Chimney technique for left subclavian artery restoration -Two cases presentations

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Abstract:

Introduction: Left subclavian artery revascularization (LSA) is frequently performed in the setting of thoracic endovascular repair (TEVAR). In recent years, the chimney technique is a notable and effective method of reperfusion of the LSA.

Cases presentations: Two case reports analyze our experience in the chimney technique for the reperfusion of the LSA. In the first case, a young male underwent in a TEVAR due to an aortic isthmus rupture by an acute dissection type B of the thoracic aorta. In the second case, a male underwent in elective endovascular repair of thoracic aortic aneurysm and in the second time he underwent in an endovascular abdominal aortic aneurysm repair (EVAR). In 3 months postoperatively, the second man's follow-up CTA showed that the stents were well formed and no obvious endoleak was noticed.

Conclusion: The revascularization of the LSA in patients who underwent in TEVAR is able to decrease the risk of stroke, SCI and upper limb ischemia. Several minimally invasive procedures have been employed to manage this procedure, one of them is the chimney graft technique.

INTRODUCTION

Thoracic endovascular aortic repair (TEVAR) is a valuable approach for patients with thoracic aortic disease (TAD) (descending thoracic aortic aneurysm or type B aortic dissection (TBAD))[1]. The endovascular management of the aortic arch, however, remains challenging because of its angulated morphology and involvement of the supra-aortic branches[2]. Durable outcomes of TEVAR require an adequate proximal seal zone. It is estimated that 23% - 40% of TEVAR will require coverage of zone 2 to create a proximal seal[3]. The coverage of the left subclavian artery (LSA) during TEVAR to achieve a proximal seal is associated with increased risk of stroke, spinal cord ischemia, and upper extremity ischemia[1].

In 2009, the Society for Vascular Surgery consensus statement recommended routine revascularization of the LSA when covered by TEVAR for proximal sealing in elective cases[1]. Several strategies have been published in the literature to preserve the orifice of the LSA such as chimney technique, hybrid technique (carotid to subclavian bypass (CSB)) and fenestrated or branched stent graft technique[2]. Notable results with use of fenestrated or branched stent graft in the aortic arch have been published. However, these approaches were limited by the morphological diversity of the aortic arch, necessitating patient specific and tailor-made devices[2,4].

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E-mail: k.maltezos@gmail.com
doi: 10.59037/hjves.v5i2.27
ISSN 2732-7175 / 2023 Hellenic Society of Vascular and Endovascular Surgery Published by Rotonda Publications
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Another endovascular approach to maintain perfusion of the LSA is the chimney technique, which was first applied in the aortic arch to rescue an inadvertently covered left subclavian artery (LSA). In recent years, the chimney technique has increased rapidly for the treatment of aortic arch disease, but the long-term efficacy remains unclear[2].

The aim of this study was to report our experience with the chimney technique for LSA preservation in TAD and to evaluate the short and mid-term outcomes in these patients.

CASE 1

A 21-year-old male patient, with unknown personal or family medical history, was transferred unconscious to our emergency department because of a mentioned traffic accident. He was intubated urgently in the emergency department. In full body computed tomography angiography (CTA) was observed an aortic isthmus rupture by an acute dissection type B of the thoracic aorta (Figure 1). The dissection was originated distal to the LSA and extended proximal to the celiac artery (C.A.). Moreover, it was observed a mandibular fracture.

The patient was immediately transferred to the operating room. A TEVAR was planned to cover the primary entry and reduce false lumen flow. Because of the short proximal neck (length: 4mm), it was preferred the chimney technique for LSA revasculization. Under general anesthesia, the right common femoral artery (CFA) and the left brachial artery was exposed. Two J guidewires were passed, the first one from the right CFA and the second one from the brachial artery to the ascending aorta. Aortic angiography was performed before stent-graft deployment. A possible rupture site in the false lumen of the descending aorta was identified. A Lunderquist® stif wire (Cook Medical, Bloomington, Indiana, USA) was used, and a Gore Comfortable Thoracic Stent Graft (31X31X10) (W. L. Gore and Associates, Flagstaf, AZ, USA) was deployed in the

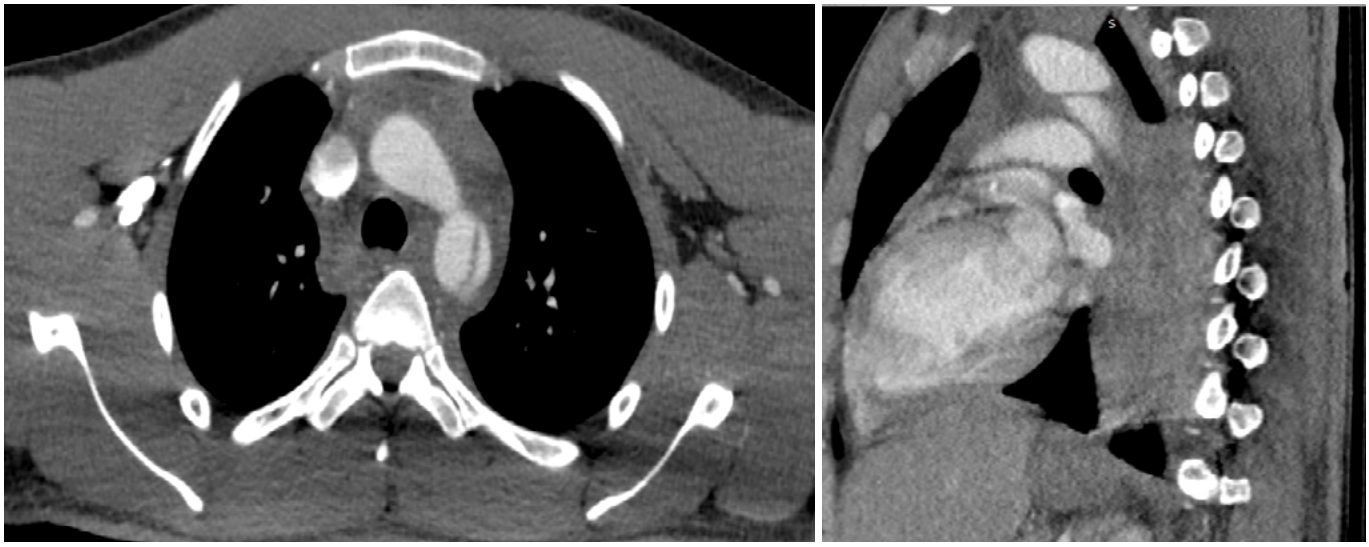

Fig 1: Aortic isthmus rupture by an acute dissection type B of the thoracic aorta

descending aorta. The chimney technique was accomplished via a VBX (W. L. Gore and Associates, Flagstaf, AZ, USA) (8 mm × 59mm ×) stent graft, which was placed appropriately at the ostium of the LSA to preserve its perfusion. At the end of the procedure, control aortography confirmed the proper positioning of the stent without evidence of a detectable leak and a patented LSA.

He presented an uneventful postoperative period, and he was transferred to the maxillofacial surgery department on the second postoperative day. One month later, a follow-up CTA revealed successful dissection exclusion with patent LSA chimney stent, and no significant endoleak was detected. Unfortunately, the patient was not appeared for subsequent follow-up.

CASE 2

A 75-year-old male patient had been admitted in our department for elective restoration of descending thoracic aortic aneurysm 6.7cm and infrarenal abdominal aortic aneurysm 6.5cm. His pertinent medical history included arterial hypertension, dyslipidemia, diabetes mellitus type II, chronic renal disease and chronic cardiac insufficiency (Ejection Fraction (E.F.): 60%). He underwent in open cholecystectomy and appendectomy.

It was preferred the staged restoration of these aneurysms. Firstly, he underwent a TEVAR to be restored the thoracic aortic aneurysm. Because of the short proximal neck (length: 12mm) (Figure 2), it was preferred the chimney technique for LSA restoration (as the previous case). Under general anesthesia, both common femoral arteries and the left brachial artery was exposed. The right CFA was chosen as the main access and the left CFA was used for control aortography that revealed the aortic arch anatomy and the descending thoracic aortic aneurysm. Two J guidewires were passed, the first one from the right CFA and the second one from the brachial artery to the ascending aorta. Aortic angiography was performed before stent-graft deployment. A Lunderquist® stif wire (Cook Medical, Bloomington, Indiana, USA) was used, and Gore Comfortable Thoracic Stent Graft (40X40X20) (W. L. Gore and Associates, Flagstaf, AZ, USA) was deployed in the descending aorta. It was implanted two thoracic grafts because of the great length of the descending thoracic aorta. The chimney technique was accomplished via a VBX (W. L. Gore and Associates, Flagstaf, AZ, USA) (11 mm × 79mm) stent graft, which was placed appropriately at the ostium of the LSA to preserve its perfusion. At the end of the procedure, control aortography via the left common femoral artery confirmed the proper positioning of the stent without evidence of a detectable leak and a patented LSA. The postoperative

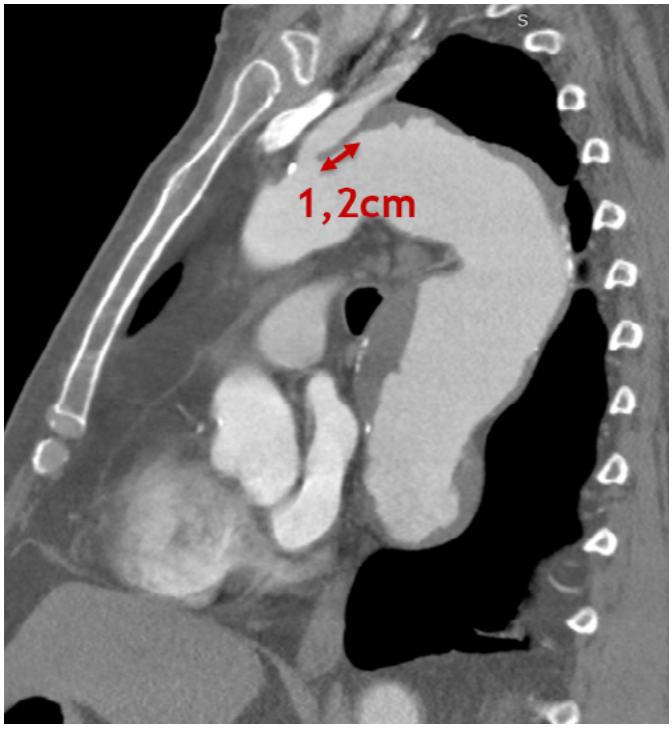

Fig 2: Short proximal neck of descending thoracic aortic aneurysm (length: 12mm)

course was unremarkable, and he was discharged on the 4th postoperative day.

On the 51st postoperative day from the first operation, he was admitted for elective repair of infrarenal abdominal aortic aneurysm. Under spinal anesthesia, it was implanted a Gore - Conformable Excluder bifurcated stent graft (Main body: CXT361414E, Right endograft extension: PLC161000, Left endograft extension: PLC141000) without complication via a transfemoral artery exposition. Intraoperative digital subtraction angiography verified the correct stent placement and the absence of endoleaks. He was discharged from the hospital 4 days postoperatively.

However, despite the patient was asymptomatic, it was observed that he has a discrepancy in arterial pressure measurements between two upper limbs (30mmHg). In CTA thoracic and abdominal aortic, it was confirmed a significant stenosis in the chimney stent graft (Figure 3).

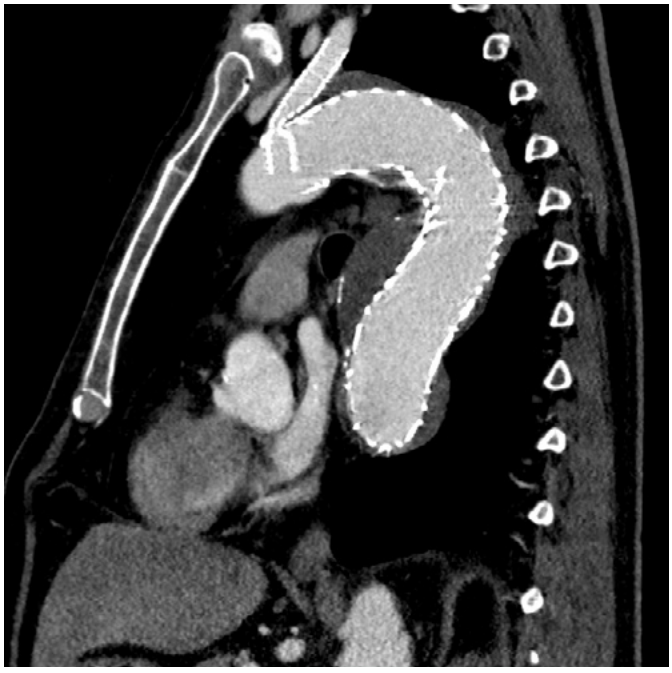

Fig 3: Stenosis in the chimney stent graft

On the 10th postoperative day from the second operation, he underwent an angioplasty of chimney stent graft. In the angio suit and under local anesthesia, it was implanted a balloon expandable bare metal stent (10x39) into the previous chimney stent graft via a left transbrachial percutaneous intervention. The intraoperative angiography confirmed the successful treatment of the stenosis. The patient was discharged on the 2nd postoperative day, uneventfully, and he received double antiplatelet therapy for 6 months. In 3 months postoperatively, the follow-up CTA showed that the stents were well formed and no obvious endoleak was noticed.

DISCUSSION

For patients with acute thoracic emergency, TEVAR is required urgently and coverage of the LSA is necessary. The coverage of the left subclavian artery during TEVAR to achieve a proximal seal is associated with increased risk of stroke, spinal cord ischemia (SCI), and upper extremity ischemia. Xie et al., under their single center's experience (a total of 547 TEVARs were analyzed), concluded that comparisons between the unrevascularized and revascularized groups were significant for a higher rate of 30-day spinal cord ischemia (SCI) (10.7% vs. 1.4%, p = 0.032). However, the mortality, stroke, and left upper extremity ischemia were not statistically significant at 30-day or mid-term between those groups[1].

A report from the European Collaborators in Stent-Graft Techniques for Abdominal Aortic Aneurysm Repair (EUROSTAR) registry of 606 patients demonstrated an SCI rate of 2.5% and found coverage of the LSA without revascularization was an independent risk factor for SCI (OR, 3.9; P = 0.027)[1,5].

Several minimally invasive procedures have been employed to manage aortic-arch lesions taking into considerations the supraaortic vessels. There are basically two main approaches: hybrid and total TEVAR. The hybrid procedure can be described as a combination of extra-anatomic bypass of supra-aortic vessels with endovascular stent-graft deployment[6]. TEVAR for aortic arch can be accomplished by fenestrated/branched stent graft or chimney technique in order to maintain blood flow to the vital organs. Fenestrated TEVAR is the delivery of a stent graft with fenestrations, which directed precisely to the target vessels[6]. Haulon et al. in 2014 performed a retrospective multicenter study for 38 patients with aortic-arch aneurysm repaired by a branch stent graft; the 30-day mortality rate was 13% and early cerebrovascular deficits were diagnosed in 16% of cases[6,7].

According to the Society for Vascular Surgery practice guidelines, the chimney technique was used to reconstruct LSA in zone 2 aortic arch disease[8]. If patient anatomy was not suitable, left common carotid artery (LCCA) to LSA bypass/transposition was performed when the patient had an incomplete Circle of Willis, dominant LSA, or aberrant right subclavian artery. However, complications of LCCA-LSA bypass/transposition include hemorrhage, wound infection, local nerve injury, etc. Compared with the hybrid technique, the chimney technique is more advantageous in terms of immediacy, reduced invasiveness, and improved safety[2,8].

Chimney graft is defined as a covered or bare stent graft that is deployed parallel to the main aortic graft stent to protect the perfusion of vital side branches[6]. It was first identified by Greenberg et al., who used it to preserve the renal-artery blood flow[9]. Yang et al. in 2012 conducted a systemic review to determine the safety and efficacy of the endovascular chimney technique for the preservation of supraaortic - branch blood flow. A total of eight articles with 51 patients who underwent TEVAR with the chimney technique from 1994 to 2011 were enrolled in the study. They concluded that the chimney-graft technique for aortic-arch pathologies is technically applicable in both elective and emergency situations and is associated with favorable perioperative outcomes with a success rate of 90.2%[6,10].

The main concern of the chimney technique is the risk of endoleak type IA (IA) from the gutters alongside the aortic stent graft, chimney stent, and thoracic aortic wall. To decrease the incidence of IA, different approaches have been reported. Theoretically, a covered stent may be helpful because it can decrease the blood flow through the mesh of the bare stent into the gutter. Beyond that, Wang et al. recommend at least 2 cm overlap between the aortic stent graft and the chimney stent to promote thrombosis in the gutter[2,11].

Ding et al. analyzed in their study the outcomes of chimney technique for preservation of the LSA in patients with type B aortic dissection. Totally, 159 patients were included in this study and the technical success of the intervention was nearly 80%. The three years mortality rate was approximately 5% and the three years grafts patency rate was 96,5%. The present study demonstrated that the chimney technique is safe and feasible for preservation of the LSA in patients with type B aortic dissection, but the durability of chimney stent needs to be evaluated carefully and the immediate type of Ia endoleak is a concern[2].

In the literature, a comparison between chimney graft technique and carotid-subclavian bypass had been published by Ramson et al[3]. Even though, the study analyzed a huge number of patients (n:81), in their majority they underwent in carotid-subclavian bypass (n:64). This is the main reason of unsignificant outcomes. The authors concluded that the chimney stent graft technique offers equivalent early results as a minimally invasive alternative for the reperfusion of the LSA. However, more follow-up studies were needed to determine long-term results of the chimney stent treatment modality[3].

CONCLUSION

The revascularization of the LSA in patients who underwent in TEVAR is able to decrease the risk of stroke, SCI and upper limb ischemia. Nowadays, this procedure is considered, especially in elective cases. Several minimally invasive procedures have been employed to manage this procedure, one of them is the chimney graft technique. However, even though the so far outcomes are very hopeful, more studies with longer follow-ups are warranted to further define the best treatment strategy.

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