Case Report

Y-Stent–Assisted Coil Embolisation of Wide-Necked Aneurysms Using a New Fully Retrievable and Detachable Intracranial Stent: Report of Two Cases

Ahmad Sobri Muda[1], Ahmad Razali Md Ralib[2], Yazmin Yaacob[1], Rozman Zakaria[1], Azizi Abu Bakar[3]

Submitted: 30 Jan 2011
Accepted: 26 Apr 2011

[1] *Department of Radiology, Universiti Kebangsaan Malaysia Medical Centre, 56000 Cheras, Kuala Lumpur, Malaysia*

[2] *Department of Radiology, Kulliyyah of Medicine, International Islamic University Malaysia, 25710 Kuantan, Pahang, Malaysia*

[3] *Department of Surgery, Universiti Kebangsaan Malaysia Medical Centre, 56000 Cheras, Kuala Lumpur, Malaysia*

Abstract

Endovascular treatment of wide-necked aneurysms poses a challenge for the endovascular therapist. The Y-stent–assisted technique has been used for stent-assisted coil embolisation for wide-necked bifurcation aneurysms. This technique has been described for basilar tip aneurysms and middle cerebral artery bifurcation aneurysms using Neuroform and Enterprise stents. We report 2 cases of wide-necked bifurcation aneurysms that were treated with Y-stent–assisted coil embolisation using a new, fully retrievable and detachable intracranial stent (Solitaire AB™). We describe the advantages of a fully retrievable and detachable stent and its feasibility of forming a Y configuration.

Keywords: *endovascular techniques, intracranial aneurysm, neurosurgery, stents, therapeutic embolisation*

Introduction

Endovascular treatment (EVT) is an established treatment in most patients with ruptured and unruptured aneurysms (1,2). However, wide-necked aneurysms present a challenge for the endovascular therapist. Many techniques assist in the embolisation of these aneurysms, such as balloon remodelling (3), jailed microcatheter (4), horizontal stent–assisted (5), and Y-stent–assisted (6). Stent-assisted techniques have the most advantages over balloon remodelling techniques (7). Many types of stents are available, from open-cell to closed-cell designs, each with its own advantages and disadvantages. The Solitaire AB™ stent (ev3 Inc., Irvine, CA) is a new stent for intracranial stenting that is fully retrievable and detachable, features that are not available in other types of stents (7,8). We present our experience with Y-stent–assisted coil embolisation of wide-necked bifurcation aneurysms using Solitaire AB™ stents. To the best of our knowledge, there have been only 2 previous cases in the English medical literature in using Y-stent–assisted coil embolisation of wide-necked bifurcation aneurysms using Solitaire AB™ stents (8).

Case Series

Case 1

A 68-year-old woman presented with a sudden loss of consciousness. On arrival, she had a Glasgow Coma Scale of 6/15. Unenhanced computed tomography (CT) scan of the brain revealed extensive subarachnoid haemorrhages, and the subsequent CT angiography showed a large wide-necked basilar tip aneurysm that measured 5.8 × 6.3 mm with a neck that measured 4.3 mm (Figure 1). After an interdisciplinary discussion and an explanation of risks, benefits, and alternatives, we proceeded with EVT using the Y-stent–assisted coil embolisation technique. Due to the tortuosity and atherosclerotic posterior circulation, especially of the posterior cerebral arteries, we postulated that we would have difficulties in good stent placement on a single release. Therefore, we used the new Solitaire AB™ stent, which is fully retrievable if the stent placement is not optimal.

The procedure was performed under general anaesthesia. Because the patient was on long-term dual antiplatelet therapy (clopidogrel and aspirin) for ischaemic heart disease, a loading dose of clopidogrel was not needed. Bilateral common femoral artery punctures were performed. A 6F guiding catheter equipped with a continuous heparinised flushing system was advanced via right femoral artery puncture with the tip at the proximal left vertebral artery. Working projections were identified and baseline runs were performed. A microcatheter (Prowler 0.021", Cordis, Miami Lakes, FL) with a GT double curve microwire (Terumo, Tokyo, JP) was advanced into the left P1 segment with the tip placed at the distal left P1 segment. A fully retrievable and detachable stent (Solitaire AB™, 4 × 20 mm) was delivered and fully deployed but not detached. On the check run, we noted a significant flow reduction into the left posterior cerebral artery. We fully retrieved and repositioned the stent without causing a significant flow reduction, and the stent was detached.

Subsequently, we navigated the microcatheter through the stent strut into the right P1 segment. A second stent was deployed and detached through the first stent mesh to form a Y configuration (Figures 2a and 2b). Loose coiling of the basilar tip aneurysm was performed using 2 detachable coils (Figure 2c). Post-procedural angiographic runs showed no immediate compromise to the major supply of the posterior circulation with occlusion and a significant slowing of flow within the basilar tip aneurysm (Figure 2d). The patient was discharged after 3 weeks in the intensive care unit and 2 weeks in the general ward and was ambulated with assistance.

The patient returned for a follow-up visit about 4 months post-embolisation. During the follow-up visit, she walked with assistance. Unfortunately, she fell and suffered a loss of consciousness during a shopping trip after the follow-up visit. An urgent CT scan of the brain showed a massive right temporoparietal subdural haemorrhage with mass effect and internal herniation. The patient underwent an urgent craniotomy due to the massive subdural haemorrhage. Unfortunately, the patient did not recover from the surgery and died about 3 days post-operatively.

Case 2

A 54-year-old gentleman presented with frequent headache. A CT scan of the brain followed by a CT angiogram revealed a large wide-necked left middle cerebral artery (MCA) aneurysm that measured 11.1 × 11.2 mm with a neck that measured 5.2 mm. There was also another aneurysm in the left posterior communicating artery. There was no evidence of intracranial haemorrhage. The patient was keen for treatment and decided on an EVT. Initially, the patient underwent an embolisation of the left posterior communicating artery aneurysm. We then planned for a Y-stent–assisted coil embolisation of the large left MCA aneurysm at a later date.

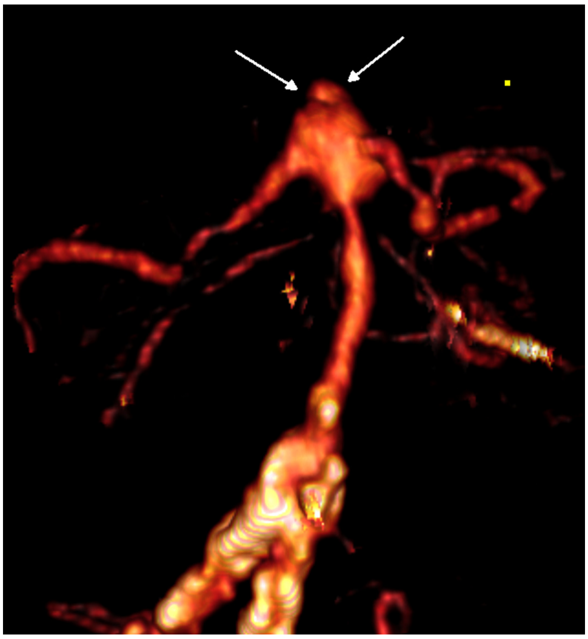

Figure 1: Three-dimensional reconstruction of computed tomography angiography showing a wide-necked basilar tip aneurysm (white arrows) measuring 5.8 × 6.3 mm with a neck measuring 4.3 mm.

Clopidogrel (75 mg daily) and aspirin (150 mg daily) were started 5 days prior to the procedure. EVT was performed under general anaesthesia. Bilateral common femoral artery punctures were done. A 6F sheath was used with the tip of the guiding catheter in the proximal left internal carotid artery. We used the Solitaire AB™ stent with the Leo stent (Balt, Montmorency, FR) to form a Y configuration and loosely coil the aneurysm. A microcatheter (Prowler 0.021") was advanced into the M2 segment of the left MCA with the tip beyond the aneurysm neck. The Solitaire AB™ stent was delivered and fully deployed but not detached (Figure 3a). The microcatheter (Prowler 0.021") was pushed through the Solitaire AB™ stent struts without difficulty with the tip within the other M2

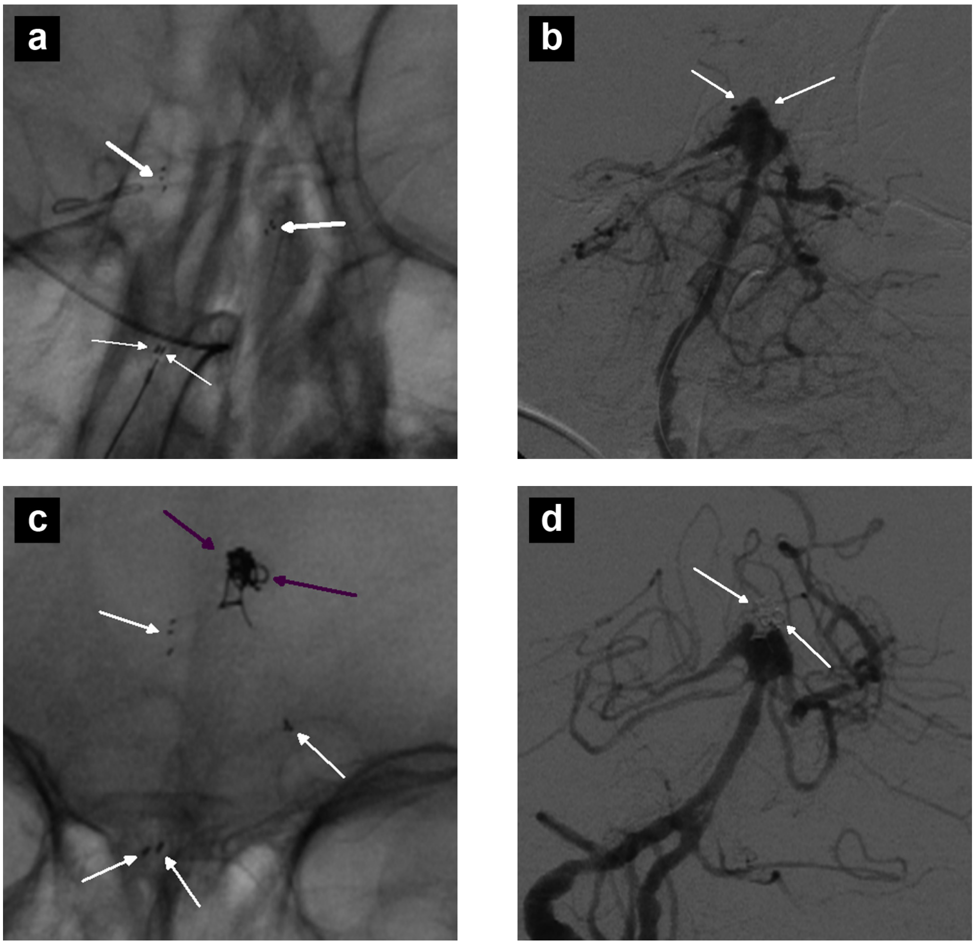

Figure 2: (a) Post-deployment of both Solitaire AB™ stents to form the Y configuration. The proximal markers (thin white arrows) and distal markers (thick white arrows) of the Solitaire AB™ stent are visualised. (b) Angiographic run post-deployment of Solitaire AB™ stents with no compromise of flow to the posterior circulation. The basilar tip aneurysm is visualised (white arrows). (c) Post-coiling of the basilar tip aneurysm (black arrows). The proximal and distal markers of the Solitaire AB™ stent are visualised (white arrows). (d) Post-embolisation angiographic run showing about a 50% obliteration of the basilar tip aneurysm (white arrows) with no compromise of flow to the posterior circulation.

branch. A Leo stent (2.5 × 18 mm) was delivered (Figure 3a). A check run showed both stents formed a proper Y configuration with patency of both M2 branches (Figure 3b). The Solitaire AB™ stent was detached. The aneurysm was loosely packed with 2 detachable coils that were deployed via an Excelsior SL 10 microcatheter (Boston Scientific, Fremont, CA) cannulated through the Solitaire AB™ stent struts (Figure 3c).

Post-embolisation angiographic runs showed a slowing of contrast filling into the aneurysm (Figure 3d). The patient did well post-procedure and was discharged 4 days later.

On a follow-up angiogram 3 months later, only about 30% of the MCA aneurysm remained opacified (Figure 4) with patency of both M2 branches. The patient was stable with no complaints, and clopidogrel and aspirin prescription were continued.

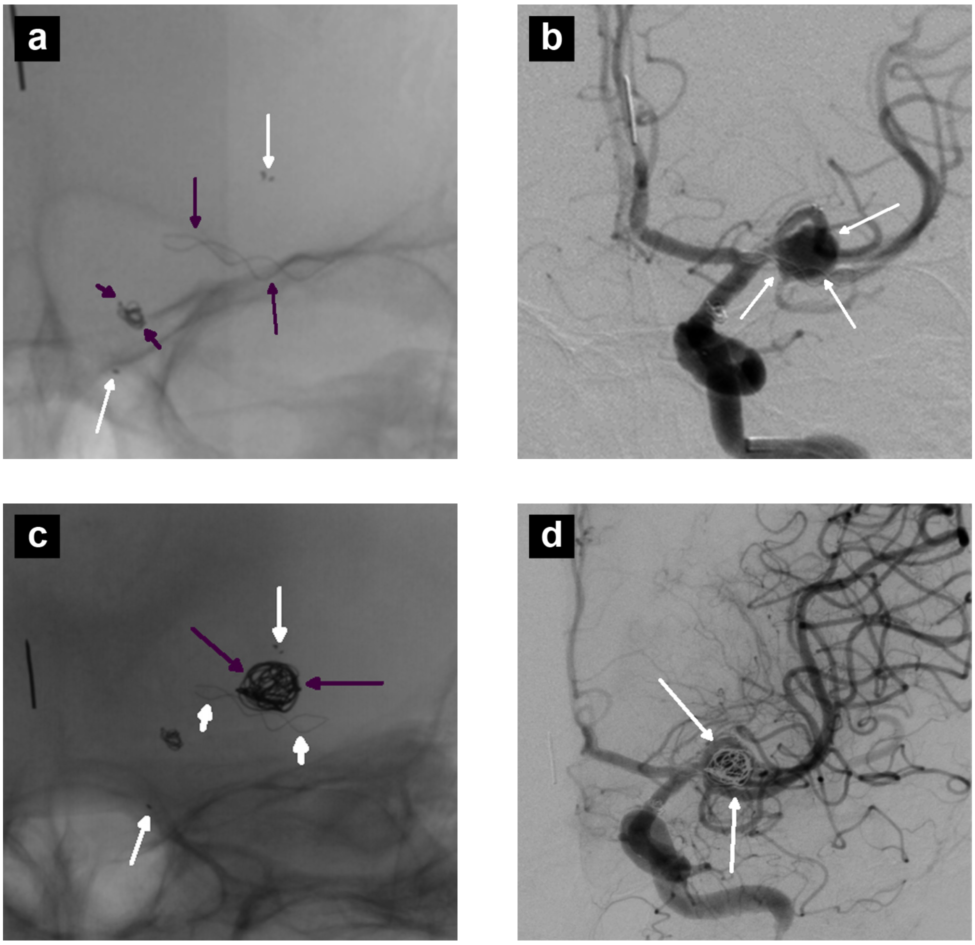

Figure 3: (a) Post-deployment of Solitaire AB™ (white arrows) and Leo (long black arrows) stents to form the Y configuration. The coils within the posterior communicating artery aneurysm are also visualised (short black arrows). (b) Angiographic run post-deployment of Solitaire AB™ and Leo stents with patency of both M2 branches. The MCA aneurysm is visualised (white arrows). (c) Post-coiling of the MCA aneurysm (black arrows). The Solitaire AB™ (long white arrows) and Leo (short white arrows) stents are visualised. (d) Post-embolisation angiographic run showing about a 50% obliteration of the MCA aneurysm (white arrows) with patency of both M2 branches.

Discussion

There are various methods for parent artery reconstruction for wide-necked aneurysms prior to coil embolisation: these include balloon remodelling, jailed microcatheter, horizontal stent–assisted, and Y-stent–assisted. Jailed microcatheter is a technique in which a microcatheter is first placed into the aneurysm and "jailed" after the stent deployment, which helps stabilise the device during the deployment of coils (4). However, this method does not allow for microcatheter repositioning after the stent has been deployed.

The balloon remodelling technique or balloon-assisted coil embolisation is a technique in which the balloon is inflated within the parent artery to achieve a dense packing of the aneurysm (3). However, it is associated with a higher percentage of procedure-related complications compared with conventional coil embolisation (3).

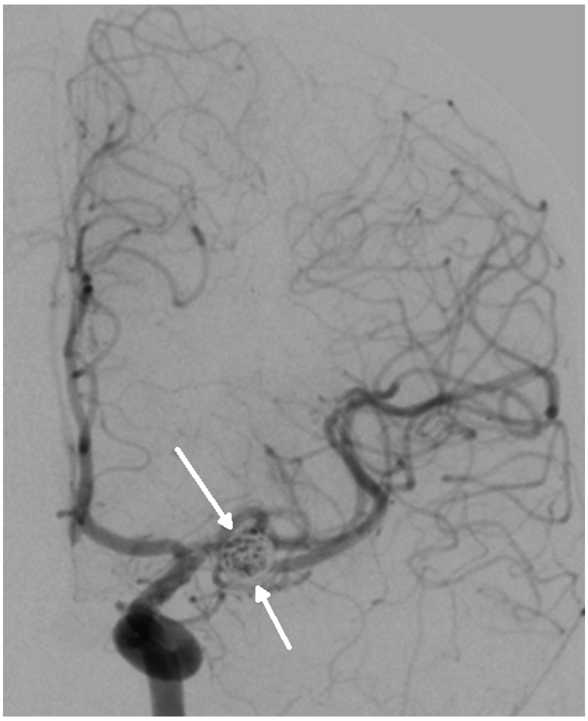

Figure 4: Left internal carotid angiogram 3 months post-embolisation showing only about 30% of the MCA aneurysm opacified with patency of both M2 branches.

Stents have revolutionised the treatment of wide-necked aneurysms. Stents provide structural support for coil embolisation, prevent coil herniation, allow for an increased packing density, and have an impact on flow diversion (4,9). The placement of a stent across the neck of the aneurysm alters the blood flow pattern and disrupts the flow into the aneurysm, thus allowing for a spontaneous thrombosis of the aneurysm (10).

Wide-necked aneurysms arising from vessel bifurcation, such as basilar tip aneurysm and middle cerebral artery bifurcation aneurysm, provide a bigger challenge for the endovascular therapist. Two treatment methods have been described for these wide-necked bifurcation aneurysms: horizontal stent–assisted and Y-stent–assisted.

The horizontal stent–assisted technique has been described as an alternative to the Y-stent–assisted technique. This technique is defined as the horizontal deployment of a stent across the neck of a terminal aneurysm, which is achieved by the navigation of the stent through the circle of Willis (5). Basilar tip aneurysms are accessed from the carotid system via the posterior communicating artery, and carotid tip aneurysms are accessed from the contralateral carotid artery via the anterior communicating artery. The advantage of this technique over the Y-stent–assisted technique is a reduction in the number of stent requirements, which reduces cost and the risk of thrombosis. However, the success of this technique depends on the availability of good-sized anterior or posterior communicating arteries. Siddiqui et al. (5) described 8 aneurysms that were treated successfully with an Enterprise stent (Cordis Neurovascular) using the horizontal stent–assited technique: 6 cases of basilar tip aneurysms and 2 cases of carotid bifurcation aneurysms.

The Y-stent–assisted technique is the other alternative for the treatment of wide-necked bifurcation aneurysms. Lozen et al. (6) described 5 basilar tip aneurysms and 1 middle cerebral artery aneurysm that were treated with Y configuration Neuroform stents (Boston Scientific, Fremont, CA). The Y configuration was successfully established in all 6 patients. For 1 patient, there was some difficulty in the delivery of the second stent due to the presence of friction within the system. The authors postulated that the use of this technique in larger calibre arteries would limit the intraprocedural friction. Rohde et al. (9) described a Y-stent–assisted coil embolisation of a wide-necked anterior communicating artery aneurysm using Enterprise stents. However, because the Enterprise stent has a closed-cell design, there was an initial difficulty in the pushing of the microcatheter through the stent struts, which probably occurred because the tip of the microcatheter was hooked on the cells of the stent. A second stent was also inserted about 4 months later to allow for a "healing-in" of the first stent and to reduce the risk of stent displacement during the insertion of the second stent.

Klish et al. (8) described 2 patients with broad-necked basilar tip aneurysms that were treated using the creation of a stent in a Y configuration at the basilar artery apex using Solitaire AB™ stents. Although Solitaire AB™ stent has a closed-cell design similar to the Enterprise stent, the Solitaire AB™ cell is approximately twice as wide as that of the Enterprise. The Solitaire AB™ allows a 3-mm diameter circle to pass through it. If a 4-mm stent is inserted through the interstices of the stent, it will open to a 3-mm diameter while passing through the interstices of the first stent. This opening is not seen in other commercially available stents. Therefore, Solitaire AB™ provides the best of the open- and closed-cell design features, especially for Y-stent–assisted coil embolisation. In their series, there were no problems in the guiding of the microcatheter through the struts of the first stent into the other posterior cerebral artery.

In both of our patients, no difficulties in the navigation of the microcatheter through the Solitaire AB™ stent strut or the deployment of the second stent through the first stent struts occurred. Because the Solitaire AB™ cell area allows a 3-mm diameter circle to pass through it, the second stent of the Y configuration need not be the Solitaire AB™ stent. In the second patient with middle cerebral artery bifurcation aneurysm, the Leo stent was used as the second stent for the Y configuration with similar ease.

During the early use of stents for aneurysm treatment, a stent was utilised to provide structural support, prevent coil herniation, and allow for the dense packing of the aneurysms (10). However, in the last few years, it has been noted that a stent alone induces flow reduction within the aneurysm to cause thrombus formation and vessel wall remodelling (11). From an in vitro study of the haemodynamic alteration of a side-wall aneurysm post-stenting using laser Doppler anemometry, a dedicated flow diverter, such as the Silk stent and Phenox flow diverter, was shown to reduce the flow in the inflow zone, outflow zone, and the central dome up to 90% (11). Early studies using the Pipeline embolisation device, which was the first endovascular construct that was specifically engineered to function as a standalone device for the endovascular reconstruction of a segmentally diseased parent vessel, demonstrated a complete angiographic occlusion of cerebral aneurysms in 93% of patients after a 12-month follow-up period (12). In view of this current data, we loosely packed the aneurysm in the second patient in the hopes of a flow diversion effect of the Solitaire AB™ stent to induce thrombosis of the aneurysm.

It was very unfortunate that the first patient died due to an acute subdural haemorrhage as a complication of antiplatelet therapy. The decision to use antiplatelet therapy to reduce thromboembolic complications in elective coil embolisation cases is highly controversial. However, Yamada et al. (13) has shown in a retrospective study that there was a significantly lower symptomatic thromboembolic complication rate in patients who receive antiplatelet therapy compared with those who do not. Although there is higher risk of haemorrhage in patients who receive antiplatelet therapy, the benefits appear to outweigh the risks (13).

Solitaire AB™ is the first fully retrievable and detachable intracranial stent (7,8). A fully retrievable stent allows for the repositioning of the stents in cases of flow compromise. In our patient with a wide-necked basilar tip aneurysm after the first Solitaire AB™ stent was fully delivered and fully deployed, there was a significant flow reduction in the left posterior cerebral artery. Due to this flow reduction, the stent was fully retrieved and repositioned. The stent was only fully detached when we were satisfied that the stent position produced no evidence of flow reduction. This repositioning is one of the advantages of the Solitaire AB™ stent and is not available in other intracranial stents.

Conclusion

Treatment of wide-necked bifurcation aneurysm using the Y-stent–assisted coil embolisation technique is safe and effective. The use of Solitaire AB™ stents in the formation of the Y configuration in this technique is relatively easy, with minimal complications, due to its large cell strut. The Solitaire AB™ stent feature of a fully retrievable stent allows for the repositioning of a fully deployed stent, which is not seen in other types of intracranial stents.

Authors' Contributions

Conception and design: ASM, YY
Provision of patients: YY, RZ, AAB
Collection and assembly of the data: RZ, AAB
Analysis and interpretation of the data, drafting of the article: ARMR, YY
Critical revision of the article: ASM, ARMR, RZ, AAB
Final approval of the article: ASM, ARMR

Correspondence

Dr Ahmad Razali Md Ralib
MBBS (UM), MMed Radiology (USM)
Department of Radiology
Kulliyyah of Medicine
International Islamic University Malaysia
25710 Kuantan
Pahang, Malaysia
Tel: +609-571 6400
Fax: +609-517 8548
Email: arazali@iium.edu.my

References

1. Roy D, Milot G, Raymond J. Endovascular treatment of unruptured aneurysms. *Stroke*. 2001;**32(9)**: 1998–2004.
2. Molyneux AJ, Kerr RS, Yu LM, Clarke M, Sneade M, Yarnold JA, et al. International subarachnoid aneurysm trial (ISAT) of neurosurgical clipping versus endovascular coiling in 2143 patients with ruptured intracranial aneurysms: A randomised comparison of effects on survival, dependency, seizures, rebleeding, subgroups, and aneurysm occlusion. *Lancet*. 2005;**366(9488)**:809–817.
3. Sluzewski M, van Rooij WJ, Beute GN, Nijssen PC. Balloon-assisted coil embolization of intracranial aneurysms: Incidence, complications, and angiography results. *J Neurosurg*. 2006;**105(3)**: 396–399.
4. Wanke I, Forsting M. Stents for intracranial wide-necked aneurysms: More than mechanical protection. *Neuroradiology*. 2008;**50(12)**:991–998.
5. Siddiqui MA, Bhattacharya J, Lindsay KW, Jenkins S. Horizontal stent-assisted coil embolisation of wide-necked intracranial aneurysms with the Enterprise stent—A case series with early angiographic follow-up. *Neuroradiology*. 2009;**51(6)**:411–418.
6. Lozen A, Manjila S, Rhiew R, Fessler R. Y-stent-assisted coil embolization for the management of unruptured cerebral aneurysms: Report of six cases. *Acta Neurochir (Wien)*. 2009;**151(12)**:1663–1672.
7. Klisch J, Clajus C, Sychra V, Eger C, Strasilla C, Rosahl S, et al. Coil embolization of anterior circulation aneurysms supported by the Solitaire AB Neurovascular Remodeling Device. *Neuroradiology*. 2009;**52(5)**:349–359.
8. Klisch J, Eger C, Sychra V, Strasilla C, Basche S, Weber J. Stent-assisted coil embolization of posterior circulation aneurysms using Solitaire AB: Preliminary experience. *Neurosurgery*. 2009;**65(2)**:258–266.
9. Rohde S, Bendszus M, Hartmann M, Hahnel S. Treatment of a wide-necked aneurysm of the anterior cerebral artery using two Enterprise stents in "Y"-configuration stenting technique and coil embolization: A technical note. *Neuroradiology*. 2009;**52(3)**:231–235.
10. Pumar JM, Lete I, Pardo MI, Vazquez-Herrero F, Blanco M. LEO stent monotherapy for the endovascular reconstruction of fusiform aneurysms of the middle cerebral artery. *AJNR Am J Neuroradio*l. 2008;**29(9)**:1775–1776.
11. Dorn F, Niedermeyer F, Balasso A, Liepsch D, Liebig T. The effect of stents on intra-aneurysmal hemodynamics: In vitro evaluation of a pulsatile sidewall aneurysm using laser Doppler anemometry. *Neuroradiology*. 2010;**53(4)**:267–272.
12. Lylyk P, Miranda C, Ceratto R, Ferrario A, Scrivano E, Luna HR, et al. Curative endovascular reconstruction of cerebral aneurysms with the pipeline embolization device: The Buenos Aires experience. *Neurosurgery*. 2009;**64(4)**:632–642.
13. Yamada NK, Cross DT 3rd, Pilgram TK, Moran CJ, Derdeyn CP, Dacey RG Jr. Effect of antiplatelet therapy on thromboembolic complications of elective coil embolization of cerebral aneurysms. *AJNR Am J Neuroradiol*. 2007;**28(9)**:1778–1782.