Balloon Entrapment: An Unusual Complication of Detachable Balloon Embolization of Traumatic Caroticocavernous Fistula

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Abstract

Traumatic caroticocavernous fistula was attempted to embolize using detachable balloons. Though the fistula could be occluded, unexpected complication was observed during the detachment of the balloon, and the fistula was later tackled using coils and liquid embolic agent. Failure analysis revealed an interesting correlation between the anatomy of sac and the course of the balloon mounted microcatheter.

Keywords
- ► Traumatic caroticocavernous fistula
- ► detachable balloon
- ► balloon entrapment

Introduction

Detachable balloon embolization (DBE) is an easy and effective way of treating traumatic caroticocavernous fistula (CCF) and is still considered by many interventionists as a first line of treatment in most of the situations.[1] The important technical concerns of balloon embolization include premature detachment of the balloon, resulting in inadvertent embolization into arterial or venous circulation, luminal compromise of parent artery leading to compromised cerebral circulation, or early recurrence due to deflation of the balloon.[2,3] We recently attempted a DBE for a traumatic CCF; however, due to an unusual technical difficulty, the balloon could not be detached or retrieved out from the system. DBE was finally abandoned and the fistula was occluded by transarterial venous sac coiling. Retrospective analysis suggested a possible relation with the orientation of the balloon within the venous sac as a cause for this unexpected complication. The plausible mechanism and cautionary measures to avoid this difficult predicament are discussed.

Case Report

A young man presented with pulsatile proptosis and chemosis of the left eye following a road traffic accident and was diagnosed to have traumatic left CCF on computed tomography imaging studies. Angiographic analysis demonstrated a direct left CCF due to a rent in the inferior aspect of horizontal cavernous segment of the left internal carotid artery. The fistula rent measured 3 mm, which opened into a cavernous sinus sac of 8 mm and drained into the superior ophthalmic vein (SOV; ►**Fig. 1A**).

A 7F shuttle sheath (Cook, Bloomington, UK) was placed in the distal left cervical internal carotid artery. A 16×9 mm GoldBal 4 (Balt Extrusion, Montmorency, France) was mounted on a Magic 1.2 F MABDTE catheter and the balloon was deployed in the cavernous sinus sac achieving near complete occlusion of the fistula. However, soon after the detachment, the balloon deflated and migrated into the SOV and hence another 4×16 mm GoldBal 4 balloon was deployed into the sac and the balloon was gradually inflated until the intermittent angiograms showed near complete exclusion of the fistula. The balloon was further inflated minimally and an attempt was made to detach the balloon. However, even after applying moderate retrieval force, the balloon could not be detached and hence an attempt was made to deflate the balloon and remove it out of the system. This maneuver too failed and, finally, the catheter was snapped at the groin and left in situ (►**Fig. 1B–D**). Alternate options would be to leave the catheter with a hub in situ, thus allowing a gradual deflation over hours, or advancing the mandrel into the catheter

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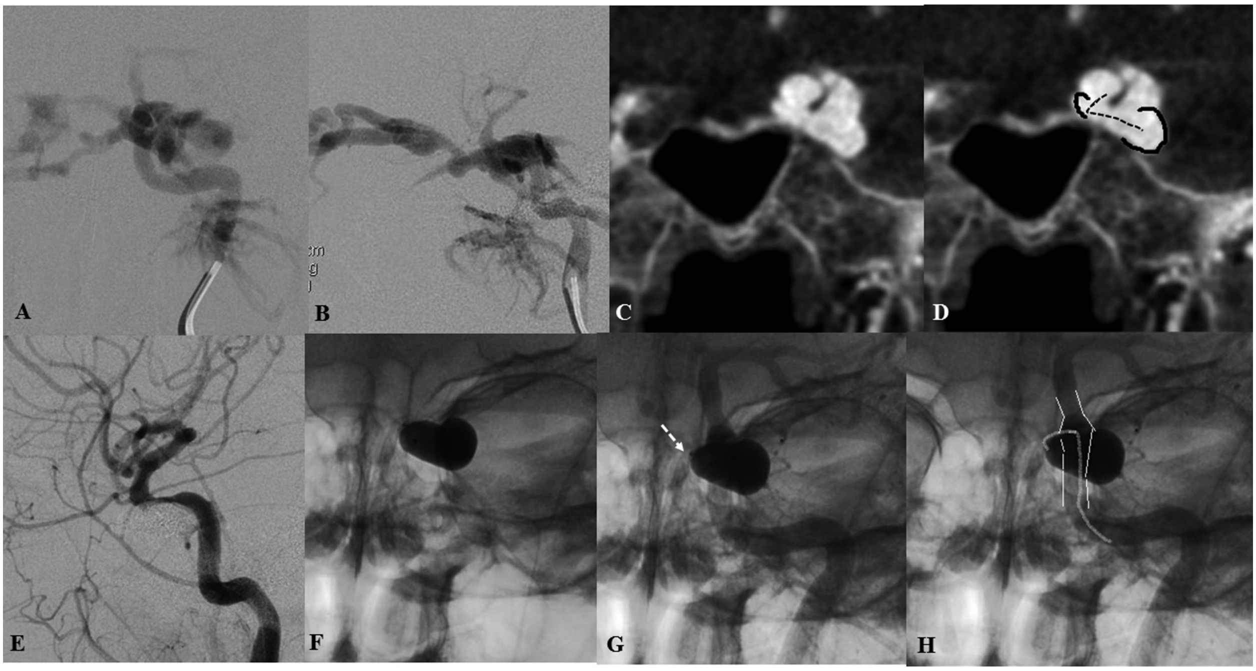

Fig. 1 Left internal carotid angiogram, (**A**) anteroposterior and (**B**) lateral views, showing direct caroticocavernous fistula with predominantly anterior venous drainage. (**C**) Coronal reconstruction of the three-dimensional angiogram demonstrated the rent in the inferior aspect of horizontal segment of the cavernous internal carotid artery. The smaller medical sac and larger lateral sac are highlighted (thick black outlines) and possible path of the microcatheter and balloon is depicted (thin doted lines) in (**D**). Immediate check angiogram revealed complete occlusion of the fistula (**E**) and position of the balloon within the cavernous sac is shown in (**F**). The detachment zone appeared to be within the smaller sac (dotted arrows in **G**), suggesting a possible entrapment of the partially wrapped microcatheter at the rent (**H**).

to open up the lumen. Thromboembolic complications due to indwelling catheter or catheter rupture are potential concerns of these techniques and were not considered.

Patient developed symptoms of CCF on the first postoperative day, and a check angiogram revealed recurrence of CCF. The deflated balloon was noted in the SOV, and the proximal end of the microcatheter migrated into the upper descending thoracic aorta. The retained microcatheter along with deflated balloon was snared and removed using a 25-mm goose neck snare. The cavernous sac was accessed transarterially through the rent using an Echelon 10 microcatheter (Medtronics/Covidien, Irvin, California) and Traxcess microguidewire (MicroVention, Tustin, California) and the sac was progressively embolized using detachable coils and SQUID (Emboflu, Switzerland) under balloon assistance till significant flow reduction across the fistula was noted. Complete exclusion of the fistula was confirmed by check angiographic study after 4 months (►**Fig. 1E–G**).

Discussion

Detachable balloons are still preferred by many interventionists as the initial choice of embolic material to treat CCF, as it simplifies the endovascular procedure and therapeutic success is relatively high. The success rate of DBE was reported to be 86%, and most of the medium- and large-sized fistulas could be treated by this technique.[1,3] The high flow across the fistula allows easy navigation of the balloon into the cavernous sac, and once it is positioned within the proximal venous sac, the microcatheter is steadied or mild tension is applied and the balloon is inflated against the rent to obtain the seal. If the sac is larger, embolization of the distal venous sac with additional balloons might be needed to finally occlude the fistula. Due to high flow of the fistula and complex sac and venous outlet orientations, the course of the balloon and the microcatheter is relatively unpredictable. However, it is generally assumed that the detachment zone of the balloon lies at or close to the rent, enabling an easy detachment. In the present case, the inflation–deflation continued to work until a point where further maneuvers were not possible. This was noticed when balloon detachment was attempted after a check angiogram that demonstrated complete exclusion of the fistula. The balloon could not be detached even after applying a moderate retrieval force and attempts to deflate the balloon and retrieve the balloon–microcatheter system too failed. Slow contrast leak through the snapped end of the microcatheter permitted gradual balloon deflation and resulted in recurrence of CCF.

The analysis of presumed path of microcatheter and the anatomy of the fistula outflow in conventional and three-dimensional (3D) rotational angiographic data revealed that the rent initially opened into a small medial sac, which, in turn, continued laterally as a larger lateral sac. Due to diametrically opposing orientation of these two sacs and the small size of medial sac, the balloon preferentially prolapsed into the larger lateral sac, with the detachment zone and distal microcatheter lying in the medial sac of the fistula. As the inflation of the balloon progressed, the microcatheter would wrap the proximal part of the detachable balloon and eventually get entrapped between the balloon and the sinus wall. Being a nonbraided microcatheter, the lumen of the

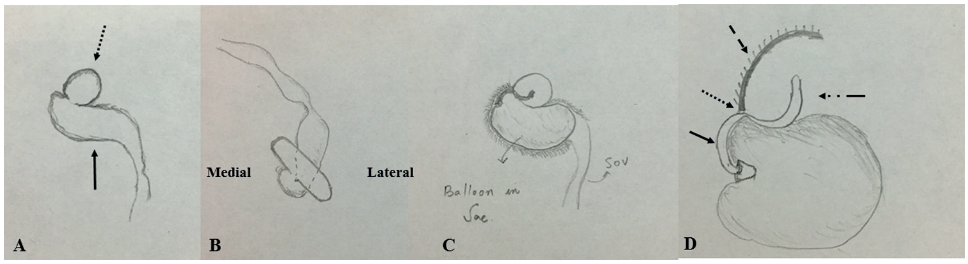

Fig. 2 Pictorial sketch explaining the plausible mechanism for the catheter entrapment. (**A**) Coronal section of the internal carotid artery (ICA) shows the rent opening into the cavernous sac. (**B**) The sac has medial to lateral orientation. Since proximal sac is smaller, balloon prolapses and lies horizontally within distal the larger sac. In such a situation, the microcatheter partially wraps around the proximal aspect of the balloon as a detachment zone is within the smaller sac (**C**) and microcatheter lumen (black arrow) would collapse and occlude when the expanding balloon compresses the microcatheter (dotted arrow) against the wall of the ICA (dashed arrows) (**D**).

Magic catheter would collapse and occlude when compressing force exceeds its kink resistance. At this stage, further inflation or deflation of balloon would become impossible (►**Fig. 2**). Though the possibility of this complication is difficult to predict preoperatively based on angiograms, it is worthwhile to note the possible course the balloon might take in 3D angiograms and actual course taken by the microcatheter. The detachment zone abutting the sinus wall or "U" course of the microcatheter should caution the interventionist about the possible catheter entrapment, and repositioning of the balloon should be attempted to avoid this potential complication.

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