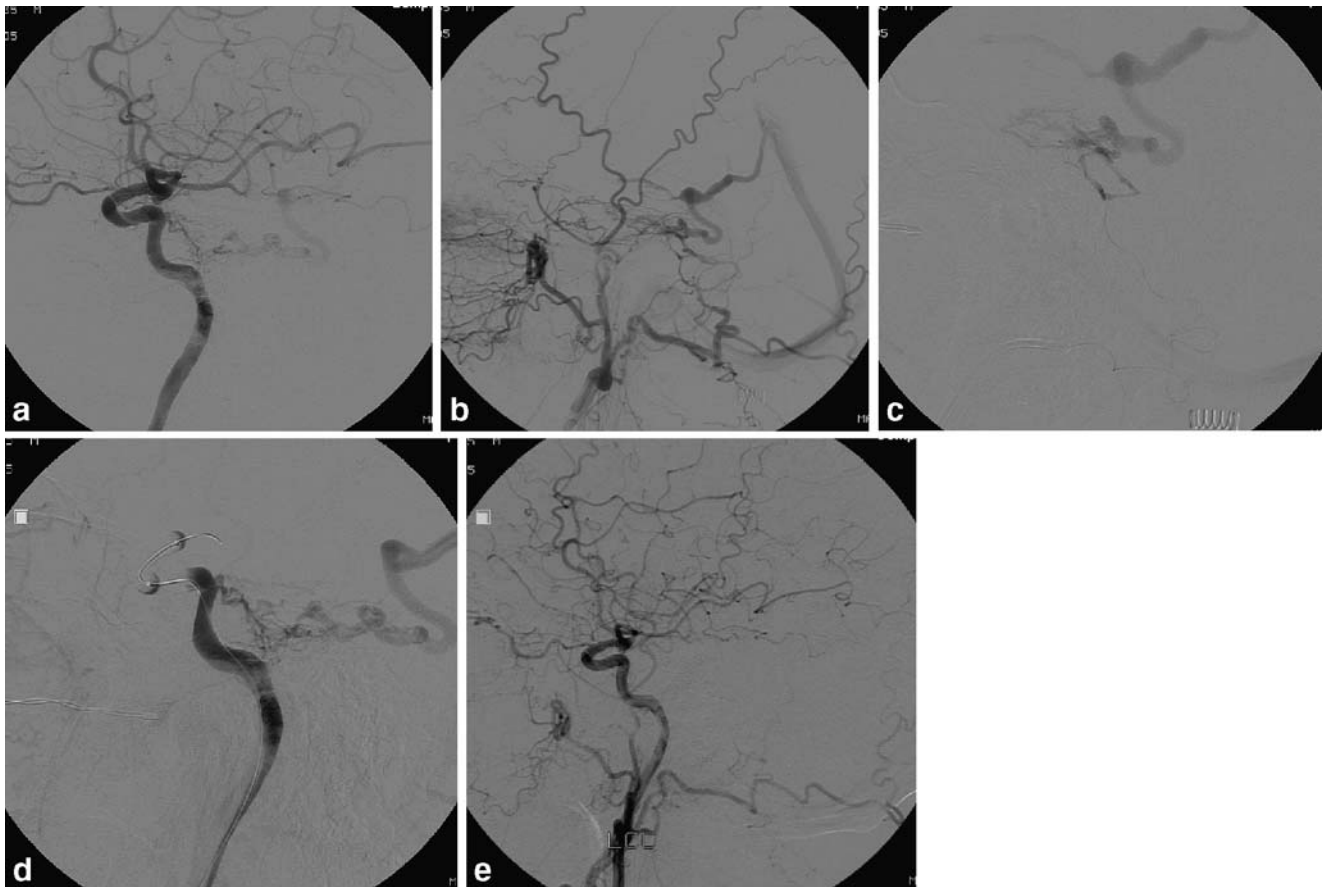


Fig. 4 Patient 4: 70-year-old man with pulsatile tinnitus and tentorial dural fistula. **a, b** Right internal (**a**) and external (**b**) carotid angiograms show a tentorial dural fistula supplied by the tentorial artery and branches of the occipital artery and with drainage to the deep venous system. **c** Microcatheter in the feeder from the occipital artery. Glue was injected but failed to penetrate the vein. **d** Right

internal carotid angiogram with balloon occlusion distal to the origin of the tentorial artery demonstrates outflow through the tentorial artery. A microcatheter was positioned in front of the tentorial artery origin and particles injected. **e** Common carotid angiogram demonstrates complete occlusion of the fistula

showed cervical central myelopathy (Fig. 5a), and angiography revealed a tentorial dural fistula with perimedullary venous drainage exclusively supplied by the right tentorial artery (Fig. 5b). Tortuosity of brachiocephalic vessels precluded positioning of a microcatheter and selective catheterization of the tentorial artery. Surgery was impossible due to poor cardiopulmonary status. Since the patient had a strong wish for treatment of the progressive tetraparesis, we decided to block the origin of the tentorial artery with a detachable balloon positioned in the ICA in the hope that the fistula would be occluded. This implied permanent occlusion of the ICA. A flow-directed detachable balloon (Goldvalve no. 16, Nycomed, Paris) was navigated into the ICA at the level of the origin of the tentorial artery (Fig. 5c). Angiographic test occlusion showed tolerance to permanent ICA occlusion [5] and the balloon was detached. In the following weeks a gradual clinical improvement was noted and MRI showed a decrease in central myelopathy (Fig. 5d). Four months after treatment she was found dead in bed; autopsy was refused.

Case 6

A 50-year-old woman presented with slowly progressive right-sided ophthalmoplegia. Lately she had noticed pulsatile tinnitus. On MRI a partially thrombosed giant fusiform aneurysm of the petrous and cavernous segment of the right ICA was apparent. Angiography showed, besides the aneurysm, a tentorial dural fistula supplied by both the right and left tentorial artery only and draining via a lateral pontomesencephalic vein into the right basal vein of Rosenthal. A microcatheter (Excelsior 10, Boston Scientific) was positioned into the left tentorial artery and, with flow and reflux controlled with an occluding balloon, a mixture containing 30% glue was injected with good penetration into the draining vein. Subsequent left and right internal and external carotid angiography showed complete closure of the fistula. In the same session, the right ICA was permanently occluded with a detachable balloon after angiographic test occlusion had shown tolerance [5] as a therapy for the giant fusiform carotid aneurysm. Immediately following emboli-

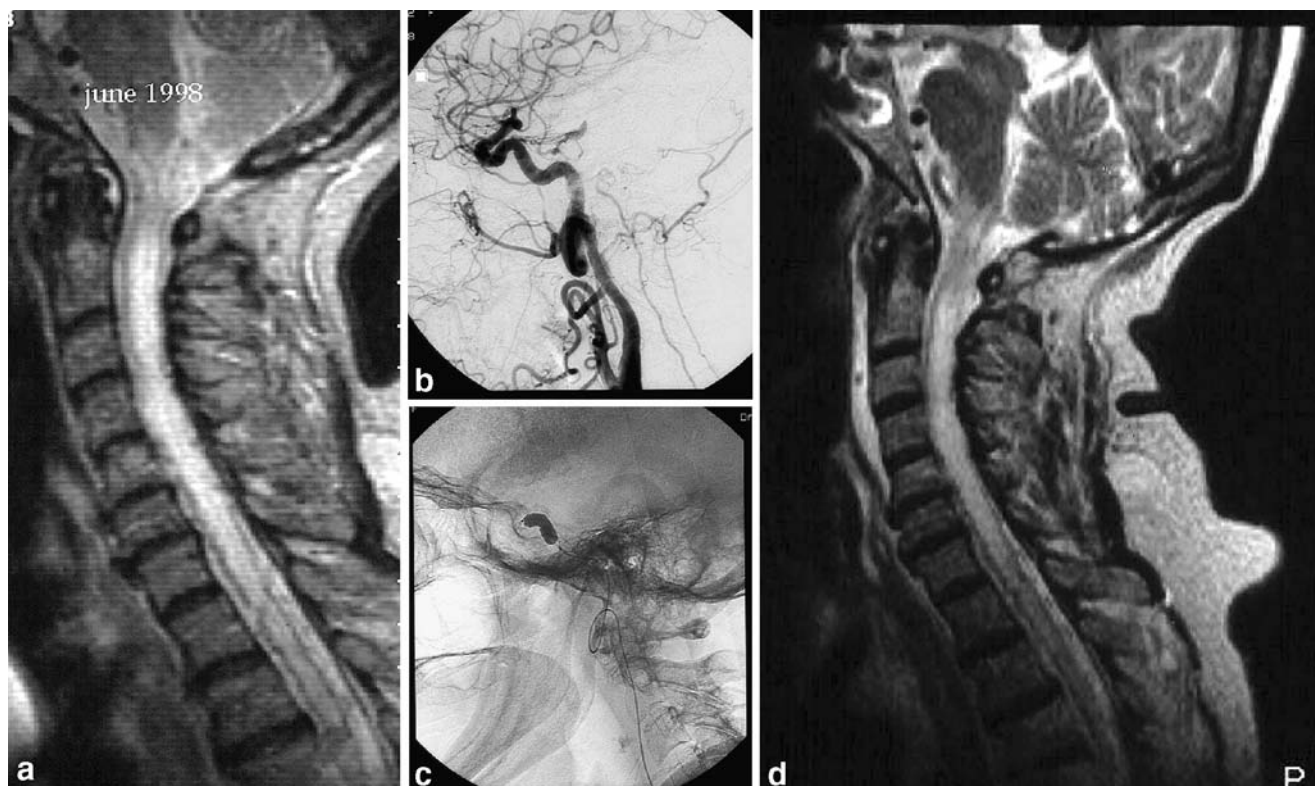


Fig. 5 Patient 5: 78-year-old woman with progressive tetraparesis and tentorial dural fistula with perimedullary venous drainage. **a** MRI shows extensive cervical myelopathy. **b** Right internal carotid angiogram demonstrates tentorial dural fistula supplied by the tentorial artery and exclusive perimedullary venous drainage. Additional angiography of the left carotid and vertebral arteries failed to identify

additional arterial supply to the fistula. **c** Detachable balloon positioned at the origin of the tentorial artery. Angiographic test occlusion demonstrated tolerance to permanent occlusion and the balloon was detached. **d** MRI 4 days after right ICA occlusion reveals decrease of extent of cervical myelopathy. Clinically there was improved strength in both arms

zation the pulsatile tinnitus was cured. Gradually the ophthalmoplegia improved. Follow-up angiography 3 months later showed persistent occlusion of the dural fistula.

Discussion

Our small series of patients with tentorial dural fistulas demonstrates the feasibility of embolization of the tentorial artery in this condition. If a microcatheter could be positioned in the tentorial artery, we found the technique of glue injection with balloon occlusion of the ICA at the level of the tentorial artery origin effective and safe: the balloon stabilizes the microcatheter and blocks the inflow of blood thereby providing flow control and preventing reflux of glue into the ICA. After flushing the microcatheter (and the arterial and venous side of the fistula) with 5% glucose solution, the glue will only slowly solidify and can be “pushed” into the draining veins thereby occluding the fistula. Although the oculomotor and trochlear nerves may derive blood supply from the tentorial artery, occlusion of small supplying vessels is unlikely with the viscous mixture of glue and iodinated oil

as embolic agent and these nerves were not damaged in our patients. When the tentorial artery is the only feeding vessel to the fistula as in our patient 4, placing a coil in the origin of the tentorial artery may result in closure of the fistula. Proximal occlusion of the tentorial artery can also be obtained by placement of a detachable occlusion balloon in the ICA at the level of the tentorial artery origin, as in patient 5. However, this implies sacrifice of the carotid artery and can only be performed when angiographic test occlusion shows tolerance to permanent occlusion [5]. When catheterization of the tentorial artery is impossible, the ICA can be temporarily occluded with a balloon at a level distal to the tentorial artery origin. Outflow will be via the tentorial artery only and particles can be injected that flow into the tentorial artery until the vessel is occluded. It is important to flush the occluded ICA vigorously through the guiding catheter before deflating the balloon to redirect remaining particles to the external carotid artery territory.

An alternative technique in embolizing the vascular territory of the tentorial artery when direct catheterization is impossible is described by Halbach et al. [6]. In this technique, the origin of the tentorial artery is blocked by an

occluding balloon in the ICA with the aim of reducing flow in the fistula. When glue is injected via a collateral supplying artery, the glue will likely better penetrate into the fistula and the draining veins. We have not applied this technique in our patients.

Conclusion

In conclusion, different techniques may be applied to embolize the tentorial artery in the treatment of tentorial dural fistulas. When direct catheterization of the tentorial artery is possible, glue injection with temporary balloon occlusion of the ICA at the level of the tentorial artery origin is effective and safe.

Conflict of interest statement We declare that we have no conflict of interest.

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