

# Endovascular Occlusion of Traumatic Carotid Cavernous Fistula by Using Detachable Balloon in Various Ways: A Case Series

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## Abstract

**Introduction** The detachable balloons are not frequently used nowadays for endovascular occlusion of carotid-cavernous fistula (CCF) because of lack of availability and supposed high risk of recurrence. This study describes the various way of detachable balloon embolization for traumatic CCF.

**Materials and Methods** We have used endovascular detachable balloon to occlude the traumatic CCF under local anesthesia in various ways in 12 traumatic cases of CCF from March 2013 to April 2015. Clinical and computed tomographic (CT) angiography follow-up was done at 6 and 12 months.

**Results** Clinical follow-up from 6 to 12 month showed persistent resolution of symptoms in 10 cases; 2 cases had developed slight proptosis and chemosis. CT angiography done in nine cases after 6 to 9 months showed no residual filling in CCF.

**Conclusion** The detachable balloon either single or double with or without coils can be used in the management of CCF by different methods. Detachable balloon is a cheaper alternative compared with coiling. It is technically easier to perform and can be performed under local anesthesia.

## Keywords

- ▶ traumatic carotid-cavernous fistula
- ▶ detachable balloons
- ▶ endovascular management

## Introduction

A carotid-cavernous fistula (CCF) is an abnormal arteriovenous communication between the carotid artery and the cavernous sinus. The fistula may occur spontaneously (25% of all cases) but it usually occurs following head trauma (75%) and may also be iatrogenic (0.1%) as a complication of surgery.<sup>1</sup> Spontaneous (nontraumatic) direct CCFs develop in patients with intracavernous aneurysms and in individuals who have connective tissue diseases that cause increased vascular wall fragility, the vascular type of Ehlers-Danlos and fibromuscular dysplasia.<sup>2</sup> According to Barrow's classification, there are four angiographically identifiable types of CCF (types A–D).<sup>1,3</sup> The type A fistula is a direct, high-flow fistula between the cavernous part of internal carotid artery (ICA) and the cavernous sinus. It occurs most frequently following head trauma and may form from a traumatic tear in the wall of the cavernous ICA. A triad of clinical findings is

specific for this type of fistulas: exophthalmos, orbital bruit, and dilated conjunctival vessels.<sup>1</sup> Complete occlusion of the fistula may be obtained by endovascular approach either with detachable balloons, coils, and other solid, or liquid agents used as embolic material or by using covered stents or flow diverters placed in the parent vessel to exclude the fistula from circulation. The detachable balloons are not frequently used nowadays for endovascular occlusion of CCF because of lack of availability and supposed high risk of recurrence. This study describes the various ways of detachable balloon embolization for traumatic CCF.

## Materials and Methods

We have used endovascular detachable balloon (Goldbal balloon; Balt Extrusion, Montmorency, France) to occlude the CCF in various ways in 12 traumatic cases of CCF from March

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**Table 1** Use of endovascular detachable balloon to occlude CCF in various ways in 12 traumatic cases

Case No.	Age (y)	Presentation	Duration of head injury (in mo)	Procedure	Outcome (6–12 mo)
1 (Representative case 1)	40 M	Proptosis, chemosis, ophthalmoparesis	2	CCF occlusion with single balloon	Complete resolution of symptoms
2	20 F	Proptosis, chemosis, ophthalmoparesis	6	CCF occlusion with single balloon	Complete resolution of symptoms
3	36 M	Proptosis, chemosis	5	Sacrifice ICA	Complete resolution of symptoms
4	50 M	Proptosis, chemosis	1	CCF occlusion with single balloon	Complete resolution of symptoms
5 (Representative case 2)	12 M	Proptosis, chemosis, orbital bruit	5	Double balloon	Complete resolution of symptoms
6	36 F	Proptosis, chemosis, ophthalmoparesis	2	CCF occlusion with single balloon	Partial resolution of symptoms
7	22 M	Proptosis, chemosis, ophthalmoparesis	1	Sacrifice ICA	Complete resolution of symptoms
8	25 M	Proptosis, chemosis	1	Double balloon	Complete resolution of symptoms
9 (Representative case 3)	20 M	Proptosis, chemosis, orbital bruit	1	Sacrifice ICA	Complete resolution of symptoms
10	18 M	Proptosis, chemosis	1	Double balloon	Partial resolution of symptoms
11	30 F	Proptosis, chemosis, orbital bruit		CCF occlusion with single balloon	Complete resolution of symptoms
12 (Representative case 4)	15 M	Proptosis, chemosis, orbital bruit	2	Use of balloon, coil, and glue	Significant resolution of symptoms

Abbreviations: CCF, carotid-cavernous fistula; F, female; ICA, internal carotid artery; M, male.

2013 to April 2015 (► **Table 1**). The cases were performed in Neurointervention Laboratory of Neurosurgery Department at SMS hospital & Medical College, Jaipur, Rajasthan. Clinical and computed tomographic (CT) angiography follow-up was done at 6 and 12 months. We describe four representative cases.

### Case 1. Detachable Balloon to Occlude Carotid-Cavernous Fistula by Transarterial Route

A 40-year-old man presented with history of severe proptosis of the left eye and restriction of the extraocular muscle in all direction. The patient had history of head injury 2 months back. Embolization of CCF by means of a detachable balloon

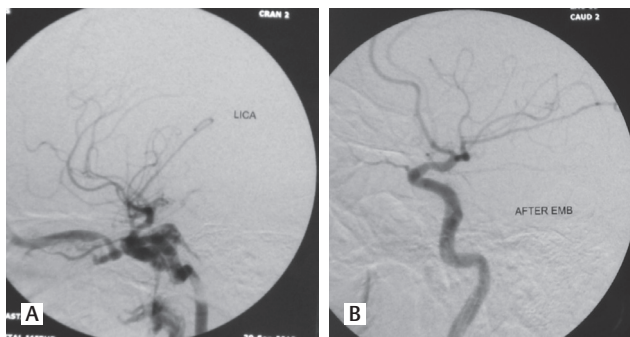
was done. Postembolization digital subtraction angiography (DSA) of the patient showed resolution of CCF (► **Fig. 1**).

### Case 2. Double Detachable Balloon to Occlude Carotid-Cavernous Fistula by Transarterial Route

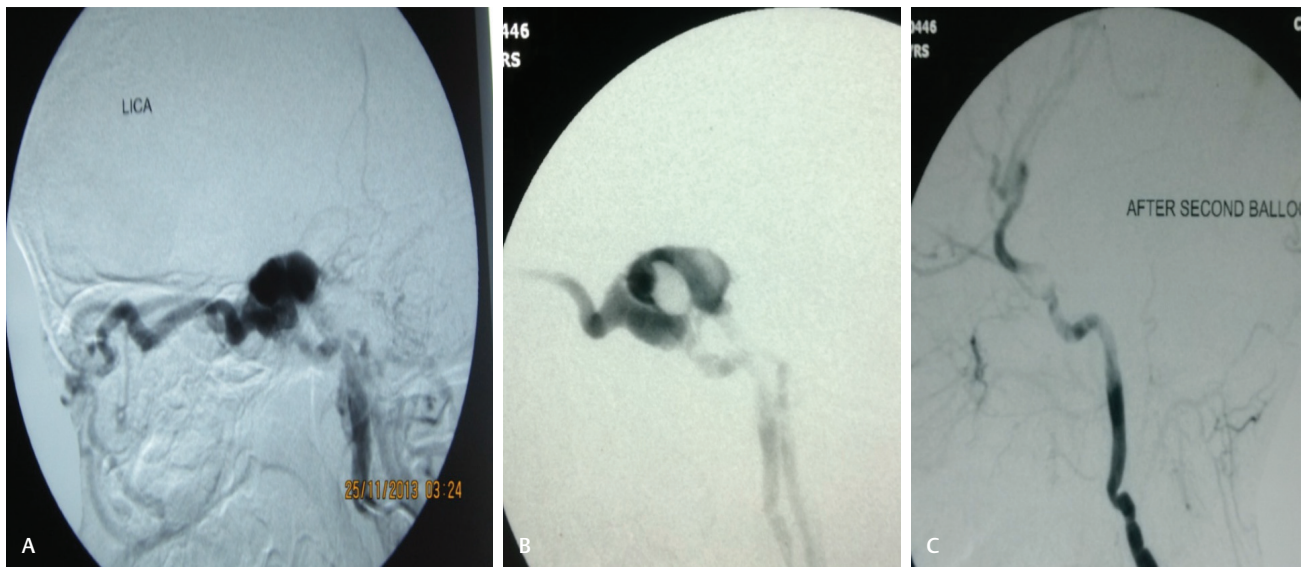
A 12-year-old boy presented with complaint of left-sided proptosis and chemosis. The patient had history of head injury 5 months back. On examination orbital bruit was present. Extraocular muscle function was not restricted. DSA was done and type A CCF was diagnosed. After first detachable balloon was applied, the flow persisted between carotid and cavernous region so second detachable balloon was used. Following second detachable balloon, fistula was completely occluded (► **Fig. 2**).

### Case 3: Detachable Balloon to Sacrifice Internal Carotid Artery to Occlude Carotid-Cavernous Fistula by Transarterial Route

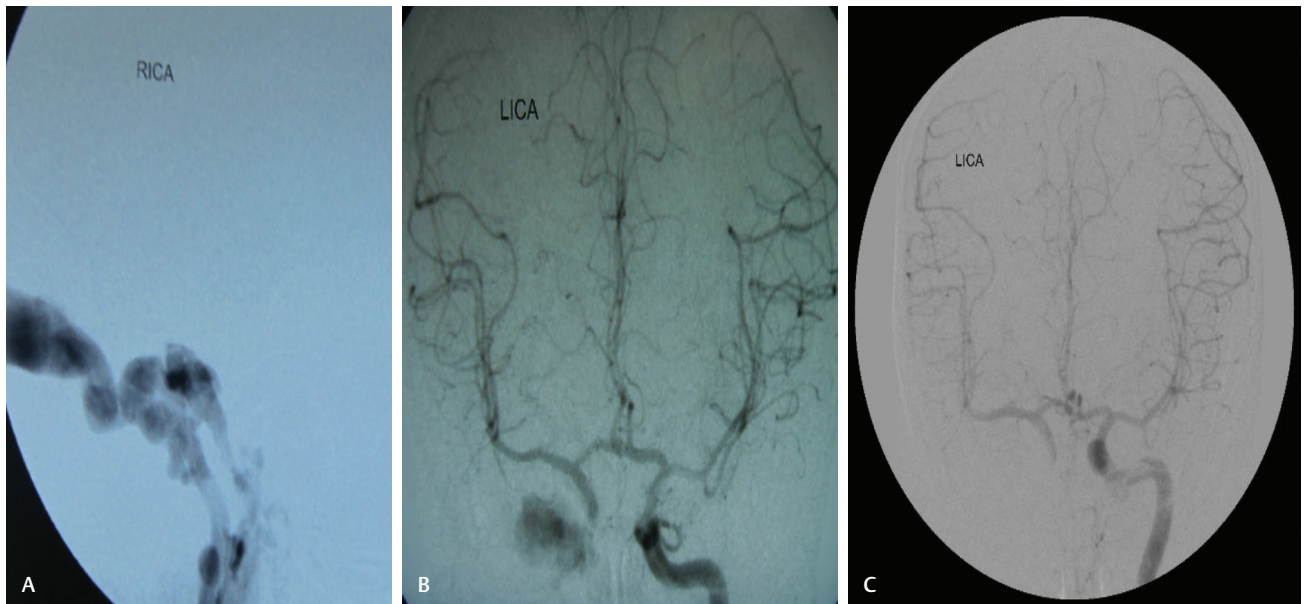
A 20-year-old man presented with complaint of proptosis and chemosis of the right eye 1 month after head injury. On examination orbital bruit heard. DSA was done, which showed a large type A CCF. There were good collaterals from anterior communicating artery and posterior communicating artery. Balloon occlusion test was performed. The patient well tolerated the balloon test occlusion. The ICA was sacrificed to occlude the fistula (► **Fig. 3**). The procedure was performed under local anesthesia with monitoring of clinical status.



**Fig. 1** (A) Type 1 CCF. (B) DSA image postembolization using single detachable balloon showing obliteration of the CCF. CCF, carotid-cavernous fistula; DSA, digital subtraction angiography; LICA, left internal carotid artery.



**Fig. 2** (A) DSA image showing type A CCF. (B) DSA showing persistence of fistula after using single detachable balloon. (C) DSA showing complete resolution of CCF after using second detachable balloon. CCF, carotid-cavernous fistula; DSA, digital subtraction angiography; LICA, left internal carotid artery.



**Fig. 3** (A) RICA injection showing CCF. (B) LICA injection showing filling of CCF. (C) LICA injection showing occlusion of fistula with sacrifice of RICA. CCF, carotid-cavernous fistula; LICA, left internal carotid artery; RICA, right internal carotid artery.

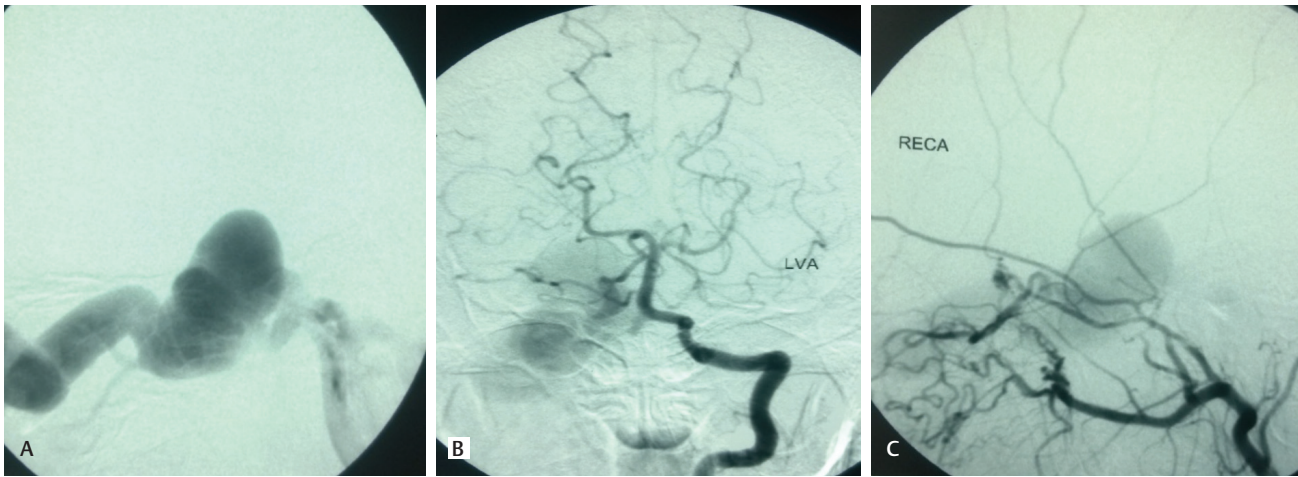
#### Case 4: Detachable Balloon along with Coils and Glue in the Management of Direct and Indirect Carotid Cavernous Fistula

A 15-year-old boy presented with history of proptosis and chemosis of the right eye 2 months following head injury. DSA showed direct and indirect CCF. Filling of fistula was through ICA and branches of the external carotid arteries. In the management of CCF, detachable balloon, glue, and coils, all three modalities of treatment were used. Detachable balloon was placed in the ICA to sacrifice ICA after good cross flow was confirmed. Catheterization of external carotid artery showed filling of indirect fistula through branches of internal maxillary artery and middle meningeal artery.

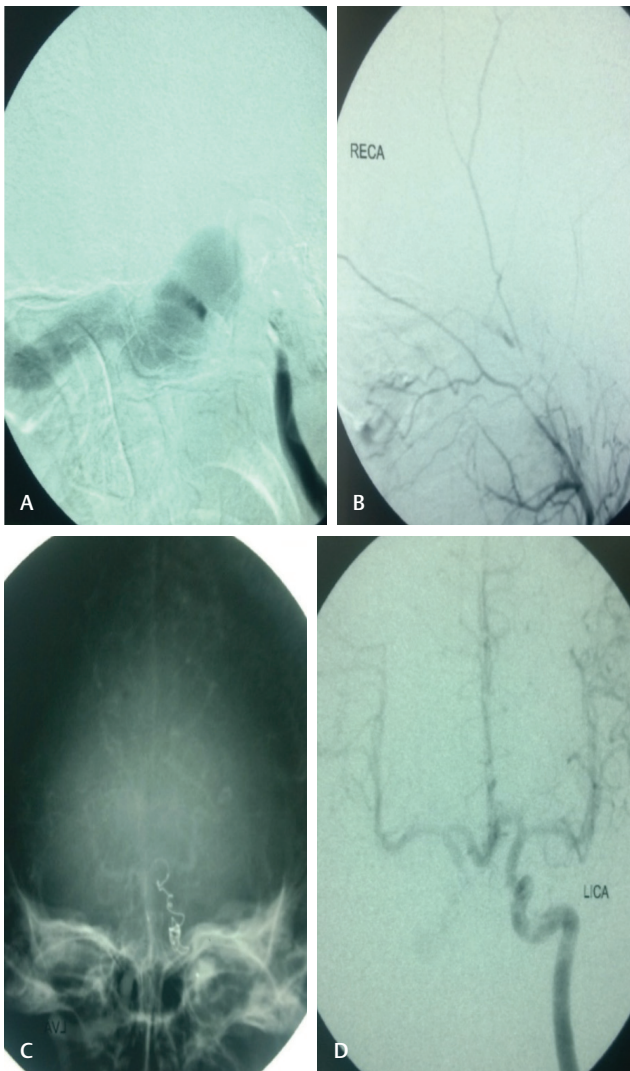
Superselective glue injection was given through branches of internal maxillary artery and middle meningeal artery supplying the fistula. Finally, for the filling of fistula through posterior communicating artery was treated with coil (►Figs. 4, 5).

#### Results

Clinical follow-up from 6 to 12 months showed persistent resolution of symptoms in 10 cases; 2 cases had developed slight proptosis and chemosis (►Table 1). CT angiography done in nine cases after 6 to 9 months showed no residual filling in CCF.



**Fig. 4** (A) DSA showing grade A CCF. (B) Left vertebral injection showing filling of CCF through posterior communicating artery. (C) RECA injection showing filling of fistula through branches of internal maxillary artery and middle meningeal artery. CCF, carotid-cavernous fistula; DSA, digital subtraction angiography; ECA, external carotid artery, LVA, left vertebral artery; RECA, right external carotid artery.



**Fig. 5** (A) DSA showing persistence of fistula after occluding ipsilateral ICA using detachable balloon. (B) RECA injection showing complete resolution of fistula. (C) DSA showing coil placement in the fistula through posterior communicating artery. (D) LICA injection showing occlusion of fistula. DSA, digital subtraction angiography; ICA, internal carotid artery; LICA, left internal carotid artery; RECA, right external carotid artery.

## Discussion

The indications for aggressive treatment of CCF include visual impairment, progressive paresis of extraocular muscles, intractable orbital pain or bruit, and progressive or severe exophthalmos.<sup>4,5</sup> For endovascular surgery, multiple options exist with respect to materials as well as routes of approach. Two general types of embolic material, detachable balloon and detachable coils, are available. Fistula occlusion using a detachable balloon delivered by a transarterial route is the preferred method for treating direct CCF.<sup>6</sup>

We used detachable balloon in the management of CCF because it is a cheaper alternative and is easy to perform. In representative series of four patients, we tried using detachable balloons in different manner to treat traumatic CCF under local anesthesia. In first case, we used a single balloon to occlude the CCF. However, in second case after applying first detachable balloon, there was still flow persisting between the carotid and cavernous region so second detachable balloon was used. Following second detachable balloon, fistula was completely occluded. In third case, we sacrificed the ipsilateral ICA to occlude the fistula using detachable balloon as the collateral flow was good. Neurologic status of the patient was monitored during the procedure, and the procedure was done under local anesthesia. In fourth case, there was presence of types A and C CCF. Filling of fistula was through the ICA, branches of internal maxillary artery, middle meningeal artery, and posterior communicating artery. We used combination of detachable balloon, glue, and coils successfully in the management of types A and C CCF.

Xu et al treated 58 patients of CCF with transarterial balloon embolization, including 7 patients with ICA sacrifice. Recurrent fistulas occurred in seven patients during the follow-up period.<sup>7</sup> Teng et al describes double balloon technique for embolization of CCF in nine patients.<sup>8</sup> In our hospital, we have managed 12 patients of direct CCF, using detachable balloon technique. In developing countries like ours where cost is a constraint, detachable balloon is gold standard alternative in the management of CCF.

## Conclusion

In recent times, there has been development of newer technique in the management of CCF, including detachable balloon, coiling, use of stent to exclude fistula, use of embolic material solid or liquid. In our series of patients, we used detachable balloon single or double with or without coils and glue in the management of CCF by different methods successfully. The use detachable balloon is a cheaper alternative compared with coiling. It is technically easier to perform and can be performed under local anesthesia.

### Conflict of Interest

None.

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