Case Report

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Assisted coiling using LEO Baby or LVIS Jr stents: Report of six cases

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Abstract

Background and purpose: Endovascular treatment of broad-neck, complex cerebral aneurysms is a challenging issue. Placement of a stent over the aneurysm neck and secondary coil embolization prevents coil migration and allows dense packing of the coils. Another challenge is represented by distal aneurysms situated in small vessels. In these cases, the use of little stents, which we are going call ministents, could be a good decision. These low-profile intracranial ministents can be deployed into arteries with diameters between 1.5 and 3.10 mm and delivered through microcatheters with an internal diameter of 0.0165 inches, which allows easier navigation in small-sized, delicate vessels. We present six cases of wide-neck aneurysms, with small parental arteries less than 2.5 mm using a low-profile ministent system (LEO Baby and LVIS Jr) plus coil embolization.

Materials and methods: We retrospectively reviewed patients in whom LEO Baby or LVIS Jr stent was used for the treatment of intracranial aneurysms. Five aneurysms were treated during 2013–2014 in our service using the LEO Baby stent and one aneurysm using LVIS Jr. Stent-assisted coil embolization was performed using the jailing technique in all cases. Clinical and angiographic findings, procedural data, and follow-up are reported.

Results: Six consecutive patients were included in this study. Four patients presented with subarachnoid hemorrhage in the subacute–chronic phase and two patients had unruptured aneurysms. Two of the six aneurysms were located at branches of the sylvian artery, one at the basilar artery, two at the anterior communicating artery, and one at the P1–P2 artery. The procedures were successful. Six-month control digital subtraction angiograms were obtained in all cases; they demonstrated complete occlusion of the aneurysms in all instances. All patients had good clinical outcomes on follow-up, as measured with the Glasgow Outcome Scale and Modified Rankin Scale.

Conclusions: The results of this small study show that the LEO Baby and LVIS Jr ministents could be safe and efficient for endovascular treatment of intracranial broad-neck aneurysms situated in small arteries.

Keywords

Endovascular therapy, broad-neck aneurysm, small arteries

Introduction

Endovascular treatment of intracranial aneurysms with detachable coils has proven to be a favorable alternative to surgical clipping.[1,2] However, coil embolization has limitations in the treatment of complex or broad-necked aneurysms because of possible coil migration into the parent vessel and long-term angiographic recurrence. Another challenge represents distal aneurysms situated in small vessels, especially those of 2 mm diameter or less. Multiple techniques and devices have become available in the last decade to treat these anatomically difficult aneurysms; the current practice includes self-expandable nitinol microstents with a closed-cell design.[3] The placement of a stent bridging the ostium of a wide-neck aneurysm creates a scaffold, which prevents the protrusion or herniation of coils into the parent artery and results in denser coil packing. In addition to the mechanical effect, intracranial stents have hemodynamic and biologic effects.[4–7] Stent deployment across the orifice of an aneurysm is thought to redirect blood flow from the sac of the aneurysm toward the distal parent artery and decrease the hemodynamic stress that contributes to thrombosis of the aneurysmal sac.[8] Furthermore, stent-induced neointimal overgrowth leads to the healing of the neck of the aneurysm.[9] Recently, low-profile, self-expandable, braided intracranial ministents, i.e. LEO Baby (Balt, Montmorency, France) and LVIS Jr (MicroVention,

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Tustin, California), have become available for the endovascular treatment of complex and/or distal aneurysms.[10,11] These low-profile intracranial stents can be deployed into arteries with diameters between 1.5 and 3.10 mm and delivered through microcatheters with an internal diameter of 0.0165 inches, which allows easier navigation in small-sized, delicate vessels.[12,13] We present a report of six cases of elective endovascular treatment of distal or broad-based aneurysms using LEO Baby or LVIS Jr stents with clinical control at one month and digital subtraction angiogram (DSA) control at 6 months.

Materials and methods

Analysis was made in the reference service of the Neuro-interventional and Diagnosis Unit of Uruguay's "CEDIVA" in coordination with the Neurovascular Center MUCAM about patients in whom endovascular treatment was performed by using LEO Baby or LVIS Jr stents during 2013 and 2014. A total of six patients were identified and included in the work, assessing age, clinic, treatment performed, and results. All the cases were treated by the same team (i.e. the authors of this paper).

Interventional procedures

All patients received 75 mg of clopidogrel and 325 mg of aspirin daily for two weeks before the procedure. All endovascular procedures were performed 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 IV heparin. A distal-access catheter was navigated through the sheath into the intracranial internal carotid artery or to the V2 segment of the vertebral artery.

Stent-assisted coiling. Stent-assisted coil embolization of aneurysms was performed by using the jailing technique in all cases. Aneurysm sacs were catheterized using a microcatheter and microguidewire before stent deployment. A second microcatheter for the stent was navigated across the aneurysm. In two cases, coiling was made after the stent was deployed. In the other four cases, the stent was deployed after coiling at the end of the procedure with the aim of securing the parent artery. The aneurysms were coil-embolized until complete occlusion was achieved or no further coils could be safely deployed within the aneurysm sac.

Follow-up. Immediate post-procedural angiograms were obtained at the end of the embolization procedures. Patients were asked to return at 1 month to clinical control (Glasgow Outcome Scale (GOS) and Modified Rankin Scale (MRS) were used; see Table 1), and at 6 months for DSA control. Post-procedural dual antiplatelet treatment, including 75 mg/day of clopidogrel and 325 mg/day of aspirin, was continued for 2 months. Then, dual antiplatelet therapy was switched to 325 mg/day of aspirin monotherapy at least for one year.

Results

Six patients, five of whom were women, were included in the study. The mean age was 50 years (range 29–70 years). Four patients presented with subarachnoid hemorrhage in the subacute (1–3 weeks) phase; two of them had $3+4$ points in the tomographic Fisher scale, the others had 1 and 3 points. The remaining patients had unruptured aneurysms. The clinic consultation reason was varied, with headache associated with vomiting the most common presentation.[4] In the other two patients, one was a finding and the other one presented with balance disorders, diplopia, and 6th nerve palsy; this last patient had a MRS of 4. Four of them had GCS 15, one of them 14 and the other one 13. Three of the patients who presented with SAH had 2 points in the Hunt and Hess scale, the other one 3 points.

Aneurysm location

Two of the six aneurysms were located at the sylvian artery; one patient had a saccular microaneurysm at the origin of the left anterior temporal artery. The other one had two big right saccular sylvian aneurysms at the horizontal M1 segment, proximally to the Sylvian bifurcation. One little aneurysm was located at the basilar artery, in the beginning of left P1. Two little aneurysms were located at the anterior communicating artery. One was a right dissecting P1-P2 aneurysm. All of them had wide neck and were located in small diameter arteries, which made them candidates for endovascular ministenting therapy.

We present some of the cases as examples.

Case 1. A 67 year old woman consulted because of episodes of dizziness and falls to the floor. A computed tomography (CT) scan revealed no bleeding. The DSA showed an anterior communicating artery (Acom) aneurysm of $6 \times 5 \times 6$ mm^3 dimensions with a wide neck (see Figure 1). The diameter of A1 and A2 vessels was lower than 2.5 mm; so in case of using a stent, a ministent would be necessary.

Using a double approach (Figure 2), a catheter 6 F was placed in the right carotid artery and via coaxial system with a microcatheter and a microguidewire the aneurysm sac was accessed; a coil was placed. Another macrocatheter of 115 cm was then placed in the left internal carotid and through coaxial system with another microcatheter and a different guidewire the distal tip of the microcatheter was positioned at left A2, where a LEO Baby stent 2.5 mm in diameter and 18 mm long was displayed from A1 to A2. Later through the other microcatheter, two coils are placed. This achieved complete

Table 1. Details of the Glasgow Outcome Scale (GOS) and Modified Rankin Scale (MRS) systems.

		Modified ranking score	
GOS score	Functional status	Score	Description
5	Resumption of normal life; there may be minor neurologic and/or psychological deficits	0	No symptoms at all
4	Able to work in a sheltered environment and travel by public transportation	1	No significant disability despite symptoms; able to carryout all usual duties and activities
3	Dependent for daily support by reason of mental or physical disability or both	2	Slight disability; unable to carry out all previous activities, but able to look after own affairs without assistance
2	Unresponsive for weeks or months or until death	3	Moderatedlsability; requiring some help, but able to walk without assistance
1	Death	4	Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
		5	Severe disability; bedridden, incontinent and requiring constant nursing care and attention
		6	Dead

GOS: Glasgow outcome score.

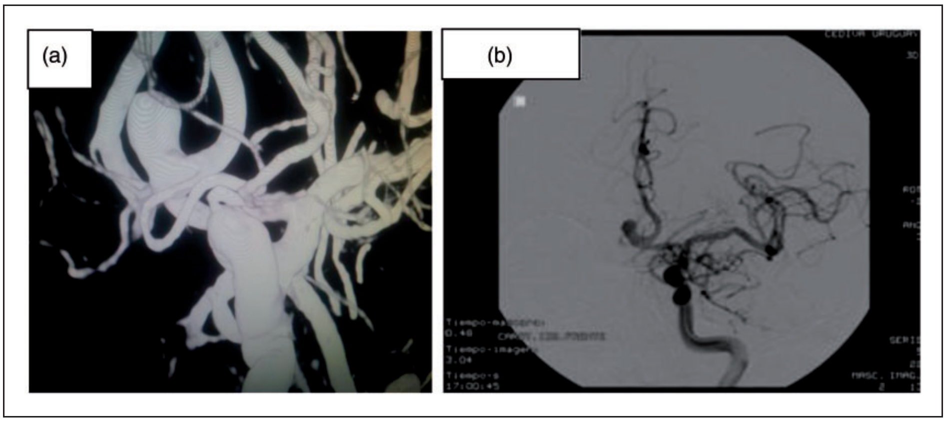

Figure 1. (a) Three-dimensional (3D) reconstruction and (b) DSA image, front projection, showing an Acom aneurysm with wide neck.

occlusion of the aneurysm and there was no occlusion of arteries.

In the clinical control one month after the procedure (Figure 3), the patient was lucid without neurological focal deficit.

Case 2. A 29 year old woman consulted for severe headache followed by nausea and vomiting. Lumbar puncture (PL) showed xanthochromic cerebrospinal fluid. In a CT scan, SAH was not seen. The DSA revealed an aneurysm at the origin of the left anterior temporal artery, which does not exceed the 2.5 mm diameter; the sac of the aneurysm was 1.6 mm × 1.69 mm with a wide neck.

A 6 F guide catheter, a microcatheter, and a guidewire system were used to access the aneurysm (see Figure 4). Then through the same guide catheter using another microcatheter and different guidewire, the LEO Baby 2.5 mm diameter by 18 mm long was deployed from the M1 temporal branch, several millimeters proximal to the aneurysm. Later, through the prepositioned system, a coil was placed inside the sac of the aneurysm. Complete occlusion of the aneurysm was achieved.

The woman had minimal distal right hand paresis in the clinical control one month after the procedure. In the DSA control 6 month after-procedure (Figure 5), there was complete occlusion of the aneurysm; the minimal paresis was reversed.

Case 3. A 53 year old woman, a smoker, consulted for severe headache and vomiting. CT and NMR showed an aneurysm at the right sylvian valley with the following characteristics: subarachnoid hemorrhage (SAH), Fisher 2, H&H 1, and Glasgow coma scale (GCS) 15. The DSA (Figure 6) revealed two big right saccular sylvian aneurysms at the horizontal M1 segment, proximally to the Sylvian bifurcation, both of them with

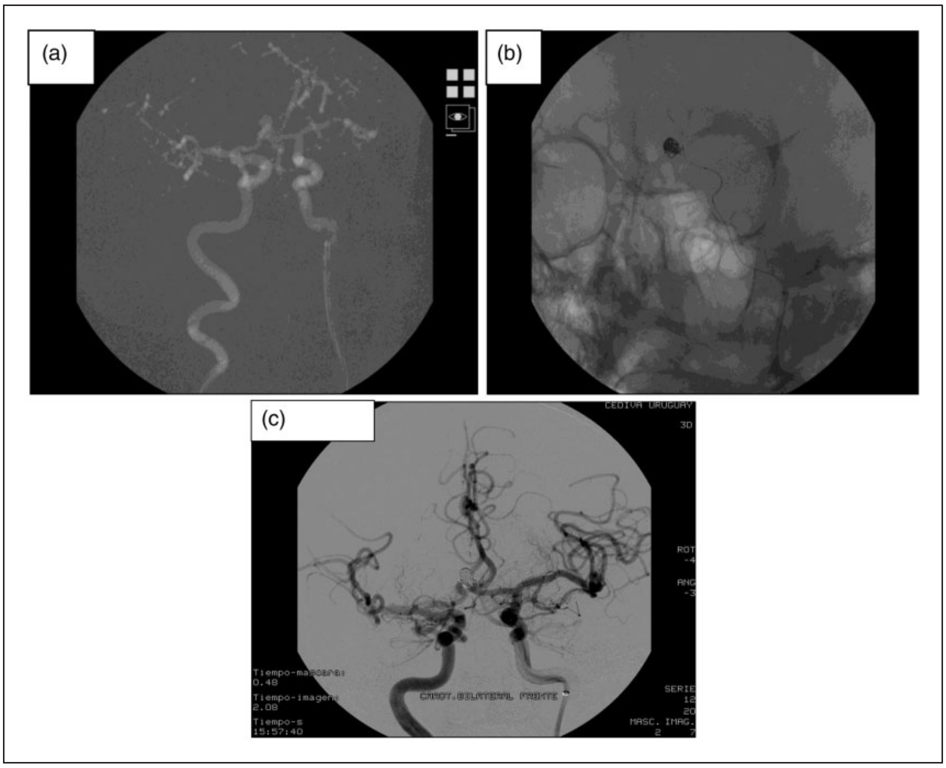

Figure 2. (a) Roadmap capture in front projection obtained after bilateral simultaneous internal carotid artery injections. (b) DSA image showing a coil already detached in the aneurysm and the stent being deployed. (c) Post-procedural DSA image after bilateral simultaneous internal carotid artery injections showing coiling by using LEO Baby stent in left A2-A1.

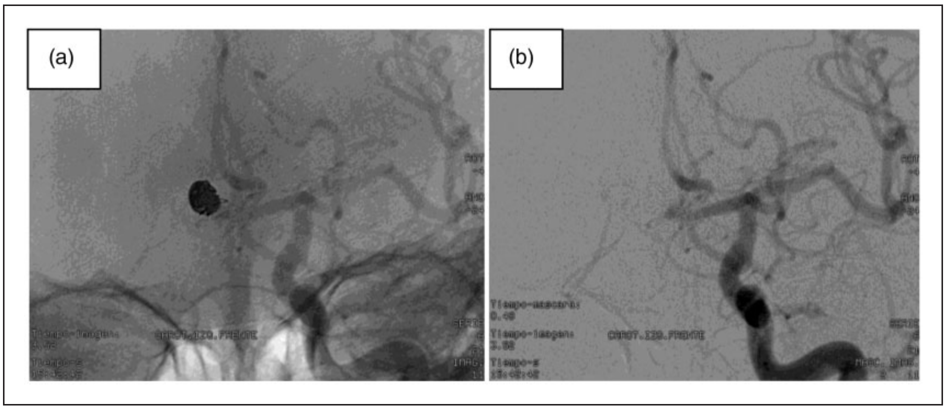

Figure 3. (a, b) DSA control 6 months later shows no recanalization, no absence of normal arteries.

wide necks. Although the sylvian artery was more than 2.5 mm in diameter, the insular vessel branch was less than 1.9 mm; hence, in the case of using a stent, a ministent must be used.

Three coils were placed in the sac of the bifurcation sylvian aneurysm causing the occlusion (Figure 7). Then the proximal aneurysm was accessed. Through another system, the LEO Baby stent 2.5×25 mm^2 was deployed leaving the distal tip of the stent between the aneurysms, and the proximal tip 1 cm proximal to the output of A1. After that, seven coils were released through the system previously placed in the proximal aneurysm.

In the clinical control one month after the procedure, the patient was lucid without neurological focal deficit. A 6 month DSA control showed complete occlusion of both aneurysms.

Case 4. A 71 year old woman presented with balance disorders, diplopia, and headache. Right 6th nerve palsy was found. She was unable to walk without assistance (4 on MRS). The DSA (Figure 8) evidenced a partially thrombosed right P1-P2 dissecting aneurysm which measured approximately $13 \times 10 \times 12$ mm^3, with a broad neck. It presented stasis of contrast in the background (eclipse sign), this being a risk factor of rupture. The P-com, P1-P2 diameter was lower than 2.5 mm.

Two approaches were made. A 5 F catheter was placed through the right humeral, in the right vertebral artery. Using a microcatheter and a microguidewire,

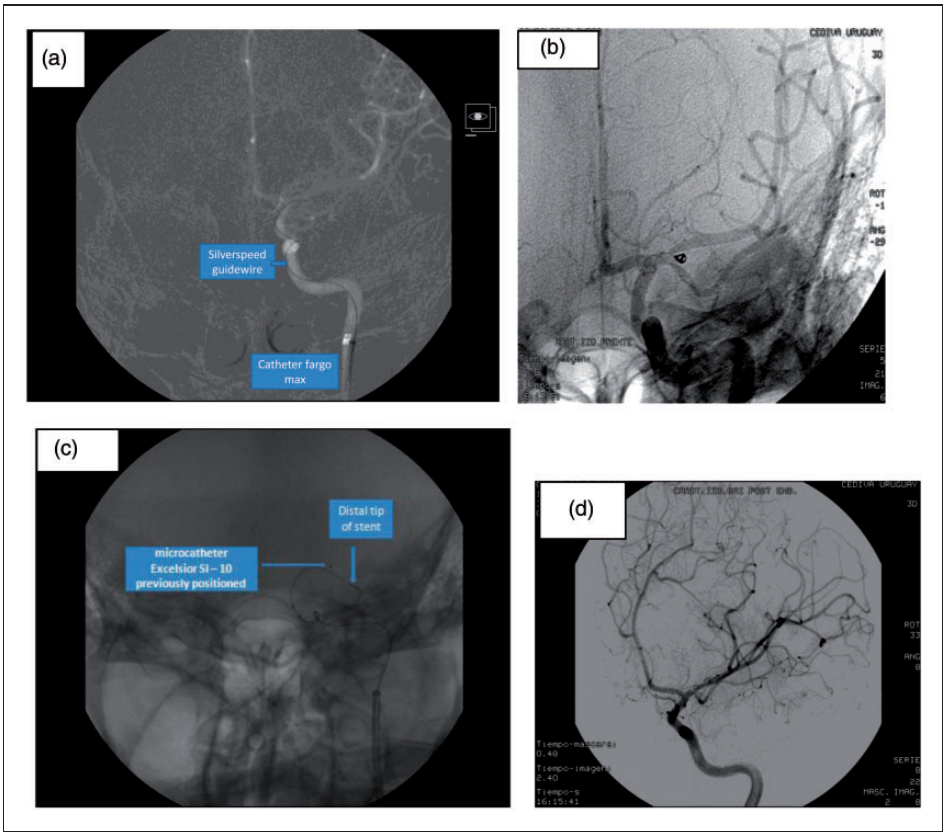

Figure 4. (a) The microcatheter is being positioned inside the aneurysm. (b) Stent Leo Baby is being deployed from the temporal anterior branch to M1. (c) The LEO Baby has been deployed and coiling has been made by the jailing technique. (d) The post-procedural DSA image shows coiling by using LEO Baby stent.

the aneurysm was accessed and two coils were deployed. Then, using a new approach through the right femoral artery, another catheter was placed in the right internal carotid artery. With another microcatheter, the LEO Baby 2.5×18 mm^2 was deployed from the start of right P2 until middle third of the posterior communicating artery (Figure 9). Once the stent was deployed, five more coils were placed inside the aneurysm through the first system. In the angiographic controls, complete occlusion of the aneurysm was evidenced with respect to the permeability of the right posterior communicating and P1 arteries.

In the one month clinical control, the patient had less balance disorders and had no headache. She was able to walk and to look after her own affairs without assistance (2 in MRS), although 6th nerve palsy persisted. A 6 month DSA control showed no recanalization (Figure 10).

Follow-up

Clinical examination was performed one month after the procedure. Only one patient (case 2) presented minimal neurological deficit (distal right hand paresis), which reversed in the second control at 6 months.

Angiographic 6 month follow-up examination was performed in all patients; none of them showed aneurismal recanalization.

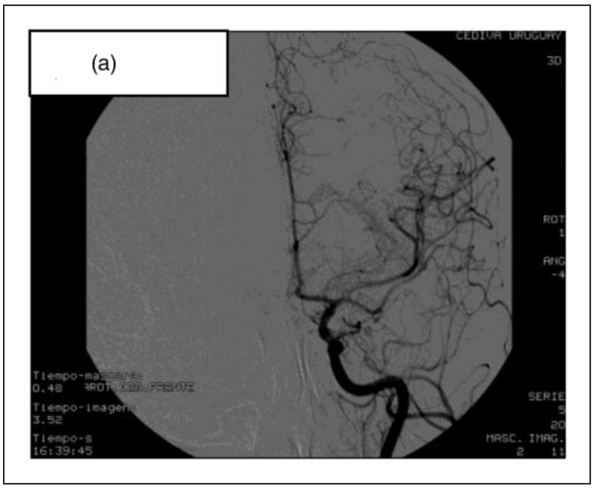

Figure 5. A 6 month DSA control showing complete occlusion of the aneurysm.

Discussion

Several endovascular techniques have been defined for the treatment of wide-neck intracranial aneurysms. Balloon-assisted coiling, stent-assisted coiling, dual or telescopic stent placement, and flow diversion by using dedicated flow diverters are the most commonly used methods for the endovascular treatment of wide-neck aneurysms.[12]

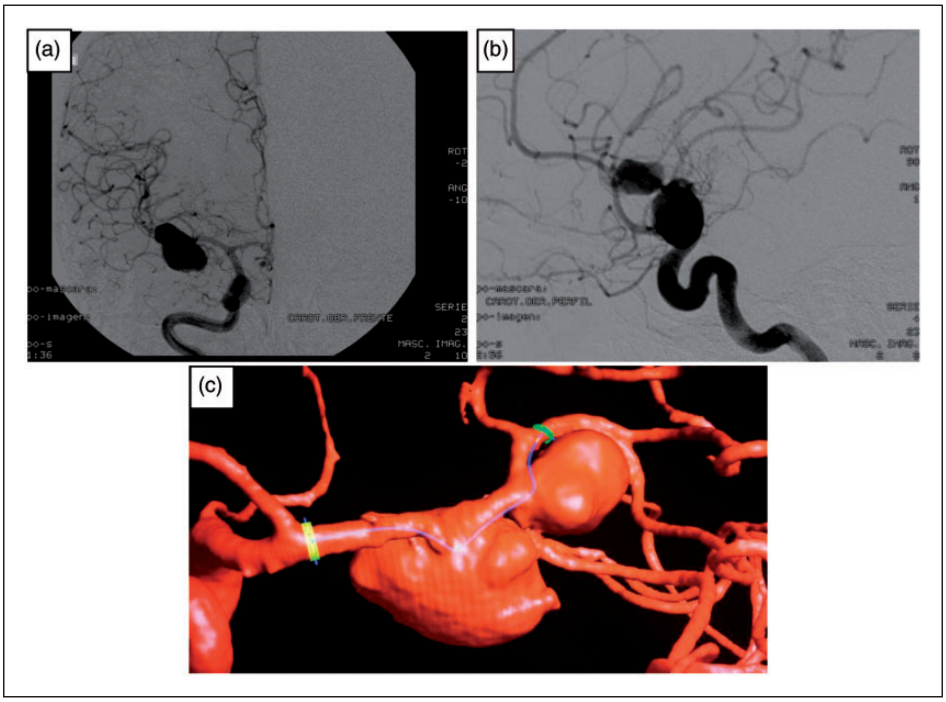

Figure 6. DSA revealing two big sylvian aneurysms with wide neck (a) in the front projection, (b) in the lateral projection. (c) 3D DSA reconstruction showing both aneurysms.

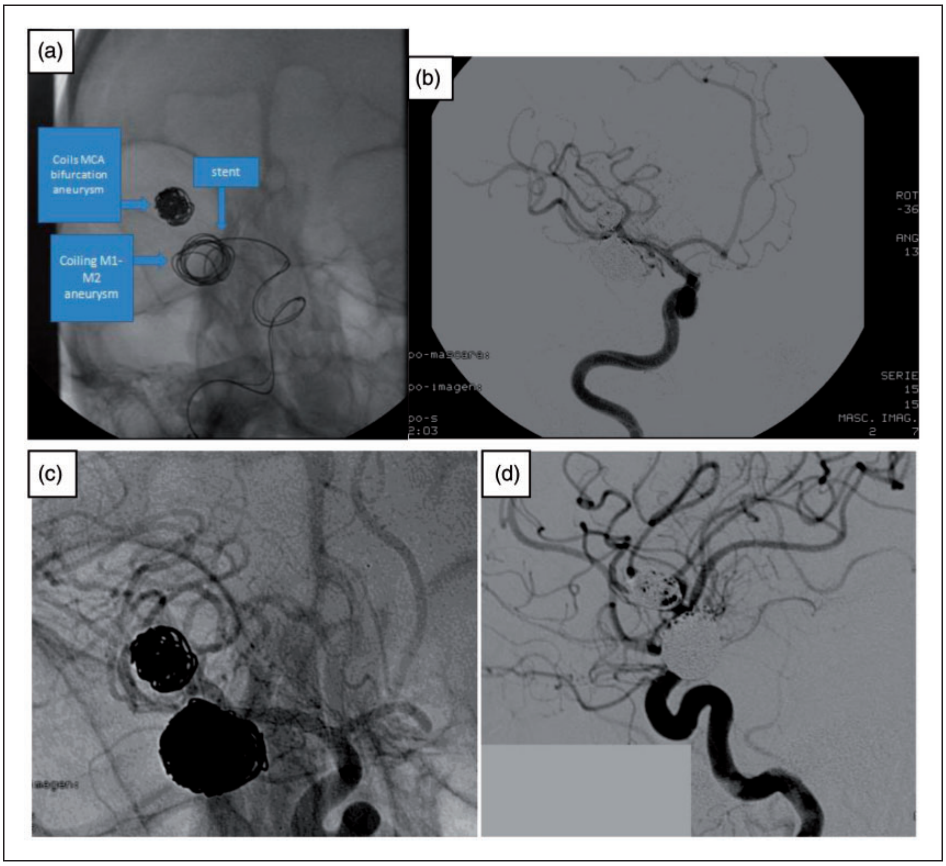

Figure 7. (a) DSA revealing coils already deployed in MCA bifurcation aneurysm, the LEO Baby already deployed (b), and coiling in the sylvian proximal aneurysm by jailing technique (c). (d) A 6 month DSA control image showing coiling of both aneurysms using LEO Baby.

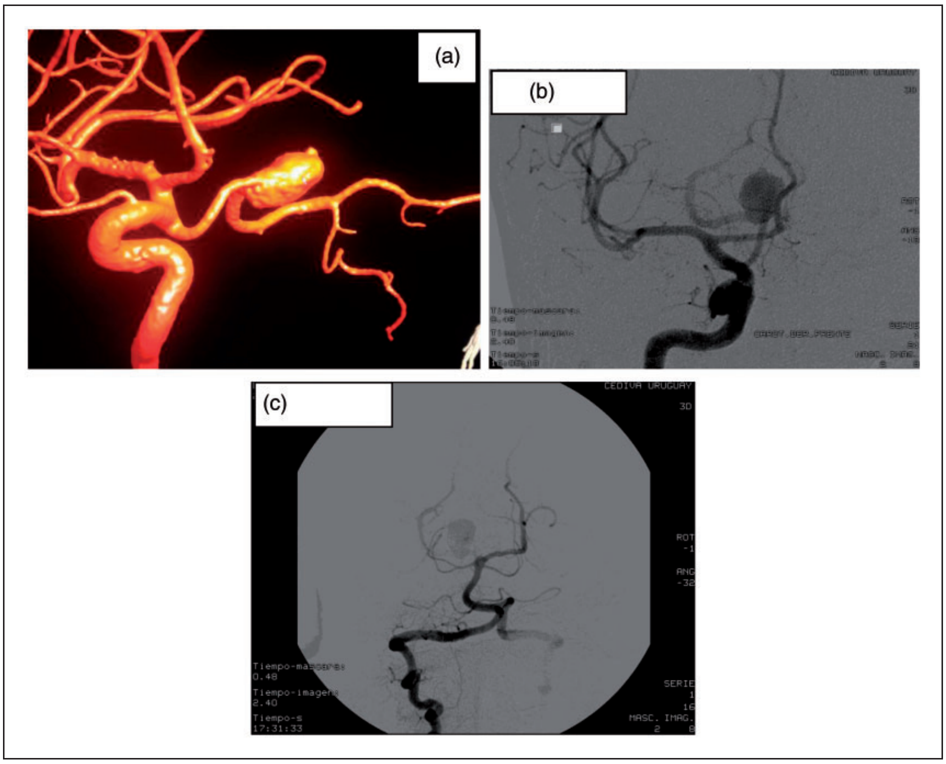

Figure 8. Procedural DSA image: (a) 3D DSA and (b) DSA in the front projection showing dissecting P1-P2 aneurysm obtained after right internal carotid artery injection. (c) DSA showing the aneurysm after right vertebral artery injection.

Balloon-assisted coiling is a relatively safe method, but it is associated with retreatment in the long term.[14,15] Stent-assisted coiling addresses both the defective wall segment of the parent artery and the aneurysm sac. Stents may enable endovascular treatment in otherwise uncoilable aneurysms by providing a scaffold during coiling. Moreover, stents decrease aneurysm recurrence rates by altering hemodynamic effects and stimulating healing reactions.[16,17] In those aneurysms situated in small vessels, the use of ministents can be very useful.

Our six case series demonstrate that favorable immediate and early follow-up angiographic results can be obtained with stent-assisted coiling by using low-profile intracranial ministents for the treatment of wide-neck, complex aneurysms situated in small arteries.

LEO Baby stents are self-expandable, low-profile stents composed of braided mesh nitinol wires. Two platinum wires enable radiographic visualization of the stent. LEO Baby stents, similar to the LVIS Jr stents, exhibit several advantages over laser-cut stents. First, LEO Baby stents have a sliding-strut design, and this hybrid design allows better wall apposition and scaffolding compared with open and closed cells. Second, LEO Baby stents are resheathable or repositionable up to approximately 95% of their length.[11] This feature is a major advantage over non-retrievable open-cell stents and Enterprise stents, which can be retrieved up to 70% of their length.[18,19] Finally, the LEO Baby stent fits inside microcatheters with luminal diameters of 0.0165 inches; therefore, these stents may exhibit improved navigation within arteries or through already-deployed stents. The struts of LEO Baby stents are not fixed (i.e. the struts can move over each other); this feature makes the catheterization of the side branch through the stent possible. Some differences exist between the LVIS Jr stent and the LEO Baby stent. The major difference is the cell size. The LEO Baby stent has a cell size of approximately 0.9 mm, which is significantly smaller than that in the LVIS Jr stent (1.5 mm).[11,20]

We did not have technical complications. Access with both stent-delivery systems were easy, and the aneurysm neck was covered sufficiently. After stent placement, total coil embolization was achieved in all cases, parent arteries remained open, and no secondary coil migration or stent migration was seen. On 6 month follow-up DSA imaging in all patients, the stent was clearly visible and patency of the parent vessel and emerging branches was assessable.

An early switch from dual antiplatelet therapy to aspirin monotherapy increases the risk of delayed thromboembolic complications in patients treated by stent-assisted coiling.[21]

The newer versions of the LEO stents, including LEO Baby stents, undergo a new surface-modification procedure to decrease thromboembolic events,[22] but a higher risk of thromboembolic events is expected with the use of these stents in smaller stented arteries.

Our six cases had successful results of stent assisted coiling for the treatment of different, wide neck, complex aneurysms situated in small diameter arteries. The

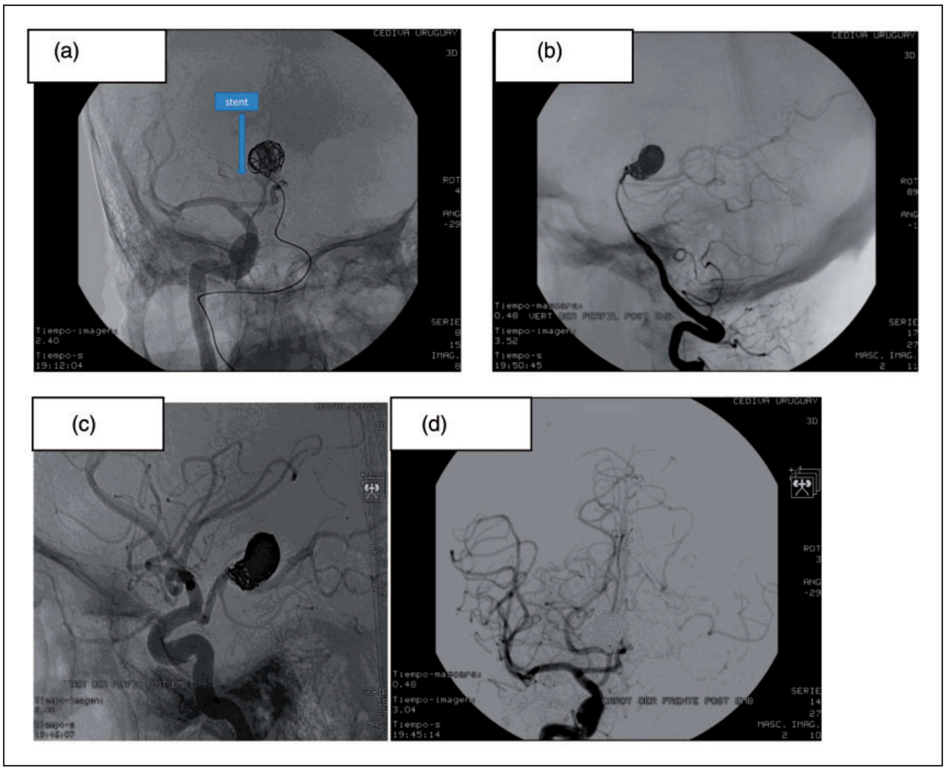

Figure 9. (a) Procedural DSA image in the front projection obtained after right internal carotid artery injection. It shows LEO Baby stent already deployed from the beginning of right P2 to the beginning of right P-com, proximal to the aneurysm. It also shows the other microcatheter in the right vertebral artery and the jailed tip of the microcatheter coiling within the aneurysm sac. (b) Post-procedural DSA image capture in the lateral projection obtained after vertebral artery injection showing the coiling. (c) Post-procedural unsubstructured DSA image capture in the lateral projection obtained after internal carotid artery injection showing coiling using the LEO Baby stent. (d) Post-procedural DSA image in the front projection obtained after internal carotid artery injection which shows the coiling using the LEO Baby stent.

endovascular treatment (EVT) of MCA aneurysms remains controversial in many centers around the world. This is because of favorable surgical results with low morbidity-mortality and recurrence rates at follow-up. However, low morbidity-mortality (5.4%–12.4%) and aneurysm-recurrence rates (9.5%–10.5%) were observed at mid- and long-term in recent EVT series by using a simple coiling or balloon-remodeling technique.[9,23–25] The complex anatomy of MCA aneurysms remains a challenge in EVT, but the development of embolization techniques such as stent-assisted coiling could enhance viability and effectiveness of EVT of MCA aneurysms.

The results of Vendrell et al.,[26] who used stent-assisted coiling of broad-neck, complex, middle cerebral artery aneurysms, clearly show that stent-assisted coiling could be a reasonable option for their treatment.

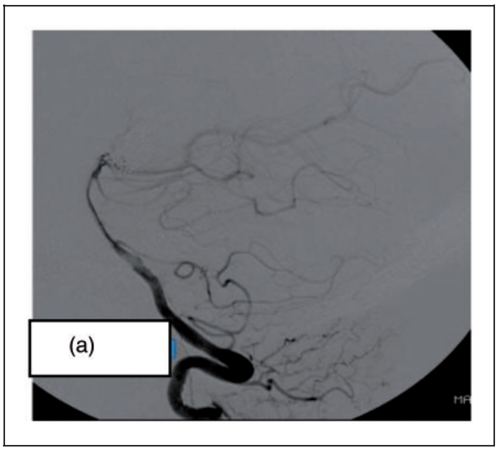

Figure 10. A 6 month DSA control through vertebral artery showing complete occlusion of the aneurysm.

Conclusions

This small study shows the feasibility of stent-assisted coiling of intracranial aneurysms using ministents. The short-term follow-up results for the treatment of complex intracranial aneurysms in this small series are encouraging. Access to smaller vessels was easy, and there were no problems with the mechanism of deployment. Moreover, the techniques were effective and were not associated with clinically significant adverse events. Last but not least EVT of complex MCA aneurysms could be considered as the treatment of choice.

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Conflict of interest

None declared.

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