Trainee Forum

Stenosis in hemodialysis arteriovenous fistula: Evaluation and treatment

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Abstract

Vascular access complications are one of the main causes associated with an increase in morbidity and mortality in stage 5 chronic kidney disease patients. The arteriovenous fistula is regarded as the vascular access of choice for hemodialysis (HD) because of its superior patency and lower complication rates. Stenosis is considered the major cause of dysfunction of arteriovenous fistula. Despite the relatively low thrombosis rates of arteriovenous fistula, surveillance programs are necessary for detection of stenosis. We report a case of a HD patient who had never achieved an adequate Kt/V since the start of maintenance HD. During the investigation, abnormal findings were found on physical examination of the fistula, in addition to an alteration in intra-access pressure (IAP) measurements. A venous stenosis was diagnosed by Doppler ultrasound and then promptly treated with percutaneous transluminal angioplasty. The purpose of the discussion is to highlight the peculiarities of arteriovenous fistulae, methods of surveillance, including physical examination, IAP, recirculation, and measurements of blood flow, and the importance of the correction procedures for the stenosis.

Key words: Arteriovenous fistula stenosis, surveillance methods, stenosis correction

Nephrology Training in Evangelic University Hospital of Curitiba, Brazil

Two years of residency in Internal Medicine is a requirement for acceptance in a Nephrology Training Program, which usually lasts another 2 years. Certification in Nephrology is not mandatory when the Nephrology Training Program is accredited by the Department of Health and Education. However, the Brazilian Society of Nephrology certifies nephrologists through a national board examination. This suffices for entering private practice, although progression in academic medicine generally requires a Masters or a PhD degree. The first year of nephrology training usually involves rotations through clinical nephrology and teaching activities: journal clubs, and clinical and pathology conferences. In the second year, in addition to the foregoing, there is training in transplantation, peritoneal dialysis, and hemodialysis (HD). Trainees learn to place central venous lines and peritoneal catheters for acute HD and peritoneal dialysis, respectively. Kidney biopsies are also learned under supervision.

The division oversees around 500 patients from 3 dialysis clinics, and 130 of these patients are treated with chronic peritoneal dialysis. Our transplant program performs between 75 and 90 kidney transplants a year and has cumulatively performed close to 1000 procedures. Acute complications from this pool of dialysis and posttransplant patients are managed at our University Hospital.

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With one of the largest emergency rooms in town, our University Hospital receives several sick patients, providing a good opportunity for management of acute renal failure.

Training in HD

In the first year of fellowship, the trainee is involved with HD treatment for inpatients, including those in intensive care units. In our unit, the most commonly used method to treat acute renal failure is extended daily HD followed by continuous veno-venous HD. Last year, we reached an average of 60 HD procedures per month in the intensive care units.

The training in outpatient HD occurs in the second year of the Nephrology fellowship and lasts for 1 year. The university division involves 120 in-hospital outpatients and 250 patients in an outpatient unit. In this rotation, the trainee is under the supervision of the chief HD attending, who is also responsible for sessions and orders in unit. Twice a week, the trainee is obligated to organize conferences about aspects of maintenance HD, bone disease, cardiovascular disease, anemia, nutrition, and vascular access. In this same rotation the trainee is responsible for inpatients who are undergoing maintenance HD.

Interventional nephrology training program

An interventional nephrologist is a nephrologist who performs interventional procedures essential to the management of patients with renal disease. Initially, nephrologists only performed kidney biopsies and inserted temporary dialysis catheters. Later, they started to insert peritoneal dialysis catheters, and recently, started performing interventional radiologic procedures including permanent tunneled catheter placement, angioplasty, and thrombolytic procedures in AV fistula and AV graft. The subspecialty originated, has developed, and continues to grow with the support of the American Society of Diagnostic and Interventional Nephrology and the Interventional Nephrology Committee of the International Society of Nephrology.

In 2005, a formal Interventional Nephrology Training Program was offered at our institution and is perhaps the first of its kind in Latin America. It was offered to and accepted by 3 renal fellows who had completed their 2-year Nephrology Fellowship. The program, intended to last 1 year, involves 4 modules: ultrasonography, vascular access, peritoneal dialysis access, and urology.

The ultrasound rotation consists of both lectures and hands-on training. It includes ultrasound physics and instrumentation and basic ultrasound interpretation, with the remainder of the time devoted exclusively to performance and interpretation of kidney, bladder, and renal transplant ultrasounds, and kidney biopsy procedures. It has an optional rotation on color Doppler ultrasound training for vascular access, renal arteries, and renal transplants.

The vascular access module involves all aspects of vascular access in this population: placement of temporary and permanent venous catheters, methods of surveillance, fistulography, and treatment of failing and failed arteriovenous fistulae by percutaneous transluminal angioplasty (PTA). Native arteriovenous fistula (AVF) constitutes around 80% of vascular access seen in our country.

During the PD access rotation, the trainee will learn the 3 techniques of placing permanent PD catheters: dissection (surgical technique); peritoneoscopic techniques using a small peritoneoscope to inspect the abdomen and a surrounding spiral guide to advance the catheter into the abdomen and the cuff into the musculature; and blind techniques using a needle, guide wire, dilator, and split sheath (Seldinger techniques), or using a trocar and a rigid guide.

In the urology rotation, which should be incorporated into all clinical nephrology training because of its importance in solving rapidly nephrourologic problems, the trainee learns about nephrostomy techniques (radioscopic or ultrasound guided), endourological procedures, and extracorporeal shock wave lithotripsy.

CASE REPORT

A 47-year-old man on maintenance HD was referred to our Interventional Nephrology Team in August 2005 because of a high negative prepump pressure during HD sessions. A radiocephalic fistula in the right forearm had been placed in April of the same year and HD had been initiated in May 2005. An adequate Kt/V had never been achieved since the start of HD. The AVF was being punctured by the “buttonhole technique” with a 15-gauge needle but blood flows above 350 mL/min led to a collapse of bloodlines.

Clinical evaluation

On physical examination of his AVF, a hard “waterhammer” pulse was found in the initial segment of the vein. When his arm was elevated above the level of the heart,
there was only a partial collapse of the vein segment (Figure 1). On examination of the entire length of the fistula, it was clear that the pulse as well as the caliber of the vein diminished abruptly at a point downstream from the anastomosis. At this point, an increase in the intensity of the thrill was found. The AVF was occluded manually several centimeters from the site of the anastomosis and no augmentation of the pulse was observed.

In our unit, we also routinely measure intra-access pressure (IAP) and venous dynamic pressure (VDP) every 2 weeks. The IAP is measured through a digital pressure meter and is normalized for mean arterial pressure (MAP) in the arterial (aIAP/MAP) and venous (vIAP/MAP) puncture sites. Venous dynamic pressure is measured according to the K/DOQI Protocol.\(^1\) The aIAP/MAP and vIAP/MAP from the last measurement were 0.12 and 0.11, respectively, and the VDP was 90 mmHg. Upon repeat evaluation, they were 0.12, 0.10, and 95 mmHg, respectively. Both tests (physical exam and decreased IAPs) suggested some venous stricture, possibly in the initial segment of the vein (juxta-anastomotic region).

**Radiological evaluation and procedure**

On the same day as the evaluation of the access pressures, we evaluated the AV fistula by a color Doppler ultrasound (Esaote Megas CVX, Genoa, Italy) with a linear 10-5 MHz probe. A stenosis was found 3 cm downstream from the anastomosis, causing more than a 50% reduction in internal diameter (significant stenosis) (Figure 2). The examination revealed a blood flow of 310 mL/min.
On the next day, an angiogram was performed. The AV fistula was cannulated using a micropuncture needle. A micropuncture wire was inserted into the vein and was used to introduce a 5 F dilator. Contrast was injected through this dilator to visualize the fistula and draining veins. The entire venous drainage up through the central circulation was evaluated. By occluding the fistula downstream (proximal) from the tip of the dilator, the vein, anastomosis, and distal artery were visualized (retrograde injection). There was no demonstrable arterial or central vein stenosis. The angiogram revealed a stenosis (greater than 50% decrease in lumen diameter) 3 cm downstream from the anastomosis (Figure 3A). During the course of the same examination, a percutaneous angioplasty (PTA) was performed. The guidewire was passed retrogradely in the direction of the anastomosis. A 4 mm balloon was inflated to provide 30% overdistalation of the vein. This resulted in successful dilatation of the venous stenosis (Figure 3B). Immediately after the PTA, the blood flow observed by color Doppler ultrasound was 860 mL/min. During the next HD session, the a1AP/MAP and v1AP/MAP increased to 0.25 and 0.23, respectively. The next month, the patient achieved a Kt/V of 1.22, and the AV fistula has been functioning well since then.

DISCUSSION

The native AVF is regarded as the vascular access of choice for HD patients because of its superior patency and lower complication rates, once it has fully matured. Despite the relatively low AVF thrombosis rate, existing guidelines advocate surveillance programs for early detection of stenosis and its correction before thrombosis occurs, to reduce morbidity and prolong access patency. Schwab et al. reported a decrease in AVF thrombosis rate from 0.16 to 0.07 per patient per year using a surveillance program and correction of AVF stenosis by PTA.

The main purpose of vascular access monitoring and surveillance programs is the early identification of stenosis, because it is the main cause of AVF dysfunction and thrombosis. A critical reduction of blood flow is often the final event that leads to the thrombosis of the fistula. The pathophysiology underlying the occurrence of stenosis is complex. It includes cellular proliferation, microvessel formation, and cytokine expression (perhaps the key factor) by smooth muscle cells, endothelial cells, and macrophages. The cytokines result in further activation and proliferation of these cell types, ending in venous neointimal hyperplasia. Potential mediators that have been suggested to play a role in this process include basic...
fibroblast growth factor (bFGF), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), and extracellular matrix (ECM) proteins. Even though these mechanisms have been studied largely in models of AV grafts, it is possible that the same mechanisms may be involved in the occurrence of stenosis of the AVF.

An early AVF failure is a term used to characterize a fistula that has never been cannulated or has failed within 3 months of use. The major cause of early fistula failure is juxta-anastomotic stenosis (JAS). The segment of the vein mobilized for anastomosis is susceptible to stenosis, either because of technical issues related to surgical procedure (kinking, axial rotations, adventitial bands), vein devascularization, increased vein turbulence, or shear stress. Other causes of early AVF failure may include accessory veins, atherosclerotic disease, arterial stenosis, anastomotic stenosis, and fibrotic veins. Beathard et al. have reported that venous stenosis was the cause in 78% of all cases with early AVF failure and of these, 43% were in the JAS location. Some studies, using other definitions of early failure, reported that the incidence of early failure was more common in forearm fistulas than in upper arm fistulas and in brachiocephalic fistulas and in brachiobasilic fistulas.

Late failure is defined as the failure of an AVF that occurs after 3 months. Stenosis is still the most common cause. Fortunately, venous stenosis in the downstream segment does not occur in AVF with the same degree of frequency as in grafts. Unlike the case with grafts, venous downstream stenosis in AVF develops more centrally at areas of vein bifurcation, pressure points, and in association with venous valves.

The NKF-K/DOQI guidelines for vascular access recommend the use of vascular adequacy parameters and physical examination for monitoring AVF and AV grafts. The methods for surveillance of AVF are summarized in Table 1. Unexplained decreases in delivered dialysis dose, as measured by Kt/V or urea reduction ratio, may be associated with vascular access dysfunction. An AVF that does not support a pump flow above 350 mL/min because of decreased flow will become ineffective, and recirculation problems will occur. Prolonged bleeding after removal of the needles from puncture sites may occasionally be an indicator of elevated IAP (in the absence of excessive anticoagulation).

Physical examination is a forgotten tool for vascular access monitoring in HD units. The observation that an experienced nurse of the HD team can predict the ultimate adequacy of a fistula with 80% accuracy simply through physical examination, and that the major causes of AV fistula failure can be identified by physical examination, suggests that this is an easy and cost-effective method of monitoring AV fistula. Everyone on the HD team should be trained to recognize fistula problems on physical examination. In our HD unit “fistula rounds” are performed every month. As part of this practice, it is necessary to obtain and record the information about the date of creation of the AV fistula, its location, vessels involved, and past history of treatment (PTA or surgical) in the patients chart.

The first step of such an examination is to evaluate the anastomosis. The 2 most important components of anastomosis examination is the thrill, which is an indicator of flow, and the pulse, which is an indicator of downstream resistance. Another component that can be evaluated is the bruit. Normally, the thrill and the bruit are prominent near the anastomosis and they are both present in systole as well as early diastole (continuous). The presence of stenosis reduces the blood flow and this, in turn, reduces the strength of the thrill. If stenosis is present at a point away from the anastomosis, the intra-access resistance rises and the flow may occur only during systole. In this situation, the thrill and bruit will be found only in systole (not continuous). With regard to the pulse, it must be soft. If it is forceful, like a “water-hammer” pulse, this often suggests the presence of stenosis. The intensity of the hyperpulsatility is proportional to the severity of the stenosis.

The second step is to examine the entire length of the AV fistula. Moving up the vein away from the anastomosis, the thrill and bruit gradually diminish. An increase in the strength of the thrill or a new palpable thrill downstream from the anastomotic site suggests the

Table 1. Methods of surveillance for arteriovenous fistula (AVF)

<table>
<thead>
<tr>
<th>Clinical evaluation</th>
<th>Physical examination</th>
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<tr>
<td></td>
<td>Kt/V</td>
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<tr>
<td>Bleeding time</td>
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Recirculation

- Static access pressure
  - Arterial intra-access pressure
  - Venous intra-access pressure
- Dynamic venous pressure
- Blood flow measurement
  - Doppler ultrasound*a
  - Ultrasound dilution*a
  - Hematocrit dilution
  - Thermal dilution
- Conductance dilution

*aThe most used methods for measurement of blood flow.
The presence of a stenosis. The pulse should be soft and compressible as in the anastomosis. The pulse becomes hard in the presence of a body stenosis. An important maneuver to evaluate the pulse is to elevate the arm above the level of the heart. Normaly, the pulse may collapse with arm elevation. If it does not, the IAP must be high and the significant stenosis may be the cause. In this case only the segment upstream from the stenosis does not collapse but the downstream segment does collapse. This is a good clue to find the location of the stenosis.

An important cause of early AV fistula dysfunction is the presence of accessory veins. They must be distinguished from collateral veins, which are pathological and develop in the presence of stenosis. The development of AV fistula depends on the inflow pressure and the resistance of draining veins. This resistance is decreased in the presence of side branch vessels (accessory veins), thus limiting the maturation of the AV fistula. Accessory veins may be single or multiple, but not all apparently decrease blood flow. An accessory vein that is less than one-fourth the diameter of the main vessel is unlikely to prove to be significant. When the fistula is occluded proximally, the thrill at the fistula should disappear. If it does not, an accessory vein may be providing an outflow channel. In this setting, palpation of the main vein below the site of the manual occlusion will reveal a thrill at the site of the accessory vein.

The third and last step on physical examination is to check for pulse augmentation. With one hand, the body of the AV fistula is manually occluded proximally and with the other hand the pulse is palpated next to the anastomosis. With this maneuver, the pulse must become hyperpulsatile. If the pulse augments poorly, it is an indicator of low inflow. In this case, the arteries, anastomosis, and juxta-anastomotic region should be evaluated. In cases that the pulse is already hyperpulsatile, the maneuver of pulse augmentation can be used to assess the severity of the stenosis. If there is no increase in pulse intensity, it means that the stenosis is severe, comparable with total occlusion. In contrast, when the intensity increases, the stenosis must be of lesser degree.

Physical signs as swelling in the access arm and multiple subcutaneous collateral veins at the neck, shoulder, and upper chest are highly suggestive of central vein stenosis. It is important for the examiner to realize that not all central vein stenoses cause these signs. It generally appears soon after access placement and is associated with a previous history of central venous catheter.

As for surveillance in AV grafts, the NKF-K/DOQI recommends the use of intra-access (static) and dynamic venous pressures, and measurements of recirculation or flow for detecting AV fistula in risk of thrombosis. The problem is that the major studies using these methods of surveillance were conducted in patients with AV graft until the publication of NKF-K/DOQI guidelines, and there are some characteristics that differentiate AV fistula from AV graft.

In AV fistula, the IAP falls to about 20% of the systemic arterial pressure in the initial segment used for arterial needle puncture. However, in a well-functioning AV graft, the systemic arterial pressure is dissipated across the 2 anastomoses: 45% at the arterial and 25% at the venous end. In dysfunctional AV fistula, the IAPs tend to be lower than in grafts, making it more difficult to detect an appropriate increase. Notwithstanding the differences in pressure profiles between AV fistula and AV graft, access flow rates tend to be quite similar when compared with similar anatomic locations. When a stenosis develops in an AV fistula, the IAP may be stable because collateral channels (accessory or collateral veins) permit exit of the inflowing blood. Consequently, the flow in upstream segment may not change. Thus, it is important to identify these side branch veins in physical examination. By contrast, when stenosis develops in any segment of AV graft the flow invariably decreases, because there are no collateral channels to dissipate the inflowing blood.

As discussed above, theoretical considerations suggest that the measurement of IAP in AVF may not be as useful as for AV grafts. However, this has not been validated in clinical studies. For a reliable measure of IAP, it must be normalized to MAP(IAP/MAP). It should be measured both at the arterial puncture site (aIAP/MAP) and venous puncture site (vIAP/MAP), because vIAP/MAP alone may fail to detect lesions located between the needles and in the juxta-anastomotic area. The indirect technique for measuring IAP uses HD machine equipment. This technique uses the pressures from arterial prepump and venous postpump drip chambers when the blood pump is turned off. The height distance from the AVF to the upper meniscus of the blood drip chamber is measured, converted into mmHg, and then added to the IAP value. Nevertheless, this methodology is prolonged, requiring 11 separate steps to assure accuracy. To simplify the process, the IAP can be measured directly. A device, called Access Alert® from Medisystems (Medisystems Corporation, Seattle, WA, USA), achieves this as it joins the sterile AVF needle to an aneroid pressure meter via a tubing (Figure 4A). Alternatively, as mentioned earlier, we measure IAP using a digital pressure meter with a filter to avoid contamination of the puncture needle (Figure 4B). As distinct from the AV grafts (where the vast majority of lesions are located at the venous anastomosis), the most...
common lesions in AVF are in the juxta-anastomotic region or in the body. It then follows that while the vIAP/MAP may be as important as aIAP/MAP for the detection of stenosis in AV grafts, in the case of AVF vIAP/MAP will be probably normal in the absence of outflow stenosis. Thus, the measurement of aIAP/MAP is more important in the prediction of stenosis in AVF. Besarab et al. proposed normal values of IAP/MAP in AVF: 0.13 to 0.43 at the arterial site and 0.08 to 0.34 at the venous site (Table 2). However, there are no studies in AVF using IAP as a method of surveillance for detection and preemptive correction of stenosis. Thus, IAP monitoring cannot be recommended as the only method for surveillance of AVF at this time. Perhaps, a hybrid program with other methods may be the choice.

Dynamic venous pressure can be measured during the first 2 to 5 min of a HD session after reducing the pump flow to 200 mL/min. Although commonly used, it should be abandoned as its utility is limited, as it can change with changes in hematocrit as well as the gauge of the needle. Moreover, its value lies in the detection of lesions that cause elevation of resistance at the outflow segment and, thus, it is more useful as a method of surveillance for AV grafts than AVF. Measurement of recirculation, on the other hand, becomes a more useful screening tool for AV fistula than in AV graft because blood flow in AV fistula, unlike AV graft, can decrease to a level less than the prescribed HD machine pump flow (<300 mL/min), while maintaining access patency.

Quantitative measurements of blood flow have proven to be the most sensitive predictor method of surveillance for impeding thrombosis in AVF. The NFK-K/DOQI recommends that vascular access with blood flow less than 600 mL/min or less than 1000 mL/min that has decreased by more than 25% over 4 months should be referred for a fistulogram. Unfortunately, this report did not make a distinction between AV fistula and AV graft. It is well known that AV fistula can remain patent even with flows below 300 mL/min. The Canadian Guidelines for vascular access recommend investigation of an AV fistula.

Table 2 Criteria for referring patient for angiography/intervention using intra-access pressure in AVF (Adapted with permission from Besarab A et al. Detection of access strictures and outlet stenoses in vascular accesses. Which test is best? ASAIO J 1997;43:M543-47)

<table>
<thead>
<tr>
<th>Stenosis degree</th>
<th>aIAP/MAP</th>
<th>vIAP/MAP</th>
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<tr>
<td>&lt;50%</td>
<td>0.13 to 0.43</td>
<td>0.08 to 0.34</td>
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<tr>
<td>&gt;50% in:</td>
<td></td>
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<tr>
<td>Venous outflow segment</td>
<td>≥ 0.44 or &lt;0.44</td>
<td>0.35 or &lt;0.35</td>
</tr>
<tr>
<td>Mid-segment</td>
<td>≥ 0.44 and &lt;0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>Arterial inflow segment</td>
<td>&lt;0.13+clinical signs</td>
<td>clinical signs</td>
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Pressures are normalized for mean arterial pressure at the arterial puncture site (aIAP) and at the venous puncture site (vIAP). An increase in the ratio of 0.2 units over time is also indication for evaluation.
with flows less than 500 mL/min or a fall in access flow greater than 20% of baseline. A comprehensive analysis of the relationship between flow, stenosis, and thrombosis is lacking in AV fistula and is essential to the determination of an optimal access protocol.

There are several noninvasive techniques for measuring blood flow: Doppler ultrasound, ultrasound dilution, hematocrit dilution, thermal dilution, and conductance dilution. Doppler ultrasound can be used to measure the velocity of blood flow and if the cross-sectional diameter is known, the volume of blood flow can be calculated. Nevertheless, this method may have inaccuracies because of operator error, turbulent blood flow, and variability in the cross-sectional diameter of AVF. Its advantage is that this examination is useful in the evaluation of vascular access anatomy and in determining the location and grade of stenosis. Some studies have reported that blood flow measured by Doppler ultrasound is a reliable indicator of subsequent short-term thrombosis risk in AV grafts and AV fistula. In the study by Bay et al., the procedure proved beneficial only for AV grafts.

The most widely used technique to measure blood flow in HD vascular access is the ultrasound dilution method using the Transonic HD01 System (Transonic Inc., Ithaca, NY, U.S.A.). The technique was originally described by Krivitsky et al. and then validated in many studies, as a safe method for the detection of stenosis and consequently is recommended as a method of surveillance to reduce the thrombosis rate. In this technique, the access blood flow is measured during an HD session. To perform the access flow measurement, the blood pump is stopped and the arterial and venous bloodlines are reversed from their normal position. Photometric flow sensors, which are connected to an electronic flow meter, are clipped onto the reversed arterial and venous bloodlines. The HD pump is restarted at a fixed blood flow, usually 200 mL/min, and a saline bolus (5 mL) is injected into the reversed venous bloodline. The saline mixes with the blood flowing through the access and is detected by the sensor on the arterial line. The data are collected on a laptop computer, and blood flow values are calculated and recorded. It basically measures the blood flow by the difference of saline concentration between the 2 sensors, correcting for a time factor.

The preemptive treatment of stenosis in AV grafts and AV fistulas (before their thrombosis) contributes to the reduction in the morbidity and mortality of patients who need chronic renal replacement therapy. After thrombosis, the salvage of vascular access becomes more difficult. With the passage of time, the thrombus can become more resistant to thrombectomy. A temporary central catheter raises the risk of infections and hospitalizations. These procedures also increase costs. All these disadvantages have an enormous effect on the quality of life of end-stage renal disease patients.

The NFK-K/DOQI guidelines recommend that each dialysis center should determine which procedure for the correction of stenosis (PTA or surgery) is best for the patients, based on the expertise at that center. There is no randomized prospective study comparing the correction of AV fistula stenosis by PTA or surgery. One retrospective study comparing both methods reported a prolonged patency rate with PTA over surgical correction in the treatment of stenosis and occluded AV fistula. Uncontrolled, published data do not indicate a preferred technique for the treatment of AV fistula stenosis.

Access stenosis should be treated if stenosis is ≥ 50% and is associated with abnormalities such as previous thrombotic episodes, elevated IAP, abnormal recirculation, abnormal physical signs, unexplained decrease in adequacy dialysis parameters, and decreased blood flow. The procedure is classified as successful if there is less than a 30% residual lesion according to NFK-K/DOQI. Percutaneous transluminal angioplasty has become a standard treatment for the correction of stenosis in AVF and AV graft. The technique has been demonstrated to be safe, easily performed, and effective. It has some advantages over surgical procedure: it is an outpatient procedure; it does not prohibit the immediate use of the access for dialysis; it has minimal to no blood loss; hospitalization is avoided; and rarely is there discomfort to the patient. The only disadvantage is that there are some lesions that do not respond to treatment and the results obtained are not permanent.

Increasingly, PTAs are being performed by interventional nephrologists who have shown that, with appropriate training, they can perform a major portion of the procedures that are necessary for access management. A report by Beathard and Litchfield with 14,067 procedures demonstrated that with academic training programs, interventional nephrologists can perform these procedures effectively and safely.

In conclusion, AVF dysfunction is an important cause of inadequate HD. Therefore, early detection of AVF dysfunction must be part of the HD patient’s care routine, especially in those who present an inadequate Kt/V. In this presentation, we reported a case whose investigation of AVF dysfunction, initially suspected by the presence of abnormalities in physical examination and IAP, was confirmed by the detection of stenosis on Doppler ultrasound and fistulogram. The early detection of AVF dysfunction by physical examination and improvements of Kt/V and
blood flow observed after correction of AVF stenosis through PTA show the relevance of establishing protocols of AVF surveillance in HD units.

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