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8-F balloon guide catheter for embolization of anterior circulation aneurysms: an institutional experience in 152 patients

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ABSTRACT

The use of 8-F balloon guide catheter (BGC) for proximal flow control was previously shown to prevent distal embolic complications during mechanical clot retrieval in patients with acute ischemic stroke. In this retrospective study, the utility of 8-F BGCs for proximal flow control during endovascular coiling of anterior circulation aneurysms was investigated. Patients who underwent endovascular coiling for anterior circulation aneurysms between August 2013 and December 2016 were retrospectively analyzed. Among a total of 152 patients included in this series, 64 patients presented with aneurysmal rupture, whereas the aneurysms were detected incidentally or due to mass effects in the remaining patients. 8-F BGCs were successfully navigated in all patients. The balloon was inflated during navigation in 19 patients. Inflation of the catheter balloon during coil embolization was required in 34 patients; this was performed as an emergency maneuver in six of these patients. Thromboembolic complications occurred in one patient. 8-F BGC can be effectively used for proximal flow control during endovascular treatment of anterior circulation aneurysms. The other advantages included improved navigation of tortuous arterial anatomy, coil stabilization during aneurysmal coiling, and freedom to utilize aneurysmal neck-remodeling balloons for additional adjunctive techniques or to deploy rescue stents. This novel approach might be safely and effectively used in patients undergoing endovascular treatment for anterior circulation aneurysms.

Keywords: balloon guide catheter, coil embolization, intracranial aneurysms

INTRODUCTION

Treatment of aneurysms by endovascular coiling is a rapidly evolving approach, with deployment of new devices as well as alternative uses of existing devices. Unlike surgical clipping in which the surgeon has access to both proximal and distal vessels that can be very useful in cases of intraprocedural rupture, at present, there are no comparable techniques for endovascular coiling defined in literature. The utility of 8-F balloon guide catheters (BGCs) for proximal flow control in patients with acute ischemic stroke to prevent distal embolic complications during

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mechanical clot retrieval has been reported in the Mechanical Embolus Removal in Cerebral Ischemia (MERCI) trial.[1] In the current study, we investigated the efficacy of 8-F BGCs for proximal flow control in anterior circulation aneurysms and described our institutional experience in a series of 152 patients.

METHODS

Patients who underwent endovascular coiling for anterior circulation aneurysms between August 2013 and December 2016 were included in this retrospective study. All patient data were obtained from hospital medical records, and all images were obtained from the picture archiving and communication system. The degree of embolic state was evaluated using the Raymond occlusion scale (RS): RS-I, complete occlusion; RS-II, residual aneurysmal neck; and RS-III, residual intra-aneurysmal contrast enhancement.[2]

RESULTS

In this series of 152 patients, there were 45 males (29.6%), and the mean age was 63.5 ± 14.2 years. The mean aneurysm size was 6.88 ± 4.6 mm. Sixty-four patients (42.1%) presented with subarachnoid hemorrhage, whereas the aneurysms in the remaining patients (57.9%) were detected due to mass effects or incidentally on routine evaluation. Posterior communicating artery was the most commonly involved site in this series, involved in 28% of all aneurysms (Table 1). 8-F Cello™ BGCs (Medtronic, Minneapolis, MN, USA) were used in 72 patients, whereas 8-F Optimo™ BGCs (Tokai Medical Products, Aichi, Japan) were used in the remaining 80 patients. The BGC was successfully navigated in all patients, and there were no intraprocedural complications.

The summary of the purpose using the balloon is shown in Table 2. During navigation in 19 patients (12.5%), who had either type III or bovine aortic arch, the BGC was inflated and advanced to a desired position for blood flow guidance and stabilization of the catheter in the parent vessel (Fig. 1).

In 130 patients (85.5%), a 4-F intermediary catheter and a microcatheter were used for particularly simple aneurysms (Fig. 2A). In eight patients (5.3%), local balloon-assisted coiling was performed for neck remodeling (Fig. 2B). In nine patients (5.9%), the double microcatheter technique was performed for large or giant aneurysms (Fig. 2C). Decision regarding the strategy for aneurysmal coiling was largely based on the dimensions and the neck size of the aneurysm.

In 34 patients (22.4%), the BGC was inflated during coil embolization; this was performed as an emergency maneuver in six patients with aneurysmal rupture of coil protrusion. In two of these six patients, the BGC was inflated to provide temporary proximal occlusion immediately after the intraprocedural aneurysmal rupture (Fig. 3). In the remaining four patients, the BGC was inflated to prevent further coil protrusion into the parent vessel. The BGC was inflated to assist coil embolization in 28 patients, and the balloon was inflated during deployment of the framing coil for stabilization in 22 of these patients (Fig. 4).

Thromboembolic complications occurred in one patient. Assessment immediately after the procedures revealed that RS-I, RS-II, and RS-III occlusions were obtained in 85 (55.9%), 37 (24.3%) and 30 (19.7%) patients, respectively. There were nine deaths in this series, none of which were directly related to the procedure; all cases were in poor clinical condition (Hunt and Hess grade 4 or 5) at presentation.

Table 1 Baseline characteristics of patients and aneurysms.

Sex	Number of patients
Male	45
Female	107
Age	Years
Mean	63.5 ± 14.2
Minimum	21
Maximum	88
Onset	Number of patients
Subarachnoid hemorrhage	64
Incidental	80
Mass-effect	8
Aneurysmal location	Number of patients
Internal carotid artery terminus	8
Choroidal segment	11
Anterior communicating artery	22
Posterior communicating artery	43
Superior hypophyseal artery	20
Middle cerebral artery	15
Distal anterior cerebral artery	13
Cavernous segment	14
Opthalmic artery	6

Table 2 Summary of the purpose using the balloon.

	Number of patients (%)
Total	152
Total balloon inflation	48 (31.6%)
For navigation	19 (12.5%)
For coil embolization	34 (22.4%)
A. For emergency	
For premature rupture	2 (1.3%)
For coil protrusion	4 (2.6%)
B. For assist coil embolization	
For the framing coil	22 (14.5%)
For the other coils	6 (3.9%)

DISCUSSION

Intraprocedural aneurysmal rupture is a major complication during endovascular coiling, with devastating and life-threatening consequences; its incidence varies between 2% and 4%.[3] During microsurgical clipping, the surgeon has access to both proximal and distal vasculatures, and

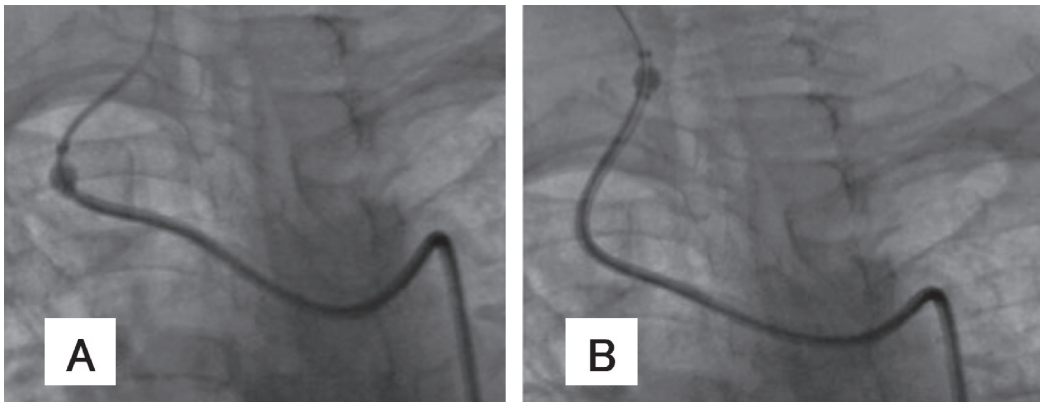

Fig. 1 Balloon inflation for the navigation of the guide catheter—intraoperative X-ray images showing the partial inflation of the balloon of an 8-F balloon guiding catheter that is used to aid in navigation.
(A) The course of the catheter showing a type III aortic arch.
(B) The balloon guiding catheter is successfully advanced into the right carotid artery.

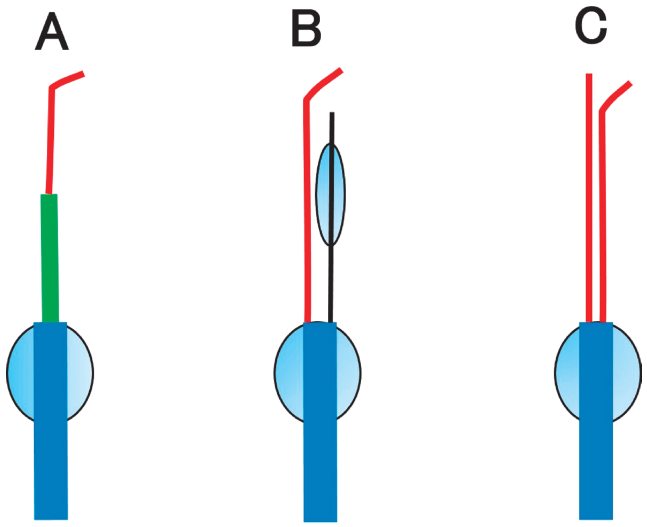

Fig. 2 Diagrams showing three strategies used in this series.
(A) The basic technique consisting of an 8-F balloon guiding catheter (blue), a 4-F distal access catheter (green), and a microcatheter (red).
(B) The optional technique consisting of a local balloon catheter (black) for aneurysmal neck-remodeling for broad-necked aneurysms.
(C) The optional technique consisting of a double microcatheter for large- and giant-sized aneurysms.

temporary clips can be applied in cases of intraoperative rupture. However, thus far, endovascular techniques, despite vast technological advancements have not provided proximal control methods.

Although balloon catheters had been introduced since 1970s, these had not been spread as a common procedure. Since its revival by Moret *et al.*[4] in 1997 and based on extensive research, balloon-assisted coil embolization has been widely adopted for use in aneurysms. Although the utility of this approach has been shown mainly for endovascular coiling of wide-neck aneurysms,

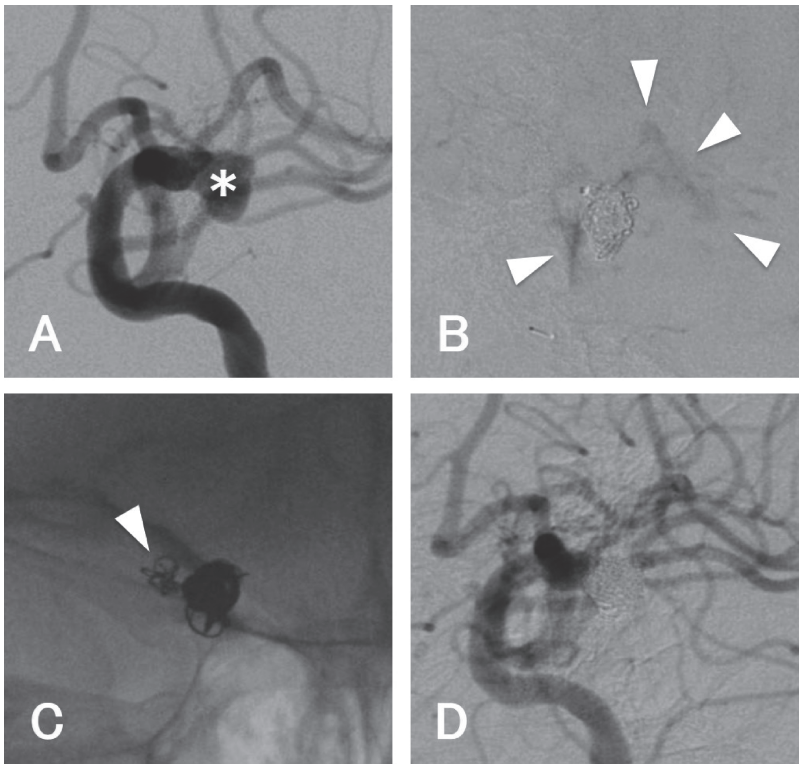

Fig. 3 Balloon inflation for the intraprocedural aneurysmal rupture.
(A) Preoperative digital subtracted angiography showing right internal carotid artery aneurysm (asterisk).
(B) Late-phase intraoperative angiography showing the extravasation of a subarachnoid hemorrhage (white arrowheads).
(C) X-ray image after additional coiling with proximal flow control showing extra-aneurysmal coil mass (white arrowhead).
(D) Postoperative angiography showing complete obliteration of the aneurysm.

it can also provide temporary hemostasis in cases of intraprocedural rupture. One limitation of this technique is the potential entrapment of the microcatheter in the aneurysmal dome during balloon inflation. In such cases, the catheter cannot be repositioned, and rescue stent deployment is not possible without balloon deflation. In the approach defined in the current study, an 8-F BGC can be used for aneurysmal blood flow reduction during coiling while being simultaneously utilized to navigate a rescue stent or a neck-remodeling balloon for adjunctive techniques.

The concept of using an 8-F BGC for proximal flow control was based on its use as an accessory tool during endovascular thrombectomy in patients with acute ischemic stroke in the MERCI trial,[1)] in which the BGC was inflated to control intracranial blood flow and to avoid distal embolic events during thrombus evacuation. A similar approach was used in the current study during the endovascular coiling of anterior circulation aneurysms. The BGC was intended to be used for proximal flow control in the event of an unexpected intraprocedural rupture (Fig. 3). It was prepared as an insurance for proximal temporary clip during surgical clipping. Although initially planned and used for emergency situations, we serendipitously found additional advantages of using an 8-F BGC. The inflation of the 8-F BGC can aid in the deployment of a compliant balloon across the aneurysmal neck. The local balloon tends to drift or “sail” away

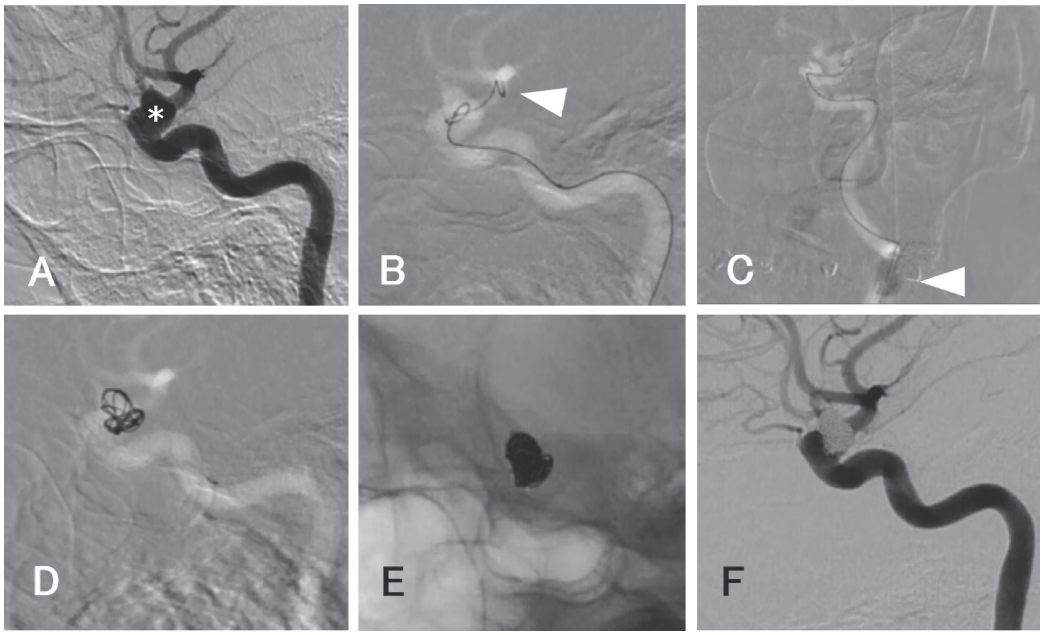

Fig. 4 Balloon inflation for the stabilization of the framing coil.
(A) Preoperative digital subtracted angiography showing broad-necked left internal carotid artery aneurysm (asterisk).
(B) Road map image showing the migration of several loops of the framing coil to the distal parent vessel (white arrowhead).
(C) The proximal balloon (white arrowhead) is inflated to reduce intra-aneurysmal flow and stabilize the frame.
(D) Please note the completed rigid frame.
(E) Postoperative X-ray image showing dense embolized aneurysm.
(F) Postoperative digital subtracted angiography showing complete obliteration of the aneurysm.

from the aneurysmal neck due to the arterial blood flow and may be difficult to place precisely across the aneurysmal neck. Induction of a transient reduction in circulatory intra-arterial flow allows for an easy deployment of the local balloon in such cases. Additionally, we found that temporary inflation of the BGC prevented further coil protrusion and migration in cases with coil protrusion into the parent vessel after detachment. Temporary blockade of flow achieved with the BGC may allow for the deployment of rescue stents if needed. In 22 patients in the current series, the BGC was inflated for stabilization during the deployment of the framing coil, as shown in the representative in Fig. 4. In particular, in patients with internal carotid artery aneurysms, proximal flow control was very helpful during the construction of the frame. As the microcatheter was free during proximal flow control, the frame could be created with delicate handling.

The 8-F BGCs were useful for catheterization of tortuous vessels, especially in patients with type III or bovine aortic arch. Partial inflation of the balloon tended to stabilize the BGC in the parent vessel and facilitated blood flow, similar to other flow-guiding catheters. To the best of our knowledge, these properties of BGCs have not yet been described in literature. Although we used 72 Cello™ BGCs and 80 Optimo™ BGCs in this study, we did not feel special difference among them.

The current study has several limitations. First, the lack of a control group was a major limita-

tion of the study. Second, Nguyen *et al*.[5] previously reported that the incidence of complications associated with BGCs was higher in patients with acute ischemic stroke as compared to those who were not treated using BGCs, although there were no significant complications observed in the current study. Finally, we acknowledge the limitations associated with the retrospective design of the current study.

CONCLUSIONS

An 8-F BGC was effectively used for proximal flow control for potential emergent events during the treatment of anterior circulation aneurysms. Other usage included improved navigation of tortuous arterial anatomy, coil stabilization, and freedom to use aneurysmal neck-remodeling balloons or rescue stents. This technique can be safely and effectively used in patients undergoing endovascular treatment for anterior circulation aneurysms.

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