Balloon-Assisted Rapid Intermittent Sequential Coiling (BRISC) Technique for the Treatment of Complex Wide-Necked Intracranial Aneurysms

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Summary

We describe our experience with balloon-assisted rapid intermittent sequential coiling (BRISC) of complex wide-necked aneurysms as an alternative to stent-assisted coiling. We use this technique in patients with acutely ruptured aneurysms, where antithrombotic treatment prior to stent deployment may not be advisable, and where the vascular anatomy is unfavorable for stenting. This is a retrospective analysis of 11 wide-necked aneurysms treated with this technique from June 2008 to January 2010. Results were analyzed in terms of aneurysm occlusion, procedural complications like thromboembolism, dissection/vasospasm, groin hematoma and any recurrence on follow-up. Coiling was successfully attempted in all cases (100%). Immediate angiographic results showed complete occlusion (class I) in 8/11, residual neck (class II) in 3/11 and no residual aneurysm (class III). Procedural complications were local thrombus formation in 3/11 procedures but no symptomatic thromboembolism, dissection in 1/11 and groin hematoma in 1/11. There was no morbidity or mortality. On follow-up study, there was one recurrence, which was subsequently coiled. In our opinion, this technique may provide an alternative to stent-assisted coiling in patients with ruptured aneurysm where antithrombotic treatment prior to stent deployment may not be advisable and in the presence of vascular anatomy unsuitable for stenting.

Introduction

Endovascular techniques for the treatment of intracranial aneurysm have evolved significantly since the introduction of Guglielmi detachable coils (GDC) in the early 1990s¹. Complex wide-necked intracranial aneurysms are, however, extremely challenging to treat by endovascular techniques.

Balloon-assisted coiling (BAC) has been accepted as an adjunctive technique for the endovascular treatment of complex wide-necked intracranial aneurysms²⁻¹⁰. When the anatomy is unfavorable, BAC alone may not be sufficient to prevent coil protrusion into the parent vessel, and an intracranial stent may be needed as a supporting scaffold. This can potentially add to the complexity of the case, especially in situations with aneurysmal subarachnoid hemorrhage where antiplatelet treatment prior to stent deployment may not be advisable.

Many modifications to BAC¹¹⁻¹⁴ have been described to address concerns regarding coil prolapse, prolonged ischemic times during temporary occlusion and lack of durability of coiling. In balloon-assisted rapid intermittent sequential coiling technique, predetermined number of coils (usually between three and five coils per balloon inflation cycle) were deployed in the wide-necked aneurysm within a maximum balloon inflation time of five minutes. This allows multiple coils to brace with each other and form stable scaffolding for deployment of further coils. This technique was used

when the first framing coil was felt to be unstable after balloon deflation and was prolapsing back into the parent vessel.

We describe our experience with a balloon-assisted rapid intermittent sequential coiling technique as an alternative to stent-assisted coiling in patients with ruptured wide-necked aneurysm and in relative contraindications for stent-assisted coiling like unfavorable tortuous vascular anatomy or parent artery too small for stent deployment.

Patients and Methods

After obtaining Institutional Review Board approval, we retrospectively identified patients who underwent endovascular coiling of intracranial aneurysms with balloon-assisted rapid intermittent sequential coiling from our Interventional Neuroradiology database. From June 2008 to January 2010, 11 patients (mean age 60 years, range 41-85 years, seven women) were treated with this technique. Clinical data and angiograms were collected from chart review and review of DI PACS records. Of 11 patients, six presented with subarachnoid hemorrhage (SAH) on NCCT, four had headache without SAH and one presented with third nerve palsy. Aneurysm location was as follows: basilar bifurcation (n=3), anterior communicating artery (A-comm, n=3), middle cerebral artery (MCA) bifurcation (n=2), internal carotid artery (ICA) bifurcation (n=1), posterior communicating artery (P-comm, n=1) and vertebrobasilar junction (n=1). All aneurysms were wide-necked. Mean aneurysm sac diameter was 10.4 mm (range 7 - 19 mm). Mean aneurysm neck length was 5.9 mm (range 5 - 11 mm) (Table 1).

Indications for the technique

There were a total of 13 aneurysms in 11 patients. Balloon-assisted rapid intermittent sequential coiling was used to treat 11 out of these 13 aneurysms. Two aneurysms (narrow-necked) were treated in separate sittings using a conventional unassisted technique. We avoided stent-assisted coiling in six ruptured aneurysms due to a fear of exacerbating risk of recurrent hemorrhage with the use of antiplatelets. In five unruptured aneurysms, parent artery diameter was too small for stent deployment. This technique was used for coiling these aneurysms when the first framing coil was felt

to be unstable after balloon deflation and was prolapsing back into the parent vessel.

Technique

All procedures were performed in a dedicated biplane neuroangiography suite (Siemens Axiom Artis, Siemens, Erlangen, Germany) under general anesthesia and systemic heparinization.

Our procedure for BAC included unilateral femoral arterial access and placement of a 7F access sheath (Pinnacle, Terumo Medical Corporation, Somerset, NJ, USA). A 7F guiding catheter (Guiding softip XF, Boston scientific, Natick, MA, USA) with two sequentially attached rotating hemostatic valves (Merit Medical Systems, Utah, USA) were used, one for the balloon catheter and the other for the coiling microcatheter. All patients were treated with platinum coils with a rapid detachment system (Micrus Microcoil system, Micrus endovascular, Mountain View, CA, USA). After reviewing the diagnostic angiogram including a 3D rotational angiogram, decision to attempt BAC was made.

We typically use either Hyperform or Hyperglide balloons with the Xpedition wire (Micro-Therapeutics Inc.) for balloon assistance. When using traditional balloon remodeling technique, temporary inflation of the balloon across the aneurysm is performed while placing a single coil within the aneurysm sac and subsequently deflating the balloon to ensure no coil loops migrate into the parent vessel before final detachment. If the first framing coil was felt to be unstable and the coil prolapsing back into the parent vessel after balloon deflation, a decision was made to attempt balloon-assisted rapid intermittent sequential coiling. Unlike the traditional approach, in this technique, we place a predetermined number of coils (usually between three and five coils per balloon inflation cycle) during a maximum balloon inflation time of 5 minutes. This allows multiple coils to brace each other within the aneurysm and form stable scaffolding for deployment of further coils.

The balloon is then deflated to allow cerebral reperfusion and to evaluate if any coil loops are prolapsing into the parent artery. Balloon inflation is never carried out for longer than five minutes to reduce ischemic time. The procedure is performed under full heparinization (activated thromboplastin time maintained at 250-300). The technique is repeated as neces-

Table 1 Demographics, clinical presentation and treatment outcomes in 11 wide-necked aneurysms treated with balloon-assisted rapid intermittent sequential coiling technique.

	Age (y)/ Sex	Location	Dome/ Neck (mm)	Presentation	Occlusion	Complication	Recurrence
1	50y/F	Vertebro-basilar junction	17/11	SAH	Class 2 (residual neck)	Rt vertebral artery dissection, stented later	No
2	76y/F	ACOM	19/10	SAH	Class 2 (residual neck)	Local thrombus in left A2	Yes (Conventional coiling of residual neck 14 months later)
3	85y/F	PCOM	7/5	Rt 3 rd nerve palsy	Class 2 (residual neck)	None	No
4	54y/M	Rt MCA bifurcation	8/5	Headache	Class 1 (complete)	None	No
5	64y/M	ACOM	8/5	Headache	Class 1 (complete)	None	No
6	79y/F	Basilar top	8/5	Headache	Class 1 (complete)	None	No
7	68y/F	Rt MCA bifurcation	8/5	Headache	Class 1 (complete)	None	No
8	55y/F	Basilar top	12/5	SAH	Class 1 (complete)	Local thrombus in left P1	No
9	53y/M	Basilar top	11/6	SAH	Class 1 (complete)	None	No
10	43y/F	Rt ICA bifurcation	13/6	SAH	Class 1 (complete)	None	No
11	41y/M	ACOM	8/5	SAH	Class 1 (complete)	Local thrombus in Rt A2, groin hematoma	No

sary to achieve adequate intra-aneurysmal coil packing density.

Illustrative case

A 54-year-old woman presented with subarachnoid hemorrhage related to a ruptured bilobed vertebrobasilar artery aneurysm (Figure 1A). In consultation with the cerebrovascular surgeon, an endovascular approach was chosen. Based on aneurysm and parent artery anatomy, balloon-remodeling technique was planned as adjunctive procedure for coiling. Stent-assisted coiling was not used to avoid antiplatelet administration in the acute phase of subarachnoid hemorrhage. Initial attempts at coiling using balloon inflation and placement

of different sizes of coils proved unstable as the coil was prolapsing repeatedly into the parent proximal basilar artery. It was decided to attempt rapid deployment and detachment of multiple coils during a single balloon inflation cycle to allow the coils to brace each other and achieve a more stable coil configuration. This technique was successful and subsequent coiling resulted in good packing density within the larger left lobule (Figure 1 B,C). We repeated this technique for the smaller right lobule (Figure 1 D,E). There was intraprocedural dissection of intradural segment of right vertebral artery, which was stented later after the acute phase of SAH subsided. At six months follow-up, catheter angiogram showed no recurrence of aneurysm and continued patency of the basi-

Figure 1 A) Catheter angiogram shows bilobed vertebrobasilar artery aneurysm. B,C) Images obtained after balloon assisted rapid intermittent sequential coiling shows good coil position within the left lobe of aneurysm sac. D,E) Similarly rapid sequential coiling of the smaller right side lobule shows good packing density of the aneurysm. F) At 6 months follow-up, catheter angiogram showed no recurrence of aneurysm and continued patency of the basilar artery as well as preserved flow to both posterior inferior cerebellar arteries.

lar artery as well as preserved flow to both posterior inferior cerebellar arteries (Figure 1F).

Results

Technical feasibility

A total of 11 aneurysms were treated with balloon-assisted rapid intermittent sequential coiling. The technique was successfully attempted in all patients.

Anatomic outcome

In the 11 aneurysms treated with this technique, occlusion was considered complete (class 1) according to Raymond and Roy classifica-

tion (15) in 8/11 cases. Small residual neck (class II) was noted in 3/11 cases at the end of the procedure. No residual aneurysm (class III) was noted on immediate post-procedure angiogram.

Procedural complications

Local thrombus formation was documented in 3/11 procedures. In these cases, immediate intra-arterial abciximab (maximum of 8-10 mg) was given. The last angiographic run showed complete resolution of thrombus with normal patency of the vessels. No symptomatic thrombo-embolic complications were documented. One patient with a vertebrobasilar junction aneurysm had procedural dissection of the intradural segment of the right vertebral artery,

which was stented later after the acute phase of SAH had subsided. One patient developed a groin hematoma not requiring intervention. There was no coil prolapse on deflating the balloon. No aneurysmal or vessel rupture occurred during treatment. All patients had a good clinical outcome without any morbidity. There was no mortality.

Follow-up

All patients had clinical and imaging follow-up. Follow-up ranged from six to 20 months with a mean follow-up duration of 11 months. Contrast-enhanced MR angiography was the most common modality used for follow-up imaging. Of the eight complete occlusions (Raymond and Roy classification class I) post procedure, all remained stable at final follow-up without any recanalization or recurrence. On follow-up study there was one recurrence which was subsequently coiled.

Discussion

In complex wide-necked aneurysms, coiling is often technically difficult because of the risk of coil prolapse in the parent artery. In instances where the anatomy is unfavorable, BAC alone may not be sufficient to prevent coil protrusion in the parent vessel and an intracranial stent may be needed as a supporting scaffold. The requirement for dual antiplatelets medication however, represents one significant potential drawback of the application of intracranial stents for aneurysm treatment. This is an important issue in the setting of acute subarachnoid hemorrhage, in which platelet inhibition could potentially result in a significant risk of bleeding complications¹⁶, especially if a ventricular drain is required.

Many modifications like a “double balloon”¹¹⁻¹³ and double microcatheter technique^{17,18} have been described for treating complex wide-necked aneurysms. Simultaneously navigating two balloon catheters, however, may be difficult in tortuous vascular anatomy. The presence of multiple catheters may be difficult in small vessel diameter and may cause catheter-induced vasospasm¹¹. These techniques also pose a high risk of the parent artery rupture⁷ and thromboembolic events¹¹. Importantly, they do not solve the problem of framing coil prolapse after the balloon(s) is/are deflated.

Kelly et al.¹² described placing multiple coils during each balloon inflation cycle (typically lasting 5-10 minutes) using a double-balloon trapping technique in a large wide-necked superior cerebellar artery aneurysm. The technique was primarily aimed at protecting the superior cerebellar artery arising from the neck of the aneurysm. Fiorella et al.¹⁴ described a technique of placing multiple coils during each balloon inflation cycle, which they named the “conglomerate mass technique”. The technique was aimed at reducing ischemic time, coil prolapse and to enhance coil mass stability. There is no major difference between conglomerate mass and our technique. Our series, however, is the first case series to describe in detail about this approach to wide-necked aneurysm coil embolization. We wanted to highlight our strategy of balloon-assisted rapid intermittent sequential coiling as one alternative to stent-assisted coiling in patients with ruptured wide-necked aneurysm, where aneurysm is initially secured using this technique in acute subarachnoid hemorrhage phase and if required, later doing stent-assisted coiling for residual aneurysm. Balloon-assisted rapid intermittent sequential coiling can also be used in relative contradictions to stent-assisted coiling like unfavorable tortuous vascular anatomy and if the parent artery is too small for stent deployment. The technique of multiple coil deployment during single balloon inflation is now feasible because of the newly available rapid detachment systems, the very compliant nature of the current generation balloons and availability of soft and ultrasoft coils with longer coil lengths¹². In our study, BAC with balloon-assisted rapid intermittent sequential coiling was successful in all attempted cases. Local thrombus formation was documented in 3/11. Though our rate of local thrombus formation was high compared to a series of BAC published earlier¹⁰, we documented no symptomatic thromboembolic complications. There was no coil prolapse on deflating balloon. Our occlusion rates with this technique are consistent with previously published reports of BAC^{19,20}. On follow-up study, there was one recurrence, which was subsequently coiled. We feel that through this technique, by creating a mesh of entangled coil, more coil packing density is achieved which could reduce the risk of recurrence. This technique also reduces ischemic time and total procedure time by reducing the number of balloon inflation cycles.

Potential complications like complete pro-

lapse of entire mass of multiple coils after balloon deflation can occur. There was no coil prolapse encountered in this study. This could be due to multiple coils bracing each other within the aneurysm and forming stable scaffold for deployment of further coils. This is however, a very small series of 11 patients and conclusions should not be drawn out. As with any novel technique, there is a learning curve to gain technical expertise. Future larger series with long-term digital subtraction angiographic follow-up is required to confirm these preliminary results.

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Conclusion

Balloon-assisted rapid intermittent sequential coiling allows good packing and affords a stable configuration across the wide-necked aneurysm.

This technique may provide an alternative to stent-assisted coiling in patients with acutely ruptured aneurysm where antiplatelet treatment prior to stent deployment may not be advisable and where the vascular anatomy is difficult for stenting.

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