Safety, Efficacy, and Durability of Stent Plus Balloon-Assisted Coiling for the Treatment of Wide-Necked Intracranial Bifurcation Aneurysms

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BACKGROUND: Wide-necked bifurcation aneurysms remain a challenge for endovascular surgeons. Dual-stent-assisted coiling techniques have been defined to treat bifurcation aneurysms with a complex neck morphology. However, there are still concerns about the safety of dual-stenting procedures. Stent plus balloon-assisted coiling is a recently described endovascular technique that enables the coiling of wide-necked complex bifurcation aneurysms by implanting only a single stent.

OBJECTIVE: To investigate the feasibility, efficacy, safety, and durability of this technique for the treatment of wide-necked bifurcation aneurysms.

METHODS: A retrospective review was performed of patients with wide-necked intracranial bifurcation aneurysms treated with stent plus balloon-assisted coiling. The initial and follow-up clinical and angiographic outcomes were assessed. Preprocedural and follow-up clinical statuses were assessed using modified Rankin scale.

RESULTS: A total of 61 patients (mean age: 54.6 ± 10.4 yr) were included in the study. The immediate postprocedural digital subtraction angiography revealed complete aneurysm occlusion in 86.9% of the cases. A periprocedural complication developed in 11.5% of the cases. We observed a delayed ischemic complication in 4.9%. There was no mortality in this study. The permanent morbidity rate was 3.3%. The follow-up angiography was performed in 55 of 61 patients (90.1%) (the mean follow-up period was 25.5 ± 27.3 mo). The rate of complete aneurysm occlusion at the final angiographic follow-up was 89.1%. The retreatment rate was 1.8%.

CONCLUSION: The results of this study showed that stent plus balloon-assisted coiling is a feasible, effective, and relatively safe endovascular technique for the treatment of wide-necked bifurcation aneurysms located in the posterior and anterior circulation.

KEY WORDS: Aneurysm, Bifurcation, Balloon remodeling, Coiling, Intracranial, Stent-assisted, Wide-necked

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Following the publication of the International Subarachnoid Aneurysm Trial results, coiling has become a valid technique for the treatment of intracranial aneurysms.[1] Recent introductions of novel techniques, such as stent-assisted coiling, flow diversion, and intrasaccular flow disruption, have expanded the role of endovascular neurosurgery in the treatment of intracranial aneurysms.[2-6]

ABBREVIATIONS: PCA, posterior cerebral artery; **WEB,** Woven EndoBridge

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However, complex bifurcation aneurysms with a wide neck incorporating more than one side branch remain a challenge for endovascular surgeons. These complex aneurysms are located at the junction of 2 branching vessels that must be protected during coiling. Implantation of a single stent into one of the side branches may not be sufficient to prevent coil protrusion into the remaining branch. Therefore, dual-stenting techniques, including X- and Y-stenting, have been described to protect both side branches during the coiling of wide-necked complex bifurcation aneurysms.[7-9] In dual-stenting techniques, 2 stents are implanted into each side branch as 1 stent intersects the other at the bifurcation point. Although recent studies

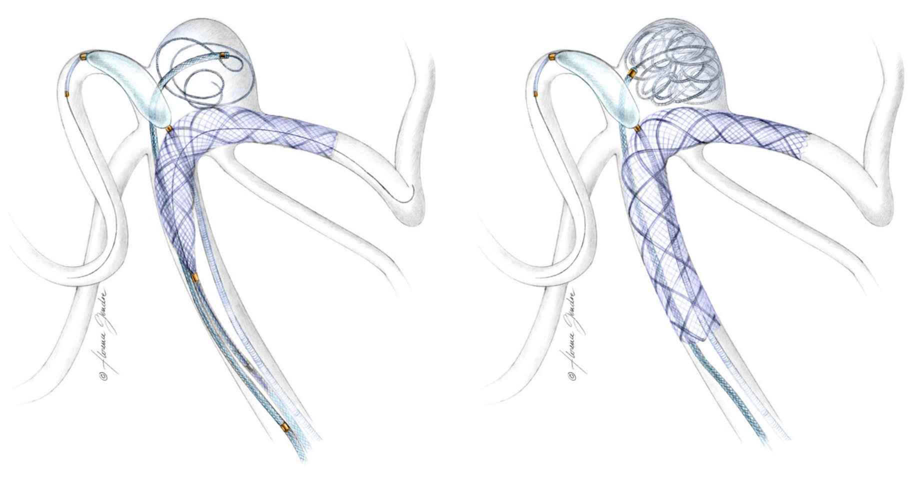

FIGURE 1. *The illustrations demonstrate the stent plus balloon-assisted coiling technique. The illustration on the left demonstrates the early stage of the stent plus balloon-assisted coiling procedure. The neck of the aneurysm is sealed by the partially deployed stent and an inflated dual-lumen balloon at the early stages of the procedure. Another microcatheter is jailed in the aneurysm sac for coil delivery. The illustration on the right shows the later stage of the procedure. The stent is fully deployed after an adequate coil mesh is formed to prevent displacement of the stent into the aneurysm sac. While protecting the other side branch by temporary balloon inflation, coiling is continued until complete angiographic occlusion of the aneurysm is achieved. © Florence Gendre, used with permission, all rights reserved.*

have demonstrated the safety of the Y-stenting procedure, there are still concerns about the technical complexity and safety of Y-stenting. In Y-stenting, attempts to catheterize the second side branch passing through the struts of the first deployed stent may cause migration or deformation of the first stent.[9-11] Moreover, intraluminal struts at the bifurcation point, which are not amenable to endothelization, may be a potential source of thromboembolic complications.[9,11] An endovascular technique combining stent assistance with balloon remodeling has been previously described in a small group of patients with wide-necked basilar bifurcation aneurysms.[12] In this technique, a single stent is implanted into one of the side branches, and the other side branch of the bifurcation is protected by temporary inflations of a balloon catheter during coiling. Therefore, this technique obviates the need for implantation of a second stent during the coiling of wide-necked bifurcation aneurysms. We call this technique "stent plus balloon-assisted coiling."

The aim of this multicenter retrospective study was to investigate the feasibility, efficacy, safety, and durability of the stent plus balloon-assisted coiling for the treatment of wide-necked bifurcation aneurysms. We also assessed the applicability of this endovascular technique for the treatment of bifurcation aneurysms located in the anterior circulation.

METHODS

Patient Selection

After institutional ethics committee approval was obtained, the databases of 4 endovascular surgery departments were reviewed to identify patients with a wide-necked bifurcation aneurysm that was coiled with the combined assistance of a self-expandable stent plus balloon microcatheter between January 2009 and March 2020. The patients' demographics and presenting symptoms, the location and size of the aneurysms, technical details and complications of the endovascular operations, and the results of neurological and angiographic assessments were recorded. Because this study is a retrospective case series, the patient consent was not sought.

Endovascular Operation

Patients were pretreated daily with 75 mg of clopidogrel and 300 mg of aspirin at least 5 d prior to the operation. In cases with ruptured aneurysm treated at the acute setting of subarachnoid hemorrhage, eptifibatide infusion was initiated just before the deployment of the stent and continued for 24 h. A loading dose of 450 mg clopidogrel and 300 mg aspirin was administered following the cessation of eptifibatide infusion. During the procedure, one of the side branches of the bifurcation was catheterized by a 0.017-inch microcatheter for stent delivery (Echelon 10 [Medtronic, Dublin, Ireland], Headway 17 [MicroVention/Terumo, Tustin, California], and SL-10 [Stryker Neurovascular, Fremont, California]). The other side branch of the bifurcation was catheterized by a double-lumen balloon microcatheter (Eclipse 2L [Balt, Montmorency, France] or Scepter XC [MicroVention]) or single-lumen balloon microcatheter (HyperGlide [Medtronic]). Another microcatheter for coiling (Echelon-10 or Headway 17) was jailed in the aneurysm sac. The coiling procedure was initiated while protecting both side branches with a partially deployed stent and temporary inflation of the balloon catheter (Figure 1). The balloon was positioned just distal to the stent deployed segment to avoid deformation of the stent by inflated balloon. Both stents were fully deployed when a

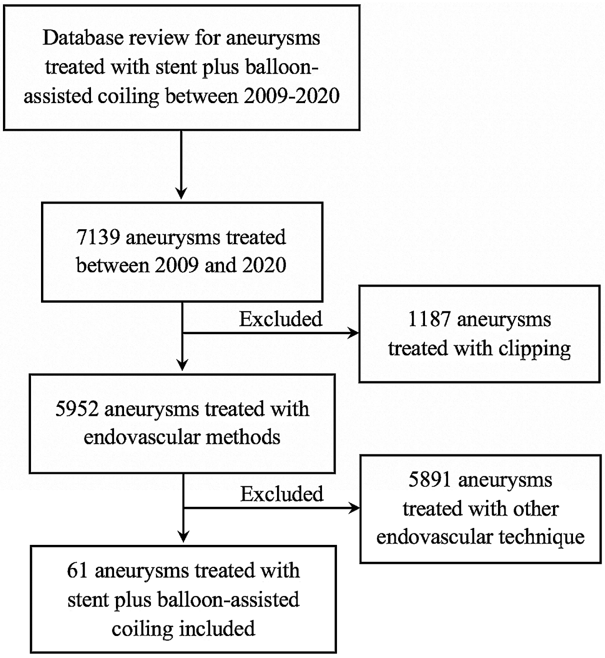

FIGURE 2. *The patient flow chart demonstrates the retrospective review process of the databases to identify the aneurysms that was treated with the stent plus balloon-assisted coiling technique.*

TABLE 1. Summary of the Patients' Demographics, Aneurysm Characteristics, and the Mean Diameters of Bifurcation Vessels

The mean age	54.6 ± 10.4 yr
Sex	
Female	43 (70.5%)
Male	18 (29.5%)
Aneurysm location	
MCA	34 (55.7%)
Basilar bifurcation	17 (27.9%)
AComA	7 (11.5%)
Carotid bifurcation	2 (3.3%)
SCA	1 (1.6%)
Aneurysm size	
2-4 mm	21 (34.4%)
5-7 mm	28 (45.9%)
8-10 mm	9 (14.8%)
11-15 mm	2 (3.3%)
16-20 mm	1(1.6%)
The mean dome-to-neck size	5.8 ± 2.6 mm
The mean dome-to-neck ratio	1.31 ± 0.15
The mean diameter of parent arteries	2.79 ± 0.53 mm
The mean diameter of stent protected branches	2.32 ± 0.45 mm
The mean diameter of balloon protected branches	2.01 ± 0.40 mm

AComA = anterior communicating artery; MCA = middle cerebral artery; SCA = superior cerebellar artery.

TABLE 2. Stents and Balloon Catheters Used at the Endovascular Procedures

	Number of patients
Deployed stent	
Leo Baby (Balt)	47 (77%)
Lvis Jr (MicroVention)	7 (11.5%)
Neuroform Atlas (Stryker)	2 (3.3%)
Neuroform (Stryker)	2 (3.3%)
Solitaire (Medtronic)	2 (3.3%)
SILK Vista (Balt)	1(1.6%)
Balloon catheter	
Scepter XC (MicroVention)	24 (39.3%)
HyperGlide (Medtronic)	17 (27.9%)
Eclipse 2L (Balt)	16 (26.2%)
Scepter C (MicroVention)	4 (6.6%)

sufficient coil pack was created in the aneurysm sac. Then, the aneurysm sac was coiled until no further coils could be safely deployed.

Follow-up

Immediate postoperative digital subtraction angiography (DSA) was performed at the end of the procedure to evaluate aneurysm occlusion according to the Raymond-Roy classification (RRC).[13] Follow-up magnetic resonance angiography was performed 3 to 6 mo after the procedure. The first DSA follow-up was performed 9 to 18 mo after the procedure. The follow-up angiographic images were evaluated to assess the degree of aneurysm occlusion and the patency of vessels.

Patients' neurological conditions were assessed using the modified Rankin scale (mRS) before the procedure, at discharge, and during the clinical follow-ups. The first clinical follow-up was performed 3 mo after discharge. The second and third clinical assessments were performed during the angiographic follow-ups. Periprocedural complications were defined as the complications that developed during the endovascular operation or within 14 d after the operation. Any complication developing more than 14 d later was defined as a delayed complication.

Statistical Analysis

The descriptive statistical analysis was performed by using SPSS statistics (IBM, Armonk, New York).

RESULTS

Patients and Aneurysms

The database reviews of four departments revealed a total of 7139 aneurysms treated between 2009 and 2020. Among 5952 intracranial aneurysms treated with the endovascular techniques, 61 patients (43 female) with 67 intracranial aneurysms who had been treated with stent plus balloon-assisted coiling were included in this study (Figure 2). The mean age of the patients was 54.6 ± 10.4 yr (range, 29-78 yr). The results of 61 aneurysms treated with the stent plus balloon-assisted coiling technique were analyzed. The analyzed aneurysms were located in the middle cerebral artery (MCA) bifurcation in 34 patients (55.7%) and the basilar artery bifurcation in 17 (27.9%) (Table 1). Four aneurysms were ruptured. Two ruptured aneurysms had been partially coiled in the setting of acute subarachnoid hemorrhage. Two patients


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FIGURE 3. *Intraprocedural and follow-up DSA images of a 63-yr-old female patient with multiple intracranial aneurysms.* **A**, *The DSA image shows a wide-necked basilar bifurcation aneurysm with a diameter of 6 mm (arrow). The neck of the aneurysm incorporates both posterior cerebral and left superior cerebellar arteries. There is also a small saccular aneurysm on the lateral wall of the P1 segment of the right posterior cerebral artery (PCA).* **B**, *Intraprocedural roadmap image shows that the P2 segment of the right PCA is catheterized by a double-lumen balloon catheter (Scepter XC) (white arrow). A 0.017-inch microcatheter for stent delivery is placed in the left PCA (black arrow). A third microcatheter for coiling is jailed in the aneurysm sac (arrowhead).* **C** *and* **D**, *Intraprocedural nonsubstrated and roadmap angio-images demonstrate the early stages of the stent plus balloon-assisted coiling procedure for the treatment of wide-necked basilar bifurcation aneurysms. Coiling is started after securing the side branches by an inflated balloon in the right PCA (white arrows) and the partially deployed stent extending from the left PCA to the basilar trunk (arrowheads).* **E**, *Intraprocedural control DSA image obtained after completing the coiling of the basilar bifurcation aneurysm (arrow).* **F**, *Intraprocedural nonsubtracted angio-image shows that the stent is fully deployed, extending from the left PCA to the basilar artery (arrowheads), and complete coiling of the bifurcation aneurysm (arrow).* **G**, *Immediate postprocedural DSA images show the stable coil mesh (black arrow) and RRC 2 occlusion (minimal neck filling). Please note the partial filling of the small PCA aneurysm coiled by the assistance of another stent deployed into the P1 segment of the right PCA (white arrow).* **H**, *12-mo follow-up DSA image shows complete occlusion of the aneurysms (RRC 1).*

had a history of subarachnoid hemorrhage caused by the rupture of the different aneurysms that had been previously treated with clipping.

The preoperative mRS score of 52 patients was 0. The preoperative mRS scores of 9 patients were ranging between 1 and 3 because of previous subarachnoid hemorrhage or surgery.

Immediate Angiographic Results

Endovascular procedures were completed without the development of any technical complications in all cases. In the majority of the cases (90.2%), a self-expandable nitinol braided stent was implanted (Table 2 and Figure 3). The immediate postprocedural DSA images revealed complete aneurysm occlusion in 53 patients (86.9%) and a neck remnant in 8 patients (13.1%) (Figure 4).

Complications

We observed periprocedural complications in 7 patients (11.5%). The periprocedural complications resulted in the symptom(s) in 3 patients (4.9%). The periprocedural complications were thromboembolic in 6 patients (9.8%) and hemorrhagic in 1 patient (1.6%) (Table 3). Intraprocedural DSA images revealed the development of an in stent thrombus in 1 case. Intra-arterial infusion of tirofiban through the microcatheter achieved complete resolution of the thrombus in this case. We observed a delayed thromboembolic complication in 3 patients (4.9%). The periprocedural and delayed complications resulted in a permanent morbidity in 2 patients (3.3%).

Follow-up

Angiographic follow-ups could be performed in 55 patients (90.2%). The mean angiographic follow-up duration was 25.5 ± 27.3 mo (range, 3-108 mo). The final follow-up angiography revealed complete occlusion of the aneurysm in 49 patients (89.1%) and neck filling in 5 patients (9.1%) and recurrent sac filling in 1 patient (1.8%) (Figure 5 and Table 4). The follow-up DSA showed a recanalization in 4 patients (7.3%). In 3 patients, the recanalized aneurysm necks remained stable at the consequent angiographic follow-ups and did not require retreatment. The 24-mo follow-up DSA of a patient with basilar bifurcation aneurysm revealed a recanalized sac. This aneurysm was retreated by the telescopic deployment of another braided stent (1.8%).

Clinical follow-ups could be performed in 60 patients. A total of 53 patients had an mRS score of 0 at the final clinical follow-up. Three patients with a preprocedural mRS scores of 1 or 2 improved to an mRS score of 0 at the last clinical follow-up. The mRS score of 5 patients with a preprocedural score between 1 and 3 did not change during the follow-up period. Two patients who developed an ischemic complication had an mRS score of 1 and 2 at the final follow-up.

DISCUSSION

Various endovascular methods, including double-balloon remodeling, coiling with the assistance of double stents or neck-bridging devices, flow diversion, and intrasaccular flow disruption, have been defined to treat wide-necked bifurcation aneurysms.[4-9,14,15] The risk of recanalization is high for wide-necked aneurysms treated with single balloon remodeling.[16] And, there are no data about the long-term durability of the double-balloon remodeling technique. Recently, new endovascular devices, such as intrasaccular flow disruptors and neck-reconstruction implants, have been introduced to facilitate the endovascular treatment of wide-necked bifurcation aneurysms. Neck-bridging devices have been developed to reconstruct a bifurcation to produce a scaffold at the aneurysm neck during coiling.[5,17,18] However, the number of anterior communicating artery (AComA) or MCA aneurysms treated with these devices was very limited in the literature. The feasibility and efficacy of the neck-bridging devices for the AComA and MCA aneurysms needs further investigation. The long-term durability of coiling with the assistance of neck-bridging devices is another concern. Neck-bridging devices have no flow diversion effect that would decrease the hemodynamic stress on the coiled aneurysm and the risk of recanalization. Therefore, the long-term occlusion rate of aneurysms coiled with the assistance of this device is lower compared with Y-stent-assisted coiling.[18] Intrasaccular flow disruptors, such as the Woven EndoBridge (WEB) device

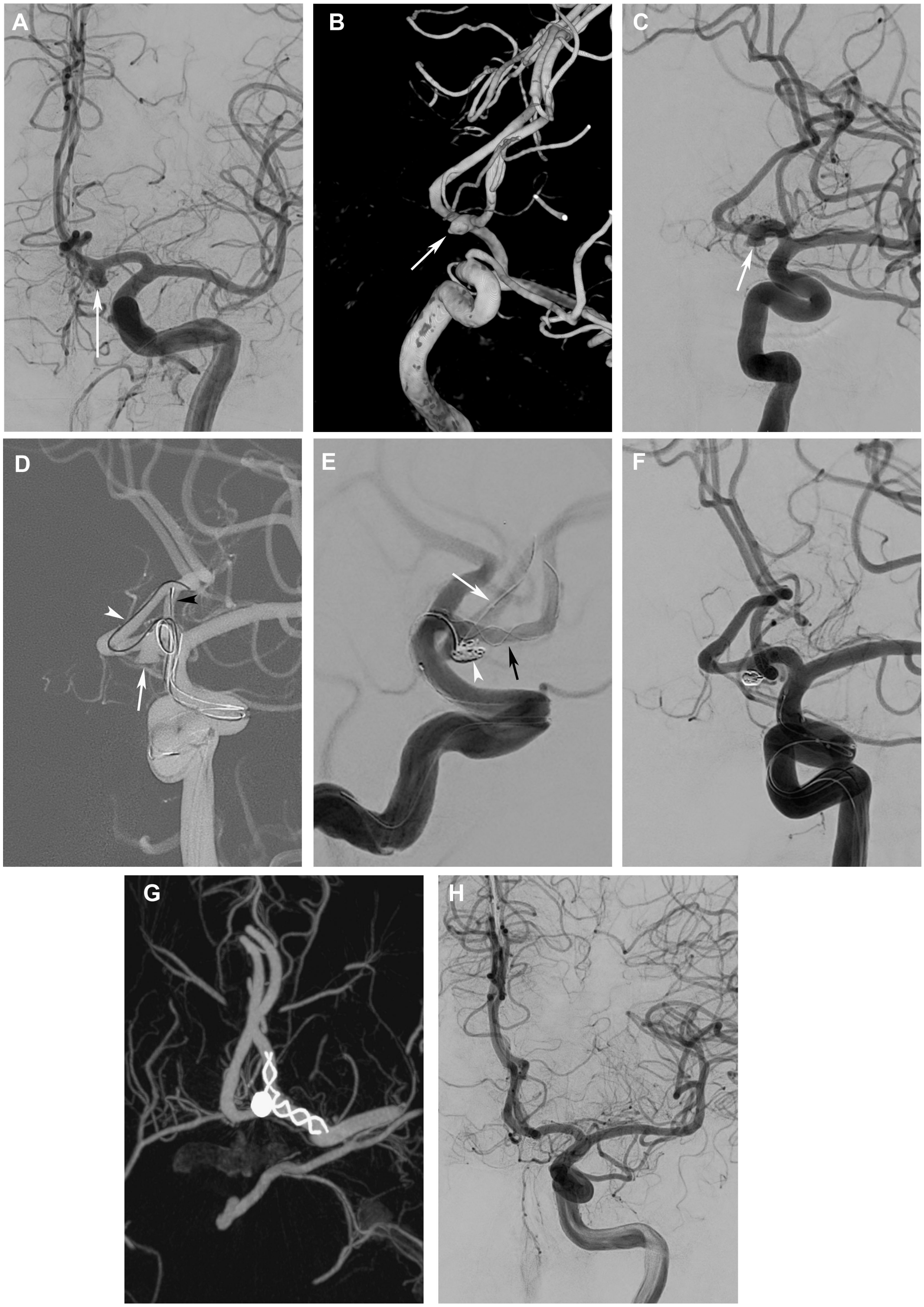
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FIGURE 4. *Intraprocedural and follow-up angiography images of a 52-yr-old male patient with an AComA aneurysm.* **A-C**, *Preprocedural DSA and 3-dimensionally (3D) reconstructed flat-panel computed tomography (CT) images show a 4-mm AComA aneurysm. The A2 segments of both anterior cerebral arteries arise from the neck of the aneurysm.* **D**, *The intraprocedural roadmap image shows the catheterization of anterior cerebral arteries with a double-lumen balloon catheter (white arrowhead) and a stent delivery microcatheter (black arrowhead). The aneurysm sac is located on the AComA (white arrow).* **E**, *The intraprocedural DSA image demonstrates the coiling procedure (arrowhead) while the side branches are protected with a partially deployed braided stent (black arrow) and a balloon catheter (white arrow).* **F** *and* **G**, *The immediate postprocedural control DSA and maximum intensity projection reconstructed flat-panel CT images show complete occlusion of the coiled aneurysm sac (RRC 1).* **H**, *18-mo follow-up DSA image shows the stable occlusion of the aneurysm.*

TABLE 3. Summary of the Periprocedural and Delayed Complications

Age/sex	Location	Size	Time	Stent	Balloon	Complication	Symptom	mRS at discharge	Last mRS
67/F	MCA	5 mm	Periprocedural	Solitaire	Eclipse 2L	Subarachnoid hemorrhage (Fisher grade 2)	Headache	1	0
67/F	AComA	5 mm	Periprocedural	Leo Baby	Scepter XC	Ischemic lesion in the caudate nucleus on DWI	Hemiparesis	1	0
55/F	MCA	11 mm	Periprocedural	Neuroform	HyperGlide	Acute stent thrombosis	Hemiplegia	2	2
59/F	MCA	5 mm	Periprocedural	Leo Baby	Scepter XC	Small bright spots on DWI (ischemic lesions)	None	0	0
50/M	MCA	2 mm	Periprocedural	Leo Baby	Scepter XC	Small bright spots on DWI (ischemic lesions)	None	0	0
43/F	ICA bif.	2 mm	Periprocedural	Leo Baby	Scepter XC	Small bright spots DWI (ischemic lesions)	None	0	0
62/M	MCA	6 mm	Periprocedural	Leo Baby	Scepter XC	Intraprocedural nonocclusive in-stent thrombus formation	None	0	0
51/F	BA	3 mm	Delayed	Leo Baby	Scepter XC	Stent thrombosis at 24-mo follow-up DSA	None	0	0
76/F	BA	12 mm	Delayed	Leo Baby	Scepter XC	Infarction in the AICA territory on DWI	Ataxia	2	1
71/F	BA	8 mm	Delayed	Leo Baby	Eclipse 2L	Small occipital infraction on follow-up MRI	None	0	0

AComA = anterior communicating artery; AICA = anterior inferior cerebellar artery; BA = basilar artery; DWI = diffusion weighted imaging; F = female; ICA bif. = internal carotid artery bifurcation; M = male; MCA = middle cerebral artery; Last mRS = the modified Rankin scale scores at the last clinical follow-up; MRI = magnetic resonance imaging; mRS at discharge = the modified Rankin scale score at discharge.

(MicroVention), have been introduced to facilitate the treatment of wide-necked bifurcation aneurysms.[4,19] The implantation of these devices into the aneurysm sac creates a flow remodeling effect at the interface of the aneurysm neck and parent artery. However, the morphology of some bifurcation aneurysms is not suitable for this technique to achieve complete and stable aneurysm occlusion. In a recent study, the rate of complete occlusion of the aneurysms treated with the implantation of a WEB device was 51.2% at the 2-yr follow-up, and 9.2% of the aneurysms required retreatment.[20] Flow diversion is another recently described endovascular strategy for the treatment of complex bifurcation aneurysms. The indications for flow diversion treatment were recently extended to include bifurcation aneurysms.[15] However, the safety and efficacy of flow diversion treatment for distal bifurcation aneurysms remains a major debate. Implantation of a flow diverter for treatment of a bifurcation aneurysm located distal to the circle of Willis carries a potential risk of arterial occlusion.[15,21,22] The occlusion risk of the covered side branch, the high rate of treatment-related morbidity, and the relatively low rates of aneurysm occlusion are the main concerns about flow diversion treatment for bifurcation aneurysms.

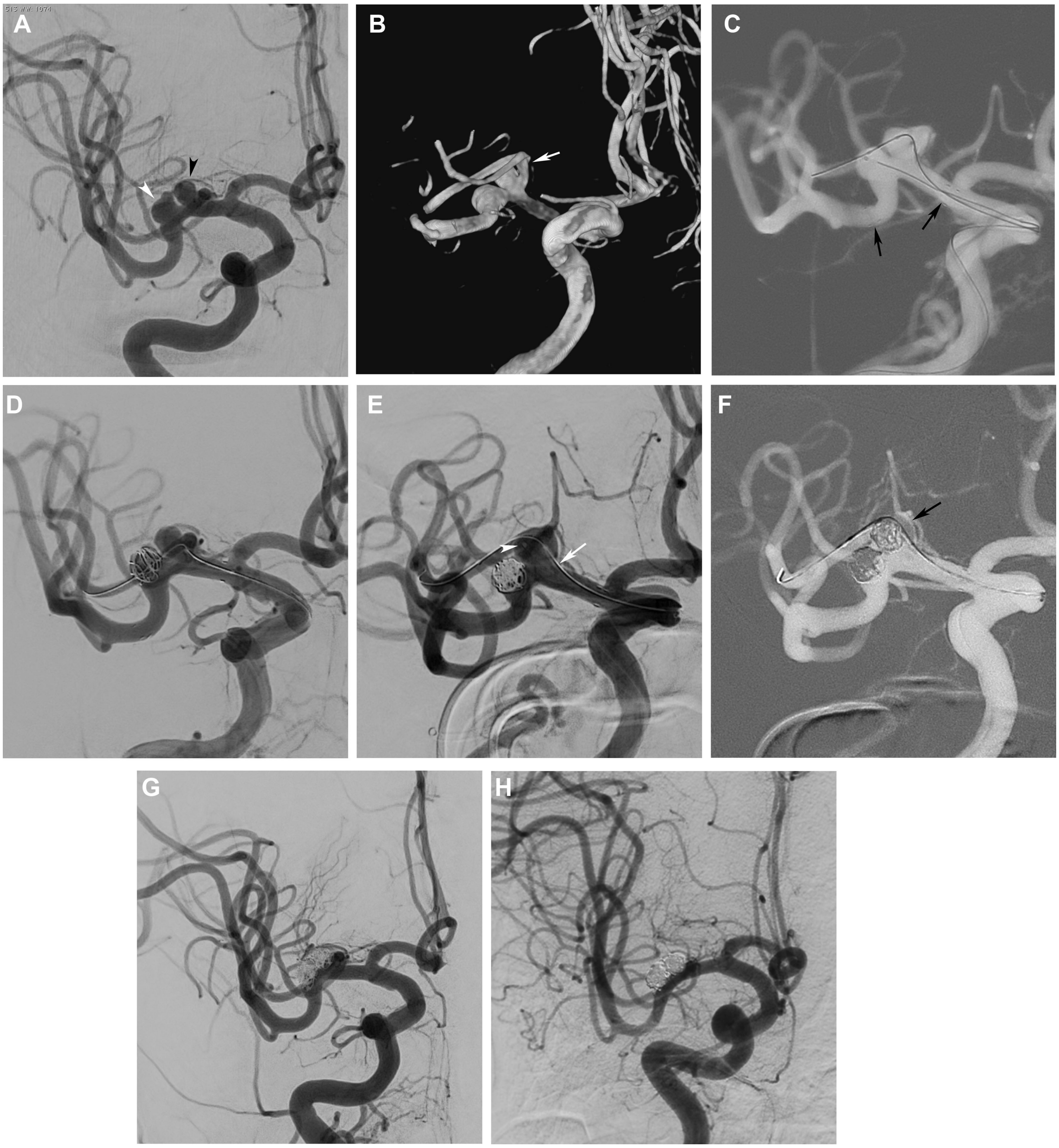

FIGURE 5. *Procedural and follow-up angiography images of a 68-yr-old male patient with MCA bifurcation aneurysms.* **A**, *Preprocedural DSA image shows 2 adjacent wide-necked aneurysms located in the right MCA bifurcation (black arrowhead) and on the inferior trunk (white arrowhead).* **B**, *3D reconstructed angiography image shows that the wide neck of the proximally located aneurysm closely incorporates the superior (white arrow) and inferior trunks of the MCA.* **C**, *The procedural roadmap image. The black arrows show the distal and proximal markers of the Neuroform Atlas stent (Stryker) deployed, extending from the inferior trunk into the M1 segment of the MCA. The superior trunk of the MCA is catheterized with a double-lumen balloon microcatheter. A 0.017-inch microcatheter is jailed in the sac of distally located aneurysm.* **D**, *The procedural control DSA images demonstrate the coiling of the aneurysm located in the inferior trunk. The double-lumen balloon is jailed in the superior trunk to be used during the coiling of proximal aneurysm.* **E**, *Procedural DSA image obtained after completion of the coiling procedure of the aneurysm sac located in the inferior trunk. The same coiling microcatheter is placed into the sac of the second aneurysm located in the MCA bifurcation (white arrowhead). The double-lumen balloon catheter is placed in the superior MCA trunk (white arrow).* **F**, *The procedural roadmap image demonstrates the coiling of a proximal aneurysm located in the MCA bifurcation. The neck of the aneurysm is protected by the Neuroform Atlas stent extending into the M1 segment and the double-lumen balloon catheter placed in the superior trunk (black arrow).* **G**, *Immediate postprocedural DSA images show the complete occlusion of both aneurysms.* **H**, *12-mo follow-up DSA images demonstrate the stable occlusion of the aneurysms and patency of the MCA branches.*

TABLE 4. Immediate Postoperative and Follow-up Aneurysm Occlusion Rates

Score	Results of Raymond-Roy class scoring	
	Immediate postoperative DSA (out of 61 patients)	Last follow-up DSA (out of 55 patients)
Raymond-Roy class 1	53 (86.9%)	49 (89.1%)
Raymond-Roy class 2	8 (13.1%)	5 (9.1%)
Raymond-Roy class 3	–	1 (1.8%)

Key Results

Despite development of alternative endovascular techniques, dual-stenting techniques remain the eligible endovascular treatment method for wide-necked bifurcation aneurysms.[23-27] However, there are still concerns that dual-stenting techniques require the successful execution of several complex endovascular maneuvers.[9,28,29] Catheterization of the second side branch by passing the catheter through the struts of the first stent and adequate expansion of the second stent at the intersection point are the most complicating stages of the Y-stenting procedure.[9,29] Bartolini et al[9] observed dislocation of the first deployed stent in 6.2% of cases treated with Y-stenting. In stent plus balloon-assisted coiling, a balloon microcatheter is placed in one of the side branches of the bifurcation before deployment of the stent into the other branch. Therefore, both side branches of bifurcation can be protected without any requirement to navigate through the struts of a stent. This is one of the technical advantages of the stent plus balloon-assisted coiling technique in that it reduces the risk of technical complications compared with Y-stenting. In the current study, 43 anterior circulation and 18 basilar bifurcation aneurysms were successfully treated with the stent plus balloon-assisted coiling. The results of the current study demonstrate that stent plus balloon-assisted coiling is a feasible endovascular method for the treatment of wide-necked bifurcation aneurysms, and it may be applied to both anterior and posterior circulation aneurysms.

Interpretation and Generalizability

We observed a periprocedural or delayed complication in 16.4%. However, majority of complications remained asymptomatic and permanent morbidity developed in only 3.3%. The complication and morbidity rates observed in the current study are considerably lower compared than the reported rates in dual-stent-assisted coiling studies. Bartolini et al[9] reported the outcomes of X- or Y-stenting procedures in 97 patients. In their study, 19.5% of patients developed a procedure-related complication that resulted in a permanent morbidity in 10%. The long-term outcomes of the Y-stent-assisted coiling using braided stents were reported in a recent retrospective study.[26] A complication rate of 17.5% was reported in that study. Spiotta et al[11] reported a thromboembolic complication rate of 26.3% among patients who were treated with the Y-stenting. The results of a meta-analysis revealed that the procedure-related stroke rate of Y-stenting was 12.5%.[27] In X- and Y-stenting, the floating struts at the intersection point of the stents are less amenable to endothelialization, which may be a source of thromboembolic events.[11,28,29] The relatively lower metal coverage ratio and the lower intraluminal metal density provided by the use of a single stent might have contributed to the relatively low rate of complications in the current study.

In the literature, the immediate aneurysm occlusion rates following dual-stent-assisted coiling procedures are quite variable. Bartolini et al[9] reported an immediate occlusion rate of 47.6% for bifurcation aneurysms treated with dual-stenting. Spiotta et al[11] observed immediate occlusion in 48.6% of aneurysms treated with Y-stenting. A recent study reported an immediate occlusion rate of 82.3% in wide-necked bifurcation aneurysms treated with the T-stent-assisted coiling.[25] A meta-analysis investigating the outcomes of the Y-stenting revealed an immediate occlusion rate of 74.3%.[27] In the current study, we observed an immediate aneurysm occlusion rate of 86.9%, which is comparable to the previous literature reporting the outcomes of dual-stenting techniques. Therefore, the angiographic follow-up results of the current study demonstrate that the stent plus balloon-assisted coiling is an effective endovascular technique for the treatment of wide-necked bifurcation aneurysms.

Self-expandable stents have flow reconstruction and biological effects on the parent artery that promote progressive thrombosis of partially coiled aneurysms and, consequently, decrease the risk of recanalization. Compared with single stenting, dual-stenting configurations produce a stronger flow reconstruction effect that decreases the hemodynamic stress on the aneurysm sac.[30,31] Chalouhi et al[31] reported that the recurrence and retreatment rates of basilar bifurcation aneurysms treated with Y-stenting were significantly lower than those of aneurysms coiled with the assistance of a single stent. Stent plus balloon-assisted coiling is actually a single-stenting procedure. Therefore, the durability of this treatment might be a concern. However, we observed a complete aneurysm occlusion rate of 89.1% at the end of the mean follow-up period of 25.5 mo, which is comparable to the occlusion rate of dual-stenting procedures.

Limitations

This study was a nonrandomized retrospective study. Therefore, there was no control group of patients who underwent alternative treatment methods such as clipping, which is an effective and safe method of treatment, especially for MCA bifurcation aneurysms. Additionally, the effect(s) of patient selection bias cannot be excluded from the results.

CONCLUSION

The results of the present study showed that stent plus balloon-assisted coiling is a feasible, effective, relatively safe, and durable endovascular treatment for wide-necked bifurcation aneurysms located at the posterior and anterior circulation.

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