Mini Review

Interventional Cardiology

Current management of aneurysmal hemodialysis arteriovenous fistulas: Brief review

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Abstract

Chronic Kidney Disease (CKD) affects over 15% of adults in the United States, as estimated by the Center of Disease Control and Prevention in 2021. End-stage renal disease is the final and irreversible stage of kidney failure which requires renal replacement therapy. The growth in end-stage renal disease and the relative paucity of transplantable kidneys means that the need for dialysis access is significant. In 2020, only about 20,000 patients received an organ out of over 90,000 patients on the waiting list for a kidney in the United States. For those who didn't receive a kidney, many patients opt for hemodialysis. The prevailing theory of 'fistula first' persists, due to reported improved outcomes with fistulas compared to grafts, such as improved patency. There are however known chronic difficulties with fistulas, including aneurysmal degeneration, thrombosis or stenosis, infection, or steal syndrome. The aim of this review article is to go over current available management modalities for aneurysmal hemodialysis arteriovenous fistula and to discuss advantages and disadvantages of each modality based on the available literature.

Keywords: Chronic kidney disease; Arteriovenous fistulas; Aneurysmal degeneration; Aneurysmal formation

Introduction

Aneurysmal degeneration is a common reason for intervention, and management can include both endovascular and open techniques. Surgical options include aneurysmorraphy, bypass, or resection. The value of each is based on immediate surgical outcome, rates of postoperative complications, need for temporary dialysis catheters (as temporary catheter placement can cause undue risk to the patient related to catheter infection and overall patient morbidity and mortality), patency of the fistula, and need for further intervention. Here is reported a brief review of the current management of aneurysmal dilation of hemodialysis Arteriovenous Fistulas (AVF).

Literature Review

Aneurysmal formation of fistulas is relatively common, and results from degeneration of the involved vessel wall [1-4]. Incidence has been reported up to 6% [5], however, recent rates have been reported to be closer to 1.5%. This degeneration can be due to repeated cannulation of the same segment of vessel, or central venous stenosis causing increased fistula pressures [6]. This can impact flow rates during dialysis. The increased diameter of the aneurysmal vessel can cause localized discomfort, with negative aesthetics as well as reduced 'real estate' for vessel cannulation [7]. More concerningly, the overlying skin may become thinned out, with a very real risk of rupture with subsequent, and potentially fatal, bleeding.

Once degeneration of the vessel wall occurs, it is defined as aneurysmal once it reaches sizes greater than 18 mm [8]. However, size alone is not a criterion for repair-only when clinical symptoms such as pain, difficulty undergoing dialysis, or concern for skin integrity occur along with the aneurysm is repair indicated.

There are two existing classifications for arteriovenous fistula aneurysms. Balaz and Bjorck's classification, is based on the presence of a stenosis/thrombosis seen in ultrasound or fistulogram. Type 1 is a fistula aneurysm with no stenosis, while type 2 with significant stenosis (>50%) in either the inflow artery (2A), at the arterial anastomosis (2B), or along the cannulation zone (2C), or in the central vein (2D). Type 3 with partial thrombosis (>50% lumen), and type 4 with complete thrombosis. Valenti, et al., classification [9], on the other hand did describe four types based on the external appearance. Type 1 is a dilatation of the whole (1a) or the proximal aspect of the fistula aneurysm (1b), while type 2 has a "camel hump" appearance with at least one discrete aneurysm, type 3 is a complex and heterogeneous fistula aneurysm, and type 4 is a pseudoaneurysm. The main aim of these classifications is to allow standardization of terminology to facilitate communication in literature. However, none of the classifications has been used widely so far.

As with much of vascular surgery, both endovascular and surgical options are available. Endovascular stent grafts are able to be placed by accessing the fistula and placing an introducer sheath. One of the requirements for stenting is that there must be an adequate seal zone for the stent to be deployed safely and effectively; if this is not present, then a stent graft is unable to be used. Case series have demonstrated that endovascular stent grafts have excellent technical success rates as well as low incidence of temporary dialysis catheter placement. However, one recent comparison of open versus endovascular repair found that patients who underwent endovascular repair had higher rates of subsequent thrombosis and difficulty with cannulation, necessitating tunnelled dialysis catheter placement [10]. Follow-up patency rates after endovascular repair have been more variable, with patency ranging from 87% at 1 year to 36% at 6 months [11]. In particular, one study reported that patients required multiple additional procedures to ensure the patency of the stent grafts. One of the reported drawbacks to stent graft use for aneurysm exclusion is the subsequent slow resorption of the aneurysm, which can potentially lead to a decrease in the real estate available for dialysis puncture. One suggested novel method to combat this is the 'pave and pop' method, which suggests stenting the aneurysm plus also draining blood from the aneurysm at the time of the index procedure with a needle in order to speed resolution [12].

One of the benefits of endovascular treatment is that any associated central vein stenosis can be treated *via* angioplasty at the same time. This is a significant advantage to the use of endovascular methods to treat AVF aneurysms. However, additional studies have demonstrated a significant rate of serious complications after the use of endovascular stent grafts. This includes stent fracture and migration possibly resulting from continued growth of the aneurysm that is not properly sealed or due to the tortuosity of the fistula leading to the stent graft migrating back into the aneurysm sac. This stent graft fracture or migration can lead to erosion, graft infection, and in some cases, haemorrhage [13,14]. This was attributed as well to repeated punctures of the stent during dialysis. Most of the access sites suffering these complications were subsequently abandoned.

The other option for AVF aneurysm repair is surgical treatment. As described by Balaz, et al., [4], this can include aneurysmoplasty, plication, resection with graft, or ligation with bypass. Additional studies have also reported excision of the aneurysm sac with reanastomosis. A recent meta-analysis and review of the literature examined 13 studies, all of which reported aneurysmorraphy as the method of repair and demonstrated pooled primary patency at 12 months of 82%, supported by other studies reporting primary patency at 1 year of 86%, 77% [15], and greater than 90% [16]. Open repair with stent grafts tends to have decreased primary patency rates and may be associated with higher rates of infection and loss of access. Tunnelled dialysis catheters are not always needed after open procedures, as the fistula may be able to be accessed outside the operative field. However, rates of this vary between studies and appear to depend on the type and extent of repair and surgeon preference. Additionally, the advent of immediate use grafts such as Artegraft (North Brunswick, NJ) has demonstrated a decreased need for temporary dialysis catheters, and quick return to dialysis *via* the AVF [17]. Rates of postoperative complications, including hematoma and infection, are low.

Conclusion

In conclusion, Aneurysms arising in arteriovenous fistulas can have serious consequences, including loss of dialysis access and life-threatening haemorrhage. There are multiple ways to repair these when indicated, including open and endovascular techniques. Although studies using endovascular stent grafts tend to report high technical success rates, there are significant potential risks of stent use, such as stent migration or fracture, leading to haemorrhage, infection, and abandonment of access. The research is variable when it comes to the need for tunnelled dialysis catheters and primary patency rates, and several studies have reported the need for continued procedures to ensure continued fistula patency. The primary advantage of performing an endovascular repair appears to be the ability to simultaneously treat central venous stenosis during the same procedure. There is limited long-term data on the use of stent grafts, including patency and complication rates. For these reasons, endovascular stent graft repairs appear to be not as commonly performed. Open surgical procedures, and especially aneurysmorraphy, have good primary patency rates at one year. The need for tunnelled dialysis catheters is variable and depends on the type and extent of repair. Even for diffuse aneurysmal degeneration of the fistula, staged open repair can provide an opportunity for fixing the aneurysm without needing a temporary catheter.

An open procedure allows for repair using autologous tissue, which has a decreased risk of infection as compared to prosthetic repair. Reported postoperative complications appear limited. Moreover, an open repair can be done under local anaesthetic or regional block, which makes it available even for sick patients who can't tolerate general ANESTHESIA. Overall, the literature appears to favor the use of open surgical repair over endovascular repair. An ideal approach would be to take patient factors into consideration when designing a treatment strategy. Although there is data available on both endovascular and open repair, further consolidation and examination of this data using meta-analysis is needed in order to accurately compare the benefits and advantages of these two methods, including postoperative outcomes and complication rates. Long-term data is also needed.

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