# Accessory Vein Obliteration for Early Fistula Failure: A Myth or Reality?

Naveed Ul Haq, Mohammed Mahdi Althaf, and Timmy Lee

**Early fistula failure (EFF) is a significant clinical problem causing lower rates of arteriovenous fistulae (AVFs) use in patients with ESRD on hemodialysis. The 2 main factors amenable to treatment and widely accepted to cause EFF are stenosis anywhere in the AVF circuit and/or presence of accessory vein (*av*). The role of stenotic lesions in causing EFF and their treatment options are relatively better defined with clear guidelines. On the other hand, assessing the significance of an *av* in causing EFF and the indications for its treatment seem to lack scientific recommendations based on robust clinical data. In this article, we review the pathophysiology of EFF as pertains to the presence of *av's*. Current recommendations for obliteration of *av*, the available techniques and the evidence to support current clinical practice are discussed. The possible cons of *av* obliteration are highlighted, while newer concepts and the need for future clinical trials are addressed.**



**Key Words:** Accessory vein, Arteriovenous fistula, Early failure, Hemodialysis

## INTRODUCTION

Hemodialysis (HD) vascular access dysfunction is an enormous clinical problem, which results in significant morbidity among patients with ESRD, causing a severe economic burden on any health-care system.[1–3] Native arteriovenous fistula (AVF) is the preferred form of permanent dialysis access because it is associated with the best long-term outcome as compared with other forms of dialysis access.[4] Despite the clinical benefits, many patients on HD do not have AVF as their dialysis access. One of the reasons for low AVF rates is early fistula failure (EFF).[5–7] EFF is defined as an AVF that never develops adequately for dialysis (failure to mature) or which fails within 3 months of starting dialysis.[8] An adequate AVF for dialysis according to Dialysis Outcome Quality Initiative guidelines is the one which (1) has a flow of greater than 600 mL/min, (2) has a diameter of 0.6 cm or greater, and (3) is approximately not deeper than 0.6 cm from the skin surface.[9] Between 23% and 46% of newly constructed AVF have problems with early failure resulting in a dismal 1-year patency of 60% to 65%.[6,7,10] Recent data have emphasized that up to 60% of the fistula fail to mature, attain these parameters, and ultimately fail to support dialysis.[11]

The two most important causes for EFF amenable to intervention are stenosis anywhere in the circuit and/or presence of accessory vein (*av*).[8,12–15] Although stenosis development is pathological and *av* presence is natural, both lead to decreased blood flow through the main AVF circuit, which may be responsible for EFF. Addressing these two entities in a timely fashion can salvage many AVF's, which otherwise would have been abandoned.[8,14–17] Although management of stenosis is well established with relatively clear guidelines, the management of *av* lacks clear scientific approach. In this article, we review the pathophysiology of EFF as pertains to the presence of *av's*. Current recommendations for obliteration of *av*, the available techniques, and the evidence to support current clinical practice are discussed. The possible cons of *av* obliteration are highlighted while newer concepts and the need for future clinical trials are addressed.

## PATHOPHYSIOLOGY OF EFF AND THE ROLE OF *av*

To devise a strategy to prevent EFF, one needs to understand the physiology of fistula maturation. Creation of an AVF leads to an immediate increase in flow through the vein due to the pressure gradient created.[18–20] This increase in flow leads to increase in wall shear stress (WSS), which is defined mathematically by the formula $4\eta Q/\pi r^3$, where $\eta$ is blood viscosity, Q is blood flow, and r is vessel radius.[21] Shear stress thus is directly proportional to blood flow whereas inversely proportional to vessel diameter. After the creation of the AVF, the flow-mediated increase in shear stress is mitigated by vessel dilatation through biological mediators.[22] The health of endothelium in both vein and the artery and their compliance is an important factor for this outward remodeling to happen.[22] Consequently, the shear stress is brought back to pre-anastomosis levels leading to vessel dilation. It seems that this positive remodeling of the vein leading to AVF maturation is dependent on increase in blood flow rather than the increase in pressure.[23] Any pathology affecting the blood flow through the newly constructed AVF can thus lead to EFF.

Both stenosis anywhere in the AVF circuit including feeding artery and juxta-anastomosis area or presence of *av* can cause a decrease in blood flow through the main AVF circuit and result in EFF. Although the clinical significance of stenosis is better defined, with it being significant if >50%, the assessment of significance of an *av* lacks clear scientific approach. The issue at the center of *av* assessment

*From the Department of Medicine, Section of Nephrology, King Faisal Specialist Hospital & Research Center, Riyadh, Saudi Arabia; and Division of Nephrology and Hypertension, University of Alabama, Birmingham, AL.*

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*Address correspondence to Naveed Ul Haq, MD, FASN, Department of Medicine, Section of Nephrology, King Faisal Specialist Hospital & Research Center, Riyadh 11211, Saudi Arabia. E-mail: nulhaq@kfshrc.edu.sa*



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and subsequent treatment is to determine what size and other features (if any) of an *av* can cause EFF, either through blood flow reduction or by causing difficulty in cannulation as will be discussed later. In general, it has been anecdotally recommended that any *av* with diameter greater than one third of the AVF diameter should be considered for ligation. It is also suggested that the significance of an *av* can be ascertained by assessing the flow of contrast through the *av* during an angiogram or by assessing the augmentation of AVF after manually occluding the *av* during the procedure.[24] Although helpful, these assessments are very subjective and none have been adequately studied to date.

According to Poiseuille's law, flow in a blood vessel is equal to $\pi r^4 \Delta P / 8\eta L$ (where $\Delta P$ is the pressure change across the vessel and *L* is the length of the vessel). With everything else the same, flow is directly proportional to the fourth power of the radius.[25] As such an *av*, 33% in diameter (currently proposed as a guide for considering obliteration) of the main AVF should not steal significant blood from the main AVF. Although diameter is the main factor determining flow in an *av* according to Poiseuille's law, it may be naïve to assess the blood flow steal through an *av* purely on its size. The Poiseuille's law is more applicable on rigid tubes and to fluids with Newtonian characters.[26] The blood vessels are both compressible, and the blood has non-Newtonian characteristics. Due to these differences, some have challenged the applicability of this law to flow in blood vessels. Despite this, previous and recent studies have reported much higher diameter of *av*, which the law will predict, for significance as compared to current recommendations. In a study of *av* significance for EFF, Planken and colleagues[27] studied 15 patients with magnetic resonance imaging angiography to look for *av* pre-radiocephalic AVF creation. *av* was present in all 15 cases, but those which failed to mature (10 of 15) had larger *av* as compared to those which matured (5 of 10). Authors concluded that an *av* is likely to be significant if its diameter is at least 70% of the diameter of AVF. In a recent study by Engstrom and colleagues of EFF caused by *av*, they found 20 patients of 145, where EFF could be attributed solely to *av* without stenosis. Obliteration of *av* lead to salvage in 100% (6 out of 6) of the AVF where *av* was ≥60% diameter of main AVF as compared with 75% (9 of 12) salvage rate if *av* was <60% in diameter as compared with main AVF. This did not reach statistical significance ($p = .51$), so the authors concluded that size was not a determinant for significance of *av*, although they mentioned that sample size may not be enough.[28] Conversely other investigators looking at *av* and EFF have not found any relationship between size and significance. Ahmed and colleagues[29] in a recent retrospective analysis of *av* obliteration for EFF done at their center did not find *av* size, determined by coil size used for obliteration, as a determinant of eventual success of *av* obliteration in terms of AVF salvage. Needless to say, not only the optimal diameter of the *av* that causes enough blood flow reduction is clear, but it is also not clear that what percentage of blood flow reduction in an AVF through *av* causes EFF. In addition, these somewhat variable results raise the questions that are there other features of an *av*, independent of diameter, which can cause EFF?

**CLINICAL SUMMARY**

- The two main factors amenable to treatment and widely accepted to cause early fistula failure (EFF) are stenosis anywhere in the arteriovenous fistula circuit and/or presence of accessory vein (*av*).
- Assessing the significance of an *av* in causing EFF and the indications for its treatment seem to lack scientific recommendations based on robust clinical data.
- In this article we review the current recommendations for obliteration of *av*, the available techniques, possible cons of av obliteration are highlighted while newer concepts and the need for future clinical trials are addressed.

## *av* OR COLLATERAL VEIN

Some authors have recommended that when a side branch is discovered on an AVF angiogram, a distinction between an *av* and a collateral vein should be made.[24] If the side branch is present in AVF with downstream stenosis from the origin of side branch, then it may only be a collateral vein getting prominent due to high pressure caused by downstream stenosis. In that case, the treatment of stenosis should cause resolution of the flow through side branch. Collateral veins as such are not pathologic in terms of causing EFF. On the other hand, if the side branch persists after the resolution of downstream stenosis, then it is classified as *av*, which may need intervention. Collateral veins like some *av's* can help maintain flow in an AVF with stenosis as discussed later.

## EVIDENCE FOR CURRENT PRACTICE

All the major studies looking at interventions for the salvage of AVF with EFF are summarized in Table 1. The table also highlights major points related to *av* presence, diagnosis, and management in these studies. Some of the more important ones are discussed in the following section.

In one of the earliest studies, Beathard and colleagues[14] showed that a considerable percentage of AVF with EFF can be salvaged by early intervention. In their prospective observational series of 63 patients with EFF, *av* without stenosis was found to be present in 39 (69.1%) patients. Three of these patients had percutaneous transluminal angioplasty later for stenosis as a secondary procedure. Total AVF success rate as defined by patency at 90 days was 82.5%. The study does not mention the criteria used to assess the significance of *av*. In addition, success rate after treatment of different types of lesions was not mentioned. In a subsequent study by Turmel-Rodrigues and colleagues[16], 69 patients with EFF were evaluated and treated with endovascular procedures with an overall success rate of 97% and a 1-year secondary AVF patency of 79%. Clinical success in terms of AVF maturation was defined as one dialysis treatment with a pump flow rate of at least 300 mL/min without any recirculation. Interestingly, no patients in this study were found to have any significant