Surgical Neurology International

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Case Report

Spontaneous regression of an intracranial aneurysm after carotid endarterectomy

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Received: 04 April 12 Accepted: 05 April 12 Published: 19 June 12

This article may be cited as:
Li Y, Payner TD, Cohen-Gadol AA. Spontaneous regression of an intracranial aneurysm after carotid endarterectomy. Surg Neurol Int 2012;3:66.

Available FREE in open access from: http://www.surgicalneurologyint.com/text.asp?2012/3/1/66/97168

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

Access this article online

Website: www.surgicalneurologyint.com

DOI: 10.4103/2152-7806.97168

Quick Response Code:

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%.[3,9,11,14,21] 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.[2,3,6,12] Senn *et al*.[26] 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.[10,16,17,19,30] Aneurysms presenting with affiliated AVMs have been classified as remote, distal, or proximal intralesional anomalies.[10,16,17] Intralesional aneurysms are usually flow related and are more susceptible to be affected by the resection or embolization of AVMs.[10,16,17,19,30] 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.[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.[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.[7,31,32] These modalities act to reduce blood flow within aneurysmal sacs, gradually resulting in their regression or thrombosis.[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

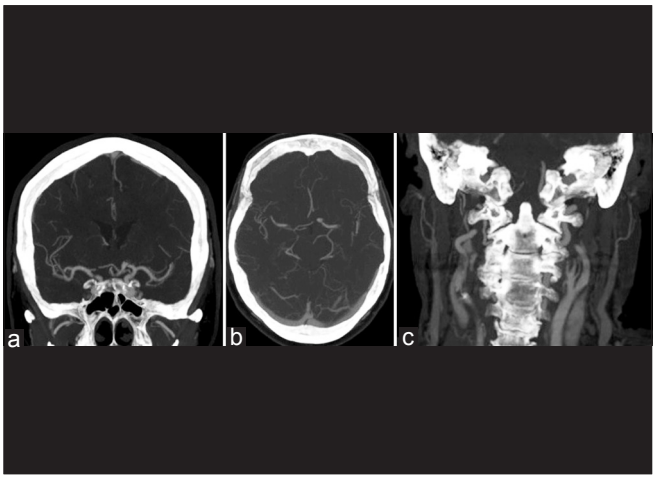

Figure 1: Axial (a) and coronal (b) CT angiogram images reveal an approximately 8-mm aneurysm along the junction of the left A1 and ACoA. Significant stenosis of the extracranial ICA at its origin is also noted (c)

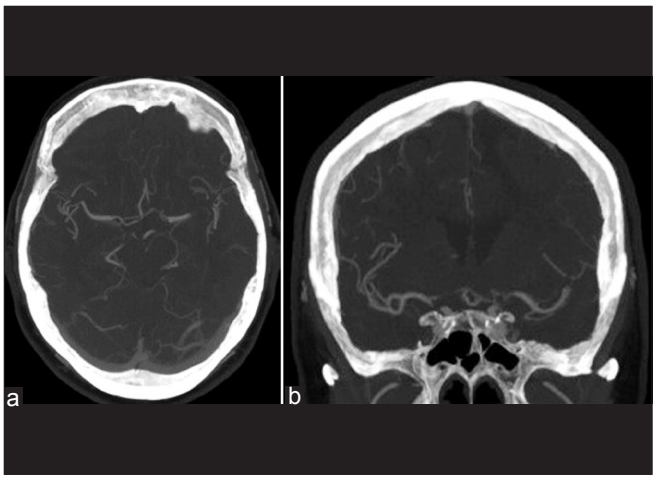

Figure 2: Axial (a) and coronal (b) CT angiogram images 14 months following a right-sided carotid endarterectomy disclose spontaneous regression/thrombosis of the aneurysm

with concurrent ICA(s), remain unknown. Pappada *et al*.[21] 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.[20,24] 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.[1,8,9,13,22,23,27]

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.[1,8,9,13,23,27] 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,[5] 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.[6,26,29] 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.[21,25,26] 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.[3,4,28] 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.[23,26] Thrombosis of aneurysms related to hemodynamic changes following cerebral revascularization has also been reported.[6,11]

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 blow 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.[18,33]

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.

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