



Case Report

When the Bridge Becomes Procedural Route. Stenting of Left Common Carotid Artery-Graft Anastomosis through Left Carotid-Subclavian By-Pass

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Abstract

Aortic arch aneurysms are pathological >1.5-fold dilatation of normal aortic arch diameter with high risk of rupture if they exceed 55 mm. Optimal medical therapy is not sufficient to modify the natural history of this condition, so interventional approach is mandatory. Beyond open surgery, hybrid procedures can be performed, but some complications must be taken in account during longer follow-up. A 76-year-old patient, with previous supra-aortic vessels debranching for endovascular exclusion of a large aortic arch aneurysm, developed a critical stenosis of left common carotid artery at the level of anastomosis with its graft. We report in detail the management of this condition with a stenting procedure. With aging, thoracic aortic diseases increase. Currently, no clear management of post-procedural complications of debranching exists. In some selected cases, redo surgery can be avoided using a very percutaneous approach.

Keywords: Aortic Arch Aneurysm; Carotid-Subclavian Artery By-Pass; Hybrid Procedure; Percutaneous Intervention; Graft Failure

Abbreviations and acronyms: AAA: Abdominal aortic aneurysm; BCA: Brachiocephalic artery; CTA: Computed tomography angiogram; LCCA: Left common carotid artery; LPA: Lateral plate mesoderm; LSA: Left subclavian artery; NE: Neuroectoderm; PM: Paraxial mesoderm; SVS: Society of Vascular Surgeons; TAA: Thoracic aortic aneurysm

Introduction

Aortic aneurysm is a dilatation > 1.5 times the normal aortic diameter. Aortic arch aneurysms are associated with adjacent aneurysm of the ascending or descending aorta and their isolated

finding is unusual. Their natural history is not well established because sudden rupture is often fatal and, on the other hand, because patients undergo surgical correction once aneurysm is found. The mean rate of growth for thoracic aneurysm is reported 0.1 cm/year, with an annual rate of 2% for aneurysms <5 cm, 3% for aneurysms 5 to 5.9 cm, and 7% for aneurysms > 6 cm in diameter. The risk of dissection or rupture is related to aneurysm's diameter and the risk rises significantly when aortic diameter is 60 mm for the ascending aorta and 70 mm for the descending aorta [1]. The Society of Vascular Surgeons (SVS) guidelines recommend treatment of aortic arch aneurysm when its diameter exceeds 55 mm [2]. Several types of intervention can be performed to exclude aneurysmal sac and prevent rupture: open surgery, hybrid procedures or totally percutaneous interventions [2]. Although angiographic results in mid-term follow-up studies are

encouraging [3,4], supra-aortic vessels patency may be impaired after longer periods and a redo surgical intervention could be harmful. In this paper we report in detail a percutaneous procedure for the management of left common carotid graft late stenosis in a patient with aortic arch aneurysm treated previously with supra-aortic vessel debranching and endoprosthesis implantation.

Case Report

A 76-year-old male patient was referred to our center on May 2022 for the management of a sub-occlusive left common carotid artery (LCCA) stenosis at level of the anastomosis between LCCA and a surgical graft of previous supra-aortic vessel debranching. He was affected by arterial hypertension and dyslipidemia, with an important familiar and personal history of vascular disease. His mother died because of cerebral aneurysm rupture and his brother had abdominal aortic aneurysm. In August 2013 the patient was

referred to our hospital for a 55 mm aortic arch saccular aneurysm involving the proximal part of descending aorta, discovered during differential diagnosis of a thoracic mass. At that time, the Heart Team decided to perform a hybrid procedure, divided in 3 steps. In August 2013 the patient underwent a LCCA and brachiocephalic artery (BCA) debranching with anastomoses to a bifurcated Dacron graft (8 mm and 10 mm diameters, respectively) and reimplantation 4 cm proximally to brachiocephalic trunk origin. In October 2013 a left carotid-to-left subclavian artery by-pass was performed using 8 mm Dacron vascular prosthesis. In December 2013 the patient underwent an endovascular treatment with implantation of aortic endoprosthesis using as proximal landing zone the distal ascending aorta and consequent aneurysmal sac exclusion. No endoleaks or other complications were observed during computed tomography angiogram (CTA) performed in January 2014 and June 2020.

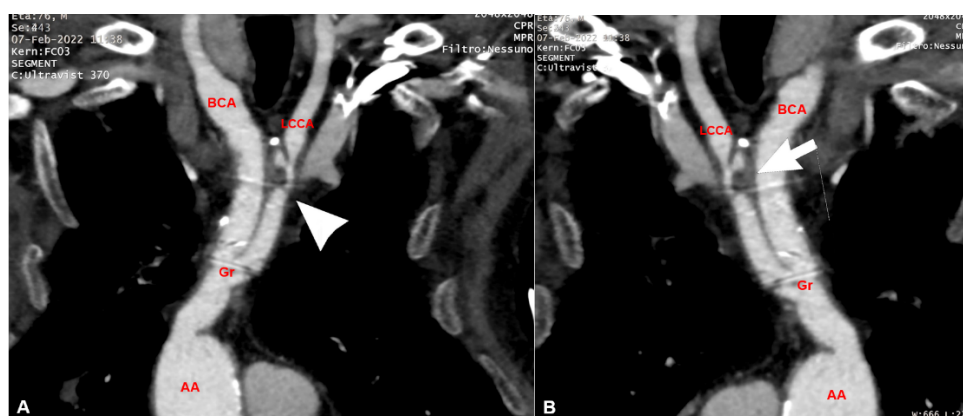


Figure 1 A-B: Pre-procedural 2D CTA of supra-aortic vessels showing critical stenosis at the anastomosis between LCCA and its graft (white arrow). AA = ascending aorta; BCA = brachiocephalic artery; CTA = computed tomography angiogram; Gr = debranching graft; LCCA = left common carotid artery.

In 2015 bilateral popliteal artery and abdominal aortic aneurysms were diagnosed and a left femoropopliteal by-pass was performed. Right popliteal artery and abdominal aneurysm are currently on follow-up. Despite the patient remained asymptomatic on optimal medical treatment (double antiplatelet therapy, maximum tolerated statin dose and anti-hypertensive drugs) during following years, in February 2022 a CTA revealed an eccentric stenosis (>75%) located in the anastomosis between LCCA and its graft, jeopardizing both left cerebral and brachial blood supply (Figure 1 A-B and Figure 2 A-B). The stenosis hemodynamic impact was confirmed by carotid ultrasound. In consideration of the absence of symptoms, we decided to perform a LCCA percutaneous revascularization instead of a redo surgical procedure. The intervention was conducted under mild sedation and local anesthesia. Bilateral brachial arterial 6 Fr accesses were

obtained; a diagnostic 6 Fr catheter was advanced through the left access into left subclavian artery (LSA) and then LCCA; the angiogram confirmed the position of LCCA stenosis and patency of LCCA-LSA by-pass (Figure 3 A-B); a Destination 6 Fr guide catheter was advanced into LCCA, and a stent was deployed (CGuard™ 8 mm x 40 MD); then, multiple balloon dilations were performed (Figure 3 C-D); further angiograms showed stenosis resolution (Figure 3 E). Finally, sheaths were removed, and hemostasis obtained. Two days later, a CT angiogram was performed showing stent patency and no complications (Figure 4 A-B and Figure 5 A-B). The patient was discharged on 3rd post-operative day with the following medical therapy: aspirin 100 mg, clopidogrel 75 mg, lisinopril 20 mg, bisoprolol 2.5 mg plus 1.25 mg, amlodipine 10 mg, atorvastatin 40 mg, lansoprazole 30 mg.

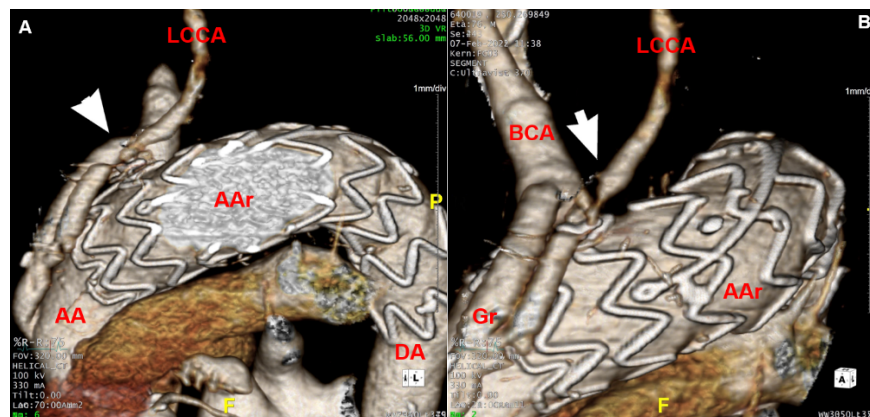


Figure 2 A-B: Pre-procedural 3D-Volume Rendering CTA reconstruction of the thoracic aorta showing aortic endograft strut with its proximal portion in Ishimaru's landing zone 0. Critical stenosis of LCCA can be observed (white arrow). AA = ascending aorta; AAr = aortic arch; BCA = brachiocephalic artery; CTA = computed tomography angiogram; Gr = debranching graft; LCCA = left common carotid artery.

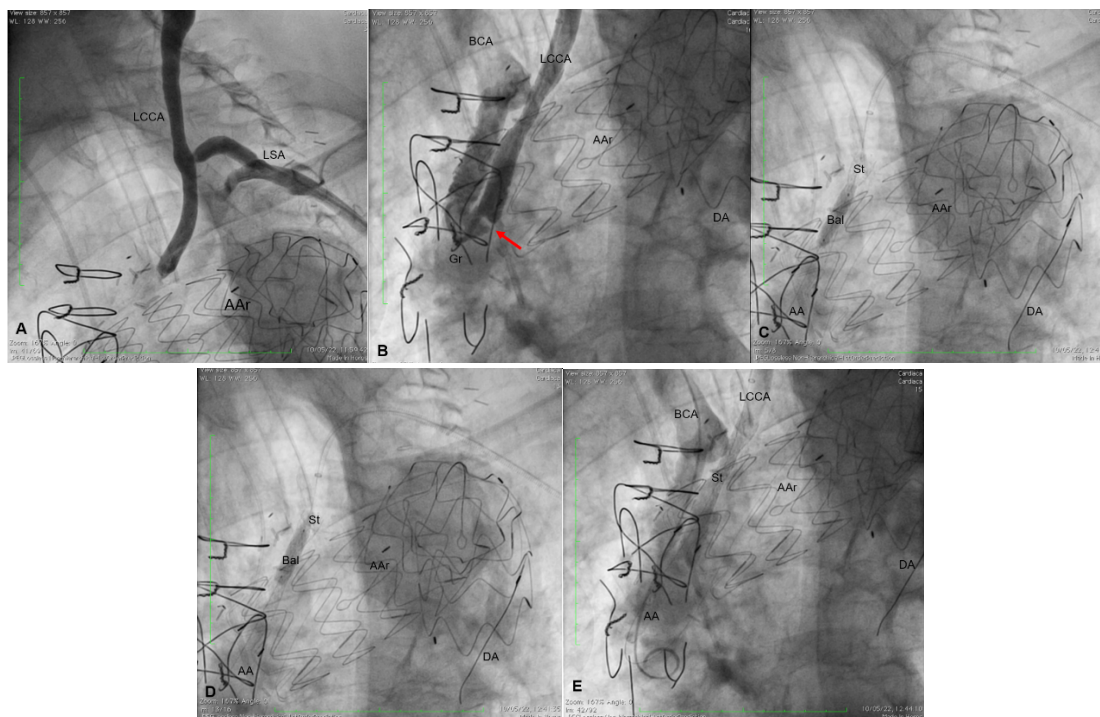


Figure 3 A-E: Procedure steps. Angiogram showing LCCA-LSA by-pass patency (A). Angiogram confirming eccentric LCCA stenosis showed by red arrow (B). Multiple balloon inflations after stent deployment (C and D). Final angiogram showing LCCA stenosis resolution (E). AA = ascending aorta; AAr = aortic arch; Bal = balloon; DA = descending aorta; Gr = debranching graft; LCCA = left common carotid artery; LSA = left subclavian artery. St = stent.

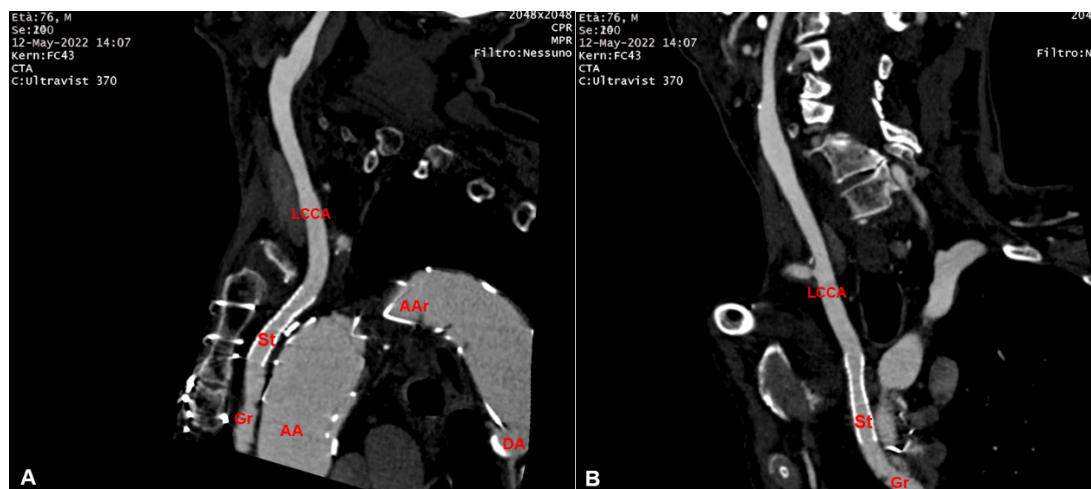


Figure 4 A-B: Post-procedural 2D CTA of supra-aortic vessels showing LCCA stent patency. CTA = compute tomography angiogram. AA = ascending aorta; AAr = aortic arch; BCA = brachiocephalic artery; CTA = computed tomography angiogram; DA = descending aorta; Gr = debranching graft; LCCA = left common carotid artery; St = stent.



Figure 5 A-B: Post-procedural 3D-Volume Rendering CTA reconstruction of the thoracic aorta. LCCA stent position can be observed (yellow arrow). AA = ascending aorta; AAr = aortic arch; BCA = brachiocephalic artery; CTA = computed tomography angiogram; DA = descending aorta; Gr = debranching graft; LCCA = left common carotid artery; St = stent.

Discussion

Aortic aneurysms represent the most common chronic aortic disease. There are some important differences between thoracic (TAA) and abdominal aortic aneurysm (AAA) that make them two distinct pathologies [5]. In experimental studies, elastic fibers degeneration and adventitial fibrosis were more pronounced in AAA than TAA; moreover, degenerative areas are more localized in TAA than AAA in which arterial wall disruption is diffuse [5]. Aorta embryological origin may influence the predisposition to a particular vascular disease. Aortic root develops from lateral plate mesoderm (LPM) whereas ascending aorta and aortic arch from neural ectoderm (NE); smooth muscle cells originating from LPM and NE are more prone to extracellular matrix degradation and cell proliferation in response to IL-1 β ; conversely, descending and abdominal aorta develop from paraxial mesoderm (PM) and their smooth muscle cells present a less important response to inflammation [6]. This behavior could explain the contribution of genetic heredity to TAAs development and their scarce response to antihypertensive or lipid-lowering drugs when compared to AAA. TAAs, especially those involving aortic arch, are difficult to manage and deserve an interventional approach. Hybrid procedures for aortic arch disease represent an alternative treatment option in higher risk patients not suitable for open repair. Although no significant differences between these different approaches in long-term survival outcomes have been reported, hybrid procedures have less reoperation rate whereas open surgery leads to less spinal cord injuries [7]. These interventions are classified in three types according to Bavaria et al [8]. type I repair consists in supra-aortic vessels debranching and reimplantation on the healthy native proximal aorta, followed by endovascular prosthesis implantation to cover the diseased aorta; type II repair differs from type I because of vessels debranching is preceded by proximal ascending aorta replacement; type III repair is represented by “frozen elephant trunk”. In our case, the patient underwent almost 9 years before a 3 staged hybrid type I repair with endovascular prosthesis deployment in Ishimaru’s landing zone 0. In recent observational and real-world studies with a maximum follow-up period of 3 years, patients’ outcomes were worse in older subjects and with proximal landing zone (0-1) respect to those younger and with landing zone 2 [3,4]. Moreover, proximal landing zone is associated with more endoleaks and reintervention rate [3]. Anastomosis site stenosis represents a cause of supra-aortic vessels debranching failure, but currently no clear recommendations exist for its management. In this case, we present a possible minimally-invasive approach by a full percutaneous procedure, restoring LCCA patency and avoiding a further surgical intervention; both

cerebral and spinal cord perfusion were maintained, since LSA warrants posterior cerebellar blood supply and upper inflow into the anterior spinal artery [2]. Our report suggests that percutaneous procedures are feasible and safe in selected patients, but further data and longer follow-up are needed.

Conclusions

Aortic aneurysms are pathological > 1.5-fold dilations of aorta. When aortic arch is affected, aneurysm management can be very challenging. Currently, treatment options are represented by open, hybrid or total endovascular repairs. Long-term complications of hybrid procedures are poorly investigated and recommendations about their management neglected. In our case, a LCCA anastomosis site stenosis was successfully treated by stenting in a patient with previous supra-aortic vessels debranching.

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