Journal of Heart and Stroke

Editorial
Published: 16 Jun, 2017

Current Status of Endovascular Therapy of Cerebral Berry Aneurysms

*George Shengelaia and Nicholas Kipshidze**

Department of Cardiovascular Research, Lenox Hill Hospital, USA

Editorial

Autopsy reports have shown that cerebral aneurysms are present in roughly 5% of population [1-3]. Subarachnoid hemorrhage (SAH) is the most serious presentation of ruptured cerebral aneurysms. Estimated annual incidence of non-traumatic SAH ranges from 2 to 23 cases per 100,000, which translates to 6,500 to 74,000 annual cases of SAH in the United States. Approximately 80% of non-traumatic SAH cases are due to ruptured cerebral aneurysms [4-7]. Untreated ruptured cerebral aneurysms are associated with a high mortality and a risk of rebleeding [8]. The case fatality of cerebral aneurysm rupture is high (from 27% to 44%), but has decreased during the past 3 decades due to continuous improvements in patient management strategies [9].

The rupture risk of cerebral aneurysms is directly related to their size, shape and location [10-12]. Women and cigarette smokers are at increased risk for cerebral aneurysm formation and growth. Cigarette smoking in particular hastens this process in both sexes. Other independent risk factors for aneurysm formation and growth are hypertension and family history of stroke, with smoking and hypertension having an additive effect, whereas hypercholesterolemia, regular physical exercise and a healthy lifestyle reduce the risks of aneurysmal SAH [13].

The two main treatment strategies for obliteration of cerebral aneurysms are neurosurgical and endovascular. In neurosurgical approach, the operator gains access to the subarachnoid space via craniotomy to exclude the aneurysm from the blood circulation by microsurgical clipping. Harvey Cushing and Walter Dandy are credited with introducing microsurgical clips to treat cerebral aneurysms [14]. This method, with advancements in forms and types of microsurgical clips, was the standard of care for aneurysm treatment before mid 90s.

Endovascular therapy obliterates an aneurysm by occluding its dome with coils. Guglielmi et al. [15] introduced electrolitically detachable platinum coil – GDC. This device was approved by the FDA for the treatment of cerebral aneurysms in 1995, recognizing coiling as a competitive treatment strategy to microsurgical clipping.

The widespread acceptance of coiling has been hindered by the potential for cerebral aneurysm to recur over time after coiling [16]. This issue is even more relevant for large cerebral aneurysms for which angiographic recurrence is more likely than for smaller lesions [17]. The two most frequent complications of cerebral aneurysm coiling are thromboembolic events, which occur in 7.3% in unruptured and 13.3% in ruptured aneurysms respectively, and intraoperative rupture with prevalence of 2.0% in unruptured and 3.7% in ruptured aneurysms respectively [18,19]. Cerebral aneurysm coiling-caused mortality during their intraoperative rupture and thromboembolic events are observed in 3.7% and 16.7% cases respectively [19].

Durability of coiled cerebral aneurysms is assessed by their recanalization, which occurs in 20.8% of cases, requiring retreatment in 10.3% [20]. The risk of rerupture of initially ruptured cerebral aneurysms treated with coils runs in parallel with the degree of the initial occlusion of aneurysm cavity [21]. Due to the possibility of recanalization of coil-embolized aneurysms, their postoperative follow up by digital subtraction and/or magnetic resonance angiography became a necessary measure [21-23].

Significant advancements in imaging technologies and interventional tools for endovascular therapy of cerebral aneurysms, which include introduction of biplane flat panel digital and magnetic resonance angiography equipments, development of microcatheters, softer detachable coils, compliant balloons, stents and flow diverters contributed to improvements in management strategies for endovascular treatment of cerebral aneurysms [24].

OPEN ACCESS

Correspondence:
Nicholas Kipshidze, New York Cardiovascular Research, Lenox Hill Hospital, New York, USA,
E-mail: nicholas02@msn.com

Received Date: *07 May 2017*
Accepted Date: *07 Jun 2017*
Published Date: *16 Jun 2017*

Citation:
Shengelaia G, Kipshidze N. Current Status of Endovascular Therapy of Cerebral Berry Aneurysms. J Heart Stroke. 2017; 2(4): 1031.
ISSN: 2475-5702

In order to improve the degree of coiling of wide-neck and complex cerebral aneurysms, neurovascular remodeling devices have been introduced. Moret et al. [25], described balloon assisted coiling (BAC) technique, in which a non-detachable single balloon placed in a parent vessel either across the neck of the aneurysm or a non-detachable double balloon placed distally and proximally to the aneurysm origin, is temporarily inflated during deployment of each coil in cerebral aneurysm [25]. Unfortunately, BAC method did not contribute to a better clinical outcome than unassisted coiling, but showed superiority of the former in anatomical results of endovascularly treated cerebral aneurysms and with improvements in balloon catheters they have been utilized with increasing popularity as a sentinel tool for intraoperative management of cerebral aneurysms that rupture during coiling [26-30].

Another approach for endovascular treatment of cerebral aneurysms, stent-assisted coiling (SAC), initially was described by Higashida et al. [31]. Since then several cohort studies comparing the SAC and coiling alone techniques have been published, however the results were controversial [32-41]. Two systematic reviews concluded that SAC seemed to have more adverse events than traditional coiling [42,43], but these studies were limited since only data on SAC was used. Hong at al. [44] recently reported results of meta-analysis of ten retrospective cohort studies that compared SAC with coiling of cerebral aneurysms. The study concluded that SAC has a significantly lower recurrence rate than conventional coiling (16.2% *vs*. 34.4%).

Analysis of complication events did not show any significant difference between the two methods. However, Bodily et al. [45] reported a qualitative, systematic review of 17 articles on SAC treatment of ruptured aneurysms, where they concluded that adverse events appear more common and clinical outcomes are likely worse than those achieved without stent assistance.

As stents were being developed for cerebral use, it was hypothesized that stents could be utilized to divert flow away from the aneurysm back into the parent vessel, and the concept of endovascular flow diversion was proposed [46-49]. Early *in vitro* and *in vivo* studies showed this concept to be valid, but clinical application was limited because of high porosity of first-generation cerebral stents. With technological improvements, cerebral flow diverters have become available for parent vessel reconstruction endoluminally and early clinical experiences have been encouraging. According to recently reported meta-analysis of 29 studies concluded that treatment of cerebral aneurysms with flow-diverter devices is feasible and effective with high complete occlusion rates [50]. However, the risk of procedure-related morbidity and mortality is not negligible.

Raymond et al. [51] have shown in preclinical studies that embolized aneurysms recanalize due to early endothelial invasion of a clot inside the aneurysm cavity [51,52]. These studies have also proved that de-endothelialization caused increased migration and proliferation of fibroblasts and macrophages at the denuded area, which lead to local deposition of collagen and thereby minimized chances of recanalization. Based on these observations Raymond [53] invented a device that would effectively remove parts of endothelial lining of aneurysm cavity mechanically, physically or chemically in a pin-pointed fashion. However, Raymond's [53] invention doesn't offer the removal of endothelial layer in a circumferential fashion at the origin of a vascular defect.

However, preclinical evaluation of another method and invention in endovascular therapy of brain aneurysms introduced by Shengelaia has proved to achieve this task by application of RF energy at the origin of such vascular defects. The most active component of the device is embedded within the wall of a balloon at its center and has a zig-zag shape in a deflated position and changes its shape to a ring-form when balloon is inflated. Further studies of this device are under way.

References

1. Menghini VV, Brown RD , Sicks JD, O'Fallon WM, Wiebers DO. Incidence and prevalence of intracranial aneurysms and hemorrhage in Olmsted County, Minnesota, 1965 to 1995. Neurology. 1998;51(2):405-11.
2. Iwamoto H, Kiyohara Y, Fujishima M, Kato I, Nakayama K, Sueishi K, et al. Prevalence of intracranial saccular aneurysms in a japanese community based on a consecutive autopsy series during a 30-year observation period. Stroke. 1999;30:1390-5.
3. Winn HR, Jane JA, Taylor J, Kaiser D, Britz GW. Prevalence of asymptomatic incidental aneurysms: review of 4568 arteriograms. J Neurosurg. 2002;96(1):43-9.
4. Stapf C, Mohr JP. Aneurysms and subarachnoid hemorrhage – epidemiology. In: Le Roux PD, Winn HR, Newell DW, editors. Management of cerebral aneurysms. Philadelphia: Saunders, USA; 2004. p. 183-7.
5. Zacharia BE, Hickman ZL, Grobelny BT, DeRosa P, Kotchetkov I, Ducruet AF, et al. Epidemiology of aneurysmal subarachnoid hemorrhage. Neurosurg Clin N Am. 2010;21(2):221-33.
6. Inagawa T. Risk factors for aneurysmal subarachnoid hemorrhage in patients in Izumo City, Japan. J Neurosurg. 2005;102(1):60-7.
7. Ingall T, Asplund K, Mahonen M, Bonita R. A multinational comparison of subarachnoid hemorrhage epidemiology in the WHO MONICA stroke study. Stroke. 2000;31(5):1054-61.
8. Rabinstein AA. Subarachnoid hemorrhage. Neurology. 2013;80(5):e56-9.
9. Nieuwkamp DJ, Setz LE, Algra A, Linn FH, de Rooij NK, Rinkel GJ. Changes in case fatality of aneurysmal subarachnoid haemorrhage over time, according to age, sex, and region: a meta-analysis. Lancet Neurol. 2009;8(7):635-42.
10. Juvela S, Poussa K, Lehto H, Porras M. Natural history of unruptured intracranial aneurysms: a long-term follow-up study. Stroke. 2013;44(9):2414-21.
11. UCAS Japan Investigators, Morita A, Kirino T, Hashi K, Aoki N, Fukuhara S, et al. The natural course of unruptured cerebral aneurysms in a Japanese cohort. N Engl J Med. 2012;366(26):2474-82.
12. Wiebers DO, Whisnant JP, Huston J, Meissner I, Brown RD, Piepgras DG, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 2003;362(9378):103-10.
13. Vlak MH, Rinkel GJ, Greebe P, Algra A. Independent risk factors for intracranial aneurysms and their joint effect: a case-control study. Stroke. 2013;44(4):984-7.
14. Louw DF, Asfora WT, Sutherland GR. A brief history of aneurysm clips. Neurosurg Focus. 2001;11(2):E4.
15. Guglielmi G, Viñuela F, Dion J, Duckwiler G. Electrothrombosis of saccular aneurysms via endovascular approach. Part 2: Preliminary clinical experience. J Neurosurg. 1991;75(1):8-14.
16. Johnston SC, Dowd CF, Higashida RT, Lawton MT, Duckwiler GR, Gress DR, et al. Predictors of rehemorrhage after treatment of ruptured intracranial aneurysms: the cerebral aneurysm rerupture after treatment (CARAT) study. Stroke. 2008;39:120-5.

17. Raymond J, Guilbert F, Weill A, Georganos SA, Juravsky L, Lambert A, et al. Long-term angiographic recurrences after selective endovascular treatment of aneurysms with detachable coils. Stroke. 2003;34:1398-403.

18. Pierot L, Spelle L, Vitry F; ATENA investigators. Clinical outcome of patients harbouring unruptured intracranial aneurysms treated by endovascular approach: results of the ATENA trial. Stroke. 2008;39:2497-504.

19. Cognard C, Pierot L, Anxionnat R, Ricolfi F; Clarity Study Group. Results of embolization used as the first treatment choice in a consecutive nonselected population of ruptured aneurysms: clinical results of the Clarity GDC study. Neurosurgery. 2011;69:837-41.

20. Ferns SP, Sprengers ME, van Rooij WJ, Rinkel GJ, van Rijn JC, Bipat S, et al. Coiling of intracranial aneurysms: a systematic review on initial occlusion and reopening and retreatment rates. Stroke. 2009;40(8):e523-9.

21. Pierot L, Delcourt C, Bouquigny F, Breidt D, Feuillet B, Lanoix O, et al. Follow-up of intracranial aneurysms selectively treated with coils: Prospective evaluation of contrast-enhanced MR angiography. AJNR Am J Neuroradiol. 2006;27(4):744-9.

22. Pierot L, Portefaix C, Gauvrit JY, Boulin A. Follow-up of coiled intracranial aneurysms: comparison of 3DTOF at 3T and 1.5T in a large, prospective series. AJNR Am J Neuroradiol. 2012,33:2162-6.

23. Pierot L, Portefaix C, Boulin A, Gauvrit JY. Follow-up of coiled intracranial aneurysms: comparison of 3D time-of-flight and contrast-enhanced magnetic resonance angiography at 3T in a large, prospective series. Eur Radiol. 2012;22:2255-63.

24. Pierot L, Wakhloo AK. Endovascular treatment of intracranial aneurysms: current status. Stroke. 2013;44(7):2046-54.

25. Moret J, Cognard C, Weill A, Castaings L, Rey A. The "remodelling technique" in the treatment of wide neck intracranial aneurysms. Interv Neuroradiol. 1997;3:21-35.

26. Chalouhi N, Jabbour P, Tjoumakaris S, Dumont AS, Chitale R, Rosenwasser RH, et al. Single-center experience with balloon-assisted coil embolization of intracranial aneurysms: safety, efficacy and indications. Clin Neurol Neurosurg. 2013;115(5):607-13.

27. Pierot L, Rajpal G, Kadziolka K, Barbe C. The place for remodeling technique and stenting in the endovascular management of intracranial aneurysms: a single-center analysis from 2008 to 2010. Neuroradiology. 2012;54:973-9.

28. Santillan A, Gobin YP, Greenberg ED, Leng LZ, Riina HA, Stieg PE, et al. Intraprocedural aneurysm rupture during coil embolization of brain aneurysms: role of balloon-assisted coiling. AJNR Am J Neuroradiol. 2012;33:2017-21.

29. Wakhloo AK, Schellhammer F, de Vries J, Haberstroh J, Schumacher M. Self-expanding and balloon-expandable stents in the treatment of carotid aneurysms: an experimental study in a canine model. AJNR Am J Neuroradiol. 1994;15:493-502.

30. Ramakrishnan V, Quadri S, Sodhi A, Cortez V, Taqi M. E-064 safety and efficacy of balloon-assisted coiling of intracranial aneurysms: a single-center study. J Neurointerv Surg. 2014;6(1):A68-9.

31. Higashida RT, Smith W, Gress D, Urwin R, Dowd CF, Balousek PA, et al. Intravascular stent and endovascular coil placement for a ruptured fusiform aneurysm of the basilar artery. Case report and review of the literature. J Neurosurg. 1997;87(6):944-9.

32. Piotin M, Blanc R, Spelle L, Mounayer C, Piantino R, Schmidt PJ, et al. Stent-assisted coiling of intracranial aneurysms: clinical and angiographic results in 216 consecutive aneurysms. Stroke. 2010;41:110-5.

33. Albuquerque FC, Gonzalez LF, Hu YC, Newman CB, McDougall CG. Transcirculation endovascular treatment of complex cerebral aneurysms: technical considerations and preliminary results. Neurosurgery. 2011;68:820-9.

34. Chalouhi N, Jabbour P, Gonzalez LF, Dumont AS, Rosenwasser R, Starke RM, et al. Safety and efficacy of endovascular treatment of basilar tip aneurysms by coiling with and without stent assistance: a review of 235 cases. Neurosurgery. 2012;71:785-94.

35. Colby GP, Paul AR, Radvany MG, Gandhi D, Gailloud P, Huang J, et al. A single center comparison of coiling versus stent assisted coiling in 90 consecutive paraophthalmic region aneurysms. J Neurointerv Surg. 2012;4:116-20.

36. Gordhan A, Invergo D. Stent-assisted aneurysm coil embolization: safety and efficacy at a low-volume center. Neurol Res. 2011;33:942-6.

37. Izar B, Rai A, Raghuram K, Rotruck J, Carpenter J. Comparison of devices used for stent-assisted coiling of intracranial aneurysms. PLoS One. 2011;6(9):e24875.

38. Jahshan S, Abla AA, Natarajan SK, Drummond PS, Kan P, Karmon Y, et al. Results of stent-assisted vs. non-stent-assisted endovascular therapies in 489 cerebral aneurysms: Single-center experience. Neurosurgery. 2013;72:232-9.

39. Kim DJ, Suh SH, Lee JW, Kim BM, Lee JW, Huh SK, et al. Influences of stents on the outcome of coil embolized intracranial aneurysms: comparison between a stent-remodeled and non-remodeled treatment. Acta Neurochir (Wien). 2010;152:423-9.

40. Kung DK, Policeni BA, Capuano AW, Rossen JD, Jabbour PM, Torner JC, et al. Risk of ventriculostomy-related hemorrhage in patients with acutely ruptured aneurysms treated using stent-assisted coiling. J Neurosurg. 2011;114(4):1021-7.

41. Ogilvy CS, Natarajan SK, Jahshan S, Karmon Y, Yang X, Snyder KV, et al. Stent assisted coiling of paraclinoid aneurysms: risks and effectiveness. J Neurointerv Surg. 2011;3:14-20.

42. Shapiro M, Becske T, Sahlein D, Babb J, Nelson PK. Stent-supported aneurysm coiling: a literature survey of treatment and follow-up. AJNR Am J Neuroradiol. 2012;33:159-63.

43. Reavey-Cantwell JF, Fox WC, Reichwage BD, Fautheree GL, Velat GJ, Whiting JH, et al. Factors associated with aspirin resistance in patients premedicated with aspirin and clopidogrel for endovascular neurosurgery. Neurosurgery. 2009;64:890-5.

44. Hong Y, Wang YJ, Deng Z, Wu Q, Zhang JM. Stent-assisted coiling versus coiling in treatment of intracranial aneurysm: a systematic review and meta-analysis. PLoS One. 2014;9(1):e82311.

45. Bodily KD, Cloft HJ, Lanzino G, Fiorella DJ, White PM, Kallmes DF. Stent-assisted coiling in acutely ruptured intracranial aneurysms: a qualitative, systematic review of the literature. AJNR Am J Neuroradiol. 2011;32:1232-6.

46. Lanzino G, Kanaan Y, Perrini P, Dayoub H, Fraser K. Emerging concepts in the treatment of intracranial aneurysms: Stents, coated coils, and liquid embolic agents. Neurosurgery. 2005;57:449-59.

47. Lanzino G, Wakhloo AK, Fessler RD, Hartney ML, Guterman LR, Hopkins LN. Efficacy and current limitations of intravascular stents for intracranial internal carotid, vertebral, and basilar artery aneurysms. J Neurosurg. 1999;91(4):538-46.

48. Wakhloo AK, Lanzino G, Lieber BB, Hopkins LN. Stents for intracranial aneurysms: the beginning of a new endovascular era? Neurosurgery. 1998;43(2):377-9.

49. Wakhloo AS, Shellhammer F, de Vries J, Schumacher J. Coated and non-coated stents for vessel reconstruction and treatment of aneurysms and AV fistulas: An experimental study. XVIII Congress of the European Society of Neuroradiology. Stockholm, Sweden. 1992;8-11:S24.

50. Brinjikji W, Murad MH, Lanzino G, Cloft HJ, Kallmes DF. Endovascular treatment of intracranial aneurysms with flow diverters: a meta-analysis. Stroke. 2013;44(2):442-7.

51. Raymond J, Sauvageau E, Salazkin I, Ribourtout E, Gevry G, Desfaits AC. Role of the endothelial lining in persistence of residual lesions and growth of recurrences after endovascular treatment of experimental aneurysms. Stroke. 2002;33(3):850-5.

52. Raymond J, Guilbert F, Metcalfe A, Gévry G, Salazkin I, Robledo O. Role of the endothelial lining in recurrences after coil embolization: prevention of recanalization by endothelial denudation. Stroke. 2004;35(6):1471-5.

53. Raymond J. Methods and devices for endothelial denudation to prevent recanalization after embolization. United States patent US 20050085836. 2005 Apr 21.