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Results of Treatment of Arteriovenous Fistulae with the Debrun Technique

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In a series of 54 caroticocavernous fistulae and eight vertebrovertebral fistulae, clinical cures were obtained in 46 of the caroticocavernous fistulae and in all of the vertebrovertebral fistulae using the Debrun coaxial catheter detachable balloon technique. Most low vertebrovertebral and about half of the posteriorly opening caroticocavernous fistulae were successfully treated by the safe transvenous approach. Technical difficulties were not infrequent but were overcome in most cases. In nine cases the artery was occluded with the fistula and in two others minimal residual shunt persisted, progressing in one to a symptomatic aneurysm. Five caroticocavernous fistulae in which the balloon could not be satisfactorily sited were not closed, and another caroticocavernous fistula closed spontaneously after a failed transvenous approach. Displacement of balloons during detachment reopened two caroticocavernous fistulae. One of these had to be closed by transcranial surgery; the other balloon embolized the middle cerebral artery, was surgically removed, and a mild hemiparesis persisted. Premature balloon detachment in a grossly atheromatous artery caused the only other major complication and contributed to the death of an 87-year-old patient. The most frequent complications were transient ophthalmoplegias. Minor modifications to the catheter system should reduce the incidence of such catastrophes and complications.

The percutaneous coaxial catheter detachable balloon technique [1–3] is now an accepted method for the treatment of caroticocavernous fistulae (CCF) and vertebrovertebral fistulae (VVF). Several published series [4–6] clearly demonstrate that, in the majority of cases, occlusion of a fistula can be achieved with preservation of normal arterial flow. Complications and technical difficulties have been recorded, but their incidence when the procedure is applied in routine practice to substantial numbers of fistulae requires elucidation. Analysis of our material is presented from this aspect.

Materials and Methods

In the past 5 years, occlusion of 54 CCF and eight VVF using the coaxial balloon catheter described by Debrun [2] and supplied by Ingenor, Paris, has been undertaken in the National Hospital for Nervous Diseases and the Middlesex and Great Ormond Street Hospitals, London. The patients were 5–87 years of age. Of those 54 with CCF, 46 had suffered closed head trauma of varying severity, and one had complicated percutaneous trigeminal coagulation. The fistulae were spontaneous in five elderly and two middle-aged patients, one of whom was a diabetic and one of whom suffered from Ehlers-Danlos syndrome. Three of the VVF were in the low cervical region. These all resulted from percutaneous insertion of internal jugular catheters during major surgical procedures. The other five fistulae were at the level fo the atlas. Two of these followed closed trauma and the other three, which occurred in relatively young patients, were spontaneous and apparently congenital.

The fistulae were treated by either the transarterial or the transvenous route. When treating CCF, the ability to withstand carotid compression on the affected side was assessed clinically before the occlusive procedures. All subsequent procedures were performed under general anesthesia. The relatively safe transvenous approach is preferred for anatomically accessible fistulae. This

TABLE 1: **Angiographic Results of Balloon Occlusions**

Fistula Type, Method, and Results			Complications
Caroticocavernous fistula:			
Venous approach:			
Fistula occluded in	2	1	Ophthalmoplegia
Method failed in	2	1	Ophthalmoplegia
Subtotals	4	2	
Arterial approach:			
Fistula occluded in	37	1	Balloon displaced, causing middle cerebral block
		1	Clot embolus
		3	Ophthalmoplegia
Fistula narrowed in	2	1	Aneurysm, with pain
Fistula and carotid occluded in	7*	1	Balloon displaced, fistula reopened
Not merited in	2		
Inadequate collateral in	3	1	Balloon embolus
Subtotals	51†	8	
Totals	54	10	
Vertebrovertebral fistula:			
Venous approach:			
Fistula occluded in	2	0	
Method failed in	1	0	
Subtotals	3	0	
Arterial approach:			
Fistula occluded in	4	0	
Fistula and vertebral occluded in	2	0	
Subtotals	6	0	
Totals	8	0	

* Previous surgical occlusion in one.
† Includes one patient with failed venous approach

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approach generally limits its application to low cervical VVF (three cases in this series), and posteriorly sited CCF draining through dilated inferior petrosal sinuses (four cases in this series). Catheterization from a femoral vein was generally used, but transjugular insertion is equally suitable for CCF.

Femoral catheterization was used for transarterial occlusion of VVF (six cases), and for those 24 new patients with CCF in which a diagnostic angiogram was necessary. In 27 other patients (especially the late middle-aged and elderly), in whom previous angiograms had shown CCF requiring transarterial occlusion, the procedure was generally performed through a sheath introduced percutaneously into the cervical carotid artery.

In 50 cases, including all the VVF and those closed by a transvenous approach, a single balloon inflated with a silicone mixture sufficed to occlude the fistulae. Two balloons were necessary in four cases, three in two cases, and four in one case. In these circumstances only the final balloon occluding the fistula was inflated with silicone; the other ones were filled with isotonic metrizamide.

Results

The angiographic results are summarized in table 1, and the complications and technical difficulties in table 2. The transvenous route involves placing the delivery catheter at the level of the fistula, and advancing the balloon catheter against the blood flow to lie adjacent to the venous opening of the fistula. Septa within the cavernous sinus or the plexiform arrangement of the vertebral veins may prevent satisfactory placement of the distended balloon, so it is not surprising that three of the seven attempts were failures (one CCF became asymptomatic, presumably due to thrombosis after the procedure). The only complications of the transvenous approach were two transient ophthalmoplegias due to pressure palsy of cranial nerve VI. This was associated with full distention of balloons of capacity 0.8 and 1 ml in the posterior part of the cavernous sinus (fig. 1). Two transient cranial-nerve III palsies and one transient combined cranial nerves III and VI palsy occurred in the cases in which transarterial occlusion was achieved with retention of arterial flow. One of these palsies took 6 weeks to resolve.

TABLE 2: **Technical Difficulties Encountered in 62 VVF and CCF Balloon Occlusions**

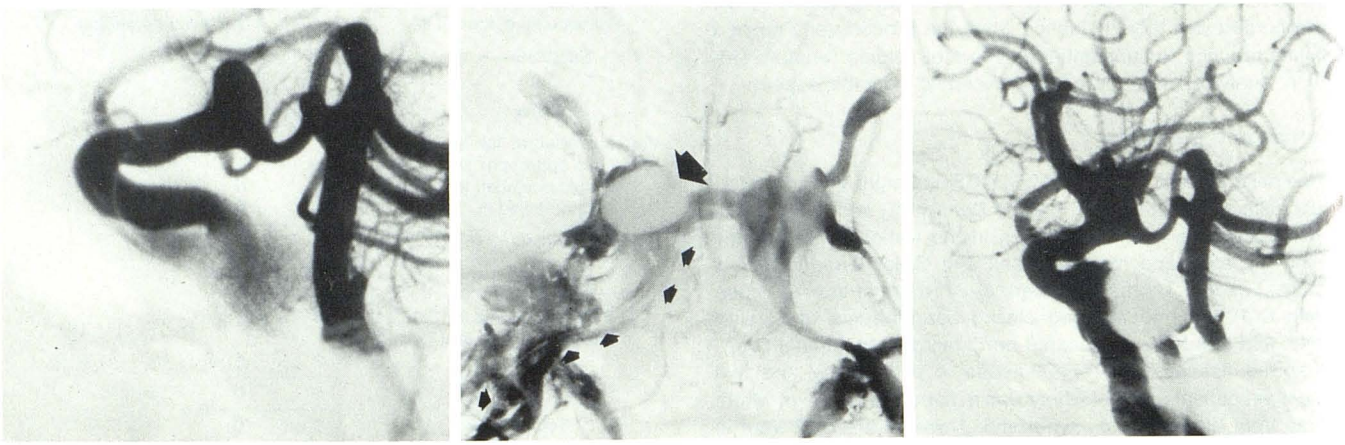
Problem	No.
Unsatisfactory placement of balloon:	
In cavernous sinus	12
In vertebral fistula	1
Rupture of balloon	6
Difficulty in detaching balloon	8
Balloon displaced during detachment	3
Spontaneous detachment of balloon	1
Balloon deflation after detachment	5
Difficulty in deflating balloon	2
Total	38

Note.—In some patients more than one difficulty was encountered. VVF = vertebrovertebral fistula; CCF = caroticocavernous fistula.

Except for occasional minor difficulty with kinking of the thin-walled transfemoral artery delivery catheter, no problems were encountered in placing flow-guided balloons at the level of the fistula. In five VVF and 42 CCF cases the balloons crossed the fistula; however, the latter group contained three posttrauma cases, in one of which the supracloinoid carotid artery had previously been clipped surgically, in which the fistula could only be obstructed if the internal carotid arteries were also occluded. This was probably because the vessels had been severed by the original trauma. In another two of the 42 cases the fistula was incompletely occluded. One of these was symptomatically cured, but the other developed an intracavernous aneurysm associated with intractable facial pain. This condition eventually required treatment by carotid ligation.

The balloons did not cross the fistula in one VVF and nine CCF treated by the transarterial approach. Collateral circulation was inadequate to allow occlusion of the carotid together with the fistula in three of the spontaneous cases. In one young posttrauma case the symptoms were insufficient to merit carotid occlusion. In another, in which the fistula was caused by tearing of a trigeminal artery from its carotid attachment, transient occlusion of the carotid at its entry to the fistula merely resulted in an increase of the trigeminal contribution through the basilar artery (fig. 2). In the other five cases the carotid or the vertebral artery was occluded together with the fistula.

Six balloons ruptured while inflated to less than maximum capacity. This may have been caused by local factors distorting the



A B C

Fig. 1.—Closure of traumatic right CCF by transvenous approach. **A**, Vertebral angiogram shows fistula opening posteriorly in cavernous sinus. **B**, Orbital phlebogram. Catheter (*small arrows*) is visible within right jugular bulb and inferior petrosal sinus, with its tip entering cavernous sinus. Distended balloon (*large arrow*) extends almost across width of sinus. **C**, Carotid angiogram. Balloon almost occludes loculus of cavernous sinus into which fistula opens, leaving minimal residual shunt. Right cranial nerve VI palsy lasting 1 month marred otherwise complete clinical cure.

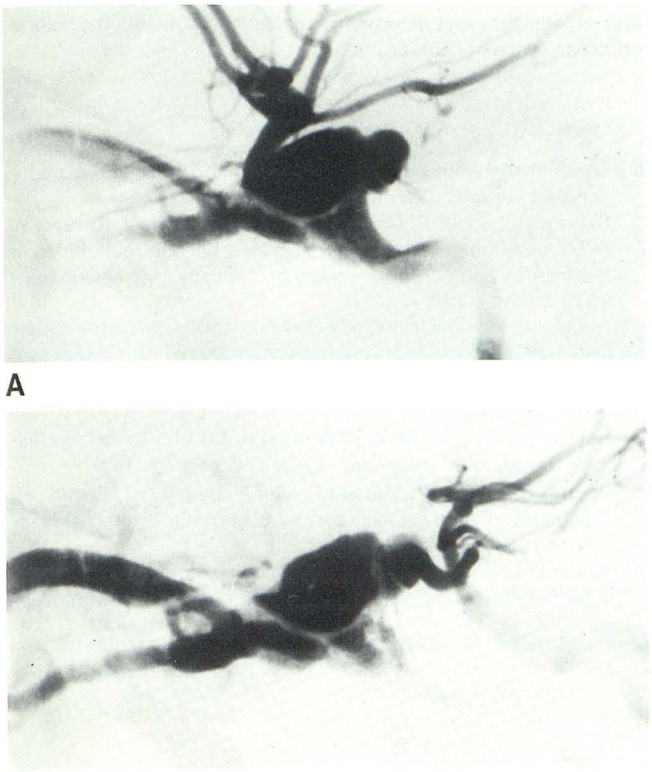


Fig. 2.—Traumatic CCF with trigeminal supply. **A**, Carotid angiogram. Aneurysm projects posteriorly from posterior part of cavernous carotid, leaking into cavernous sinus. Venous drainage mainly anteriorly through ophthalmic veins. **B**, Vertebral angiogram. Trigeminal artery fills aneurysm and fistula. Transcarotid balloons incompletely occluded fistula, even when carotid artery was also occluded. Transvenous siting of balloon failed, and symptoms were not considered serious enough to merit risk of attempt at transvertebral closure.

balloons so that endoluminal pressure was unevenly distributed. In two of these cases fluid silicone mixture was extruded, but no symptoms occurred, and all the ruptured balloons were easily withdrawn.

In eight patients there was difficulty in detaching a balloon, usually because of arterial tortuosity or acute angulation of the balloon catheter as it passed through the fistula. The arterial twisting caused resistance to the passage of the coaxial catheter, which tended to kink the balloon catheter and pull on the balloon. A balloon occluding a high VVF was displaced proximally so that the artery also was occluded, but the clinical result was satisfactory. Another balloon occluding the internal carotid artery and a fistula became displaced, obstructing the artery more proximally and leaving the fistula patent. It was subsequently closed surgically. One posttrauma fistula could be completely occluded with preservation of carotid flow by a balloon wedged through the fistula and placed mainly within the cavernous sinus but projecting into the artery. This balloon was pulled slightly further into the carotid artery during detachment, and then was slowly propelled from the fistula by the carotid flow. It embolized the origin of the middle cerebral artery (fig. 3). The balloon was immediately removed by surgery, and fortunately the patient suffered only a minor residual hemiparesis; however, he is understandably reluctant to allow further attempts at occlusion of his fistula.

Five contrast-filled balloons deflated after detachment within the cavernous sinus, presumably because the neck ligatures were ineffective. Deflation is an obvious source of risk, but these particular balloons caused no complications. In two cases, balloons which had been advanced through a tortuous carotid artery, but could not be placed in a satisfactory position for occlusion of a fistula, proved difficult to deflate, probably due to kinking of the balloon catheter. One was retrieved, but the other detached spontaneously during withdrawal through an atheromatous carotid artery, which suggests that it had been loosened from the catheter during the manipulation necessary to achieve deflation. This elderly patient died after craniotomy for removal of the balloon and closure of the fistula. Finally, in one patient there was a clot embolus that occluded a middle

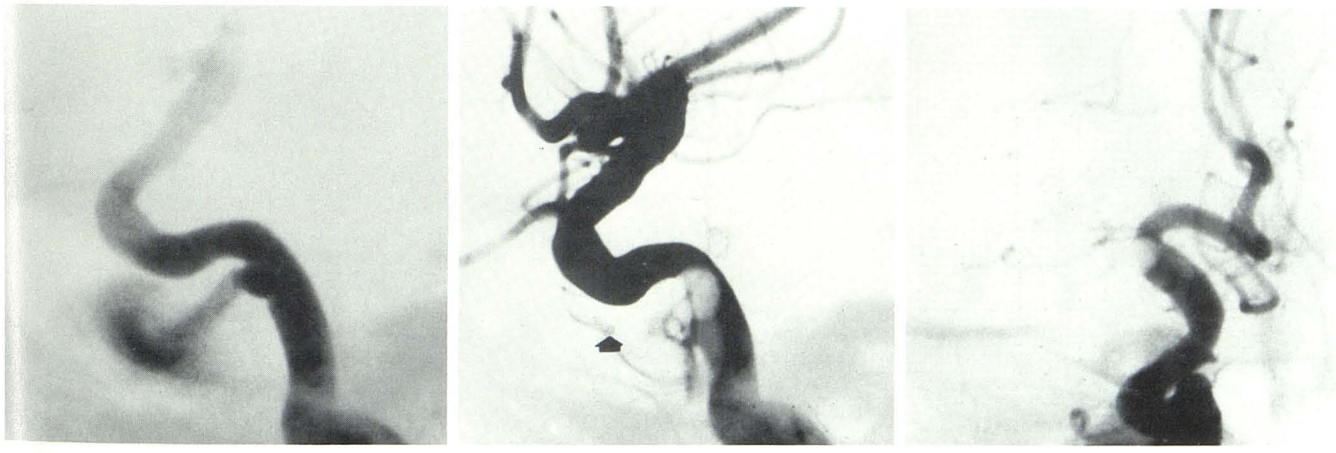


Fig. 3.—Traumatic CCF complicated by cerebral balloon embolus. **A**, Right carotid angiogram. Early film shows traumatic aneurysm projecting anteriorly from posterior cavernous segment, with jet of contrast through fistula into cavernous sinus. **B**, Silicone-filled balloon occluding fistula prior to detachment. Tip of balloon is marked by silver pellet (*arrow*). Most of balloon is in cavernous sinus, but proximal part projects into and narrows carotid artery. **C**, Anteroposterior projection carotid angiogram after detachment. Balloon was displaced proximally to embolize origin of middle cerebral artery, and fistula reopened.

cerebral cortical branch causing transient mild hemiparesis. This unfortunate and avoidable complication occurred early in the series at the end of an otherwise successful procedure, and was due to failure to maintain an adequate perfusion of the carotid sheath.

Discussion

Balloon occlusion is the most satisfactory method of treating arteriovenous fistulae. The clinical results in the present series emphasize this, especially since one of the failures closed spontaneously, and in another the displaced balloon facilitated surgery by occluding the internal carotid artery just proximal to the fistula. In three of the failures, repeat balloon embolization was still applicable.

The necks of balloons vary considerably in size at present. Standardization to a neck narrow enough to grip the catheter firmly should reduce the already uncommon occurrence of spontaneous detachment, and also facilitate satisfactory closure by the elastic ligature. The trial of a flexible coaxial wire in place of the detaching catheter did not prove advantageous; however, a slightly stiffer Teflon balloon catheter tubing has facilitated detachment.

Some of our complications were avoidable, and difficulties have diminished with increasing experience, but we still believe that balloon occlusion should only be performed where neurosurgical cover is available and emergency measures to maintain cerebral perfusion can be instituted.

REFERENCES

1. Serbinenko FA. Balloon catheterization and occlusion of major cerebral vessels. *J Neurosurg* **1973**;41:125–145
2. Debrun G, Lacour P, Caron JP, Hurth M, Comoy J, Keravel Y. Detachable balloon and calibrated leak balloon techniques in treatment of cerebral vascular lesions. *J Neurosurg* **1978**;49:635–649
3. Debrun G, Legre J, Kasbarian M, Tapias PL, Caron JP. Endovascular occlusion of vertebral fistulae by detachable balloons with conservation of the vertebral blood flow. *Radiology* **1979**;130:140–147
4. Berenstein A, Kricheff II, Ransohoff J. Carotid-cavernous fistulas: intraarterial treatment. *AJNR* **1980**;1:449–457
5. Debrun G, Lacour P, Viñuela F, Fox A, Deake CG, Caron JP. Treatment of 54 traumatic carotid-cavernous fistulas. *J Neurosurg* **1981**;55:678–692
6. Peeters FLM, van der Werf AJM. Detachable balloon technique in the treatment of direct carotid-cavernous fistulas. *Surg Neurol* **1980**;14:11