

Midterm results of T-stent–assisted coiling of wide-necked and complex intracranial bifurcation aneurysms using low-profile stents

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OBJECTIVE Coiling of wide-necked and complex bifurcation aneurysms frequently requires implantation of double stents in various configurations. T-stent–assisted coiling involves the nonoverlapping implantation of 2 stents to protect the daughter vessels of bifurcation and is followed by coiling of the aneurysm. The authors studied the feasibility, efficacy, and safety of the T-stent–assisted coiling procedure as well as the midterm angiographic/clinical outcomes of patients with wide-necked bifurcation intracranial aneurysms treated using this technique.

METHODS The authors retrospectively identified patients with wide-necked bifurcation intracranial aneurysms treated using double-stent–assisted coiling with a T-stent configuration.

RESULTS Twenty-four patients with 24 aneurysms and a mean of age of 51.91 years were identified. The most common locations were the middle cerebral bifurcation (45.8%) and anterior communicating artery (35.7%). T stentings were performed using low-profile stents. The procedures were performed with a technical success rate of 95.8%, and an immediate total occlusion rate of 79.2% was achieved. We observed periprocedural complications in 16.7% of cases and a delayed thromboembolic event in 4.2%. The complications caused permanent morbidity in 1 patient (4.2%). No deaths occurred. The mean angiographic follow-up duration was 9.3 months. The total occlusion rate at the last follow-up was 81.2%. The recanalization rate was 4.5%. Modified Rankin Scale scores of all patients at the last follow-ups were between zero and 2.

CONCLUSIONS T-stent–assisted coiling using low-profile stents is a feasible, effective, and relatively safe endovascular technique used to treat wide-necked and complex intracranial aneurysms. The midterm angiographic and clinical outcomes are outstanding.

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KEY WORDS intracranial aneurysm; wide-necked; endovascular; stent-assisted coiling; vascular disorders

STENT-ASSISTED coiling is increasingly used to treat wide-necked intracranial aneurysms.^{3,5,15,19,22} During the endovascular treatment of a wide-necked aneurysm, stents provide a mechanical scaffold to prevent coil prolapse into the parent artery. However, a single stent may not suffice for the endovascular treatment of wide-necked and geometrically complex bifurcation aneurysms involving both daughter branches of bifurcation.^{10,27} Therefore,

endovascular treatment of wide-necked and complex bifurcation aneurysms often necessitates the implantation of double stents in various configurations, such as X and Y stenting.^{2,11,20,25,27} Previous case series and retrospective studies showed the efficacy and durability of the Y-stent–assisted coiling procedure.^{12–14} However, Y stenting is associated with some technique-related complication risks and difficulties, especially when 2 closed-cell stents are

ABBREVIATIONS ACoA = anterior communicating artery; aPTT = activated partial thromboplastin time; DSA = digital subtraction angiography; MCA = middle cerebral artery; mRS = modified Rankin Scale.

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used.^{6,12,26} Y stenting requires the passage of a second stent through the interstices of the stent deployed first. Attempts at catheterization of the second daughter vessel may cause the migration, dislocation, or deformation of the first stent.^{6,18,25} Furthermore, a sandglass-like deformity and narrowing of the second stent may develop at the crossing point of stents, which may induce thrombogenesis. Moreover, tangled stent struts at the crossing point of Y stenting may create technical difficulty during the catheterization of an aneurysm in cases requiring retreatment.²⁶ Cho et al. described the nonoverlapping Y-stent–assisted coiling (T-stenting) technique to resolve the safety issues associated with Y stenting.⁹ There are very limited data in the literature regarding the safety and efficacy of the T-stent–assisted coiling technique. Furthermore, to date, there are no data on the applicability of T-stent–assisted coiling to the treatment of anterior circulation aneurysms.

This retrospective study evaluated the safety, efficacy, and midterm durability of T-stent–assisted coiling using low-profile stents (Leo+Baby; Balt) for the treatment of wide-necked and complex bifurcation aneurysms.

Methods

Patient Population

After approval of the institutional ethics committee was obtained, we performed a retrospective review of the interventional database records. Patients with a wide-necked complex bifurcation aneurysm that was treated by coil embolization with the assistance of double stents in a T-shaped stent configuration between October 2012 and December 2015 were identified. Because the images and data could not be identified by the patients, we did not obtain patient consent. The decision regarding the most appropriate method of treatment in every case was made by our multidisciplinary neurovascular teams made up of expert interventional neuroradiologists and neurosurgeons, in consideration of multiple factors including the morphology of the aneurysm, anatomy of target and parent arteries, medical condition of the patient, any contraindication for antiplatelet therapy, etc. The T-stent–assisted coiling procedure was performed in the treatment of patients with wide-necked and complex bifurcation aneurysms. Wide-necked aneurysms were defined as aneurysms with a dome-to-neck ratio < 2 or a neck diameter > 4 mm. Complex bifurcation aneurysms were defined as wide-necked aneurysms incorporating more than 1 daughter vessel. Medical records and radiological images of patients were collected. Two interventional neuroradiologists (K. Aydin and M. Barbuoglu) and a neurosurgeon (M. Berdikhojayev) evaluated the procedure reports, medical charts, and radiological images of the patients. The patient demographics, presenting symptoms, location and size of aneurysms, previous medical history related to intracranial aneurysms, stent deployment success, technical and clinical complications, and degree of aneurysm occlusion were recorded.

The review of our database records revealed a total of 24 patients in whom endovascular treatment with dual-stent–assisted coiling in a T-shaped configuration was attempted. All 24 of these patients (i.e., 24 aneurysms) were included in the study. There were 13 male (54.2%)

and 11 female patients, with a mean age of 51.91 ± 11.69 years (range 30–66 years). All but 1 of the aneurysms reported in this retrospective study were unruptured. One patient with an anterior communicating artery (ACoA) aneurysm was referred to our hospital for endovascular treatment 2 weeks after the rupture of the aneurysm. Another patient with a middle cerebral artery (MCA) aneurysm had a history of subarachnoid hemorrhage caused by the rupture of a contralateral MCA aneurysm that was treated by primary coil embolization at that time. One patient had a recanalized aneurysm that was previously treated by open surgery (clipping). Twenty-three of the 24 aneurysms had not received prior treatment. The mean dome size of the aneurysms was 7.50 ± 3.23 mm (range 3–16 mm). The mean neck size was 5.08 ± 1.95 mm (range 2–10 mm). The aneurysms were located in the MCA bifurcation in 11 patients (45.8%), the ACoA in 9 patients (37.5%), and the basilar artery bifurcation in 4 patients (16.7%).

Preoperative patient conditions were evaluated using a modified Rankin Scale (mRS). The preoperative mRS scores of all patients except 1 were zero; specifically, 1 patient had a preprocedural mRS score of 2 because of a previous history of subarachnoid hemorrhage.

Endovascular Procedure

All patients received 75 mg clopidogrel and 300 mg aspirin daily for at least 5 days prior to the procedure. Antiplatelet activity was evaluated before the procedure (VerifyNow, Accumetrics) to ensure a good response to clopidogrel (platelet aggregation inhibition $> 40\%$). Patients who responded inadequately to clopidogrel were switched to prasugrel, with a starting daily dosage of 10 mg. Every endovascular procedure was performed using a femoral approach with the patient under general anesthesia. Systemic anticoagulation was initiated immediately after the insertion of a femoral introducer sheath with a bolus dose of 5000 IU of intravenous heparin. The bolus dose was followed by a slow heparin infusion to maintain an activated clotting time that was 2-fold greater than the baseline value. A 6-Fr guiding sheath (Neuron Max, Penumbra) was placed in the internal carotid artery or the proximal vertebral artery at the beginning of the procedure. A bolus dose of 2 mg of nimodipine (Nimotop, Bayer Health Care AG) diluted in 140 ml of 0.9% NaCl solution was infused through the guiding sheath for 10 minutes to prevent the development of vasospasm during the procedure. We modified the T-stent–assisted coiling technique slightly by catheterizing both the daughter branches and the aneurysm sac simultaneously to avoid any catheter maneuvering through the interstices of the stents.⁹ Two microcatheters for stent delivery (Echelon 10 [Medtronic] or Vasco 10 [Balt]) were placed in the daughter vessels. Another microcatheter for coil delivery (Echelon 10 or Headway 17, MicroVention/Terumo) was “jailed” into the aneurysm sac before stent deployment. Because a very large and complex neck geometry creates a high risk for displacement of the stents into the aneurysm sac, we postponed the full deployment of stents until a sufficient coil mass formed in the aneurysm sac. Before the coiling procedure, 2 stents were partially

deployed to create a sufficient scaffold to seal the neck (Fig. 1 left). After sufficient protection of the daughter and main vessels was achieved by the partially deployed stents, the coiling procedure was started using bare platinum coils. The coiling procedure was continued until an adequate coil mesh was formed to prevent the displacement of stents into the aneurysm sac. At that point, the stents were fully deployed without overlapping, creating a T-stent configuration (Fig. 1 right). The proximal end of the first stent, forming the short arm of the T configuration, was placed at the aneurysm neck, incorporating the corresponding daughter vessel. Following the full deployment of the short stent, the longer second stent was fully deployed in the other daughter vessel, extending proximally into the main vessel. After the full deployment of the stents, coiling of the aneurysm was continued if needed until complete occlusion was achieved or no further coils could be safely deployed within the aneurysm sac. All but one of the deployed stents was the low-profile Leo+Baby stents. In 1 patient, a Solitaire (Medtronic) stent was combined with a Leo+Baby stent. At the end of the procedure, the femoral puncture site was sealed using an arterial closure device (Exoseal, Cordis). Following completion of the endovascular procedure, intravenous heparin was administered by continuous infusion to keep the activated partial thromboplastin time (aPTT) 2-fold greater than the baseline value for 24 hours. Antiplatelet activity was rechecked at discharge to confirm an inhibition ratio between 40% and 80%. Postprocedural dual antiplatelet treatment, including 75 mg/day of clopidogrel and 300 mg/day of aspirin, was continued for 3–6 months. Dual antiplatelet therapy was switched to aspirin thereafter.

The development of any technical complication at any stage of the procedure was considered a technical failure, regardless of angiographic and clinical outcomes. Technical and clinical complications were recorded. Complications were defined as periprocedural if they occurred within 72 hours postprocedure or were considered delayed if they occurred later than 72 hours postprocedure. A postprocedural control cranial CT examination was

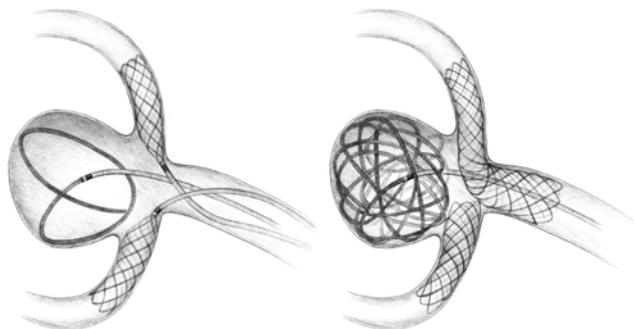


FIG. 1. Illustrations elucidating T-stent–assisted coiling of an ACoA aneurysm. **Left:** The A₂ segments of both anterior cerebral arteries are catheterized, and another microcatheter is “jailed” in the aneurysm sac for coil delivery. Then, 2 stents are partially deployed to the daughter vessels of the bifurcation to prevent the protrusion of the coils. **Right:** The stents are fully deployed into the daughter vessels after an adequate coil mesh is formed to prevent the displacement of the stents into the aneurysm sac. Copyright Berker Celik. Published with permission.

performed within 2 hours following the endovascular procedures.

Follow-Up Evaluation

Immediate postprocedural angiograms were obtained at the end of the endovascular procedures to evaluate aneurysm occlusion according to the Raymond classification as well as patency of stents and intracranial arteries in the territory of the target artery.²⁴ The first angiographic follow-up was performed at 3–6 months. The second and third follow-up digital subtraction angiography (DSA) sessions were generally performed at 8–12 and 18–24 months, respectively. Follow-up angiograms were performed to assess the aneurysm filling status and the development of in-stent stenosis or thrombosis. Progressive thrombosis on follow-up imaging was defined as an improvement in the Raymond classification from sac or neck filling (Class 3 or 2) toward total occlusion (Class 1). Recanalization was defined as a deterioration in the Raymond classification. Neurological status of all patients was evaluated using the mRS score during discharge and during the angiographic follow-up evaluations. An additional clinical follow-up evaluation was performed 2 months after discharge, before the first angiographic follow-up.

Results

The endovascular procedures were completed in all cases (Fig. 2). The technical success rate of the procedures was 95.8% (Fig. 3). A minor technical complication developed during the stent deployment in 1 patient (4.2%). In this patient, the stent in the main artery (long arm of the T stent) was not fully apposed to the vessel wall. We performed an in-stent balloon angioplasty (Scepter XC, Microvention/Terumo), which achieved full wall apposition. The final angiographic result after coiling was successful; no periprocedural or delayed symptoms developed in this patient.

Immediate postprocedure angiograms revealed a Class 1 occlusion in 19 aneurysms (79.2%), Class 2 occlusion in 4 aneurysms (16.6%), and Class 3 occlusion in 1 aneurysm (4.2%; Fig. 4).

There were no deaths in this study. Periprocedural complications, including the technical complication, occurred in 4 patients (16.7%). Only 1 of the periprocedural complications was symptomatic (4.2%), and it did not cause any permanent morbidity. In this patient, the periprocedural complication was hemorrhagic. A mild and limited extravasation developed during the coiling of a basilar bifurcation aneurysm. An immediate postprocedural cranial CT examination revealed that the contrast extravasation was confined to the basal cisterns. The patient did not develop any neurological symptoms other than a moderate headache for 5 days, and her mRS score at discharge was zero. In 2 patients with ACoA and MCA aneurysms, in-stent thrombus formation was visualized during the endovascular procedures (8.3%). The intraarterial bolus infusion of Tirofiban (Aggrastat, Merck) through the microcatheter resulted in the complete resolution of thrombi in both cases. Both patients remained asymptomatic, and

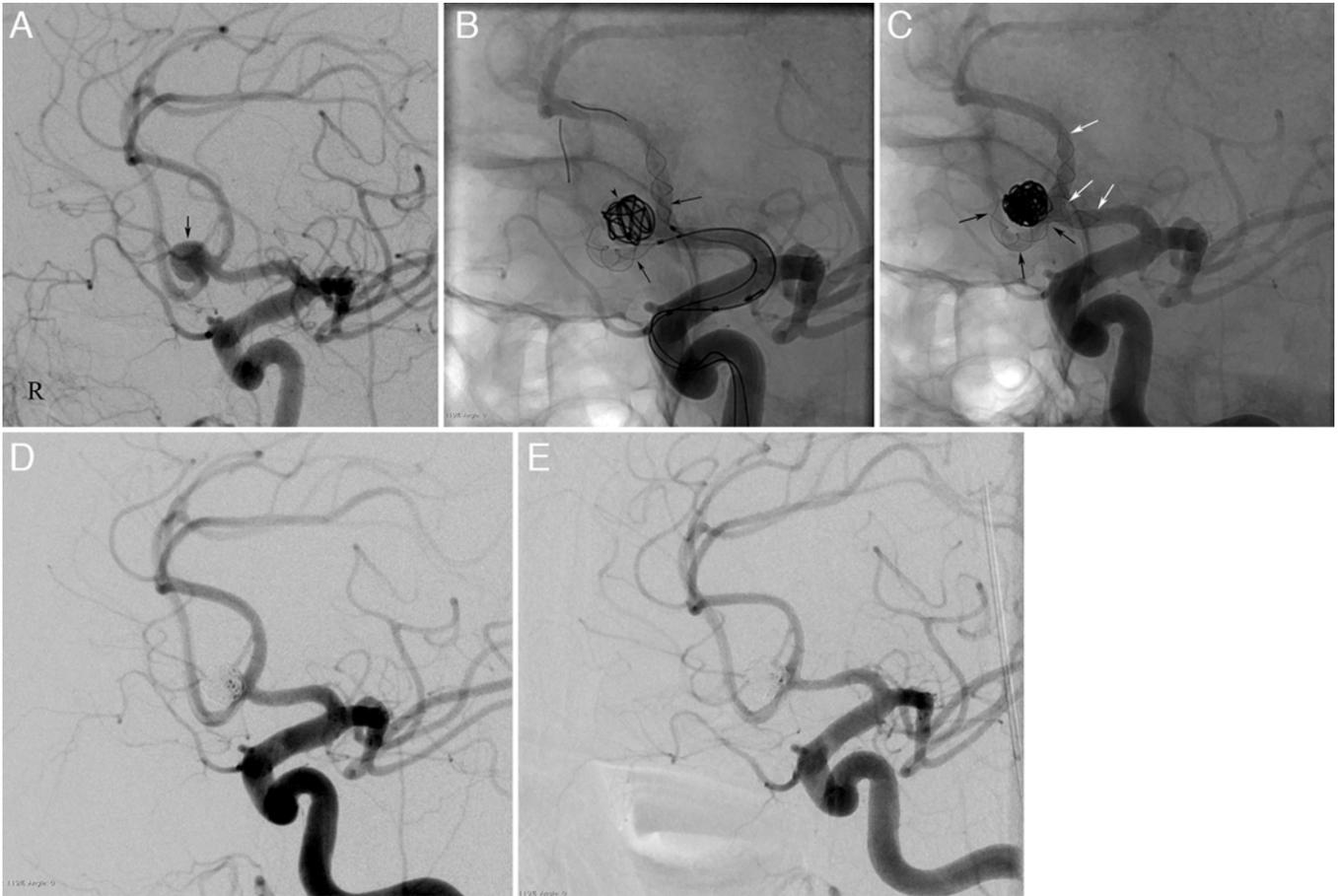


FIG. 2. Procedural and follow-up angiographic images of a 62-year-old male patient with an unruptured ACoA aneurysm. **A:** A preprocedural DSA image in the left anterior oblique projection reveals a 7-mm wide-necked aneurysm (arrow) located in the ACoA. The neck of the aneurysm incorporates both A_2 origins. **B:** A nonsubtracted angiographic image obtained during the procedure shows that both stents (arrows) are partially deployed into the daughter vessels to prevent coil protrusion. The coils (arrowhead) are delivered into the aneurysm sac through a jailed microcatheter. **C:** A nonsubtracted angiographic image obtained during the procedure shows the full deployment of the stents following the formation of a coil pack that is sufficient to prevent stent displacement. The long arm of the T stent (white arrows) extends from A_2 to the A_1 segment of the left anterior cerebral artery (white arrows). The stent in the A_2 segment of the right anterior cerebral artery (black arrows) forms the short arm of the T stent. **D:** Immediate postprocedural control DSA image shows a Raymond Class-2 occlusion with minimal neck filling. **E:** Eight-month follow-up DSA image demonstrates the complete occlusion of the aneurysm.

their cranial MRI examinations did not reveal any ischemic lesions. Their mRS scores at discharge were zero. We observed a delayed complication in 1 patient (4.2%). In this patient, who had a right MCA bifurcation aneurysm, we observed a moderate monoparesis in his left arm 2 months after the endovascular procedure. The control cranial MR examination revealed a small infarction in the right internal capsule. His symptoms improved within 4 weeks. At the 12-month follow-up, the DSA examination demonstrated a Raymond Class 1 occlusion of the aneurysm, and his final mRS score was 1.

Follow-Up Evaluations

Angiographic follow-up evaluations were performed in 22 patients (91.7%) as of the time of submission of the paper. The mean length of follow-up was 9.3 ± 4.8 months (range 3–24 months). The final follow-up angiograms revealed a Class 1 occlusion in 18 patients (81.2%) and Class 2 occlusions in 4 patients (18.2%). The follow-up

of 5 aneurysms with a partial immediate occlusion (Raymond Class 2 or 3) revealed 2 aneurysms (40%) with an improvement in Raymond class (progressive occlusion). Only 1 aneurysm (4.5%) exhibited recanalization, but it has not required retreatment.

In-stent stenosis was present at the follow-up angiography examinations in 6 patients (27.3%). In-stent stenosis was morphologically mild (< 50%) and asymptomatic in all cases. Consequently, no further intervention was performed to treat in-stent stenosis.

The mRS score at the final clinical follow-up evaluations was zero in 22 of 24 patients. The mRS score of the patient with a preprocedural mRS score of 2 did not change at the follow-up evaluations, and the patient who developed a delayed ischemic complication had an mRS score of 1.

Discussion

The risk of coil prolapse is the main restrictive and

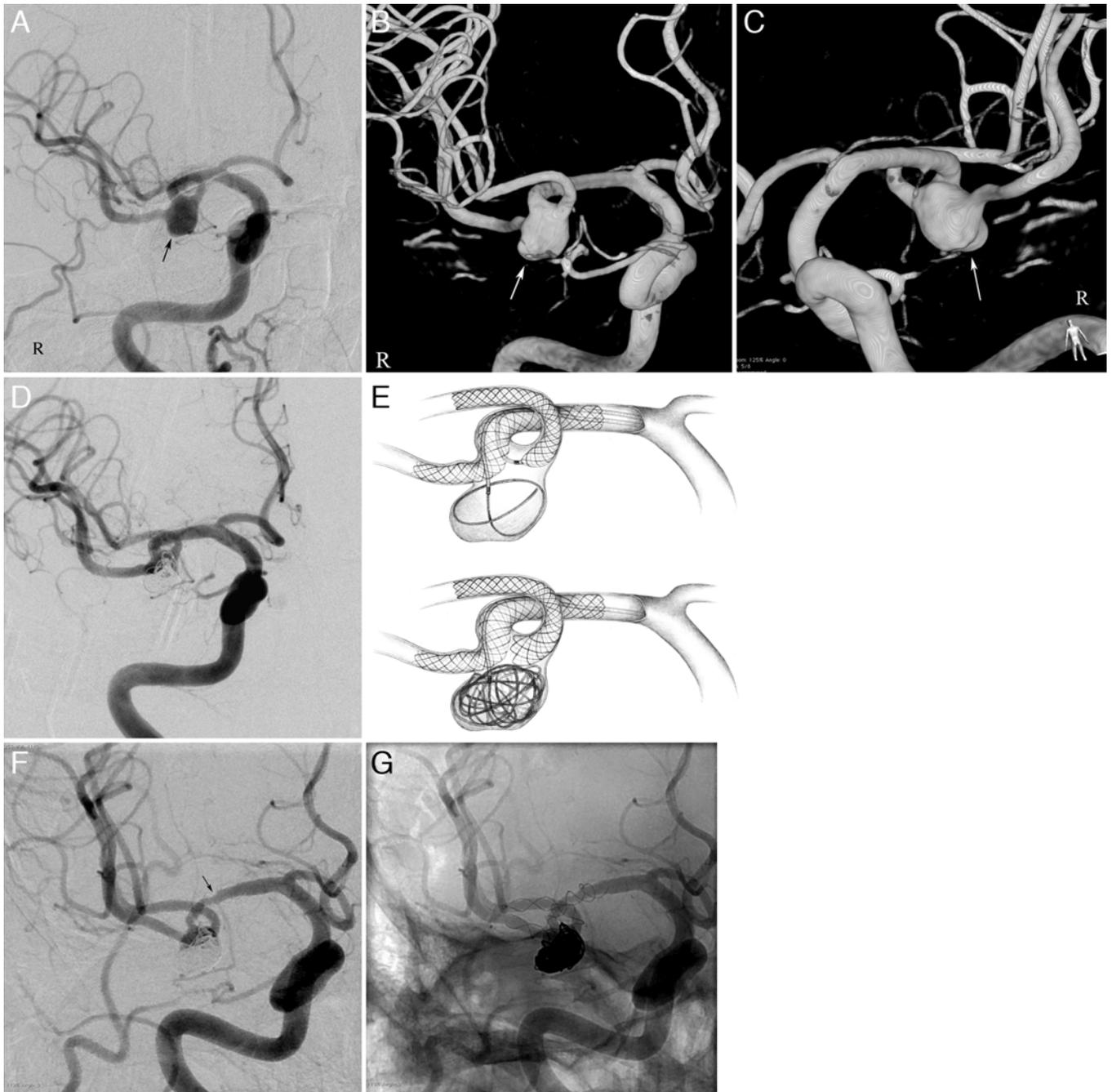


FIG. 3. Procedural and follow-up angiographic images of a 58-year-old male patient with a right MCA bifurcation aneurysm. **A–C:** Pre-procedural DSA and 3D reconstructed angiographic images show a wide-necked, 7-mm aneurysm (white and black arrows) located at the MCA bifurcation. The morphology of the aneurysm is very complex and incorporates the inferior and superior trunks of the MCA. **D:** The immediate postprocedural DSA image shows a Class 2 occlusion with minimal neck filling. **E:** An illustration demonstrating the stent configuration. The longer stent extends from the superior trunk to the M₁ segment of the MCA. The proximal end of the shorter stent is located just at the neck of the aneurysm facing the longer stent. The coils in the sac support the short stent and prevent displacement of the stent into the aneurysm. The distal end of the short stent terminates in the inferior trunk. Copyright Berker Celik. Published with permission. **F and G:** Nine-month follow-up DSA and nonsubtracted angiographic images reveal a near-total aneurysm occlusion with only minimal neck filling and a moderate degree of in-stent stenosis (arrow). The size of residual neck filling is decreased compared with that on the immediate postprocedural DSA image.

complicating factor of successful endovascular treatment of wide-necked bifurcation aneurysms. The development of balloon remodeling and stent-assisted coiling techniques made it possible to treat some of the wide-necked

bifurcation aneurysms that were not previously amenable to endovascular surgery.^{10,22} However, endovascular treatment of wide-necked and complex bifurcation aneurysms incorporating both daughter vessels is still a challenge for

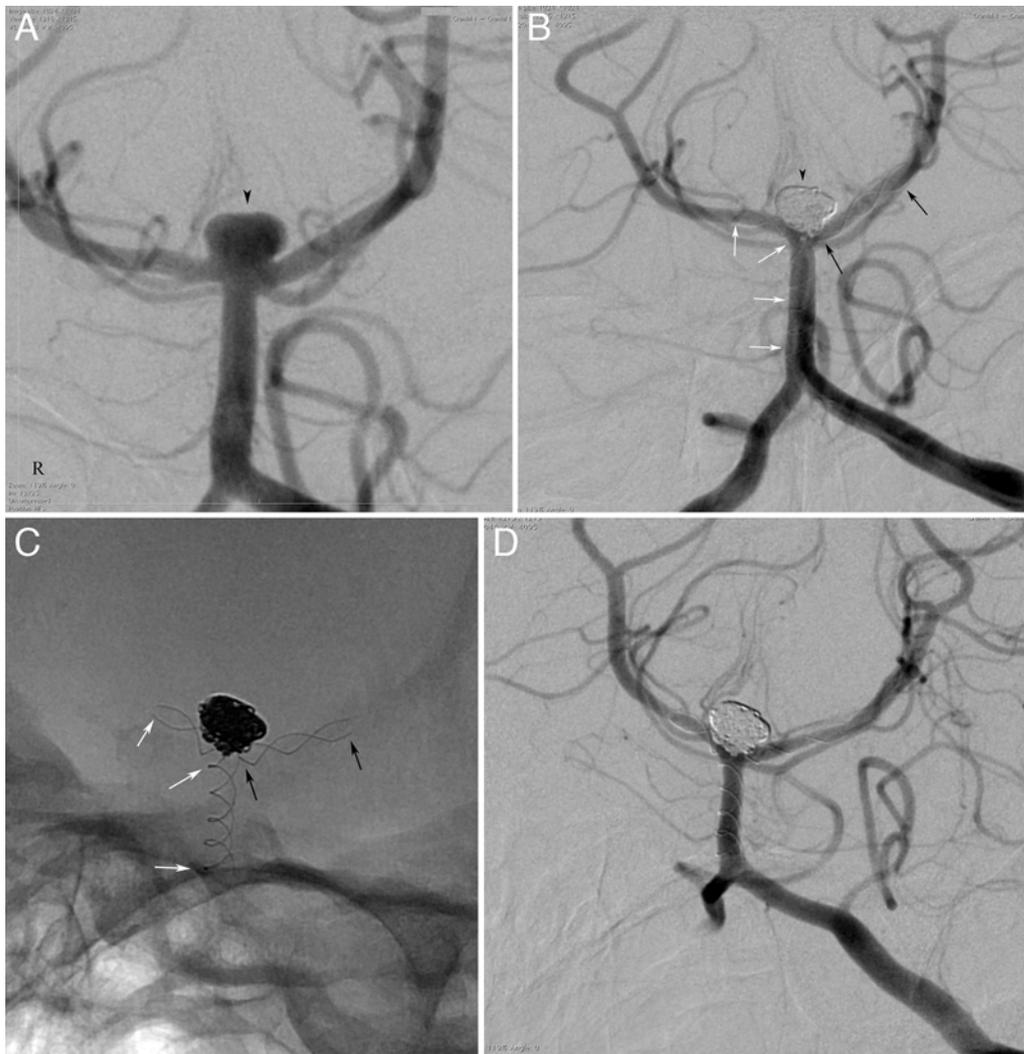


FIG. 4. Procedural and follow-up angiographic images of a 32-year-old female patient with a basilar bifurcation aneurysm. **A:** Pre-procedural DSA image reveals a wide-necked aneurysm (*arrowhead*) with a diameter of 5 mm located at the basilar artery bifurcation. The neck of the aneurysm incorporates both posterior cerebral arteries. **B:** The immediate postprocedural DSA image shows the complete occlusion of the aneurysm after a successful T-stent–assisted coiling procedure (*arrowhead*). The long arm of the T stent is formed by the extension of the stent from the right posterior cerebral artery to the basilar trunk (*white arrows*). The short arm of the T stent extends from the neck of the aneurysm to the left posterior cerebral artery (*black arrows*). **C:** A nonsubtracted angiographic image demonstrates the T stenting (*arrows*). **D:** A 12-month follow-up DSA image shows the stable, complete occlusion of the aneurysm with minimal in-stent stenosis.

endovascular neurosurgeons. The coiling of these complex bifurcation aneurysms necessitates the protection of all daughter vessels. The double-balloon remodeling method has been described to treat complex bifurcation aneurysms.⁴ However, the arrest of blood flow during balloon inflation intervals, risk of coil prolapse after balloon deflation, and relatively high recanalization rates are the main disadvantages of double-balloon remodeling.⁸ Chow et al. described the Y-stent–assisted coiling technique for the treatment of wide-necked basilar bifurcation aneurysms in 2005.¹⁰ Since then, double-stent–assisted coiling procedures in various stenting configurations have been increasingly used to treat wide-necked bifurcation aneurysms.

The T-stent configuration was first described for the treatment of coronary atherosclerotic bifurcation lesions.⁷ Cho et al. adapted this dual-stenting configuration for the

endovascular treatment of wide-necked basilar bifurcation aneurysms.⁹ They described the technique and reported the initial results of the T-stent–assisted coiling procedure in a small case series of basilar bifurcation aneurysms. In the current study, we reported the largest case series of bifurcation aneurysms treated with the T-stent–assisted coiling technique. In our study, the technical success rate of the procedures was 95.8%, which demonstrates that T-stent–assisted coiling is a feasible endovascular technique to treat wide-necked bifurcation aneurysms. Furthermore, 83.3% of the aneurysms reported in this study were anterior circulation aneurysms, which shows that the T-stent–assisted coiling technique is applicable to the anterior circulation aneurysms.

In the current study, a minor technical complication occurred in 1 patient (4.2%). However, it did not cause treat-

ment failure or morbidity. The rate of technical complications in the current study was relatively low compared with those reported in previous double-stent–assisted coiling studies. In a multicenter study reporting the results of Y-stent–assisted coiling, technical complications related to stent deployment occurred in 6.7% of cases.¹² Furthermore, all the technical complications in the aforementioned study resulted in the failure of endovascular treatment. In Y stenting, the attempts at catheterization of the second daughter vessel through the struts of the first stent may cause dislocation and even migration of the first stent into the aneurysm sac.^{1,6,12,15,26,27} Recently, Bartolini et al. reported the results of Y- and X-stent–assisted coiling procedures in 97 patients.⁶ In their study, the first deployed stents were dislocated into the aneurysm sacs, resulting in incomplete treatment in 6.2% of the cases. Akgul et al. reported protrusion of the first stent into the aneurysm in 1 of 9 patients (11.1%) treated with Y stenting.¹ Furthermore, this technical complication resulted in the incomplete treatment of the aneurysm and a delayed thromboembolic complication leading to permanent morbidity. Thus, dislocation of the initial stent is an infrequent but significant technical complication of the Y-stenting procedure. By definition, the T-stenting technique does not require any attempt at catheterization through the interstices of stents, which is one of the main technical advantages of T stenting.

We observed morbidity due to a delayed thromboembolic event in 1 patient (4.2%). The procedure-related complication rates in previous double-stent–assisted coiling studies have ranged between zero and 42.1%.^{1,2,6,9,12,14,26,27,30} A thromboembolic event is the most common complication of double-stent–assisted coiling procedures. Spiotta et al. reported a thromboembolic complication rate of 26.3% among patients who were treated with the Y-stent–assisted coiling technique, and half of the complications were due to delayed events.²⁶ In another retrospective study, the treatment of bifurcation aneurysms with Y- and X-stent–assisted coiling techniques caused a permanent neurological deficit in 10% of patients.⁶ Fargen et al. reported a periprocedural thromboembolic complication in 4 of 45 patients (8.9%) treated with Y-stent–assisted coiling, and all the complications were symptomatic.¹² It is known that incomplete opening and kinking of the second stent at the crossing point of the stents constitutes the major cause of thromboembolic events observed after Y stenting. A focal narrowing of the second stent may cause flow disruption and thromboembolic complications. Moreover, intraluminal crossing struts of 2 stents in a Y configuration are less amenable to endothelialization, which may be a source of delayed thromboembolic events.²⁶ T stenting lacks such a stent crossing point. Full conformability with vascular anatomy and complete wall apposition of the stents are the technical features of T stenting that may be advantageous with respect to decreasing the risk of thromboembolism. In contrast, simultaneous use of multiple microcatheters in T stenting creates a potential risk of thromboembolism. To reduce this potential complication risk, we used low-profile stents that can be delivered through the microcatheters with a distal shaft profile of 1.7-Fr. Moreover, we precisely controlled the aPTT values and systemic blood pressures during the entirety of each endovascular procedure.

In the literature, the immediate complete aneurysm occlusion rates following double-stent–assisted coiling procedures are relatively low compared with the results of conventional coiling or single-stent–assisted coiling studies.^{6,14,26} Sipotta et al. reported that an immediate complete occlusion was achieved in only 23.6% of the aneurysms treated with Y-stent–assisted coiling.²⁶ The immediate complete occlusion rate following the double-stent–assisted coiling treatment of wide-necked bifurcation aneurysms was 46.7% in another study.⁶ These relatively poor immediate complete occlusion rates may be explained by the fact that larger and more complex aneurysms are more likely to be treated with double-stent–assisted coiling techniques. The immediate complete occlusion rate of 79.2% in our study is considerably higher compared with the results of previous double-stent–assisted coiling studies. These data show that T-stent–assisted coiling is an effective endovascular technique for the treatment of wide-necked and complex bifurcation aneurysms.

Stents deployed as a component of stent-assisted coiling procedures have some hemodynamic and biological effects on the parent vessels that impede recanalization.^{13,14,23,28,29} Stent deployment creates a flow-diverting effect in the parent artery. This effect decreases the hemodynamic stress on the aneurysm neck that contributes to thrombosis of the aneurysmal sac.^{13,21} Furthermore, stent-induced neointimal overgrowth leads to healing of the aneurysm neck, promotes progressive thrombosis, and reduces the risk of recanalization. In our series, 40% of the aneurysms with a postprocedural partial filling showed a progressive occlusion, and a complete occlusion rate of 81.2% was achieved during a mean follow-up period of 9.3 months. We observed the recanalization of 1 aneurysm (4.5%). In a computational fluid dynamics study, Kono and Terada demonstrated that the Y stenting model showed a stronger reduction of flow velocity in the aneurysm models compared with T stenting.¹⁷ Based on these data, they stated that Y stenting may be a desirable configuration to decrease the recanalization rates. However, progressive thrombosis and the follow-up complete occlusion rates in our study do not support this hypothesis. The complete occlusion and recanalization rates in our study are comparable to those of previous Y-stent–assisted coiling studies.^{1,6,12,14,26,27,29} Bartolini et al. achieved a complete occlusion rate of 85.8% during a mean follow-up duration of 17 months. In a multicenter study, a complete occlusion rate of 60% during a mean follow-up duration of 9.8 months was achieved following Y-stent–assisted coiling.⁶ Spiotta et al. reported that 63.2% of the aneurysms treated with Y stenting were occluded at a mean follow-up of 16 months²⁶ and that 21% of the patients required retreatment. Aside from the configuration of stents, flow diversion capacity is also associated with the porosity of stents.^{16,23} The stents with relatively smaller pore sizes have relatively greater flow diversion capacities. We used the low-profile Leo+Baby stent, a braided stent with a relatively high metal coverage ratio and small pore size.⁵ The high flow diversion capacity of the Leo+Baby stent may have contributed to the favorable follow-up complete occlusion rate in our series.

There are some limitations of the current study that

should be acknowledged. First, this study was a nonrandomized retrospective study. Therefore, there was no control group of patients who underwent alternative endovascular treatments. Additionally, the effects of patient selection bias cannot be excluded from the results. Another limitation of our study is the relative small number of patients.

Conclusions

T-stent-assisted coiling using low-profile stents is a feasible, effective, and relatively safe endovascular technique used to treat wide-necked and complex intracranial aneurysms. This study demonstrated the applicability of this endovascular technique to anterior circulation aneurysms. The midterm angiographic and clinical outcomes are outstanding, although the long-term outcomes of this promising endovascular technique remain to be demonstrated.

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Disclosures

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Conception and design: Aydin, Barburolu, Aras, Sencer. Acqui-

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