Case Report

Spontaneous regression of an intracranial aneurysm after carotid endarterectomy

Yiping Li, Troy D. Payner, Aaron A. Cohen-Gadol

Goodman Campbell Brain and Spine, Indiana University Department of Neurological Surgery Indianapolis, Indiana, USA

E-mail: Yiping Li - liyip@iupui.edu; Troy D. Payner - tpayner@goodmancampbell.com; *Aaron A. Cohen-Gadol - acohenmd@gmail.com

*Corresponding author

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Abstract

Background: Recent studies have hypothesized that hemodynamic changes in parent vessels are responsible for the formation and regression of cerebral aneurysms. One author has described regression of a “flow-related” 4-mm posterior communicating artery (PCoA) aneurysm following ipsilateral carotid endarterectomy (CEA), resulting in reversal of blood flow in the PCoA.

Case Description: We report a 68-year-old woman with a coincidental intracranial aneurysm (ICA) and contralateral internal carotid artery stenosis. The aneurysm spontaneously regressed subsequent to contralateral ICA endarterectomy as documented by repeat computed tomographic angiography. This report also demonstrates the first known case of an ICA in the anterior cerebral artery territory to undergo spontaneous regression.

Conclusions: We conclude that the regression and potentially the formation of this aneurysm correlated with hemodynamic factors associated with stenosis of the contralateral ICA.

Key Words: Carotid artery, endarterectomy, intracranial aneurysm, regression

INTRODUCTION

Cerebral aneurysms arise from focal areas of high flow that lead to damage and destructive remodeling along the arterial wall. Disorders associated with formation of an aneurysm include congenital defects, high blood pressure, atherosclerosis, and less commonly, toxins, infections, medications, or head trauma; however, development of an intracranial aneurysm (ICA) from stenosis of the internal carotid artery is rare.[21]

The frequency of concurrent extracranial ICA stenosis and an unruptured cerebral artery aneurysm is not known exactly, but has been estimated to be approximately 3%. [3,11,14,21] Optimal management, including the timing of intervention for the patients with extracranial ICA stenosis with concurrent ICAs, has been debated. Three surgical options are considered: carotid endarterectomy (CEA) only, aneurysm clip ligation or endovascular intervention only, or both.

The presence of a small ICA is not an additional risk factor for CEA.[14,15,28] Some argue that perioperative fluctuations in blood pressure (despite concerted efforts to control blood pressure during operation) and use of anticoagulants during CEA may potentiate focal areas of high blood flow in the cerebral vasculature, thus increasing the risk of aneurysm rupture. [6,24,29] Recent studies have hypothesized that hemodynamic
changes in parent vessels are responsible for the formation and regression of cerebral aneurysms.\textsuperscript{[2,3,6,12]} Senn \textit{et al.}\textsuperscript{[20]} described regression of a “flow-related” 4-mm posterior communicating artery (PCoA) aneurysm following ipsilateral CEA, resulting in reversal of blood flow in the PCoA.

We report a patient with a coincidental 8-mm ICA and contralateral significant ICA stenosis. The aneurysm spontaneously regressed subsequent to contralateral CEA. The clinical implications and potential mechanisms underlying this aneurysm’s formation and regression will be discussed.

CASE REPORT

A 68-year-old woman presented with left foot numbness and underwent magnetic resonance (MR) imaging which demonstrated a small area of subacute infarction within the right medial frontal lobe. Computed tomography (CT) angiography revealed severe stenosis along the origin of the extracranial right ICA and a concomitant left anterior communicating artery (ACoA) aneurysm measuring approximately 8 mm. Her left ICA did not harbor any stenosis [Figure 1].

The right ICA stenosis was deemed symptomatic, and CEA was performed uneventfully prior to considering any treatment for the aneurysm.

A repeat CT angiography to assess the state of the 8-mm incidental aneurysm 14 months later surprisingly revealed an almost complete regression of the aneurysm [Figure 2]. No residual stenosis along the contralateral ICA was noted. No further intervention except surveillance imaging for the regressed aneurysm was contemplated.

DISCUSSION

The patients who harbor vascular anomalies contributing to altered intracranial hemodynamic flow, such as in the case of arteriovenous malformations (AVMs), exhibit increased propensity to present with concomitant ICAs.\textsuperscript{[10,16,17,30]} Aneurysms presenting with affiliated AVMs have been classified as remote, distal, or proximal intracerebral anomalies.\textsuperscript{[10,16,17]} Intracerebral aneurysms are usually flow related and are more susceptible to be affected by the resection or embolization of AVMs.\textsuperscript{[10,16,17,30]} The spontaneous regression of flow-related aneurysms secondary to resection or embolization of AVMs has been reported in the literature, while aneurysms remote from the AVM have conversely been reported to enlarge.\textsuperscript{[10,16,17]} These reports suggest aneurysms form as a result of high hemodynamic flow patterns within the AVM and subsequently regress when the flow patterns are altered postoperatively. Redirection of hemodynamic blood flow to remote aneurysms may cause enlargement or even facilitate rupture.\textsuperscript{[10,16,17]}

It is important to understand the hemodynamic relationship between vascular anomalies and their contributions to blood flow redirection. Pipeline stents are a form of flow-diverting stents currently being studied for the treatment of ICAs.\textsuperscript{[7,31,32]} These modalities act to reduce blood flow within aneurysmal sacs, gradually resulting in their regression or thrombosis.\textsuperscript{[7,31,32]} Treatment of AVMs and carotid stenosis may have similar theoretical effects on diverting hemodynamic flow. These factors must be considered in preoperative planning for patients presenting with aneurysms and concomitant flow-altering vascular anomalies.

Optimal management strategies, including the timing and method of intervention for ICA stenosis associated
with concurrent ICA(s), remain unknown. Pappada et al. proposed clip ligation of ipsilateral anterior circulation aneurysms greater than 5 mm prior to CEA. This approach has been justified by aneurysmal ruptures reported as a result of CEA. Opponents of this treatment methodology have advocated CEA prior to aneurysm treatment, as coincidental aneurysms do not appear to enlarge after endarterectomy. Long-term follow-up studies are not available for either approach.

The authors believe that the risk of aneurysm rupture (especially contralateral to the ICA stenosis) is small following CEA as they do not appear to enlarge after endarterectomy, and by performing a CEA, there would be a reduction of flow toward the contralateral aneurysm. We hypothesize that the ACoA aneurysm in their patient may have initially developed secondary to increased flow through the now-dominant left A1 caused by the gradually stenosed right ICA. By increasing the patency and flow of the right ICA via CEA, a redirection of hemodynamic flow ensued and resulted in reduced flow through the left A1. Balancing blood flow through bilateral A1s and potentially relative reduction of flow through the left A1 led to regression of this “flow-related” aneurysm within 14 months after surgery. Based on the CREST (The Randomized Carotid Revascularization Endarterectomy vs. Stenting Trial) study, there is no conclusive superiority between carotid stenting and endarterectomy. The authors therefore elected to proceed with an endarterectomy after discussion of the treatment options with the patient.

Spontaneous regression of an ICA is unusual; only a few such cases have been reported. The regression is most likely secondary to hemodynamic changes within the blood flow in the parent vessel and the aneurysm sac. Evidence suggests that the hemodynamic changes secondary to stenosis of feeding arteries may lead to compensatory changes in the blood flow through anastomotic vessels. The increase in blood flow and change in velocity through these smaller vessels can increase the pressure on the arterial wall, facilitate weakening, promote remodeling, and result in the gradual formation of an aneurysm. After resolution of the feeding vessel stenosis, hemodynamic flow through the aneurysm wall will change yet again. Similarly, regression of aneurysms on the “feeding arteries” secondary to obliteration of concomitant AVMs has been documented in the literature. The disappearance of hemodynamic imbalance following exclusion of an AVM has been postulated to explain the resolution of the aneurysm similar to those mechanisms after amelioration of the ICA stenosis. Thrombosis of aneurysms related to hemodynamic changes following cerebral revascularization has also been reported.

The above case report underscores the importance of careful follow-up among patients who harbor a cerebral aneurysm and who undergo CEA. If the endarterectomy leads to a more balanced flow through the feeding vessels to the cerebral aneurysm, a less aggressive treatment option for the aneurysm may be considered with an appropriate follow-up (1–2 years) to see if any flow-related changes in the aneurysm have occurred.

It is also important to discuss the reason for CT angiography in this patient. Digital subtraction angiography (DSA) has benefits for the diagnosis of intracranial anomalies, including dynamic visualization of collateral blood flow within vessels located in dense or bony locations. The authors elected to perform a CT angiography for preoperative diagnosis and postoperative follow-up. DSA was not performed because of the slightly increased risk associated with DSA; moreover, CT angiography has been reported to have comparable diagnostic utility for the visualization of intracranial lesions.

CONCLUSIONS

When managing patients with coexisting ICA and ICA stenosis, hemodynamic patterns should be considered as part of the decision-making process. Flow-related aneurysms may regress after reversal and restoration of blood flow in the proximal arteries.

REFERENCES

1. Adams HP Jr. Carotid stenosis and coexisting ipsilateral intracranial aneurysm. A problem in management. Arch Neurol 1977;34:515-6.
2. Andrews BT, Edwards MS, Gannon P. Acutely thrombosed aneurysm of the middle cerebral artery presenting as intracranial hemorrhage in a 3-year-old child. Case report. J Neurosurg 1984;60:1303-7.
3. Ballotta E, Da Giau G, Manara R, Baracchini C. Extracranial severe carotid stenosis and incidental intracranial aneurysms. Ann Vasc Surg 2000;14:5-8.
4. Benedetti A, Curri C, Colombo F. Rebleeding of an angiographically healed aneurysm. Surg Neurol 1983;20:206-8.
5. Brott TG, Hobson RW 2nd, Howard G, Roubin GS, Clark WM, Brooks W, et al. Stenting versus endarterectomy for treatment of carotid-artery stenosis. N Engl J Med 2010;363:11-23.
6. Cantore G, Santoro A, Da Pian R. Spontaneous occlusion of supraclinoid aneurysms after the creation of extra-intracranial bypasses using long grafts: Report of two cases. Neurosurgery 1999;44:216-9; discussion 219-20.
7. Chan TT, Chan KY, Pang PK, Kwok JC. Pipeline embolisation device for wide-necked internal carotid artery aneurysms in a hospital in Hong Kong: Preliminary experience. Hong Kong Med J 2011;17:398-404.
8. Chang HS, Kim JS. Quantification of operative benefit for unruptured cerebral aneurysms: A theoretical approach. J Neurosurg 1995;83:413-20.
9. Gallego Leon JJ, Concepcion Aramendia L, Ballenilla Marco F, Vázquez Suarez JC. Concomitant endovascular treatment of concomitant extracranial carotid stenosis and intracranial aneurysm. Our experience. Interv Neuroradiol 2009;15:53-9.
10. Halim AX, Singh V, Johnston SC, Higashida RT, Dowd CF, Halbach VV, et al. Characteristics of brain arteriovenous malformations with coexisting aneurysms: A comparison of two referral centers. Stroke 2002;33:675-9.
11. Haque R, Kellner C, Solomon RA. Spontaneous thrombosis of a giant fusiform aneurysm following extracranial-intracranial bypass surgery. J Neurosurg 2009;110:469-74.
12. Housepian EM, Pool JL. A systematic analysis of intracranial aneurysms from the autopsy file of the Presbyterian Hospital, 1914 to 1956. J Neuropathol Exp Neurol 1958;17:409-23.

13. Kann BR, Matsumoto T, Kerstein MD. Safety of carotid endarterectomy associated with small intracranial aneurysms. South Med J 1997;90:1213-6.

14. Kappelle LJ, Eliaziw M, Fox AJ, Barnett HJ. Small, unruptured intracranial aneurysms and management of symptomatic carotid artery stenosis. North American Symptomatic Carotid Endarterectomy Trial Group. Neurology 2000;55:307-9.

15. Khanna RK, Malik GM, Qureshi N. Predicting outcome following surgical treatment of unruptured intracranial aneurysms: A proposed grading system. J Neurosurg 1996;84:49-54.

16. Kondziolka D, Nixon BJ, Lasjaunias P, Tucker WS, TerBrugge K, Spiegel SM. Cerebral arteriovenous malformations with associated arterial aneurysms: Hemodynamic and therapeutic considerations. Can J Neurol Sci 1988;15:130-4.

17. Lasjaunias P, Piske R, Terbrugge K, Willinsky R. Cerebral arteriovenous malformations (C.AVM) and associated arterial aneurysms (AA). Analysis of 101 C.AVM cases, with 37 AA in 23 patients. Acta Neurochir (Wien) 1988;91:29-36.

18. Lu L, Zhang LJ, Poon CS, Wu SY, Zhou CS, Luo S, et al. Digital subtraction CT angiography for detection of intracranial aneurysms: Comparison with three-dimensional digital subtraction angiography. Radiology 2012;262:605-12.

19. Lv X, Li Y, Yang X, Jiang C, Wu Z. Characteristics of arteriovenous malformations associated with cerebral aneurysms. World Neurosurg 2011;76:288-91.

20. Navaneethan SD, Kannan VS, Osowo A, Shrivastava R, Singh S. Concomitant intracranial aneurysm and carotid artery stenosis: A therapeutic dilemma. South Med J 2006;99:757-8.

21. Pappada G, Fiori L, Marina R, Citerio G, Vaiani S, Gaini SM. Incidence of asymptomatic berry aneurysms among patients undergoing carotid endarterectomy. J Neurol Neurosurg Psychiatry 1997;61:257-62.

22. Pappada G, Fiori L, Marina R, Vaiani S, Gaini SM. Management of symptomatic carotid stenoses with coincidental intracranial aneurysms. Acta Neurochir (Wien) 1996;138:1386-90.

23. Redekop G, TerBrugge K, Montanera W, Willinsky R. Arterial aneurysms associated with cerebral arteriovenous malformations: Classification, incidence, and risk of hemorrhage. J Neurol 1998;245:539-46.

24. Riphagen JH, Bernsen HJ. Rupture of an intracerebral aneurysm after carotid endarterectomy: A case report. Acta Neurol Belg 2009;109:314-6.

25. Sekhar LN, Sclabassi RJ, Sun M, Blue HB, Wasserman JF. Intra-aneurysmal pressure measurements in experimental saccular aneurysms in dogs. Stroke 1988;19:352-6.

26. Senn P, Krauss J, Remonda L, Godoy N, Schroth G. The formation and regression of a flow-related cerebral artery aneurysm. Clin Neurol Neurosurg 2000;102:168-72.

27. Shoumaker RD, Avant WS, Cohen GH. Coincidental multiple asymptomatic intracranial aneurysms and symptomatic carotid stenosis. Stroke 1976;7:504-6.

28. Stern JW, Whelan M, Brisman R, Correll JW. Management of extracranial carotid stenosis and intracranial aneurysms. J Neurosurg 1979;51:147-50.

29. Suh BY, Yun WS, Kwun WH. Carotid artery revascularization in patients with concomitant carotid artery stenosis and asymptomatic unruptured intracranial artery aneurysms. Ann Vasc Surg 2011;25:651-5.

30. Sun Y, Li AM, Li YX, Chen J, Shi H, Jiang YH, et al. Statistical study on correlation between cerebral arteriovenous malformation and hemodynamic aneurysms. Zhonghua Wai Ke Za Zhi 2010;48:1726-30.

31. Wong GK, Kwan MC, Ng RY, Yu SC, Poon WS. Flow diverters for treatment of intracranial aneurysms: Current status and ongoing clinical trials. J Clin Neurosci 2011;18:737-40.

32. Yeung TW, Lai V, Lau HY, Poon WL, Tan CB, Wong YC. Long-term outcome of endovascular reconstruction with the Pipeline embolization device in the management of unruptured dissecting aneurysms of the intracranial vertebral artery. J Neurosurg 2012;116:882-7.

33. Zhang LJ, Wu SY, Niu JB, Zhang ZL, Wang HZ, Zhao YE, et al. Dual-energy CT angiography in the evaluation of intracranial aneurysms: Image quality, radiation dose, and comparison with 3D rotational digital subtraction angiography. AJR Am J Roentgenol 2010;194:23-30.