Delayed stenosis following placement of a polyethylene terephthalate endograft in the cervical carotid artery

Report of three cases

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Three patients with carotid artery (CA) pseudoaneurysms were treated using four polyethylene terephthalate endografts (Wallgraft endoprostheses). Two patients received a single graft and one patient with bilateral pseudoaneurysms received two grafts. Complete occlusion of the pseudoaneurysm with patency of the arterial lumen was achieved following endograft placement in all patients. The clinical follow-up interval ranged from 12 to 18 months and included angiography or ultrasonography studies or both. One patient experienced neurological symptoms, and in-graft stenosis ranging from 50 to 100% occurred in three of the four grafts. Although the Wallgraft endoprostheses produced good initial results for the treatment of cervical CA pseudoaneurysms, as demonstrated on radiography, it was associated with a high rate of stenosis or occlusion in all three patients.

KEY WORDS • pseudoaneurysm • carotid artery • graft • endovascular therapy

C AROTID artery aneurysms and pseudoaneurysms present difficult clinical problems. If left untreated, hemorrhage or embolus-induced neurological symptoms are possible. The placement of an endograft represents an attractive treatment alternative because it is only minimally invasive, can reach areas not easily accessible during surgery, and maintains luminal patency while correcting the abnormality. The latter factor is the most important, however, and is the key to success in treating this group of patients. We present our patency results in three patients who underwent placement of four covered stents for treatment of one or more pseudoaneurysms of the CA.

The premounted Wallgraft tracheobronchial endoprosthesis (Boston Scientific/Medi-tech, Natick, MA) is composed of polyethylene terephthalate graft material, which is bonded to a biomedical superalloy monofilament wire that is braided into a tubular mesh (Wallstent endoprosthesis; Boston Scientific/Scimed, Minneapolis, MN). The Wallgraft endoprostheses has been approved by the US Food and Drug Administration for the treatment of tracheobronchial strictures produced by malignant neoplasms or of benign strictures after all alternative therapies have been exhausted. It was used in our three patients as an “off-label” device because it was the only endograft of sufficient size available in the US at the time the patients were treated.

Case Reports

Case 1

History and Examination. This 52-year-old man had a medical history that was remarkable because 10 years earlier he had undergone bilateral CA endarterectomies for treatment of greater than 70% CA stenosis and hemispheric transient ischemic attacks referable to the left CA distribution. A repeated endarterectomy and placement of a synthetic patch was performed on the patient’s left side 4 years prior to our procedure, again for symptoms of hemispheric transient ischemic attacks. More recently, he presented to his family physician with a 6-month history of bilateral pulsatile neck masses that had continued to increase in size. Imaging evaluation undertaken at the referring medical center included angiography studies, the results of which demonstrated bilateral pseudoaneurysms extending from the CCA into the ICA bilaterally.

Operation and Postoperative Course. The patient was transferred to our facility for endovascular therapy rather than a repeated operation. He underwent anticoagulation therapy with heparin and was given a loading dose of 300
mg clopidogrel before the procedure. The patient’s right side was approached initially and the right external CA was occluded with coils to prevent possible backflow of blood into the aneurysm (Type II endoleak). The right pseudoaneurysm was then treated using an 8/70–mm Wallgraft endoprosthesis extending from the CCA to the ICA. Dilation of the device was achieved using a 5-mm balloon in the ICA and a 7-mm balloon in the CCA. The aneurysm was completely obliterated, with filling due to graft material porosity. An ultrasonography study obtained the following day demonstrated no flow in the aneurysm, with excellent flow in the graft. A small arteriovenous fistula located in the right groin area was noted on the ultrasonogram, but was not treated. The patient received 325 mg aspirin and 75 mg clopidogrel daily. The man remained neurologically intact and returned to our institution 5 months later to undergo treatment of the left side (Fig. 1 left). Following anticoagulation therapy, the pseudoaneurysm on the left side was also treated using an 8 × 70–mm Wallgraft endoprosthesis, which was dilated to 5 mm in the ICA and to 8 mm in the CCA. The left aneurysm was completely obliterated save for filling through graft material porosity (Fig. 1 center); an ultrasonography study performed the following day demonstrated excellent flow within the endograft and no flow in the aneurysm. Patency of the graft on the right side was exhibited on angiography at the time of left endograft placement, and the pseudoaneurysm was completely obliterated. The patient was maintained on a regimen of 325 mg aspirin and 75 mg clopidogrel daily. He returned to his local hospital 5 months after the left endograft placement procedure with aphasia and right-sided hemiparesis (Fig. 1 right). Carotid artery ultrasonography demonstrated complete occlusion of the left endograft with normal flow on the right side. The patient underwent treatment at his local hospital and, despite extensive rehabilitation, remains aphasic with right-sided hemiparesis 12 months following his stroke.

Case 2

History and Examination. This 72-year-old woman with a remote history of trauma to the left side of the neck was examined because she had experienced several episodes of ocular transient ischemic attacks during the past 12 months while receiving antiplatelet therapy. During the course of her evaluation, angiography studies were performed and demonstrated a left ICA aneurysm at the C1–2 level, with irregularity of the ICA indicative of a previous dissection (Fig. 2 left). Because of her symptoms and the relatively high location of the pseudoaneurysm, we decided to obliterate the lesion endovascularly.

Operation and Postoperative Course. The patient was given intravenous heparin and a 300-mg loading dose of clopidogrel. She underwent placement of a 7 × 30–mm Wallgraft endoprosthesis that could not be advanced to cover the aneurysm completely because of vessel tortuosity. Nonetheless, the endograft was inserted partially over the aneurysm. Although filling of the pseudoaneurysm after endograft insertion was minimal, the actual placement of the endograft around the artery bend resulted in a dissection of the artery above the graft site. The dissection was successfully treated using a 6 × 20–mm No. 6 French self-expanding stent (Wallstent endoprosthesis). Together the endograft and self-expanding stent completely obliterated the pseudoaneurysm. There was some vessel wall irregularity just distal to the stent, which led us to suspect intimal dissection, but it was not flow limiting and was left untreated because of the difficulties associated with placing the endoprosthesis around the bend in the ICA.
The patient tolerated the procedure well, but became transiently aphasic with right-sided hemiparesis that evening, despite continued heparin therapy. She was taken back to the interventional suite the following day where angiography demonstrated exclusion of the aneurysm and patency of the previously placed stent and graft. The area of vessel irregularity was again noted, but remained unchanged. Given the patient’s symptoms, however, a 5/31-mm self-expanding coronary stent (Magic Wallstent; Boston Scientific/Scimed) was placed over the site and a balloon was dilated to 5 mm, with excellent results demonstrated radiographically (Fig. 2 center). Anticoagulation therapy with heparin was continued for several days and the patient’s neurological status improved. The patient was discharged 6 days after the initial endograft placement procedure and was placed on a daily medication regimen of 325 mg aspirin and 75 mg clopidogrel. The patient was followed clinically, became neurologically intact, and remained asymptomatic. Follow-up angiography was performed 7 months after endograft placement and demonstrated a narrowing of 75% within the endograft, yet no significant stenosis in the Wallstents (Fig. 2 right). The patient remains asymptomatic, neurologically intact, and asymptomatic 13 months following the initial endograft placement.

**Case 3**

**History and Examination.** This 41-year-old man sustained a gunshot wound to the left side of the neck at the Zone 1–2 interface. A computerized tomography scan demonstrated jugular venous occlusion and a Zone 1 hematoma with mild tracheal deviation requiring intubation by surgical exposure. Because of suspected CA injury, angiography was performed and revealed an injury to the left CCA at the level of the thoracic outlet, with gross extravasation (Fig. 3 left). After discussing surgical options, we decided to treat the injury site with an endograft.

**Operation and Postoperative Course.** Given the patient’s associated injuries and neck hematoma, we decided not to use systemic anticoagulation therapy except for the administration of a 3000-U heparin bolus during the procedure. An 8/30-mm Wallgraft endoprosthesis was placed without difficulty and was dilated with a 6/30-mm balloon. Final angiographic images demonstrated patency of the graft with complete obliteration of the arterial injury (Fig. 3 center). The patient remained neurologically stable, was extubated after 5 days, was administered 325 mg aspirin and 75 mg clopidogrel daily, and was discharged from the hospital 7 days after endograft placement. Because of our prior problems with narrowing of the Wallgraft endoprosthesis, routine follow-up angiography studies were performed 10 months later and revealed a 50% stenosis within the endograft (Fig. 3 right). The patient remains asymptomatic and neurologically intact.

**Discussion**

Treatment of cervical CA aneurysms or pseudoaneurysms has traditionally been accomplished by either surgical repair or CA occlusion. Surgical repair can be quite difficult technically, especially if the abnormality is
in either Zone 1 or 3. Although endovascular occlusion of the CA is very effective, some patients cannot tolerate such occlusion. Other treatments have included coil placement in the aneurysm or stent insertion across the aneurysm site with or without supplemental coils. Coil placement alone is often unsatisfactory, especially if the aneurysm has a particularly wide neck or lacks a complete supporting aneurysm wall, which is essential to achieve complete coil distribution. Stent insertion across the lesion can change the flow into the aneurysm and this procedure has been reported to be successful. The placement of a stent can produce a neck of sorts to support coils already within the aneurysm, but the use of coils alone is still fraught with a lack of pseudoaneurysmal wall support for the coil pack. The most attractive means to obliterate an aneurysm from the cervical CA while preserving lumen patency is the placement of a covered stent. This procedure is of course predicated on the continued patency of the endograft. We have treated three patients, all of whom experienced narrowed or occluded endografts.

The reason for narrowing within endografts is unknown, but is most likely related to an inflammatory response to the graft material. There are three polymers that have been used as material for self-expanding peripheral endovascular grafts: polyethylene terephthalate, expanded polytetrafluoroethylene, and polyurethane. These three materials differ in thromboresistance, durability, and physical characteristics, factors that combine to determine the degree of resulting inflammation and neointimal proliferation. Inflammation has been shown to occur in Wallgraft endoprostheses that were implanted in animal arteries 1 month previously. Although the inflammation tends to abate in 5 to 6 months, it is replaced by a fibrotic neointima on the luminal surface, which produces an ingraft stenosis of up to 50%. Dolmatch, et al., found that a polyethylene terephthalate–covered Wallstent invites a much greater inflammatory response than an uncovered Wallstent in a canine model. A similar response was actually demonstrated in one of our patients, in whom narrowing occurred only within the endograft and not in the uncovered stents placed just distally.

As attractive as endograft placement is for the treatment of cervical CA aneurysms, we have only been able to find five studies in which the authors report using the Wallgraft endoprosthesis to treat CA aneurysms or pseudoaneurysms in a total of seven patients. All these patients were successfully treated, with excellent immediate results. Clinical follow up was performed in all patients but ranged from less than 1 month to 9 months, with ultrasonographic follow up in three patients at 6, 8, and 9 months. No neurological symptoms occurred in any patient. All ultrasonographic examinations demonstrated a widely patent endograft lumen and resolution of the abnormality. There were no reports of endograft narrowing. Although we cannot say with absolute certainty, perhaps our angiographic follow up provided a better anatomical definition of restenosis than that identified in studies in which only ultrasonographic follow-up imaging was performed. We obtained follow-up angiograms in three of four cases of endograft placement and follow-up angiograms and ultrasonograms in the other case, which demonstrated complete occlusion.

Each of our three cases represents a different clinical scenario. The Wallgraft endoprosthesis delivery apparatus is quite large (at least No. 9 French) and relatively stiff, factors that resulted in a CA dissection while we attempt...
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tions until further data are available. 


tuations was with the polyethylene terephthalate covering rather than with the stent itself. Certainly this is an interesting speculation regarding this case, but it involves only one patient and one data point, and therefore must be regarded as such.

Pseudoaneurysm formation at the site of a previously performed CA endarterectomy, as noted in Case 1, has been recognized for quite some time, although its incidence remains quite rare.4 It is believed to be more common in patients undergoing placement of graft material as a patch, but could in fact be an underlying difficulty in the original arterial wall or with the healing process.10 Although our patient underwent an extensive evaluation for such problems at another institution, none was found. The patient in Case 3 is the only one in whom the endograft did not extend into the ICA. He is also somewhat younger than the other two patients, remains asymptomatic, and has less in-graft stenosis. The reasons for this are unclear and long-term follow up must be undertaken.

Coil placement in the external CA on the right side in the patient in Case 1 was based on our prior experience in treating peripheral aneurysms, in particular abdominal aortic aneurysms, that may have patent branches allowing leakage of blood into the aneurysm around the graft. The purpose of coil insertion in this case was to prevent this backflow of blood into the aneurysm sac, termed a Type II endoleak. In retrospect, we believed that coil insertion was probably unnecessary and, therefore, it was not performed on the contralateral side. This was confirmed by the absence of backflow into the aneurysm on 24-hour follow-up ultrasonography studies. In light of our current finding of in-graft stenosis and occlusion, we recommend test occlusion of the ICA prior to endograft placement, if possible. That is not to say that one should not proceed even in light of a positive occlusion study, but at least one can define the expected outcome for total endograft occlusion, which unfortunately occurred in our first patient.

Although the Wallgraft endoprosthesis is currently available for off-label use in the arterial system, our initial experience with this endoprosthesis in the CA has demonstrated worrisome in-graft stenosis. Although vascular endografting of CA pseudoaneurysms by using the Wallgraft endoprosthesis remains an attractive treatment alternative, because of patency problems in our first three patients, we recommend use of this device only in emergency situations until further data are available.

Disclaimer

None of the authors has any affiliation with or financial interest in Wallgraft endoprosthesis or Boston Scientific or its subsidiaries.

References


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