Avoiding intraarterial balloon detachment in the treatment of posttraumatic carotid-cavernous fistulae with detachable balloons.

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Avoiding Intraarterial Balloon Detachment in the Treatment of Posttraumatic Carotid-Cavernous Fistulae with Detachable Balloons

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Since the introduction by Serbinenko [1] of the concept of using detachable balloons to occlude arteriovenous fistulae and the development of the latex detachable balloon system by Debrun et al. [2], detachable balloons have become the treatment of choice in the management of posttraumatic carotid-cavernous fistulae [3, 4]. Using this method, the fistula can be occluded with preservation of flow through the internal carotid artery (ICA) in most patients [3–5]. Complications of the technique are infrequent, particularly when routine sterile precautions and systemic heparinization are used [3, 6, 7].

Intraarterial detachment or migration of a balloon may rarely occur [8, 9]. The potential for serious consequences is obvious, particularly if the balloon occludes not only the ICA but also the collateral pathways via the posterior communicating and anterior cerebral arteries [8].

Although the aim of the embolization is to occlude the fistula while preserving internal carotid flow, angiographic demonstration of fistula occlusion with a patent carotid artery does not necessarily mean that the balloon can be detached safely. Two patients in whom the potential for intraarterial balloon embolization was recognized are described to illustrate this principle. Analysis of the balloon position, the size of the fistula, and the size of the adjacent cavernous sinus can be used to prevent intraarterial balloon detachment. Similar cases and the principles to be learned from them have not been reported previously.

Materials and Methods

In both patients, a flow-directed coaxial latex detachable balloon system (Ingenor, Paris) was used, as described and developed by Debrun et al. [2]. The embolization procedures were performed with neuroleptoanalgesia and systemic heparinization (6000 U given intravenously at the beginning of the procedure).

Case Reports

Case 1

A 53-year-old woman was involved in a motor vehicle accident, suffering a left frontoparietal skull fracture and epidural hematoma. The hematoma was surgically evacuated without incident, but immediately after the injury she also noted a pulsatile bruit in her left ear accompanied by left-sided headache. The bruit persisted, and she gradually developed preorbital swelling, enlargement of the episcleral vessels of the left eye, and engorgement of the veins over her forehead. Similar findings were present on the right but to a lesser degree. On admission to hospital 5 months after her injury, a pulse-synchronous bruit could be heard over the entire cranium. Mild proptosis and retinal vein engorgement were present on the left. Visual acuity was 20/60 on the left and 20/20 on the right. Extraocular movements were full.

Cerebral angiography confirmed the presence of a left carotid-cavernous fistula that drained exclusively to both superior ophthalmic veins (figs. 1A and 1B). The precavernous part of the carotid siphon was enlarged, probably as a result of the trauma. Balloon embolization was attempted on the next day. Neither a no. 9 balloon (5 mm × 1.5 mm uninflated) nor a no. 17 balloon (2.5 mm × 1.3 mm uninflated) could be maneuvered across the fistula; evidently these balloons were too large. At a second sitting 9 days later, a no. 15 balloon (2 mm × 0.8 mm uninflated) was used. Fluoroscopic monitoring of a hand injection after inflation of the balloon demonstrated occlusion of the fistula with preservation of flow through the ICA. Biplane film angiography before detachment of the balloon, however, showed that the balloon appeared to be wedged within the dilated precavernous part of the carotid siphon rather than within the cavernous sinus (figs. 1C and 1D). Subsequent film subtraction confirmed this impression (figs. 1E and 1F). The balloon was deflated and eventually repositioned within the cavernous sinus and detached. Although inflation of the balloon to its maximum volume of 0.1 cm^3 resulted in only partial occlusion of the fistula (figs. 1G and 1H), the patient's bruit disappeared 24 hr later. Visual acuity and appearance returned to normal, and 8 months later she was still asymptomatic.

Case 2

A 71-year-old woman fell down stairs and struck her head, losing consciousness for 2–3 hr and sustaining soft-tissue injuries to the left orbit and cheek. Within a few days, she developed pulsatile tinnitus and left retroorbital headache, with diplopia for gaze in all directions. By the time of her embolization 7 weeks later, severe proptosis and chemosis were present bilaterally, with marked restriction of extraocular movement and marked impairment of visual acuity (J-16 bilaterally using the Jaeger near vision card). A loud pulse-synchronous bruit could be heard throughout the cranium.

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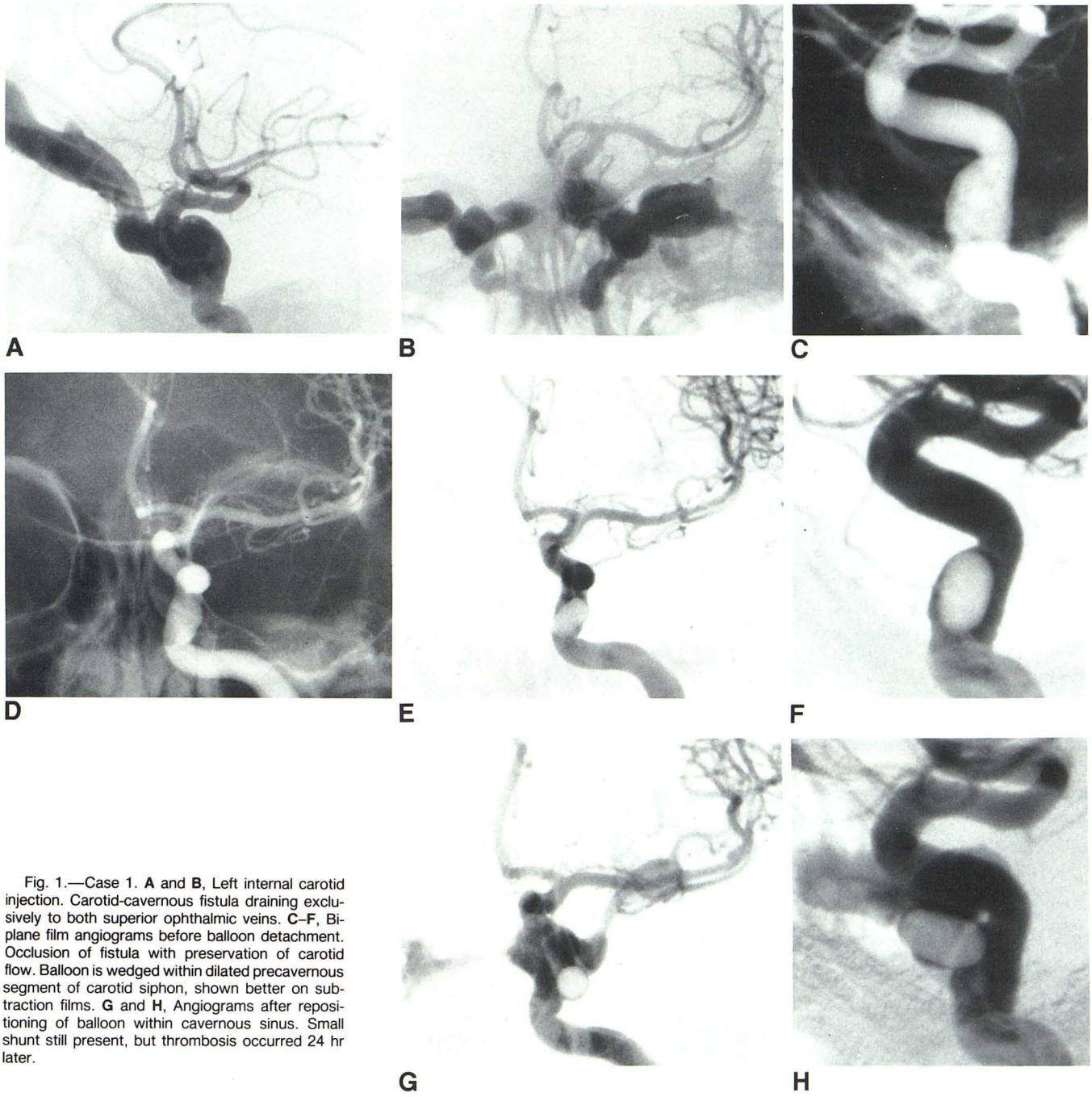

Fig. 1.—Case 1. **A** and **B**, Left internal carotid injection. Carotid-cavernous fistula draining exclusively to both superior ophthalmic veins. **C–F**, Biplane film angiograms before balloon detachment. Occlusion of fistula with preservation of carotid flow. Balloon is wedged within dilated precavernous segment of carotid siphon, shown better on subtraction films. **G** and **H**, Angiograms after repositioning of balloon within cavernous sinus. Small shunt still present, but thrombosis occurred 24 hr later.

Angiography confirmed the presence of a left carotid-cavernous fistula with bilateral drainage to the superior ophthalmic veins as well as posterior and inferior drainage (figs. 2A and 2B). At embolization, a no. 17 balloon was positioned so as to occlude the fistula and preserve ICA flow as determined fluoroscopically. The biplane film angiogram before detachment showed the balloon to be projecting medially but only partly within the cavernous sinus (figs. 2C–2F). Further inflation of the balloon tended to push it back into the ICA. With very slight deflation and gentle traction on the balloon catheter the balloon could be withdrawn to be totally within the internal carotid artery. It was evident that the fistula was large, approximating the size of the inflated balloon (5 mm in diameter allowing for magnification), yet the space available to the balloon medially in the cavernous sinus appeared to be 5 mm or less. It was concluded that neither a smaller nor a larger balloon would be helpful in providing safe positioning of the balloon within the cavernous sinus. Accordingly, after a successful 10 min carotid occlusion test under systemic heparinization using the detachable balloon system, the ICA was occluded using a no. 16 detachable balloon at the fistula site (fig. 2G). This was followed immediately by a second no. 16 balloon in the cervical ICA. The patient tolerated carotid occlusion without complication. The patient's condition returned to normal with the exception of a mild left sixth nerve palsy that still persisted 6 months after embolization and that might have been the direct result of trauma.

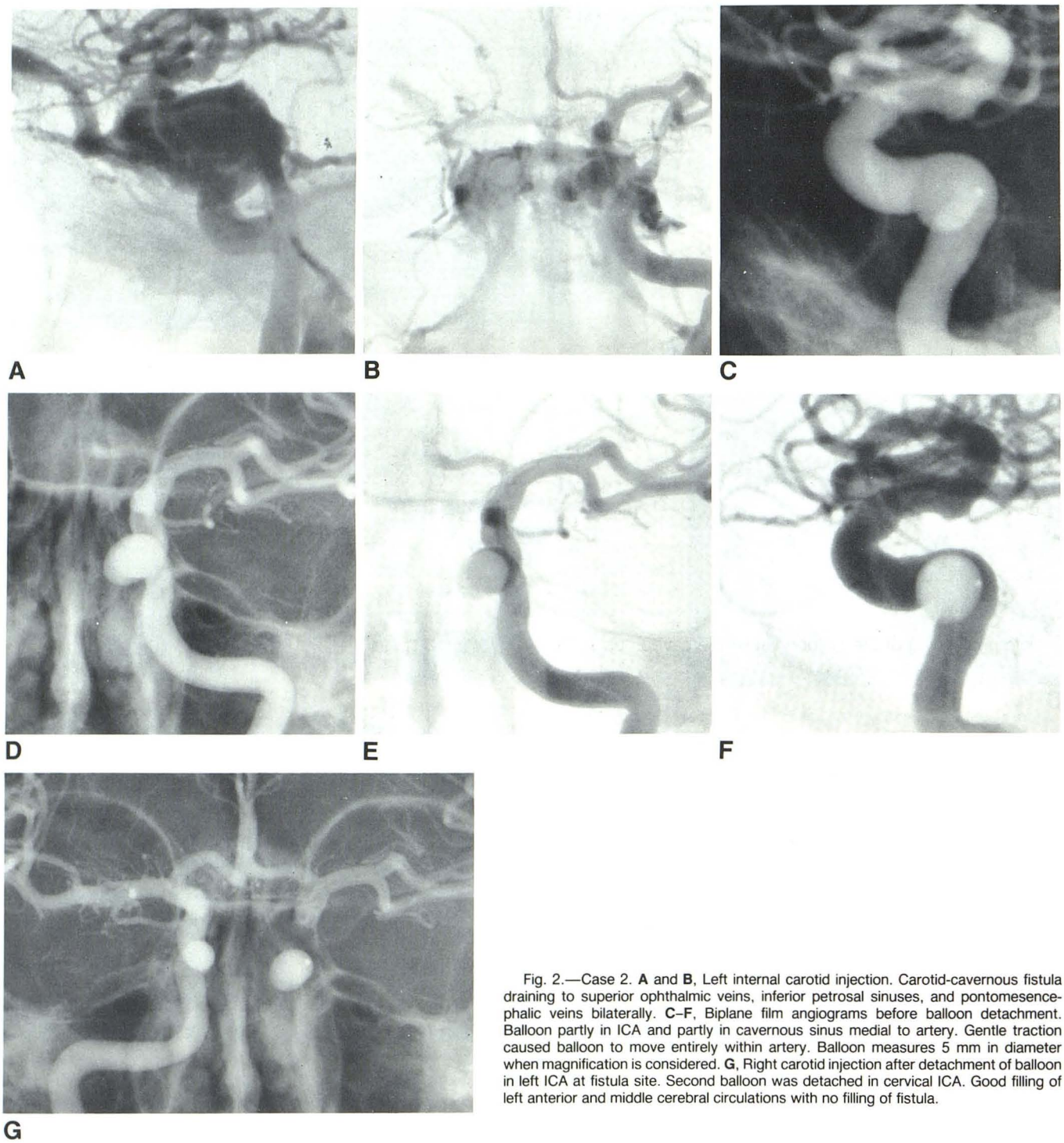

Fig. 2.—Case 2. **A** and **B**, Left internal carotid injection. Carotid-cavernous fistula draining to superior ophthalmic veins, inferior petrosal sinuses, and pontomesencephalic veins bilaterally. **C–F**, Biplane film angiograms before balloon detachment. Balloon partly in ICA and partly in cavernous sinus medial to artery. Gentle traction caused balloon to move entirely within artery. Balloon measures 5 mm in diameter when magnification is considered. **G**, Right carotid injection after detachment of balloon in left ICA at fistula site. Second balloon was detached in cervical ICA. Good filling of left anterior and middle cerebral circulations with no filling of fistula.

Discussion

In most patients undergoing detachable balloon embolization of posttraumatic carotid-cavernous fistulae, the balloon can be seen on the video monitor to move to a position that is clearly within the cavernous sinus. Both the position of the balloon and its configuration while inflated are helpful in making this determination. In a few cases, however, the fistula may appear to be occluded with preservation of carotid flow, yet the balloon may not be in a position that is safe for detachment. As case 2 demonstrates, the balloon may be only partly within the cavernous sinus. Occasionally, as in case 1, the balloon may be entirely within the arterial lumen yet wedged against the fistula site because of abnormal vascular anatomy. A dilated, traumatized segment of the cavernous carotid artery must not be mistaken for the cav-

ernous sinus. In either of these situations, detaching the balloon may cause it to become an embolus in the arterial lumen. Several principles should be followed to avoid this complication.

First and most important, biplane angiography must always be performed and carefully reviewed before balloon detachment. Additional oblique views may be necessary in some cases. Digital subtraction equipment (or on-line electronic subtraction) will provide immediate subtracted images for analysis. If cut film is being used and the position of the balloon is in doubt, film subtraction should be done immediately to clarify the situation. When the balloon is entirely within the cavernous sinus, detachment is usually quite safe. When a part of the balloon protrudes into the ICA, however, intraarterial detachment or subsequent migration of the balloon is a hazard, and detachment should not be performed.

The following information acquired fluoroscopically during the procedure will aid in determining the appropriate size and position of the balloon relative to the fistula: In choosing the appropriate balloon, it is important to know the size of the fistula and the size of the adjacent cavernous sinus. The size of the fistula can often be estimated by noting the maximum diameter at which the balloon can be passed back and forth across the fistula by using gentle traction. In case 2, the balloon could be passed back and forth repeatedly across the fistula while inflated to a diameter of 5 mm, as shown in figures 2E and 2F.

Safe positioning of the balloon within the cavernous sinus requires that the balloon be capable of being inflated to a diameter greater than that of the fistula. Hence, the size of the cavernous sinus adjacent to the fistula site is also important in estimating the safe potential for balloon expansion. In case 2, the relatively small space available to the balloon compared with the size of the fistula meant that the balloon could not be inflated sufficiently to prevent its being dislodged into the ICA during detachment. In this situation, occlusion of the ICA at the fistula site was deemed the safest procedure.

The direction in which the balloon moves on further inflation is also important. If further inflation pushes the balloon back into the ICA, detachment is probably not safe. The balloon should be deflated and attempts made to reposition the balloon farther within the cavernous sinus. If this is not possible, consideration should be given to occluding the ICA at the fistula site after a balloon carotid occlusion tolerance test.

Finally, if doubt as to the safety of the balloon position exists, gentle traction can be exerted on the balloon catheter. If the balloon can be withdrawn into the carotid artery, detachment is obviously not safe as a similar degree of traction may be produced during the detachment procedure.

After tying each balloon, the radiologist should exert gentle traction on the balloon, both to ensure an adequate ligature and to estimate the degree of tension that can be applied without moving the balloon on the catheter. With a well-tied balloon, we believe it is safe to exert gentle traction on the balloon catheter to test balloon position.

In summary, our experience shows that when embolizing posttraumatic carotid-cavernous fistulae with detachable balloons, fluoroscopic demonstration of occlusion of the fistula with preservation of flow through the ICA does not necessarily mean that the balloon can be detached safely. Biplane angiography (supplemented with oblique views when necessary) must be performed and carefully reviewed before detachment. Digital or film subtraction should be done whenever the balloon position is in doubt. Manipulation of the balloon under fluoroscopic control can give important information about the size of the fistula and of the adjacent cavernous sinus. Expansion of the balloon into the ICA with further inflation probably indicates an unsafe balloon position. Gentle traction on the balloon catheter can also be used to assess the risk of intraarterial balloon detachment. The combination of a large fistula with a small cavernous sinus may preclude safe balloon detachment, and consideration should be given to occluding the ICA at the fistula site if tolerance of carotid occlusion has been shown.

REFERENCES

1. Serbinenko FA. Balloon catheterization and occlusion of major cerebral vessels. *J Neurosurg* **1974**;41:125–145
2. Debrun G, Lacour P, Caron JP, et al. Detachable balloon and calibrated-leak balloon techniques in the treatment of cerebral vascular lesions. *J Neurosurg* **1978**;49:635–649
3. Debrun G, Lacour P, Viñuela F, Fox A, Drake CG, Caron JP. Treatment of 54 traumatic carotid cavernous fistulas. *J Neurosurg* **1981**;55:678–692
4. Berenstein A, Kricheff II, Ransohoff J. Carotid-cavernous fistulas: intraarterial treatment. *AJNR* **1980**;1:449–457
5. Graeb D, Robertson W, Lapointe J, Nugent R. Embolization of post-traumatic carotid-cavernous fistulae. *BC Med J* **1984**; 26:83–87
6. Barrow DL, Fleischer AS, Hoffman JC. Complications of detachable balloon catheter technique in the treatment of traumatic intracranial arteriovenous fistulas. *J Neurosurg* **1982**;56:396–403
7. Leipzig TJ, Mullan SF. Deflation of metrizamide-filled balloon used to occlude a carotid-cavernous fistula. *J Neurosurg* **1983**;59:524–528
8. Chalif DJ, Flamm ES, Berenstein A, Choi IS. Microsurgical removal of a balloon embolus to the internal carotid artery. *J Neurosurg* **1983**;58:112–116
9. Langford KH, Vitek JJ, Zeiger E. Migration of detachable miniballoon from the ICA causing occlusion of the MCA. *J Neurosurg* **1983**;58:430–434