Stent/Balloon Combination Assist Technique for Wide-Necked Basilar Terminal Aneurysms

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Summary

We describe an enhanced endovascular procedure for the coiling of broad-necked basilar terminal aneurysms with a combined balloon/stent assist technique. A balloon-assisted catheter is inserted in the origin of one posterior cerebral artery (PCA) and an assisted stent is deployed from the opposite PCA to the basilar artery. A microcatheter for coiling is inserted through the stent strut (trans-cell approach), and the aneurysm is coiled under stent support and assisted balloon inflation to keep the patency of both PCAs. This technique is more beneficial for reducing the risk of stent deformity than Y-stenting, and it provides a simpler procedure than other advanced stent techniques. Additionally, it enables an easy approach when retreatment is necessary for aneurysm recurrence. This technique may be one of the useful procedures for embolizing broad-necked basilar terminal aneurysms safely and effectively.

Introduction

Broad-necked or no-neck aneurysms at the top of the basilar artery (BA) are quite difficult to embolize while preserving both posterior cerebral arteries (PCAs). Preservation of both PCAs is essential, especially the hypoplastic posterior communicating arteries. Various assist techniques are applied, including double catheter, double balloon, and the stent combination techniques (for example; Y-configura-

tion, kissing, horizontal, or waffle-cone stenting). Y-stenting may be the most popular technique among them for preserving bilateral PCAs¹⁻⁴. However, Y-stenting has some disadvantages. For instance, it is sometimes difficult to penetrate the second stent through the most adequate strut of the previously deployed stent, and stent deformity might induce a higher risk of thrombogenesis and cause difficulty with retreatment. Furthermore, closed-cell design stents such as the Enterprise (Codman, Miami Lakes, FL, USA) make stenting susceptible to “cobra-necking” kinking when deployed in a tightly curved BA-PCA junction⁵. In addition, the combination of two open-cell design stents carries the risk of tangling and causing thorny protrusion of struts. Therefore, we propose an enhanced endovascular procedure for these difficult aneurysms, called the combined stent/balloon assist technique, and present some tips and pitfalls.

Procedure

The patient is managed with prescribed dual anti-platelet therapy as with usual stent-assisted embolization. After placing the 7Fr sheath, the 7Fr guiding catheter is placed on the extracranial vertebral artery. A microcatheter to deliver the stent and a microballoon catheter for neck remodeling are coaxially inserted into the guiding catheter. We usually use the combination of Prowler Select Plus (Codman) and HyperForm (Covidien, Irvine, CA, USA). The

Figure 1 Schematic images of the combined stent/balloon assist technique for wide-necked basilar terminal aneurysms. The microcatheter for coiling is inserted into aneurysm sac through stent strut with a trans-cell approach. The balloon catheter is placed at the basilar artery-posterior cerebral artery junction under jailed approach.

Figure 2 A 67-year-old woman with large broad-necked aneurysm at the BA tip. A) Anterior-posterior view. B) Three-dimensional image. The balloon catheter (HyperForm: arrow) was placed in the left PCA, and then the stent (Enterprise) was deployed from the right PCA to the BA trunk. C) Arrowheads show distal and proximal markers of stent. D) The aneurysm was embolized with stent/balloon assist. E, F) Final angiogram showing both PCAs are well preserved.

microcatheter for stent delivery is advanced in one PCA and the balloon catheter is placed in the opposite PCA. The balloon is placed at the origin of the PCA attached to the stent body. After deploying the stent in an appropriate position, the microcatheter for stenting is withdrawn. Instead, a microcatheter for coiling is

inserted into the aneurysm sac through the stent strut with a trans-cell approach (Figure 1). Coils are placed under the adequately inflated balloon as with the usual neck remodeling balloon-assist technique. After the aneurysm is sufficiently packed with coils, the microcatheter and balloon catheter are removed.

Table 1 Patients with basilar-terminal aneurysms treated by the stent/balloon combined technique.

	Age	Sex	Symptom	Max Size (mm)	Neck (mm)	Dome/Neck Ratio	Guiding System	Stent (Enterprise, Length)	Result	Volume Embolization Rate (%)	Complication	mRS (30d)	Follow-up (month)	Follow-up Result	Re-treatment
1	67	F	Incidental	11.6	10	1.04	7Fr Guiding catheter	28 mm	Complete	37.6	None	0	14	Complete	No
2	58	F	Incidental	9.6	9.2	1.04	7Fr Guiding catheter	28 mm	Residual Dome	32.2	In-stent thrombosis	0	7	Neck Remnant	No
3	62	F	Incidental	7.6	5.0	1.24	6Fr Guiding sheath	22 mm	Neck remnant	29.1	None	0	6	Neck Remnant	No
4	62	F	Incidental	11.3	9.9	0.99	7Fr Guiding catheter	28 mm	Neck remnant	29.3	None	0	4	Neck Remnant	No
5	70	F	Incidental	9.8	8.6	1.14	6Fr Guiding sheath	28 mm	Complete	34.4	None	0	3	Complete	No
6	67	F	Incidental	6.8	7.1	0.73	6Fr Guiding catheter	22 mm	Complete	Not achieved	None	0	2	Complete	No

mRS: modified Rankin Scale.

Clinical Application

We adopted this technique for six patients (average age: 64.3 ($\pm$ 4.4), six females) with extremely broad-necked BA terminal aneurysms (Table 1). All the patients were successfully treated without neurological deficits (Figures 2 and 3). Volume embolization rate was 32.5 ($\pm$ 3.6) %. One patient required local fibrinolysis with tissue plasminogen activator and anti-thrombotic agents (Ozagrel Sodium) because of in-stent thrombosis (Figure 4). The patient was fully intact without neurological deficits in all courses, and post-operative MRI showed no large infarcted lesions except for a few high intensity spots in the ipsilateral occipital area. Postoperatively, this patient was regarded as a poor responder to clopidogrel based on a platelet aggregation test. All the aneurysms were sufficiently packed without flow impairment to either PCA due to coil herniation. There has been no recurrence thus far after six months of follow-up.

Case Presentation

A large broad-necked aneurysm at the BA tip was incidentally found in a 67-year-old woman (Figure 2). The maximum aneurysm size was approximately 11 mm. She was managed with prescribed dual anti-platelet therapy

for two weeks before treatment, and then coil embolization was carried out by combined stent/balloon assist technique. A 7Fr guiding catheter was placed at her left vertebral artery via a transfemoral approach. Then, a balloon microcatheter (HyperForm) was placed in the left PCA and the stent-deploying catheter (Prowler Select Plus) was advanced to the right PCA. Thereafter, the stent (Enterprise: 4.5mm-28 mm) was deployed from the right PCA to the BA trunk. A balloon was placed in a jailed way at the origin of the PCA attaching the stent body. Instead of a microcatheter for stenting, a microcatheter for coiling was inserted into the aneurysm sac through the stent strut. The aneurysm was sufficiently embolized with stent/balloon assist preserving both PCAs. Volume embolization rate was 37%. The MRI diffusion image acquired one week postoperatively showed only two small high intensity spots. The patient was discharged without any complication. There was no aneurysm recurrence during 11 months of follow-up.

Discussion

Advantage of stent/balloon compared with other advanced techniques

Other advanced stent techniques like horizontal stenting⁶ and kissing stenting⁷ may be useful for very limited cases, but require a dif-

Figure 3 A 62-year-old woman with a large unruptured broad-necked aneurysm. A) Anterior-posterior view. B) Three-dimensional image. C) As the right PCA originated more caudally than the left one at a sharp angle, the balloon was set at the right PCA (arrow) and the stent was deployed from the left PCA to the BA terminal (arrowheads). D) Final angiogram demonstrates patent PCAs and no protrusion of coils into either PCA or BA-tip.

ferent access route or a larger guiding catheter. The waffle cone technique^{8,9} has little consensus for safe deployment and has earned little confidence for its ability to support coils. Generally, Y-stenting is recognized as the most useful support technique. It may have some benefits that make embolization sufficient, and help to avoid the recanalization due to the effects of branch straightening and hemodynamic rectification¹. However, there are some disadvantages, such as complicated procedures with multiple catheters, and sandglass-like deformity of the stent at the crossed point. Such an artificial “crescent” deformity will raise the risk of ischemic complications¹⁰. In particular, a tangled stent strut may disturb the reinsertion of a microcatheter when the aneurysm must be re-treated.

The combined balloon/stent assist technique provides a simpler procedure than other advanced stent techniques, its most notable benefit being that the stent mesh is neither impaired nor broken by deployment of another stent. Furthermore, the retreatment through

the mesh of a previously placed single stent is easier than working through the overlapped mesh after Y-stenting, and it also enables various multiple catheter techniques to be used again. In addition, a balloon can be inflated and controlled without resistance, and it provides better coiling than the usual balloon assist technique. Additionally, this combined stent/balloon assist technique can be applied to broad-necked terminal type aneurysms located in other places (for instance; internal carotid artery terminal or middle cerebral artery aneurysm) as well as in BA terminal aneurysms.

Tips and Pitfalls

As for choosing the side to use for each assist device, the stent is usually placed in the side of the PCA arising cranially, with a more obtuse-angled BA-PCA junction to avoid stent kinking or coning¹¹. We recommend using a stent relatively longer than the usual selection for stabilization and avoidance of migration due to balloon manipulation¹². In particular,

Figure 4 A 53-year-old woman with a large unruptured BA terminal aneurysm. A) Anterior-posterior view. B) Three-dimensional image. The stent was deployed along the left PCA to the basilar artery, and the balloon catheter was placed on the right PCA. C,D) Arrowheads indicate stent markers. E) During embolization, opacification worsened because of stent-induced thrombus in the left PCA and thrombus at the origin of the right PCA (arrows). Forced local fibrinolysis with an anti-thrombotic agent resulted in successful recanalization.

adequate stent negotiation during stent deployment is essential for cases with sharp-angled branching PCA, so as to avoid crescent deformity of the stent at the BA-PCA junction¹¹. The position of the balloon is better kept as close as possible to the stent body. However, if it is inflated in the more proximal BA-PCA junction, the balloon might compress and squeeze the stent, bringing about excessive stress against the arterial wall of BA. However, this interference may be temporary and the stent will recover spontaneously after deflation of the balloon. Depression of the stent might impair the supportiveness of the coil mass and increase the risk of herniating the coil into the vascular lumen. Therefore, it should be inflated just distal to the BA-PCA junction. We can adequately arrange the assist force with the degree of balloon inflation, occasionally with the herniation technique.

The balloon catheter usually should be jailed. But it might be possible in exceptional cases to navigate the balloon catheter by a trans-cell approach (Figure 5). This procedure

could be applied if the microcatheter for coiling is first placed under the jail technique or if balloon assist for preserving another PCA becomes required after stenting during the course of usual stent-assist coiling. If a 5-6Fr guiding catheter is required for the access problem (such as the small diameter of vertebral artery and poor collaterals from the other axis), a balloon catheter could be navigated by a trans-cell approach. In addition, this procedure has a benefit in that the stent-strut may prevent the upper protrusion of a balloon catheter into the aneurysmal sac. However, there are some pitfalls. First, the excessive stress in advancing the balloon catheter through the stent-strut may cause migration of the stent and destruction of the stent mesh. Second, there is uncertainty of penetrating the balloon catheter through the stent and placing it in its proper position. If the balloon manipulation fails, we must treat it as a worst-case scenario with single stenting. Third, the stented PCA is usually straightened a little², and the neck is rather narrowed. Such remodeling may

Figure 5 A 67-year-old woman with recurrence of unruptured BA terminal aneurysm. A) Anterior-posterior view. B) We approached transbrachially with a 6Fr guiding catheter from the right vertebral artery because of trouble with the access route due to her very atherosclerotic aorta. Usual the stent assist embolization did not work well because of instability of coils. A balloon catheter was advanced through the stent-strut and placed in the left PCA. Arrowheads show stent markers and the arrow shows the balloon catheter. C) The balloon performed well pushing up coils. D) The aneurysm was successfully embolized with both PCAs patent.

cause the deviation of the aneurysm to the un-assisted PCA and change the course of the PCA to the reversed branching style. This might make the insertion and advancement of a balloon catheter by the trans-cell approach difficult. Therefore, we generally recommend balloon setting first, and then advancing the stent delivery system into the opposite PCA. This order may allow for easier maneuverability in navigating the balloon catheter into the reversed branching type of PCA, particularly

in cases requiring a round insertion technique along the aneurysmal wall.

Conclusion

We demonstrated a combined stent/balloon assist technique for embolization of broad-necked BA terminal aneurysms. This technique may well be a useful treatment option for BA terminal aneurysms.

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Tuberothalamic Artery Infarction Following Coil Embolization of a Ruptured Posterior Communicating Artery Aneurysm Belonging to a Transitional Type Posterior Cerebral Artery

A Case Report

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Key words: tuberothalamic artery, Allcock's test, fetal type posterior cerebral artery

Summary

There are many potential anatomical variations in the connection between the internal carotid artery and the posterior circulation through the posterior communicating artery (PCoA). We describe the endovascular treatment of an aneurysm arising near the origin of the PCoA belonging to a transitional type posterior cerebral artery. Coil embolization subsequently resulted in thrombo-occlusion of the adjacent PCoA causing thalamic infarction even though sufficient retrograde flow had been confirmed preoperatively by Allcock's test.

Introduction

A fetal type posterior communicating artery (PCoA) refers to an artery in which the dominant flow of the posterior cerebral artery (PCA) originates from the anterior circulation. Its incidence has been reported to vary from four to 29% of the population. Four to 12 branches (with an average of seven) with a diameter between 0.1 and 0.6 mm arise from the PCoA¹. The tuberothalamic artery commonly arises from the caudal part of the PCoA, which

is close to the PCA, or from the border between the caudal and middle third of the PCoA². The present report describes thrombo-occlusion of a thalomoperforating artery after coil embolization on rupture of a transitional type PCoA.

Case Report

A 67-year-old man was referred to our emergency room with an acute change in mental status. On examination he was noted to be stuporous. He had a history of head trauma 15 years ago, with minimal cognitive dysfunction. Computed tomography (CT) scan of the brain disclosed evidence of subarachnoid hemorrhage within the basal cisterns, with intraventricular extension and a moderate degree of hydrocephalus (Figure 1). Cerebral angiogram showed a large left PCoA area saccular aneurysm (Figure 2). A transitional type left PCoA, as described by van Raamt et al., was noted³. The flow to the left PCA was mainly supplied by the left PCoA. However adequate supply from the vertebro-basilar system was demonstrated by Allcock's test (Figure 3)⁴. Coiling of the aneurysm was done with the double catheter technique. The