

INTRODUCTION

Proper vascular access is a key factor in the treatment of children on hemodialysis (HD) and is represented by three variants: tunneled central venous catheters (CVLs), arteriovenous fistulas (AVFs), and arteriovenous grafts (AVG) that use biological or prosthetic material [1].

Recently, the European Society for Pediatric Nephrology Dialysis Working Group (ESPN Dialysis WG) developed a guideline with recommendations on choosing the type of venous access, preoperative evaluation, monitoring, and prevention of complications of different types of venous access in children with chronic end-stage renal disease (ESRD) [1].

Although in adult patients with HD the “fistula first” principle is recognized for vascular access, in children it is not yet widely applied. In a group of 552 children prospectively followed in the International Pediatric Hemodialysis Network (IPHN) Registry with 870 venous accesses, only 26% were AVFs, while 72% were CVLs [2]. CVLs allow for relatively easy mounting, immediate use, and needle-free dialysis, but have multiple disadvantages, including infections, thrombosis, and stenosis, that can lead to central vein obstruction and reduced chances of developing AVF in the future [3,4]. Although AVFs have a significant primary failure rate (25% in children [4] and up to 40% reported in adult patients [5]) and long maturation times, and require highly experienced vascular surgeons, they have the advantages of a lower rate of infections, fewer hospitalizations, and greater longevity than CVLs.

Although microvascular surgery techniques allow the creation of an AVF at body weights < 10 kg, the Kidney Disease Outcomes Quality Initiative (K-DOQI) guidelines still recommend that it be performed at a weight > 20 kg in patients under 19 years of age who are not expected to receive a kidney transplant in the following year; vascular access should be created approximately 3 months before the estimated time of AVF use [1]. Many variables are cited as causes of primary AVF failure, but initial vein diameter appears to be the most important predictor of fistula maturation [6]. A study that included 83% radiocephalic AVFs showed that even low body weight was an independent predictor of primary failure [7].

One of the main complications of AVF is the formation of aneurysms in the fistula vessels. Given that the purpose of creating a fistula is to achieve vascularization of increased caliber, defining an aneurysm in this situation is difficult. Pseudoaneu-

rysm generally occurs at the puncture site or anastomosis and is a hematoma that communicates with the vascular lumen of the fistula. Over time, it may develop a fibrous sac without endothelium or vascular wall structures. True aneurysms are harder to define; the proximal fistula artery dilates and remodels in response to increased blood flow, and the vein of the fistula increases its diameter at least three times until maturation. Most AVFs have a sinuous trajectory and are asymmetrically dilated (Figure 1). Pasklinsky and colleagues described as aneurysms the dilation of the vessel to at least three times the diameter of the native vessel, with a minimum size of at least 2 cm [8,9]. Rajput et al. defines an aneurysm as a focal dilation of the AVF vein up to a diameter at least two times larger than the adjacent normal venous segment of the AVF [10].

While pseudoaneurysms are primarily a result of surgery, infection, or puncture followed by prolonged bleeding, the cause of aneurysms is less clear. Repetitive puncture leads to multiple fibrous scars in the vessel wall, which can expand over time to form localized aneurysms. With the appearance of these aneurysmal areas, the increased blood flow increases parietal stress, favoring eccentric remodeling and additional increase in vessel diameter [11]. Aneurysms may occur upstream or downstream of stenoses present in the AVF.

The natural evolution of aneurysms is usually benign, with a low risks of rupture or to affect functioning of the fistula. The risk of rupture should be considered only in case of a rapid increase in size, local pain, infection or change in the overlying skin. These changes can cause a subcutaneous rupture or a free rupture of the skin [12]. If an aneurysm has ruptured or is at imminent risk of rupture (with ulceration or local infection of the skin), emergency ligation is required. Depending on the anatomy of the fistula, AVF can be saved, but in these situations priority is given to the prevention and control of life-threatening hemorrhages. In less urgent situations, the therapeutic options are surgical or interventional. Endovascular techniques have been used in the treatment of AVF aneurysms and have relied on the use of a coated stent or stent-graft to rule out the aneurysm, but this technique compromises subsequent puncture in the stented area [13-15].

AIM

The objective of the study was to evaluate complications of vascular access in children on long-term hemodialysis by arteriovenous fistula or by central venous line.

vein thrombosis that required its change. In 8 patients (38%) of the 21 patients using CVLs, thrombotic occlusion of at least one deep vein was observed at 3 months after the removal of the CVL from that venous axis.

DISCUSSION

Kidney transplantation is the first option for children with ESRD. Published data show that in children requiring hemodialysis, vascular access through CVLs is most commonly used. Although performing an AVF is not as easy as installing a CVL and an AVF takes time to mature before it can be used, the AVF should be considered the optimal method of vascular access in the absence of an imminent transplant. The main reason for performing AVF in these patients is the small size of the vessels, although there are studies that encourage performing AVF at a vein diameter of 1.5-2.5 mm [16]. In the group of patients presented in this paper, patients were accepted for AVF at a vein diameter of at least 3 mm, and this probably contributed to the high rate of primary maturation (86%), mostly similar with the results of a multi-center pediatric HD cohort study of Midwest Pediatric Nephrology Consortium in 2019 [17]. Primary patency was 72,7% at 18 months, higher than reported in a retrospective study of 47 patients published in Korea (2016) which reveal a primary patency of 60,5% at 1 year [7]. In contrast with this study, in our group the first choice in the majority of patients (64%) was brachiocephalic fistula versus radiocephalic (18%), in most cases the decision being supported by small diameters of radial artery and distal cephalic vein. In the Korean study radiocephalic fistula was performed in 82,7% of patients, and the minimum venous size diameter was only 2 millimeters. In this context, our data support the idea that a larger venous size diameter at the time of creation of AVF is related with a higher rate of primary patency. Aneurysms were present

in 27% of patients with AVF, all of them having uncontrolled high blood pressure; there are no specific data regarding the incidence of aneurysm in pediatric population with AVF; in adult population, the incidence of aneurysms is reported to be high (43,5%) in a narrative review of the published literature [18].

It is anticipated that the large-scale implementation of the current recommendations (2019) of the European Society of Pediatric Nephrology, which recommend a scheduled AVF approximately 3 months before use, will increase both the skills of vascular surgery specialists and the number of children who will benefit from this type of vascular access, to the detriment of central venous lines.

CONCLUSIONS

This study revealed several essential points for the prevention and treatment of AVF complications. Performing additional imaging (angio-CT for major deep veins in the area of interest) before performing an AVF in children who have had multiple central venous catheters may reveal occlusive/nonocclusive thrombosis in large venous trunks. These may contraindicate performing an AVF or indicate a different location for the AVF than was planned, or bypass surgery of the thrombosed segment. Effective control of hypertension can reduce the rate of formation and progression of AVF aneurysms. Use of a monitoring algorithm that includes periodic clinical follow-ups along with vascular ultrasound in these patients can ensure early detection of aneurysms/pseudoaneurysms, their progression rate, and the appearance of venous stenoses or thrombosis and enable timely treatment. Access to an interventional cardiology/radiology service with skills in performing endovascular procedures on arteriovenous fistulas (dilation of vascular stenoses, implantation of stents/stents-grafts to exclude aneurysms etc.) can be a major benefit in selected cases.



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