

Original Research Article

Spectrum of vascular abnormalities in color Doppler examination of upper extremities tested for suitability for AV fistula creation in patients of renal failure

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ABSTRACT

Background: Almost all patients with end stage renal disease require haemodialysis at some stage of their disease and arteriovenous fistula is the most convenient option. The purpose of this study was to analyse the prevalence of vascular abnormalities in the upper limbs of patients posted for creation of haemodialysis access. Knowledge of the variant anatomy of upper limb vessels helps in better planning of surgery, avoiding unnecessary surgery and improving the success rate of haemodialysis access creation.

Methods: This study is a retrospective analysis of colour Doppler study of 150 upper extremities of end stage renal disease patients posted for AV fistula creation. The limbs were evaluated for arterial and venous anatomy rendering them fit or unfit for fistula creation.

Results: We found abnormal vasculature in more than 60% of the upper limbs. Congenital arterial abnormality was found in 9 % of upper limbs and venous abnormality was found in 65 % of upper limbs. Unnecessary surgery could be avoided in approximately 74 % of patients. 10 % had correctable abnormality.

Conclusions: Pre-operative ultrasound and Doppler assessment resulted in more patients being subjected to proximal fistulas and alternate suitable dialysis processes like permcath or peritoneal dialysis. Primary fistula success rate obtained by this pre-operative evaluation was close to 95 %.

Keywords: Arteriovenous fistula formation, Fistula success rate, Haemodialysis

INTRODUCTION

Patients with end stage renal disease require haemodialysis at some stage of their disease and arteriovenous fistula is the most convenient option. The purpose of this study is to analyse the prevalence of vascular abnormalities in the upper limbs of patients posted for creation of haemodialysis access. Knowledge of the variant anatomy of upper limb vessels helps in better planning of surgery, avoiding unnecessary surgery

and improving the success rate of haemodialysis access creation.¹ This study is a retrospective analysis of Colour Doppler study of 150 upper extremities of end stage renal disease patients posted for AV fistula creation. The limbs were evaluated for arterial and venous anatomy rendering them fit or unfit for fistula creation. We found abnormal vasculature in more than 60% of the upper limbs. Congenital arterial abnormality was found in 9 % of upper limbs and venous abnormality was found in 65 % of upper limbs. Unnecessary surgery could be avoided in

approximately 74 % of patients. 10 % had correctable abnormality. Pre-operative ultrasound and Doppler assessment resulted in more patients being subjected to proximal fistulas and alternate suitable dialysis processes like permcath or peritoneal dialysis. Primary fistula success rate obtained by this pre-operative evaluation was close to 95 %.

METHODS

This study is a retrospective analysis of Colour Doppler examination of 150 upper limbs of end stage renal disease patients posted for AV fistula creation. The study was performed over 18 months.

The patients selected were of all age groups. There was no history of previous surgery or recent vein punctures on the limbs being tested. Patients with known systemic vasculitis and other congenital vascular abnormalities were excluded from the study.

We followed standard upper limb Doppler protocol for the study. The study was performed with the patient in a comfortable supine or sitting position with hands supported and moderate compression with tourniquet applied at upper arm to promote adequate distension of veins.

All the superficial and deep veins of the arm and forearm were evaluated by colour Doppler examination. The entire brachial artery and its bifurcation into the radial and ulnar arteries were evaluated. The radial and ulnar arteries are evaluated until the wrist. The arteries were evaluated noting the anatomical variants like abnormal origin or bifurcation of the artery, arterial lumen, flow and atherosclerotic changes. The basilic and cephalic veins were evaluated till their confluence with the proximal vein i.e. axillary and subclavian veins. Any venous anatomical variations, venous lumen, focal or diffuse wall thickening as well as abnormal branching pattern were recorded. Depth of the vein from the skin as well as distance between artery and vein were also measured. These measurements were performed at three most suitable sites in the forearm and at the elbow, indicated by the distance from the wrist crease respectively. Presence of accessory veins and signs of central venous stenosis were also noted.

Doppler Allen's test was performed to check the compensatory increase in flow in the ulnar artery on flow diversion from radial artery which is to be expected after fistula creation thus preventing ischemia of the hand. 3 minutes clenched fist test was performed to test the arterial hyperemic response. This helped in predicting steal phenomenon. An abnormal response to this test was considered a contraindication to fistula creation.¹

Appropriate site for the fistula formation was decided after examining all the above Doppler parameters.

RESULTS

We found abnormal vasculature in more than 70% of the upper limbs. Congenital arterial abnormality was found in 9 % of upper limbs. Atherosclerotic changes in the radial arteries were seen in 80 % of the radial arteries, in these patients a proximal fistula at the level of brachial artery was recommended.

Venous abnormality was found in 65 % of upper limbs. Unnecessary surgery could be avoided in 74 % of patients by choosing a suitable proximal site and thus minimizing the fistula failure rate.

10% had correctable abnormality like accessory veins, focal venous stenosis or a deep basilic vein. The corrective surgeries involved ligation of accessory veins, creating a proximal fistula through superficialization of basilic vein. Corrective venoplasty was performed in patients with proximal focal venous stenosis.

75 % of the patients were considered unfit for radio-cephalic fistula creation. Of these patients 22 cases were found with thin cephalic and basilic veins in the entire arm, hence they were considered unfit for fistula creation.

The primary fistula failure rate in the patients who underwent pre-operative evaluation and were followed up postoperatively was 0. 7 patients were lost to follow up.

DISCUSSION

Once the kidney function goes below 15 %, dialysis is necessary for the patient to survive until a kidney transplant is possible. AV fistula and AV graft are the two techniques used for haemodialysis. According to the experts as well as The National kidney foundation, AV fistula is the gold standard for the vascular access in the haemodialysis patients because of their long lasting effectiveness, low morbidity and higher affordability.²

Pre-operative physical assessment (inspection and palpation) of upper limb vessels is done by the surgeons to decide the site for the fistula formation which is difficult in obese patients. In addition, factors which affect maturation of AV fistula and its successful outcome i.e. high bifurcation of artery, atherosclerotic changes, accessory veins, focal venous stenosis, and occlusive arterial plaques etc cannot be assessed by physical examination alone.

Comeaux et al did a study and found that 66% (33 of 50) of patients who had not undergone surgery previously had vascular abnormalities at preoperative US mapping. Our study confirmed the findings of this author.³

Knowledge of the anatomy and its variants is useful in planning a fistula and reducing the primary failure rate.

Patent cephalic vein with good lumen in forearm and thin cephalic in arm can only be diagnosed by Doppler ultrasound which is a very important factor affecting the fistula maturation. Lumen of the vein should be more than 2 mm in the forearm, and artery should be at least 1.6 mm to create a forearm fistula and to have adequate flow for maturation⁴ (Figure 1).

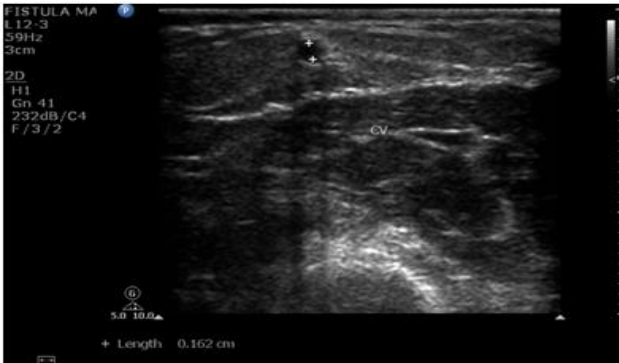


Figure 1: Thin cephalic vein in the proximal forearm with lumen of 1.6 mm.

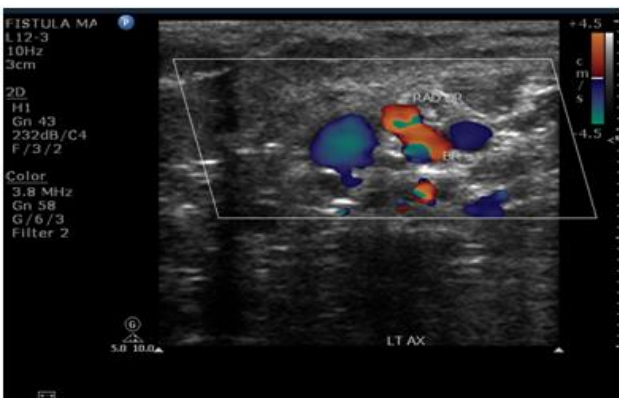


Figure 2: High origin of radial artery from axillary artery. Ulnar artery was the dominant artery in the forearm.

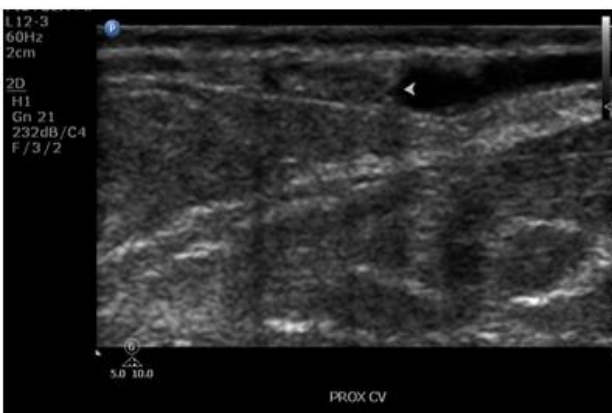


Figure 3: Complete stenosis of the cephalic vein in the mid arm. No identifiable lumen of the cephalic vein proximally.

Cephalic vein is the most commonly used vein for fistula creation. Basilic vein can be used for fistula in the absence of a suitable cephalic vein (stenosis of cephalic vein or thin/ non-visualized cephalic vein) (Figure 3).⁶

Anatomical variations like high origin and bifurcation of artery also play an important role in AV fistula formation. Forearm fistula must be created in such patients only if there are adequate flow volumes in the forearm arteries (Figure 2).⁵

Superficialization of a deeply placed basilic vein can be performed if basilic vein is deeper than 6mm from the skin. Basilic vein should be examined for adequate size for at least 4cm in length caudal to the antecubital fossa to make it suitable for harvesting.

Ultrasound is the modality of choice to differentiate accessory veins from the main vein. Accessory veins can be ligated provided the main vein has a good lumen and flow (Figure 4).⁷

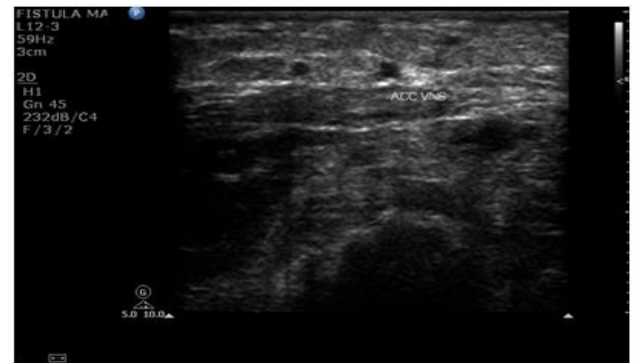


Figure 4: Forearm accessory veins.

A focal venous stenosis can be corrected by venoplasty if rest of the vein is normal. Allen's test is important to check the compensatory increase in flow in ulnar artery when compressing the radial artery. Compensatory increase in flow is important to prevent ischemia after fistula formation (Figure 5).^{8,9}



Figure 5: Allen's test-compression of the radial artery shows compensatory increase in flow in the ulnar artery.

Only Color Doppler ultrasound can evaluate all these factors. No other modality or test gives as detailed information of vasculature as colour Doppler ultrasound. By evaluating and considering all the factors we have observed fistula success rate of close to 100%. We have found that ultrasound Doppler is a best non-invasive method for the evaluation of the vessels before placement of AV fistula.

It not only helps in prevention of complications but also gives information about the correctable factors for the fistula formation. Complications can be prevented earlier and factors can be corrected before placement of fistula. Overall, we observed a 0 fistula failure rate after ultrasound mapping of both arteries and veins. The surgeons also report having increased confidence once mapping was performed. They reported taking extra time to find a vein reported on Doppler examination to create an access in an obese or otherwise technically difficult arm rather than abandoning the site. Thus, preoperative US mapping is now routinely performed in all our patients prior to haemodialysis access creation. Preoperative US vascular mapping prior to haemodialysis placement has facilitated significant positive changes in the management of this difficult patient population who have associated co-morbidities. Although more proximal fistulas are being attempted, the primary fistula success rate has significantly improved with reduced complications.¹⁰

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