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Case Report

Embolization of Carotid Cavernous Sinus Fistula Using the Double-balloon Kick-in Technique

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Abstract

The use of a detachable balloon is a common and effective method for treating carotid cavernous fistula This treatment method, however, is not without risk because the balloon may not enter the cavernous sinus through the fistula, or the inflated balloon may retract into the internal carotid artery through the fistula. Under these circumstances, the internal carotid artery would have to be sacrificed to achieve therapeutic results. We present a case of embolization using the double-balloon kick-in technique, which utilizes a larger non-detachable balloon and a smaller detachable balloon. The non-detachable balloon is used to squeeze the smaller detachable balloon into the cavernous sinus through the fistula between the internal carotid artery and cavernous sinus to achieve the desired therapeutic effect. [*Tzu Chi Med J* 2010;22(1):50–53]

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1. Introduction

Carotid cavernous fistula (CCF) refers to abnormal blood flow between the carotid artery and the cavernous sinus and can be classified into both direct and indirect types [1]. The direct type is usually secondary to trauma or rupture of an aneurysm. The first line of treatment for direct CCF is detachable balloon embolization and this method has a high success rate. The internal carotid artery is usually preserved at the same time [2–7], but occasionally the embolization may fail when the fistula is too large or too small. An excessively small fistula will not allow the balloon to pass through the fistula and enter the cavernous sinus. If the fistula is too large, the balloon may retract into the internal carotid artery through the fistula after it enters the cavernous sinus. Embolization using the double-balloon technique can overcome these difficulties and improve the success rate [8].

We present a patient who had a fistula, which was too small for a small detachable balloon to be carried by the flow of blood into the cavernous sinus. We used a relatively small detachable gold-valve balloon and a larger non-detachable balloon to successfully squeeze the smaller gold-valve balloon into the cavernous sinus to achieve the therapeutic effect.

2. Case report

A 59-year-old female patient lost consciousness due to a motor vehicle accident and was found by passersby who took her to the emergency department. Her physical examination on admission to the emergency department was remarkable for multiple facial contusions, scalp edema, and epistaxis. She scored 9 points on the coma index, Glasgow Coma Scale score was E3V1M5, and her pupils measured 4 mm on the right side and 5 mm on the left side. Both pupils demonstrated a positive light reflex. The muscle strength in her lower limbs bilaterally was grade IV and her blood pressure was 180/85 mmHg on admission. An abdominal sonogram taken on admission was negative for intra-abdominal hemorrhage, and the laboratory results were normal except for mild anemia. Non-enhanced computed tomography examination results of the head performed in the emergency room showed a skull fracture on the right side and an extensive subarachnoid hemorrhage and cerebral edema (Fig. 1). Contrast-enhanced head computed tomography performed in the emergency department did not reveal an aneurysm; however, the left superior ophthalmic vein was engorged (Fig. 2).

Subsequently, the patient went to the operating room to receive cerebral spinal fluid drainage and placement of an intracranial pressure monitor. The intracranial pressure measured during surgery was 17 mmHg. After the operation, the patient was admitted to the surgical intensive care unit, where her intracranial pressure increased to 29 mmHg 6 days after hospitalization. The intracranial pressure was eventually controlled using drug therapy. After 2 weeks of hospitalization, the patient's left eye had gradually protruded, the conjunctiva showed congestion, and auscultation over the left orbit was notable for a murmur synchronized with the heartbeat, which were highly suggestive of CCF. Cerebral angiography performed the following day confirmed a left CCF.

Left carotid digital subtraction angiography also revealed an engorged superior ophthalmic vein, but the middle cerebral artery appeared to be relatively thin (Fig. 3). We used a 9 Fr guiding catheter (Guider; Boston Scientific, Natick, MA, USA) and a No. 15 detachable gold-valve balloon (GVB 15; Nycomed Ingenor, Paris, France) for the embolization. Although a No. 15 GVB has the smallest volume in the series, it still could not be advanced into the cavernous sinus through the CCF fistula despite multiple attempts. For this reason, we advanced a larger non-detachable balloon (Sentry; Target, Fremont, CA, USA) into the left internal carotid artery via a right femoral artery puncture. After this non-detachable balloon entered the left internal carotid artery, we used this larger

Fig. 1 — Non-contrast head computed tomography shows diffuse subarachnoid hemorrhage in basal cisterns and Sylvian fissures (arrowheads), and pneumocephalus in the right temporal area (arrow).

Fig. 2 — Contrast-enhanced head computed tomography shows an engorged left superior ophthalmic vein (arrow). A small amount of free air is seen in the right temporal lobe (arrowheads).

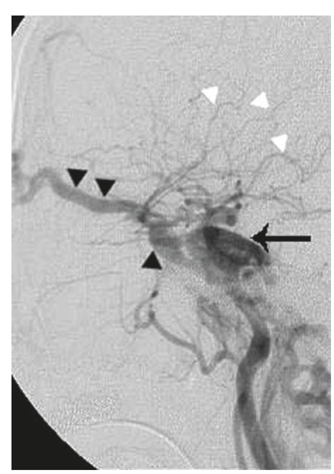

Fig. 3 — A lateral view of the left carotid digital subtraction angiogram shows the cavernous sinus (arrow) and the engorged superior ophthalmic vein (black arrowheads). Relatively thin branches of the middle cerebral artery are also visible due to the steal phenomenon (white arrowheads).

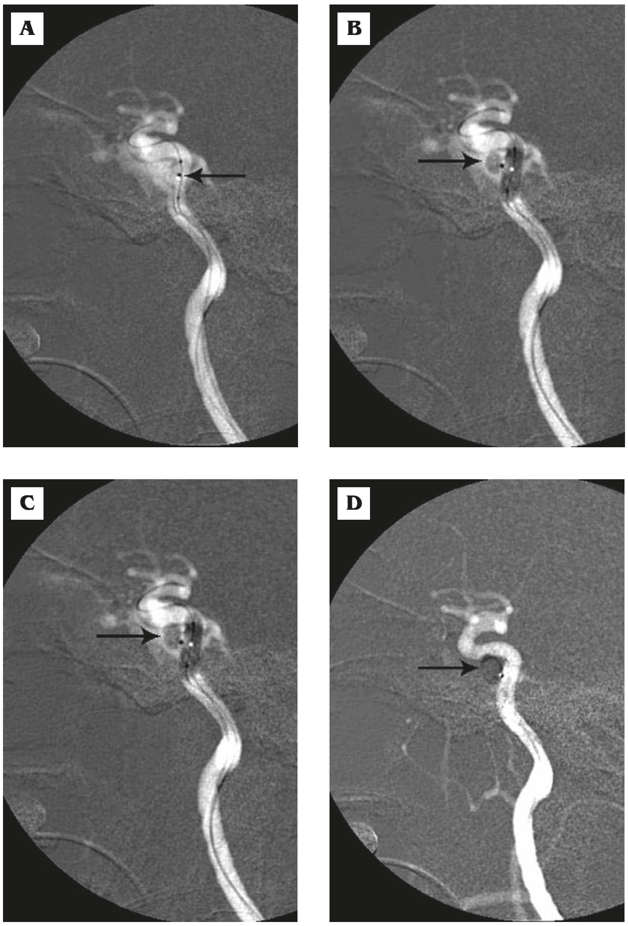

Fig. 4 — Fluoroscopic images during the operation show the various steps in the double-balloon kick-in embolization technique. The black arrows indicate the detachable balloons changing shape and position along the course of the embolization. (A) A deflated GVB 15 balloon (the middle small round dense mark) was placed in the orifice of the fistula and a non-detachable Sentry balloon (the upper and lower smaller radio-opaque marks) was used to cover the posterior aspect of the GVB 15 balloon. (B) The detachable balloon was partially inflated after being kicked in to the cavernous sinus by gradually inflating the non-detachable balloon. (C) The detachable balloon was further inflated to occlude the fistula. (D) The non-detachable balloon was removed and the detachable balloon is ready to be detached.

balloon to kick-in the smaller detachable gold-valve balloon through the fistula to achieve embolization using the following steps. First, the smaller balloon was placed at the opening of the fistula on the internal carotid artery side of the fistula and the larger balloon was placed immediately after it and was slightly inflated to cover the smaller balloon. The smaller balloon was then slightly inflated and mounted at the opening of the fistula, and the larger balloon was inflated until the smaller balloon was squeezed through the fistula into the cavernous sinus. The

Fig. 5 — A lateral view of the left carotid digital subtraction angiogram after detachment of the detachable balloon shows total occlusion of the fistula with no visible blood entering the cavernous sinus.

smaller balloon inside the cavernous sinus was further inflated and the larger balloon was slightly deflated to ensure that the smaller balloon would not retract back into the internal carotid artery via the fistula. The smaller balloon was inflated to occlude the orifice of the fistula, and the larger balloon was slightly deflated to check for any blood flow through the orifice. If there was any flow, the smaller balloon was inflated continuously until the orifice was completely occluded. Finally, the larger balloon was deflated and retracted.

Repeat digital subtraction angiography confirmed successful embolization, and the small balloon was detached and left in the cavernous sinus (Figs. 4 and 5). The preoperative vascular murmur due to the CCF completely disappeared, and the protrusion and swelling of the left eye and the conjunctival congestion gradually improved. The patient's consciousness and muscle strength in the lower limbs gradually recovered, and the patient was discharged 2 weeks after the embolization with follow-up in the outpatient department. There has been no recurrence of the fistula within 3 years after the embolization.

3. Discussion

Patients with CCF can have various manifestations depending on the type, size, and position of the fistula, including retrobulbar pain, blurred vision, conjunctival congestion, exophthalmos, and vascular murmur. If persistent retrobulbar pain and rapid vision loss are experienced or retrograde cortical venous drainage is found on angiography, immediate treatment is required to prevent complete vision loss or intracranial hemorrhage.

Balloon embolization is usually used for the treatment of CCF. The success rate of the embolization is related to the size of the fistula and the cavernous sinus (2–7). Therefore, embolization may fail if the fistula is excessively large or small, or if the fistula is relatively large compared with the size of the cavernous sinus. If the fistula is too small or blood flow is inadequate to carry the balloon into the cavernous sinus, the embolization can be performed using the double-balloon technique (8).

A report by physicians at the Taipei Veterans General Hospital in 2000 described the successful use of this technique in 11 cases and nine patients (8) using two detachable balloons. The double-balloon embolization technique is useful when the fistula is too small or the blood flow is inadequate to carry the deflated or partially inflated balloon into the carotid artery. This technique is also useful when the width of the cavernous sinus is smaller than the opening of the fistula (8). In this previous study, the use of two detachable balloons for the embolization meant that the surgeons needed to bind the balloon onto the thin microcatheter manually (8), a technique that relies heavily on individual experience and skill (9,10). If the balloon is tied too tightly, the balloon cannot be detached. An excessively loose binding may result in premature detachment of the balloon and serious complications.

In our case, we used a detachable balloon and a non-detachable balloon for embolization. The non-detachable balloon used was the over-the-wire type of balloon, and its advantages include convenience, ease of passage of the balloon through tortuous vessels following the guide wire, prevention of both premature detachment and failure to inflate, and most importantly, since the larger balloon has a longer shape, its contact with the smaller balloon is unlike contact between two spheres. The contact area is increased, stability is improved, and the stress applied on the smaller balloon is relatively even. Therefore, the success rate of embolization is increased.

Although the use of the double-balloon embolization technique may improve the success rate, it still has some potential risks. First, it is possible to rupture the internal carotid artery. Second, it can make the fistula larger and cause the fistula to rupture. Finally, a new fistula between the carotid artery and the cavernous sinus may develop (8). The limitations of use are similar to those of balloons in general, i.e. some larger fistulas require two or more balloons to complete the embolization. If the gap cannot be filled by more than two balloons, other methods may be necessary such as a detachable platinum coil, stent or quick drying liquid tissue glue (11,12).

In addition to the carotid artery, the veins may be used as the path of embolization (13,14). If either path is difficult or hindered, or both are removed because of surgery, a direct puncture into the cavernous sinus may be used for the embolization (15).

In summary, we used the double-balloon kick-in embolization technique to successfully treat a patient with CCF who could not be treated using the conventional single-balloon embolization method. This technique requires good fluoroscopy equipment and an experienced medical team to achieve successful results and reduce the rate of complications.

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