

Endovascular Stent Repair of a Carotid Artery Pseudoaneurysm

A minimally invasive method using a covered stent to re-treat a pseudoaneurysm in an effort to avoid the technical difficulties associated with traditional open surgical repair.

BY PAYAM JARRAHNEJAD, MD; SAMIR GADEPALLI, MD; NIRMAN TULSYAN, MD;
MARLENE D. VALENTIN, MD; AND KEVIN JAMES, MD

Carotid pseudoaneurysm formation complicates 0.3% of all carotid endarterectomies.¹ Mechanisms include suture failure, degeneration of the arterial wall and/or patch material, trauma, and/or infection. Intra-aneurysmal turbulent flow promotes clot formation and dislodgment, with subsequent intracerebral embolization. Without treatment, pseudoaneurysms pose a long-term risk of embolization or flow-related complications. Conventional repair is effective but can be technically challenging due to pseudoaneurysm location or size. Endovascular repair for injuries of the extracranial carotid artery system is not only less invasive but can potentially be the only feasible option. The high position of many of these lesions often makes traditional open repair technically difficult.¹⁻⁴ The authors present a case of endovascu-

lar repair of an internal carotid artery pseudoaneurysm after internal carotid artery stenting for recurrent stenosis, using the Wallgraft endoprosthesis (Boston Scientific Corporation, Natick, MA).

CASE REPORT

A 79-year-old man underwent a left carotid endarterectomy for symptomatic stenosis in 2001. One year later, follow-up duplex for surveillance revealed the presence of a recurrent high-grade left internal carotid stenosis, which was managed by angioplasty and stenting. The patient presented to our institution 1 year after stent placement with complaints of a new left-side neck mass. The neck mass developed over a 6-day period and was associated with a persistent headache. His medical history was significant for polycythemia vera, peripheral

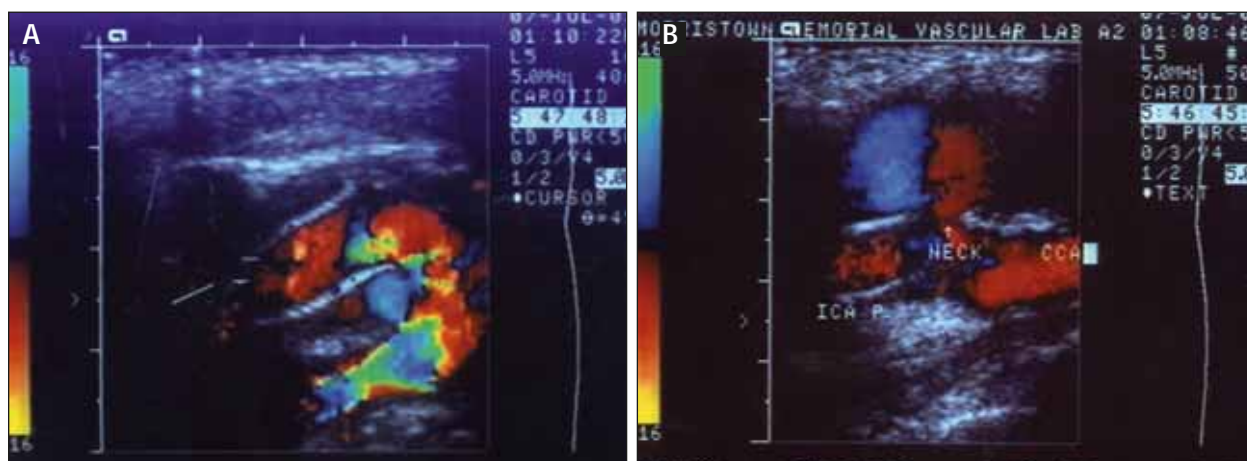


Figure 1. Carotid duplex reveals a 5-cm, left internal carotid artery pseudoaneurysm (A), with a narrow neck and active bidirectional flow (B). The neck is at the proximal extent of the pre-existing stent.



Figure 2. The arch aortogram demonstrates the pseudoaneurysm at the proximal edge of the previous carotid stent.

vascular disease, atrial fibrillation, hypertension, and a previous nondisabling left cerebrovascular accident. His surgical history was notable for multiple lower-extremity revascularizations. The patient's medication included warfarin, digoxin, clopidogrel, and diltiazem.

Physical examination revealed that the patient was in a rate-controlled atrial fibrillation with a blood pressure of 135/80 mm Hg. Pertinent findings included a 4-cm, tender, pulsatile mass on the left side of the neck at the level of the hyoid bone immediately anterior to the sternocleidomastoid. An audible bruit and palpable thrill was appreciated over the lesion. The results of neurologic examination and contralateral carotid vascular examinations were within normal limits. A CT scan of the head was significant for minimal periventricular white matter disease as well as mild ventricular and sulcal prominence appropriate for the patient's age. Carotid duplex examination revealed a 5-cm, left internal carotid artery pseudoaneurysm, with a narrow neck and active bidirectional flow. The neck was at the proximal extent of the pre-existing stent (Figure 1).

Given the large size and high location of the pseudoaneurysm, an endovascular approach was chosen. The procedure was performed with local anesthesia and intravenous sedation. A radial arterial line was placed prior to the procedure for accurate blood pressure monitoring. The right common femoral artery was accessed using the Seldinger technique. A hydrophilic guidewire was advanced into the aortic arch. An arch aortogram was obtained through a pigtail catheter, demonstrating the pseudoaneurysm at the proximal edge of the previous carotid stent (Figure 2).

Heparin (5,000 units) was administered intravenously. A Wallgraft endoprosthesis measuring 12 mm in diameter X 30 mm in length was advanced over the guidewire

into the internal carotid artery. Distal portions of the Wallgraft and previous stent were aligned within the internal carotid artery. A second Wallgraft of identical dimensions was then deployed within the first Wallgraft, with 2 cm of overlap. Angiography performed after deployment demonstrated an endoleak filling the pseudoaneurysm. Therefore, a 6-mm-diameter angioplasty catheter was advanced over the guidewire and inflated to 8 atm at the distal internal carotid artery. A second angioplasty was performed, with a 10-mm-diameter balloon within the larger portion of the stent until the Wallgrafts were properly apposed. Completion angiography demonstrated no endoleak, as well as a widely patent internal carotid artery (Figure 3). The patient's hemodynamic and neurological status remained appropriate and stable throughout the procedure.

Postoperatively, the patient was again placed on antiplatelet therapy. Immediate postoperative carotid duplex showed a thrombosed pseudoaneurysm with no evidence of flow within the aneurysm sac (Figure 4). The patient was discharged to rehabilitation 3 days after the procedure.

The patient was readmitted 4 days later with symptoms consistent with amaurosis fugax and left hemispheric transient ischemic attacks. An angiogram revealed a near-complete stenosis of his recently stented left carotid artery (Figure 5). He was taken emergently to the operating room. A carotid artery bypass procedure was performed using a prosthetic PTFE graft with removal of his previous stents. Postoperatively, he was extubated and breathing on his own, but had sustained a major ipsilateral stroke with dense hemiplegia. He was transferred to the intensive care unit and required ventilator support for 3 days. After a lengthy family discussion, he was placed on comfort measures and terminally weaned.

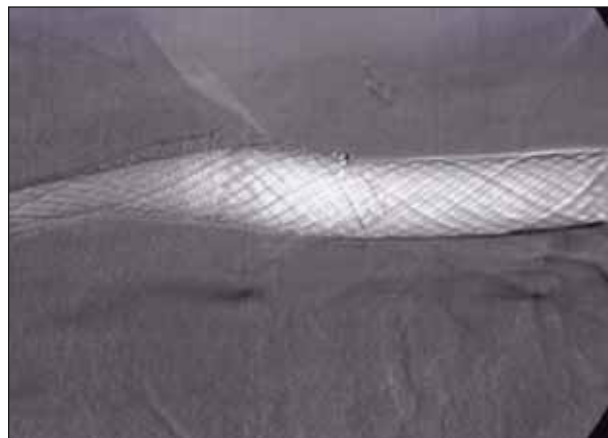


Figure 3. Completion angiogram demonstrates no endoleak, as well as a widely patent internal carotid artery.

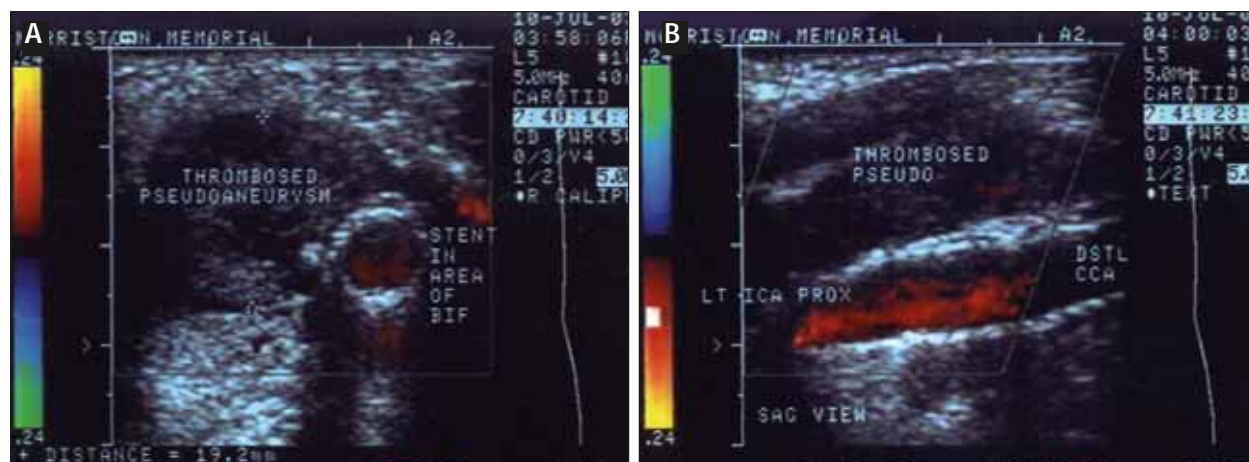


Figure 4. Immediate postoperative carotid duplex shows a thrombosed pseudoaneurysm with no evidence of flow within the aneurysm sac. Cross-sectional (A) and longitudinal (B) views.

DISCUSSION

Pseudoaneurysm of the extracranial carotid arteries is rare after endarterectomy. In 1986, Branch and Davis¹ described that only 57 individual cases were reported at the time (0.3%). No statistically verifiable difference was found for the incidence of these false aneurysms between cases closed primarily and those with patch graft closure. Presentation is associated with a painful, pulsatile mass in the region appearing anywhere between 2 weeks to 15 years later. Our patient developed the aneurysm a year after stenting of the internal carotid artery due to restenosis after endarterectomy.

The most common etiology for all extracranial aneurysms is infection. Pseudoaneurysms develop more commonly after patch angioplasty versus primary repair, particularly with the use of Dacron.^{5,6} However, in this case, the most likely cause was thought to be degeneration of the arterial wall causing the pseudoaneurysm. We suspect that recurrent arterial trauma from the patient's original stent led to the development of the pseudoaneurysm. Review of the original stent placement performed for restenosis suggests that the edge of the stent was only partially opposed at its proximal portion. This would allow for motion during each cardiac cycle and the possibility of erosion with recurrent injury.

Complications from such aneurysms include neurological symptoms by thrombosis, rupture, embolization, or compression of nearby cranial nerves.³ Evaluation of the patient must ascertain whether he or she is a candidate for carotid stent grafting. Morphologic assessment of the lesion by color flow duplex scanning, CT angiography, and/or digital subtraction angiography should also be included as part of the evaluation. These studies are

important in selecting the appropriate device and quantifying the potential risk of embolic complications.⁹ This patient was shown to have a pseudoaneurysm by duplex imaging, and an intraoperative angiogram was performed to define the location of the lesion. A follow-up angiogram and duplex were performed after pseudoaneurysm repair. The role of postoperative duplex scanning is to confirm the internal carotid artery patency and pseudoaneurysm thrombosis.

The potential etiology of this patient's postprocedure thromboembolic event is unclear and includes flow irregularities either within the stent or at its edges. Reinspection of the completion angiogram demonstrates small flow irregularities within the stent, but follow-up angiography at readmission suggests the distal stent–stent interface as the source of the thromboemboli and, therefore, no clear conclusion can be drawn. Moreover, the distal stent–internal carotid artery interface may also be a potential source.

The cause of the distal covered stent irregularity was also unclear. At the time of covered stent implantation, final deployment positioning was technically difficult, and maneuvering may have contributed to flow abnormality at the distal endpoint. However, the completion angiogram after covered stent deployment suggested possible flow irregularity at the distal endpoint. Duplex ultrasound, however, did not demonstrate flow disturbance, therefore no further intervention was proposed until the patient returned with new neurological symptoms.

The traditional treatment of choice for carotid pseudoaneurysm has been operative repair. In 1805, Cooper performed arterial ligation as repair for pseudoaneurysm. However, the patient later developed hemiplegia and



Figure 5. Angiogram reveals a near-complete stenosis of the recently stented left carotid artery.

died.³ The morbidity and mortality rate for ligation has not improved significantly, with studies citing between 30% and 60% neurological deficit rate and 50% mortality.^{1,3} Operative repair represents a significant technical challenge due to reoperative neck inflammation and potential cranial nerve injuries.⁸ Furthermore, most defects are distal, making them difficult to reach without subluxation of the mandible, requiring nasotracheal intubation, and thus further increasing morbidity and mortality.

The Wallgraft used is usually selected because of its self-expanding nature (ie, requiring no *in situ* balloon dilatation), thereby theoretically decreasing the amount of manipulation on an already damaged vessel. In this case, however, the pseudoaneurysm had persistent flow, despite stent deployment. Therefore, a balloon was inflated to increase stent–stent and stent–wall apposition.^{4,9}

Alternative procedures to repair the aneurysm include endoaneurysmorrhaphy with either polytetrafluoroethylene or vein graft. To enhance surgical exposure of distal internal carotid artery, nasotracheal intubation with or without mandibular subluxation can be used.¹⁰ Longer follow-up is needed in this patient to determine long-term patency of the graft and stenting procedure.⁷

CONCLUSION

This case represents many of the common problems encountered when presented with a patient with a pseudoaneurysm. We described a minimally invasive method using a covered stent to re-treat the pseudoaneurysm in an effort to avoid the technical difficulties associated with traditional open surgical repair. This approach, however, yielded its own unique set of challenges. Difficulty in placing the stent may have contributed to the development of a flow irregularity that was not initially detected despite completion angiogram

and duplex surveillance. Open surgical repair was ultimately required but the patient suffered a major ipsilateral stroke at the time of repair. This report serves as a reminder that the use of minimally invasive approaches carries its own unique set of complications and challenges, which may not initially be obvious at the time of the procedure. ■

Payam Jarrahnajad, MD, is from the Department of Surgery, Morristown Memorial Hospital, Morristown, New Jersey. He has disclosed that he has no financial interest in any product or manufacturer mentioned herein. Dr. Jarrahnajad may be reached at (973) 971-5684; payamjarrahnajad@yahoo.com.

Samir Gadepalli, MD, is from the Department of Surgery, Morristown Memorial Hospital, Morristown, New Jersey. He has disclosed that he has no financial interest in any product or manufacturer mentioned herein. Dr. Gadepalli may be reached at (973) 971-5684; samir.gadepalli@ahsys.org.

Nirman Tulsyan, MD, is from the Department of Vascular Surgery, Cleveland Clinic Foundation, Cleveland, Ohio. He has disclosed that he has no financial interest in any product or manufacturer mentioned herein. Dr. Tulsyan may be reached at (216) 444-3857; nirmantulsyan@yahoo.com.

Marlene D. Valentin, MD, is from the Department of Vascular Surgery, Good Samaritan Hospital, Cincinnati, Ohio. She has disclosed that she has no financial interest in any product or manufacturer mentioned herein. Dr. Valentin may be reached at (513) 872-2785; valentinmd@hotmail.com.

Kevin James, MD, is from the Department of Surgery, Morristown Memorial Hospital, Morristown, New Jersey. He has disclosed that he has no financial interest in any product or manufacturer mentioned herein. Dr. James may be reached at (973) 540-9700; kvjmd@msn.com.

1. Branch CL, Davis CH Jr. False aneurysm complicating carotid endarterectomy. *Neurosurgery*. 1986;19:421-425.
2. Duke BJ, Ryu RK, Coldwell DM, et al. Treatment of blunt injury to the carotid artery by using endovascular stents. *J Neurosurg*. 1997;87:825-829.
3. Pretre R, Kursteiner K, Reverdin A, et al. Blunt carotid artery injury: devastating consequences of undetected pseudoaneurysm. *J Trauma*. 1995;39:1012-1014.
4. Simonato F, Righi C, Mellissano G, et al. Stent-graft treatment of a common carotid artery pseudoaneurysm. *J Endovasc Ther*. 2000;7:136-140.
5. El-Sabroun R, Reul G, Cooley DA. Extracranial carotid artery aneurysms: Texas Heart Institute experience. *Ann Vasc Surg*. 2000;14:239-247.
6. Borazjani BH, Wilson SE, Fujitani RM, et al. Postoperative complications of carotid patching: pseudoaneurysm and infection. *Ann Vasc Surg*. 2000;17:156-161.
7. Bush RL, Lin PH, Dodson RG, et al. Endoluminal stent placement and coil embolization for the management of carotid artery pseudoaneurysms. *J Endovasc Ther*. 2001;8:53-61.
8. Terramani TT, Workman MJ, Loberman Z, et al. Adjunctive endovascular techniques in the management of postoperative carotid artery pseudoaneurysms—useful armamentarium for vascular surgeons—three case reports. *Vasc Endovasc Surg*. 2003;37:207-212.
9. Powell RJ, Rzuicidlo EM, Schermerhorn ML. Stent-graft treatment of a large internal carotid artery vein graft aneurysm. *Vasc Surg*. 2003;37:1310-1313.
10. Szopinski P, Iwanowski J, Kielar M, et al. Post-traumatic pseudoaneurysm of stenotic internal carotid artery repair by stent-graft. *Vasc Surg*. 2000;34:81-85.
11. Kubaska SM III, Greenberg RK, Clair D, et al. Internal carotid artery pseudoaneurysms: treatment with the Wallgraft prosthesis. *J Endovasc Ther*. 2003;10:182-189.