

# HEMODIALYSIS ACCESS – A CREATIVE ATTITUDE IS NECESSARY

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## Abstract

Creating and maintaining a functional vascular access (VA) is a critical factor in the survival of a dialysis patient. It implies a creative attitude either to maintain its functionality or to build a new one wherever possible, being it autologous or synthetic.

We describe the VA history of a 59 years-old male patient, with extreme obesity, which started in 2012 with failed attempts of VA construction in both forearms until a functional brachiocephalic arteriovenous fistula (AVF) in the right upper limb was achieved. However, it required ligation due to severe venous hypertension secondary to central venous disease related to previous CVC use. As he had no good superficial conduit in the left arm we decided to harvest the arterialized right cephalic vein and implant it in the left arm, creating an autologous arteriovenous shunt between the brachial artery and axillary vein (AV). Despite initial patency, it failed irreversibly approximately one year after creation. As no more superficial veins were available in the upper limbs, a prosthetic access was the next step. We decided for a hybrid graft (HG) between the left brachial artery and the AV because of the patient's biotype and scarred axilla that impeded a safe re-intervention on the AV. This graft was used between 2015 and 2017 with multiple interventions to maintain patency. In 2017 a significant diffuse prosthesis deterioration and reduced AVF flow were noticed with no possible segmental reconstruction. We were then forced to proceed with subtotal graft substitution preserving the outflow stented segment of the HG, using an early cannulation graft to prevent CVC use. After this successful reconstruction, the patient started hemodialysis on the following day with no intercurrents registered.

## INTRODUCTION

A detailed pre-operative history and physical examination is essential in the evaluation of a patient with end stage kidney disease and indication for a vascular access construction. Complementary venous and arterial ultrasound mapping provides crucial information for planning the access construction and decreases primary failure rate.<sup>1-4</sup>

After construction, surveillance is important to attest the vascular access function and patency and identify correctable lesions that may lead to access loss and it can be done during or outside the hemodialysis sessions.<sup>5,6</sup> Duplex ultrasound should also be the first line imaging method in patients with suspected dysfunction.<sup>7,8</sup>

However, even when the monitoring is correctly done, under certain circumstances the access failures to mature, develops dysfunction or thromboses which make us search for alternatives. However, we might be faced with exhausted venous conduits for the creation of a new access, requiring our creativity.

## CLINICAL CASE

The authors describe the vascular access history of a 59-year-old male patient, with morbid obesity. The patient weighted around 130 kilograms with particularly central obesity and end stage kidney disease with requirement to enter a hemodialysis program.

His chronic kidney disease was secondary to diabetic nephropathy and his first vascular access was built in 2012. Planning the access creation was made with physical examination and ultrasound evaluation with venous and arterial mapping, once he achieved stage four of chronic renal disease, approximately six months before planned vascular access requirement.

Despite what we consider to have been a good planning and surgical construction, we had to deal with primary failure of several autologous accesses constructed in both upper limbs, not only bilateral radio-cephalic fistulas but also a left brachio-cephalic fistula, until it was possible to achieve the maturation of a brachio - cephalic fistula in the right upper limb. During this period, the patient progressed to five stage of chronic renal disease

and was inevitable to use a central venous catheter (CVC) in both internal jugular veins and the right subclavian vein. The thrombophilia study conducted was negative.

In 2013, the patient developed severe right upper limb venous hypertension, secondary to central venous stenosis, requiring fistula ligation. It was a normal debit fistula with 740ml/min, measured with Doppler ultrasound on the brachial artery, with turbulent flow and prolonged hemostasis time associated to venous hypertension. Angiography identified a long pre-occlusive central vein stenosis encompassing the right subclavian vein. Simple angioplasty was conducted at first but with restenosis before three months after the procedure. Due to the stenosis location and risk of eventual stent thrombosis, we performed a translocation of this cephalic vein and constructed a brachio-axillary vascular access in the left upper limb (Fig. 1). Meanwhile, it was necessary to use a new CVC in the femoral vein.



**Figure 1** Right cephalic vein translocation to the upper left limb.

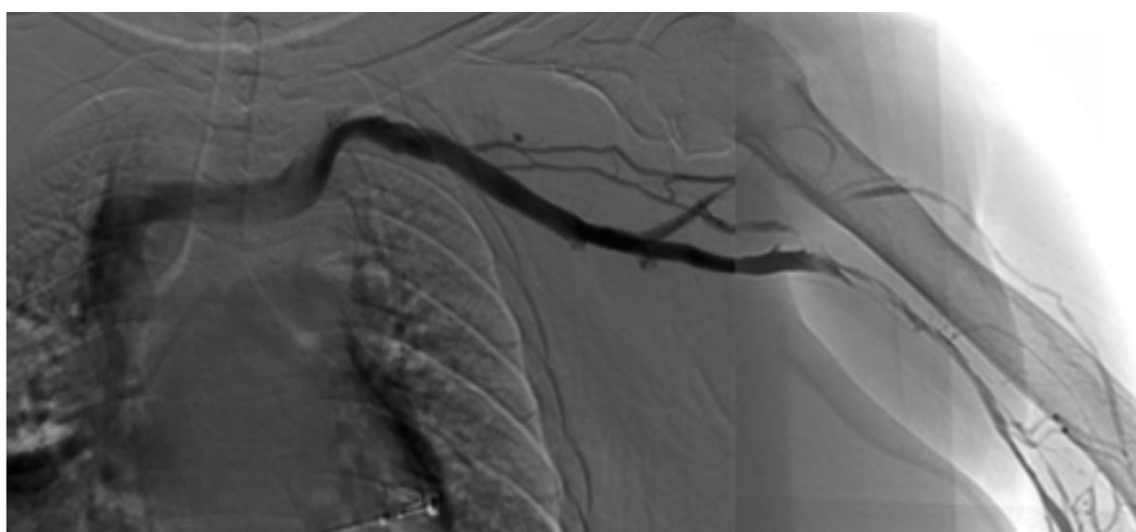
In 2014, one year after the cephalic translocation, the quality of dialysis through this access started to decrease significantly precipitated by a cephalic arch vein stenosis and aneurysmal degeneration that culminated with access thrombosis, despite simple angioplasties and stenting of the cephalic arch. On physical and ultrasound evaluation we identified a fusiform, with long extension, aneurysm with organized thrombus, which made us abandon this cephalic vein for further investment.

After aneurysmatic cephalic vein excision, we created a new brachio – axillary access with an hybrid graft. An open surgical approach to the brachial artery was used to perform the proximal anastomosis. Distal anchoring of the Gore Hybrid Vascular Graft on the axillary vein was delivered through a 14French introducer using the wire and “peel-away” technique (Fig. 2).

Between June 2014 and May 2015, despite several interventions with simple angioplasties due to juxta-anastomotic area stenosis to maintain the primary assisted patency of this hybrid Graft, the access thrombosed. Correction was made with surgical thrombectomy and creation of a new proximal anastomosis. Since May until October, simple angioplasties due to neo-intimal prosthetic hyperplasia were still performed.

During this period, difficult cannulation access was identified by the nurses at the hemodialysis center so as deterioration of the graft in the context of multiple punctures, despite resort to ultrasound assisted cannulation. That was the motive why we decided to extract an impaired graft segment and conduct an interposition graft with a ePTFE tubular graft (Fig.3).

Along the following period until 2017, the dialysis quality progressively decreased so as graft flow, reaching 350ml/min due to diffuse neointimal hyperplasia within the graft that caused hemodynamic effect with a decrease in lumen area superior to 70%. As a result, it was necessary to replace the graft. Since the distal segment anchored



**Figure 2** Angiographic image after the Hybrid graft implantation.



**Figure 3** *Ultrasound image after the segmental interposition with a simple ePTFE Graft.*



**Figure 4** *Post implantation of the Early cannulation Graft.*

to the axillary vein was free of significant stenosis, it was possible to preserve that segment constructing an interposition graft with an early cannulation ePTFE graft (Gore Acuseal®) (Fig. 4).

This latter procedure was uneventful. There was no necessity of CVC use and the patient started hemodialysis, through this vascular access on the next day.

He has now 16 months of follow up and required only one simple angioplasty, eleven months after the procedure, due to distal juxta-anastomotic stenosis in order to preserve its primary assisted patency.

#### DISCUSSION / CONCLUSION

In general, central venous catheters are associated with inferior hemodialysis quality and reduced average life expectancy for this patients<sup>9</sup>. Therefore, all efforts should go towards building a functioning arteriovenous vascular access.

The appropriate vascular access for a patient depends on his individual available vessels and surgeon experience. Once this objective is reached, regular monitoring of vascular access and a dedicated team to treat any complications that may arise is necessary to achieve the best functionality possible.

In complex situations like the one here exposed, the vascular surgeon experience is essential, as well the capacity to promptly diagnose access failure in order to explore the residual vascular patrimony of the patient and to select the most adequate solution, whether by open or endovascular surgery. There are some published studies concerning the functionality of vascular accesses in obese patients as described by Micah R Chan et al and Kats M et al,<sup>10,11</sup> but the results are still debatable.

Considering the evolution of this particular vascular access so as the most recent published literature, once the functioning upper limb access was threatened by central venous stenosis, endovascular solutions should be considered. Still, there is some controversy about the best approach with some authors publishing good results, yet others presenting reduced primary patency on long-term follow up.<sup>12,12</sup> In our daily practice, we tend to favor endovascular treatment of this central vein stenosis but, in this particular case, once presented with early restenosis and considering the lesion characteristics so as absence of immediately accessible venous patrimony in the left upper limb for an autologous access construction and the existence of an arterialized and matured right cephalic vein made us lead to that solution, which is somehow also described in the literature. Great saphenous vein and femoral vein translocation to the upper arm are commonly believed to have higher

complications rates, with poor maturation of the first one even considering good patency with the last one.<sup>14-18</sup>

The cephalic arch is prone to the development of hemodynamic significant stenosis being the most frequent location for stenosis of the upper arm dysfunctional vascular accesses, corresponding to 30-55% of all stenosis sites.<sup>19</sup> While endovascular solutions seem a reasonable option for the first pathology preventing an open surgical revision that might jeopardize the creation of a future basilic vein fistula, whether to choose between simple angioplasty, bare metal stent, graft stent or even drug eluting balloon is debatable with high recurrence rates.<sup>20-22</sup> Vascular access aneurysms are frequently accompanied by pre or post-aneurysm stenosis. In our case, the thrombosed aneurysm was complicated by wall-adherent thrombus which implied ligation of the aneurysmal section and graft interposition. The option for the hybrid graft was made considering the biotype of the patient and despite having considered basilic vein employment, the low basilic vein diameter (<6mm, both arms), an axillary zone with a previous surgical approach and necessity of continuous dialysis sessions, preferably without novel use of CVC, made us elect the construction of a new access with an hybrid prosthesis.

The future of prosthetic grafts for AV access appears bright as new approaches and technology are being investigated. Modifications in already existing grafts or development of new graft materials are being developed in an attempt to improve primary and secondary patency rates and reduce complications. Some grafts have also been upgraded with a silicone layer within the PTFE to allow early cannulation and to reduce needle hole bleeding.<sup>23</sup>

In this clinical case the use of a Hybrid Graft followed by simple graft and then early cannulation graft interpositions was described. Hybrid Grafts have hemodynamic advantages and also the possibility of anchoring its distal zone on what is expected to be a difficult surgical access region. Limitations come normally from the size of the graft that is 6 mm (according to the currently commercially available grafts) and of the outflow veins that should be larger than 4 mm. Other disadvantages are related to the published prosthesis infection rates that are around 7% and make this, together with the degradation at the puncture site, a long-term concern. On the other hand, early cannulation grafts allow an almost immediate cannulation and hemodialysis preventing unnecessary placement of a central venous catheter. The prosthesis is inserted into the vein, and the suture line is created on the outside surface of the prosthesis and is not located within the bloodstream at the graft-vein juncture with hemodynamic improvements. Nevertheless, prosthetic grafts still have significantly higher thrombotic threshold velocities than autologous grafts and require a higher flow to maintain patency.<sup>24-32</sup>

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Differential diagnosis should include malignancy and a special attention to this pathology in the transplant-recipient population should be present.

*Despite mucormycosis being a rare infection, its prevalence is expected to raise together with increasing number and survival of the organ transplantation population as well as acquired immunodeficiencies. A high level of suspicion is recommended in the presence of the right clinical setting, as early diagnosis may be determinant for the prognosis.*

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