14 Approach to an Arteriovenous Access with Hyperpulsatile Pulse

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Physical examination of dialysis vascular access is a skill easy to master and implement in clinical practice by everyone involved in the care of dialysis patients [1]. In the USA, the Centers for Medicare and Medicaid Services mandate all dialysis vascular access be examined before each treatment [2, 3]. Arteriovenous fistula (AVF) remains the preferred permanent dialysis vascular access. An established well-functioning AVF generally is less problematic when compared an arteriovenous graft. The common problems associated with an established AVF include (but not limited to) stenosis in the outflow and inflow segments, aneurysm formation in the body of an AVF, central vein stenosis, and infection. Stenosis is a relentless pathology that continues to progress unless diagnosed early for timely intervention with the currently available option of performing percutaneous endovascular angioplasty. Left untreated, stenosis will eventually progress to reduction of blood flow and thrombosis.

In order to perform a detailed physical examination of an AVF, it is essential to understand its basic segments. The different segments of an AVF are described earlier in the chapter – *Approach to Arteriovenous Fistula with Faint Thrill*. In this chapter, the approach to an AVF with hyperpulsatile will be discussed.

14.1 Defining Hyperpulsatile Pulse

The palpation of an AVF involves feeling for the pulsations and thrill. A normal fistula is soft, compressible with a soft continuous thrill all along its outflow segment.

In the presence of stenosis in the outflow segment, the pulsation in the segment distal to the stenosis has a strong bounding character, provided the inflow segment is widely patent (Fig. 14.1). The thrill in a hyperpulsatile outflow segment is diminished or absent.

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14.2 Etiology of Hyperpulsatile AVF

The hyperpulsatile pulse develops by and large due to the development of stenosis in the outflow segment with a patent inflow segment. The exact pathophysiology behind the development of stenosis is as yet unclear, but neointimal hyperplasia has been implicated in majority of cases [4]. Infrequently, in a high-flow fistula (defined as blood flow more than 2 L/min), the outflow segment may appear to be hyperpulsatile. The strong character to the pulse is because of a large volume of blood flowing through a small-capacity outflow vein. The upper arm AVF is more likely to feel hyperpulsatile due to high flows compared to the forearm AVF.

14.3 Clinical Findings Associated with Hyperpulsatile AVF

The hyperpulsatile AVF is often accompanied by various clinical findings that can assist in the diagnosis of outflow segment stenosis. Table 14.1 summarizes the clinical findings that are described in details below.

14.3.1 Arm Elevation Test

A simple arm elevation test can provide additional clinical finding to confirm outflow segment stenosis. In an AVF with a patent outflow segment with arm elevation, the entire outflow segment collapses. In the presence of outflow segment stenosis, the segment distal to the stenosis remains distended and firm (Fig. 14.2) [3].

14.3.2 Thrill

A thrill is the vibrations that are easily palpable over an AVF. A normal thrill is fine, continuous, and best felt at the arteriovenous anastomosis and transmitted along the outflow

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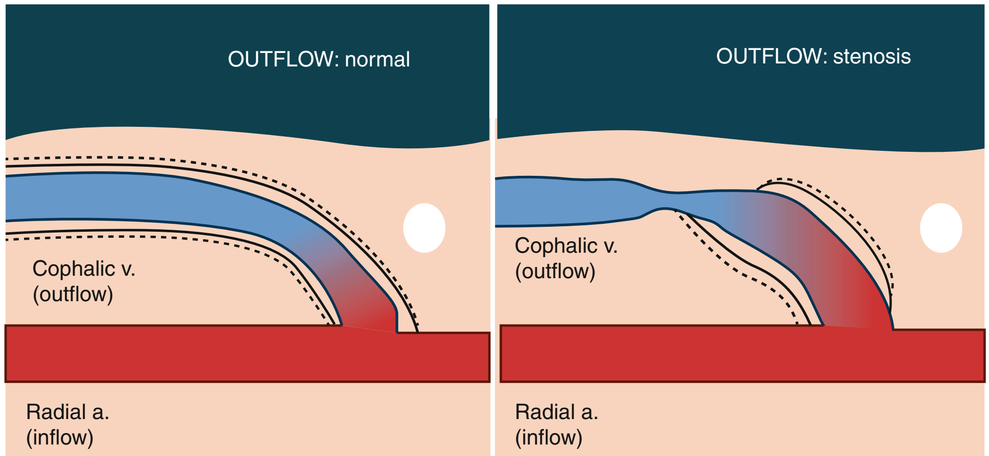

Fig. 14.1 Panel **a**: Normal outflow segment with a continuous thrill and soft pulsations. Panel **b**: Stenosis in the outflow segment with hyperpulsatile segment distal to the stenosis (shown with *dashed lines*)

Table 14.1 Clinical findings associated with hyperpulsatile pulse and outflow stenosis

1.	Arm elevation test – distended distal segment and flattened proximal segment
2.	Thrill – absent over the distal segment and strong over the stenotic segment
3.	Bruit – high pitched over the stenosis, occasionally with “whistle-like” character
4.	Prolonged bleeding from needle puncture sites
5.	Frequent dialysis venous alarms due to high venous pressures
6.	Development of aneurysms – if left untreated

segment. The vibrations over the stenosis are strong and easily palpable and tend to disappear as one moves the finger proximally along the outflow segment. The segment distal to the stenosis may not have any vibrations as the segment is firm and pulsatile.

14.3.3 High-Pitched Bruit

A bruit is the sound accompanying a thrill. A normal bruit is soft pitched and continuous during the entire cardiac cycle. In case of outflow stenosis, the bruit tends to be high pitched in character and is primarily heard during the systolic phase of the cardiac cycle. The bruit over a severely stenosed segment may have a “whistle-like” character that is very easy to identify [3].

14.3.4 Prolonged Bleeding

Besides presenting with a bounding pulse in an AVF, patients with outflow segment stenosis can present with prolonged bleeding when the dialysis needles are withdrawn after completion of treatment. The bleeding from the needle puncture site generally stops if adequate and appropriate pressure is applied for 10–15 min. In the absence of coagulation deficiencies (thrombocytopenia, therapeutic anticoagulation), if the bleeding continues for longer period, one needs to rule out outflow segment stenosis.

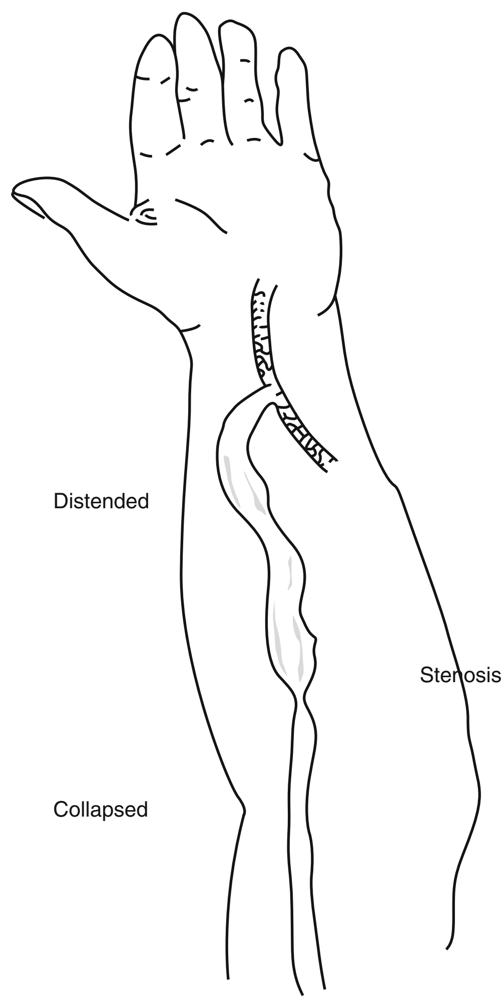

Fig. 14.2 Arm elevation test – outflow stenosis with distal distended segment and proximal collapsed segment (Reprint from www.fistulafirst.org)

14.3.5 High Dialysis Venous Pressures

The venous pressures on the dialysis machine remain elevated despite proper needle placement and in the absence of any kinks in the extracorporeal dialysis circuit. In the USA, the average blood pump speed is maintained at 350–400 mL/min with a well-functioning AVF. The venous pressure recorded with this blood flow is generally less than 200 mmHg. In the presence of stenosis, the high venous pressures cause the venous safety alarm to trip frequently stopping the blood pump.

14.3.6 Development of Aneurysm

The constant elevated back pressure causes the venous segment distal to the stenosis to dilate and lead to formation of an aneurysm.

14.4 Treatment Approach

Stenosis tends to progress unless treated in a timely manner. The progression of stenosis can lead to decrease in blood flow and eventual thrombosis and potential loss of an AVF. The algorithm in Fig. 14.3 outlines the common clinical approach to manage patients with hyperpulsatile AVF.

Regular and complete physical examination of an AVF before each dialysis therapy remains the corner stone for early diagnosis. Once the outflow stenosis is suspected on clinical examination, close attention to associated clinical findings can help confirm the clinical suspicion. The next step is to refer the patient for a fistulogram for possible endovascular intervention, which remains the current treatment of choice for most patients. Treating stenosis with percutaneous angioplasty involves minimal morbidity as compared to an open surgical treatment. Endovascular procedures can be safely performed in an outpatient setting with patient returning to regular dialysis treatment on the same day.

Venous outflow stenosis tends to recur and needs proper monitoring and surveillance protocols in place to prevent progression to thrombosis. Outflow stenosis that tends to recur at short interval (<3months) or with significant (>30 %) elastic recoil of intimal tissue may need to be evaluated for possible stent placement. The interventionalist performing these invasive procedures needs to be well versed with the current guidelines from KDOQI regarding the indications for stent placement. An example of recurring stenosis in a

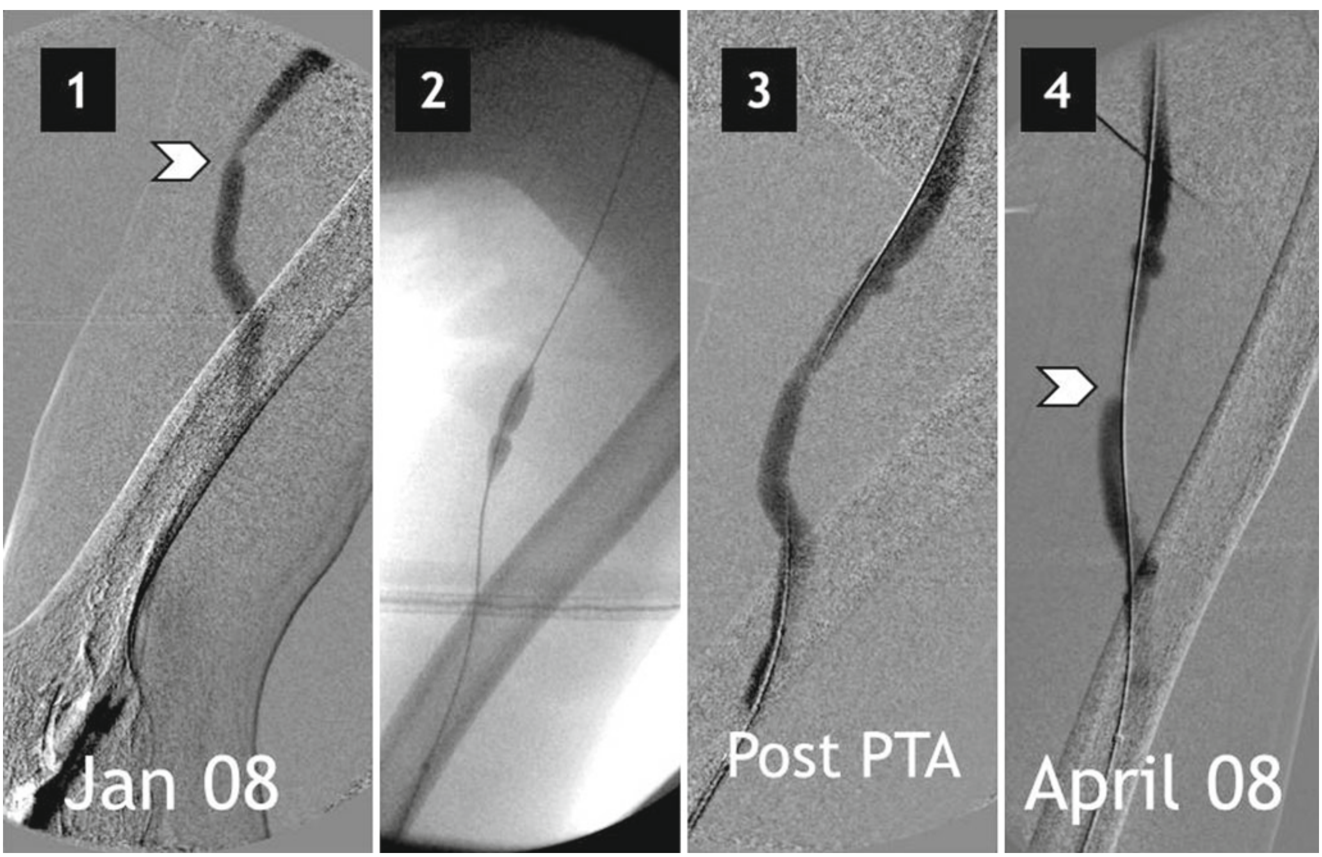

Fig. 14.3 Recurrent outflow stenosis (marked by *white chevron*) in a transposed basilic vein–brachial artery fistula in the right upper arm. *Panels 1*, *2*, and *3* show the successful outcome of percutaneous angioplasty. *Panel 4* shows the recurrence of the stenosis in 3 months

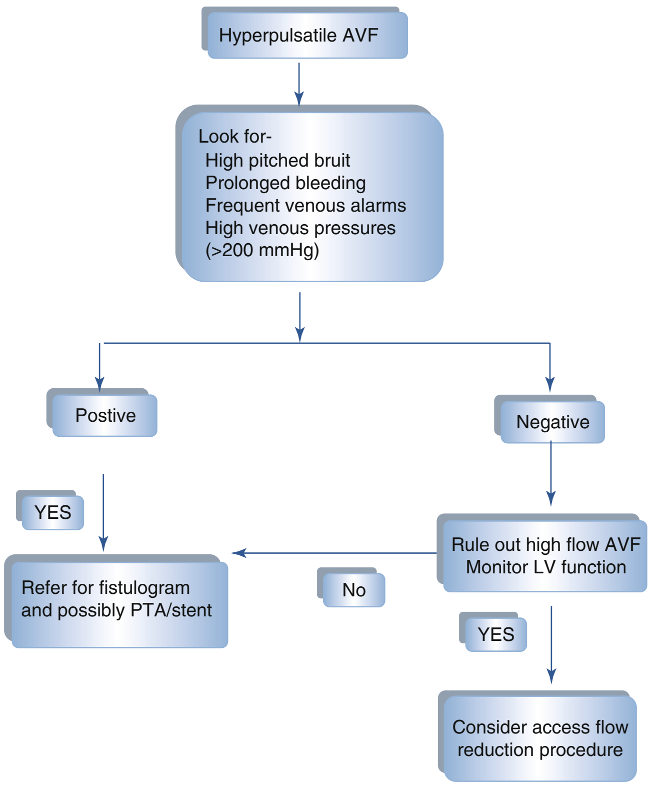

Fig. 14.4 Algorithm for management of hyperpulsatile arteriovenous fistula (AVF). *PTA* Percutaneous angioplasty, *LV* Left ventricular

transposed basilic vein–brachial artery AVF is shown in Fig. 14.4.

An upper arm AVF generally has a higher access blood flow compared to forearm AVF. The average blood flow reported in a study of 96 patients comparing access blood flow in the upper arm and forearm AVF was 1.58 vs. 0.94 L/min. An AVF with flows exceeding 2 L/min is considered to be a high-flow AVF. AVF with flows greater than 2 L/min can increase the risk of developing high-output cardiac failure [5].

Hyperpulsatile AVF without other clinical indications to suspect outflow stenosis can be due to high access flow. The measurement of AVF flow using either Doppler ultrasonography or transonic dilution technique can help confirm the diagnosis of high-flow AVF. Patients with underlying cardiac disease and poor left ventricular function with high-flow AVF may need further intervention to reduce the access blood flow. Patients at high risk of cardiac decompensation may benefit with procedures targeted towards reducing the access blood flow. In rare situation, an AVF may need to be ligated to preserve cardiac function.

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