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CASE REPORT

Stent-Graft Treatment of Late Stenosis of the Left Common Carotid Artery Following Thoracic Graft Placement

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Abstract We report the case of a patient with subtotal occlusion of the origin of the left common carotid artery (CCA) following thoracic graft placement. Retrograde endovascular placement of a stent-graft by minimal cervical access was undertaken to repair the occlusive lesion of the left CCA and prevent future complications of endoluminal thoracic reconstruction. The retrograde endovascular repair of CCA lesions, as other authors have already suggested, may be the treatment of choice in "high-surgical-risk" patients. In these cases where the ostium of supra-aortic trunks is compromised following thoracic aorta stent-graft migration, endoluminal placement of a stent-graft in the CCA can guarantee both maintenance of carotid flow and thoracic stent-graft fixation.

Keywords Common carotid artery · Migration · Stenosis · Stent-graft · Subtotal occlusion

Endoluminal arterial stenting of focal brachiocephalic vessel lesions has shown excellent results in previous studies [1–3]. However, the risk of atheroembolization remains a concern. In 1996, Queral and Criado demonstrated a hybrid (open and endovascular) technique to treat atherosclerotic lesions of the supra-aortic trunks (SATs) [4]. This technique consisted of surgical exposure of the common carotid artery (CCA) with distal clamping in order to prevent atheroembolization, and retrograde deployment of stents. Subsequent publications demonstrated that endoluminal stenting of the SATs using the retrograde approach has excellent functional outcome, safety, and midterm results [5, 6].

We report the case of a patient with subtotal occlusion of the origin of the left CCA following thoracic graft placement. Retrograde endovascular placement of a stent-graft by minimal cervical access was undertaken to repair the late stenosis of the left CCA and prevent future complications of endoluminal thoracic reconstruction.

Case Report

A 67-year-old man was admitted to our hospital with subtotal occlusion of the ostium of left CCA, found on a follow-up CT examination to check the previously treated thoracic aneurysm. The patient experienced no neurologic symptoms. His past medical history included arterial hypertension, hyperlipidemia, severe chronic obstructive pulmonary disease, and coronary heart disease; and his social history included cigarette smoking. Two years earlier the patient had undergone endovascular treatment of a thoracic aorta aneurysm involving the aortic arch with two Talent thoracic endoprostheses (Medtronic Vascular Santa Rosa, CA, USA). Complete occlusion of the left subclavian artery was necessary for total exclusion of the thoracic aneurysm, but due to good collateralization no symptoms followed the occlusion (Fig. 1).

On admission, neurologic examination demonstrated no focal findings. In the subsequent vascular assessment, duplex scanning demonstrated no severe narrowing of the left and right internal carotid arteries, while retrograde flow was noticed to the left vertebral artery. A cerebral CT scan

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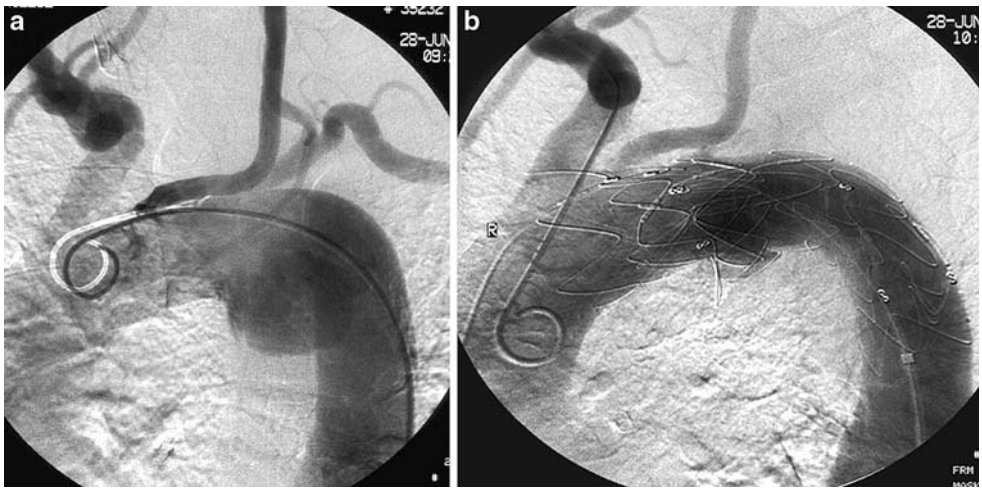

Fig. 1 **A** Thoracic aorta aneurysm involving the aortic arch. **B** Exclusion of the thoracic aneurysm with two Talent thoracic endoprostheses. There is complete occlusion of the left subclavian artery, and good visualization of the left CCA

revealed no significant findings. A diagnostic arch aortogram demonstrated subtotal occlusion of the origin of the left CCA. There was no evidence of endoleak (Fig. 2). Collateral flow was checked angiographically. We documented a well-developed circle of Willis and delayed arrival of contrast material, filling the left internal carotid artery and its branches in the head, compared with the right side. A right carotid angiogram (head view), contralateral to the left subtotal occlusion, recognized collaterals by the contrast filling of the anterior communicating artery, with dilution, to the anterior cerebral artery (small collateral supply).

A decision was made to proceed to endovascular treatment of the left CCA stenosis. Optimal antiplatelet therapy

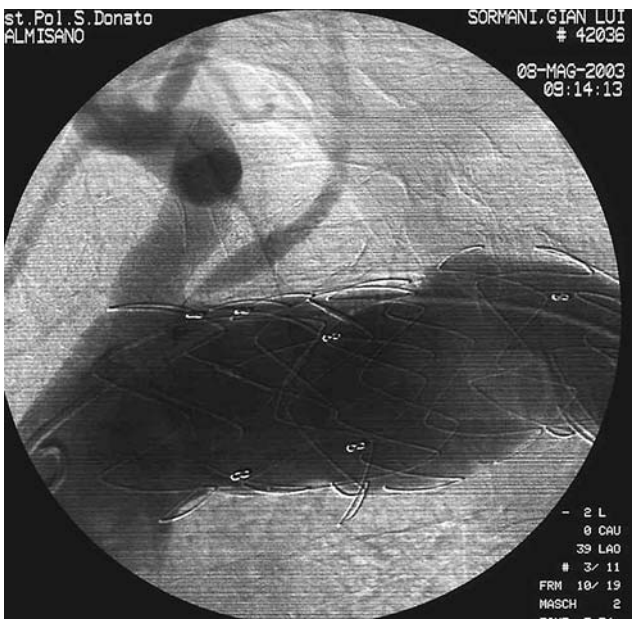

Fig. 2 Subocclusive stenosis of the origin of the left CCA 2 years following thoracic endoprosthesis implantation. There are no signs of endoleak

(aspirin 160 mg once daily and ticlopidine 250 mg twice daily) was commenced 3 days before the procedure. After written informed consent had been obtained, the CCA was isolated using a minimal left latero-cervical incision, 3 cm long, under local anesthesia. The CCA was clamped distal to the puncture site to prevent the possibility of subsequent atheroembolization. A retrograde puncture was made with a 16G needle and under fluoroscopic control a 0.035 inch hydrophilic Terumo wire (Terumo, Tokyo, Japan) was positioned a few millimeters before the lesion and a 7 Fr Cordis short sheath was inserted into the CCA (Cordis, Miami, FL, USA). Retrograde angiography allowed visualization of the origin of the CCA stenotic lesion. The patient received 8000 IU heparin (80 kg; 100 IU/kg) to maintain ACT $\geq$200. During the procedure angiography was performed through a pigtail catheter placed in the aortic arch after cannulation of the right femoral artery and placement of a 4 Fr sheath. The hydrophilic wire was placed in the descending thoracic aorta and the sheath was advanced across the stenosis. A 19 mm expanded PTFE (ePTFE)-covered balloon (Jostent, Abbott Laboratories, Abbott Park, IL, USA) hand-crimped on a 9 mm $\times$ 20 mm Fox Balloon (Abbott Laboratories, Abbott Park, IL, USA) was inserted through the sheath. The stent-graft was positioned at the level of the stenosis, covering the whole of the lesion and protruding 1–2 mm into the aortic arch; the sheath was withdrawn to uncover the stent-graft and the stent-graft was deployed. After optimal positioning of the stent, one postdilatation was performed with a 10 $\times$ 20 mm Synergy balloon (Medtronic, Minneapolis, MN, USA).

The stagnant column of blood surrounding the sheath was aspirated and the CCA flushed through the sheath prior to establishing antegrade flow. Final angiographic assessment demonstrated an accurate result (Fig. 3) and an intracranial angiogram indicated correct visualization. Local hemostasis was achieved by 6-0 Prolene sutures at the puncture site. The heparin was not reversed and the

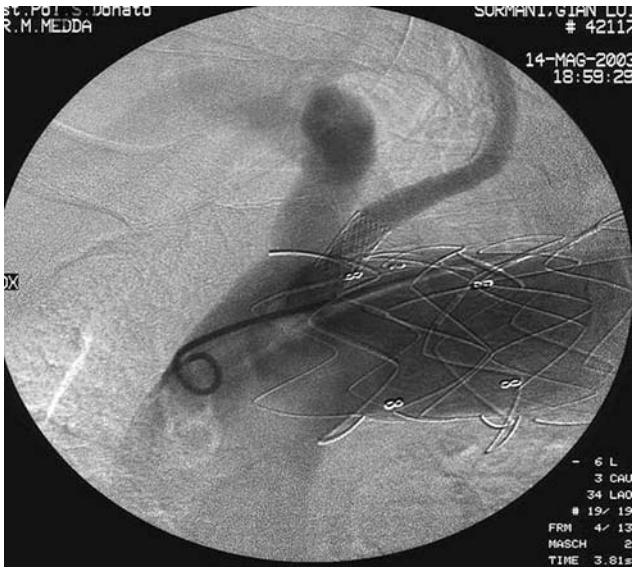

Fig. 3 Stent-graft placed at the origin of left CCA, protruding 1–2 mm inside the aorta. There is good visualization of the left CCA and no signs of endoleak

wound was closed in standard fashion. The patient was discharged on dual antiplatelet therapy for 3 months (aspirin 160 mg once daily and ticlopidine 250 mg twice daily) and aspirin 160 mg once daily thereafter. The postoperative period was uneventful. The patient is neurologically asymptomatic, and had a normal 3 year postoperative follow-up duplex scan revealing good patency of the stent-graft. The 3-year follow-up CT scan of the thoracic aorta was also normal.

Discussion

We have reported a case of asymptomatic subtotal occlusion of the left CCA treated with retrograde placement of a stent-graft. In general, the natural history of occlusive lesions involving the CCA is not well defined, but they are known to cause cerebral ischemia from embolization and thrombosis. Although guidelines for treating lesions of the SATs have not been established, most agree that high-grade (more than 75%) stenotic lesions of the CCA proximal to a patent internal carotid artery should be considered for repair in asymptomatic patients [5, 6]. Most strokes arising from a stenosed artery are not hemodynamic but embolic; and probably with subtotal occlusion there is relative protection from emboli by the decrease in the arterial diameter. In the presented case the left subclavian artery was occluded and there was radiological evidence of subclavian vertebral steal. Moreover, the collateral circulation checked with angiography was not well developed. It has been reported that collateral circulation is important in reducing the risk of hemispheric stroke and transient ischemic attack in patients with symptomatic severe internal carotid artery stenosis [7]. We believe that an additional occlusion of the left CCA could have considerable effects on brain perfusion, with the possibility of stroke development.

The etiology of the subtotal occlusion of the origin of the left CCA was due to forward migration of the thoracic endoprosthesis rather than to progression of atherosclerosis, since the angiographic appearance of the left CCA 2 years earlier was normal and there were no atherosclerotic lesions to the other SATs.

The endovascular approach has many theoretical advantages over open surgical repair, including the ability to perform such procedures under local anesthesia, a shorter recovery time, and a shorter length of hospital stay [6]. Moreover, this approach seems to be more familiar to vascular surgeons, while stent propagation and placement may be more easily performed in cases of tortuous transfemoral routes [8, 9]. These factors were of particular importance in our case since the patient was unable to receive general anesthesia because of severe cardiopulmonary disease.

Our procedure for stenting of the CCA was derived from the technique described by Queral and Criado [4]. The cerebrovascular complications of the interventional treatment of SAT lesions are principally related to thromboembolism. By controlling the CCA distal to the site of intervention and by flushing the vessel before restoring flow to the internal carotid artery, periprocedural ischemic strokes can be prevented. However, retrograde carotid access has been associated with some complications including hematoma formation and CCA dissection. Levien et al. performed 44 retrograde angioplasty for stenotic lesions of the aortic arch branches [10]. Perioperative complications included wound hematoma that required drainage in 2 patients. It is considered that there is a higher risk of hematoma formation after a percutaneous carotid puncture, while open surgical cutdown is safer since it allows direct visualization and repair of the artery after sheath removal [11]. Sullivan et al. reported 3 iatrogenic dissections of the left CCA that occurred during retrograde intervention of the CCA [5]. In 1 case, artery dissection was immediately converted to a surgical carotid-subclavian transposition. Because of concerns about creating an iatrogenic dissection with a retrograde approach, the authors suggested that tight, eccentric lesions of CCA origin should be treated with antegrade placement of guidewires via the femoral artery that may subsequently be retrieved through an arteriotomy of the CCA. Allie et al. reported one more case of CCA dissection in a series of 23 combined carotid endarterectomies with retrograde balloon angioplasty and stenting of left CCA lesions [12]. Undoubtedly, the retrograde approach requires great experience with endoluminal techniques, so as to reduce the incidence of dissection.

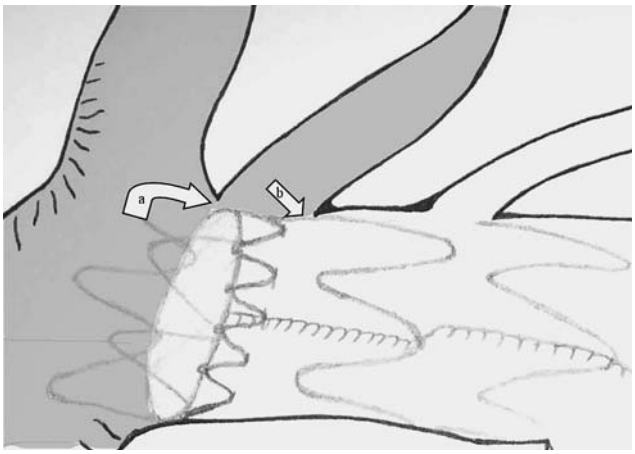

Fig. 4 Arrows a and b show the blood flow effects on the thoracic graft at the ostium of the left CCA that may compromise graft fixation. In the case of a cervical reconstruction with left CCA ligation (e.g., carotid-carotid bypass under local anesthesia), these hemodynamic effects might have been even stronger

The efficacy of the stenting of CCA stenoses is not well documented since most reports combine the results of innominate, subclavian, and CCA interventions, making interpretation difficult. One concern regarding treatment of lesions of CCA origin is restenosis following angioplasty and stenting. However, the large diameter and high-flow characteristics of the origins of SATs make them well suited for endovascular recanalization [13]. Peterson et al. treated 9 CCA origin stenoses endoluminally with balloon-expandable stents during a 4 year period and found no cases of restenosis at routine duplex surveillance [6]. Chio et al. reported an incidence of 5.1% restenosis in 42 cases of elective stenting of lesions involving only the origin of CCAs, treated successfully with repeat balloon angioplasty [14]. Allie et al. found two ostial restenoses >70% at 24 months in 23 patients with retrograde stenting of CCA lesions that were successfully treated with repeat dilation/stenting [12]. It seems that the incidence of restenosis is low and, once diagnosed, it can be easily managed.

Given the specific clinical and anatomic characteristics of our patient, we chose to place a stent-graft in the origin of the left CCA in order to preclude any flow to the upper side of the thoracic endoprosthesis that could cause migration or endoleaks in the future (Fig. 4). Deployment of a bare stent instead of a stent-graft might have distorted the frontal part of the thoracic endograft, compromising its fixation at the aortic wall. Secondary hemodynamic effects of blood flow on the distorted rim of the endograft might result in endoleak formation. Currently the literature contains only case reports or small series of stent-graft placement in the carotid artery, usually to treat post-traumatic or post-surgical pseudoaneurysms or arteriovenous fistulas [15]. Thrombosis of stent-grafts may be a concern though patients remain on antiplatelet therapy. Recently, Cothren et al. reported a series of 23 patients who underwent stent-graft placement for blunt grade III carotid artery injuries [16]. The long-term patency (3–6 months following stent placement) was only 55% and was much worse than the 95% patency of those treated with antithrombotic agents alone. Carotid artery occlusion was attributed to thrombosis and neointimal hyperplasia and occlusion rates were remarkably high. It must be stressed that responsible mechanisms that can explain this alarming carotid artery occlusion rate might include hypercoagulability after mechanical trauma. Moreover, most patients received antithrombotic treatment with Coumadin (warfarin) instead of antiplatelet factors. Consequently, the value of these conclusions is limited. In the case presented here, the patient had no evidence of restenosis at the 3 year duplex ultrasound follow-up.

In conclusion, the retrograde endovascular repair of CCA lesions, as other authors have already suggested, may be the treatment of choice in "high-surgical-risk" patients. In these cases where the ostium of SATs is compromised following thoracic aorta stent-graft migration, endoluminal placement of a stent-graft in the CCA can guarantee both maintenance of carotid flow and thoracic stent-graft fixation.

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