



BMH Med. J. 2026;13(3):69-73. **Review Article**

Preoperative evaluation of patients planned for autogenous hemodialysis access - a literature review

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Abstract

The prevalence of patients on chronic dialysis in India is 129 per ten lakh population. Dialysis requires high flow access to blood vessels which is enabled by the creation of an arteriovenous fistula. The procedure, though seeming deceptively simple, is life changing for the patient. It requires microsurgical training and more importantly, intensive preoperative planning to ensure success.

Introduction

Palliative physicians Drs James Cimino and Michael Brescia revolutionized the treatment of chronic renal failure, first with their simple venipuncture technique in 1962 [2] and then in 1966 with the conception of the autogenous fistula [3], which dramatically reduced patient morbidity and improved patient care. It continues to be the first access site assessed by a plastic surgeon in planning an arteriovenous fistula for hemodialysis access.

Who needs a fistula?

Patients suffering from ESKD are drawn up a detailed and individualized Life Plan. The dialysis access route and the kidney replacement therapy (KRT) are determined based on the patient's circumstances and the clinician's expertise. Planning begins long before dialysis is initiated at an eGFR is at 10-15ml/min/1.73m² [4].

Decision making

The guidelines put forth by the National Kidney Outcomes Initiative (NDOQI) were first drawn up

in 1996, and last updated in 2019 provide a comprehensive insight into various aspects of management of patients suffering from End Stage Kidney Disease (ESKD). The 2019 Clinical Practice Guideline for Vascular Access is an invaluable tool in the armamentarium of plastic surgeons who seek to provide the best results for their patients. The vascular access team consists of the plastic surgeon, nephrologist, dialysis operator, other healthcare providers as well as the patient themselves [4].

"Right access, in the right patient, at the right time, for the right reasons"

The previous "fistula first" approach was driven by overall better results compared with alternatives. However, this has now been replaced by a patient-centred approach in view of the higher complications and maturation failure in certain patient groups. Maturation is defined clinically as a straight segment of vein >10cm long that lies superficially and can be easily cannulated. Sonologically, it may be defined by the Rule of 6s: depth of around 6mm below the skin surface, vein diameter >6 mm and blood flow 600 mL/min [4,5]. In the absence of post operative imaging, however, maturation can be described functionally as ability to use the fistula for a minimum of 6 sustained consecutive dialysis sittings [6].

Goals of preoperative evaluation

A thorough evaluation and planning prior to the procedure plays a key role in reducing failure rates and adverse outcomes [7]. The ideal hemodialysis access site must be easy to cannulate and good flow rates with minimal morbidity. Generally, the wrist arteriovenous fistula (AVF) has a lower complication rate and are thereby preferred over arteriovenous grafts (AVGs) and central venous catheters (CVCs) [8].

Plan

Any AVF plan must include the following considerations

1. Appropriateness and likelihood of success: the patient must be able to wait for fistula maturation
2. Vessel preservation: Primary access and Secondary access routes: the 2016 guidelines recommend exhausting distal access sites prior to proximal sites. The non dominant hand is preferred over the dominant hand. The options include snuffbox fistula > Brescia-Cimino wrist fistula (cephalic vein to radial artery) > forearm cephalic fistula > midforearm cephalic fistula > antecubital fistula > brachio-cephalic fistula at elbow > a transposed basilic vein-brachial artery fistula [5]
3. Creation: The fistula site must be located at least 2 cm proximal to the planned access site [9].
4. Contingency: steps to mitigate untoward events following creation of access
5. Succession: plan for the next access even before creation of the present one.

Preoperative assessment

Any assessment broadly follows the best practice guidelines issued by the National Kidney Foundation:

History

Age, patient survival, comorbidities, patient preference, BMI, timing - creation takes place approximately 6 - 9 months prior to the hemodialysis (HD) initiation planned by the nephrologist to allow time for maturation (upto 3-4 months) as well as time to create another access route in case of failure to mature.

Physical examination

A thorough examination may render further vessel mapping unnecessary in most cases. available vascular sites, previous failed sites, future access sites, vessel suitability - a risk of delayed maturation implies prolonged dependence on central venous catheter for dialysis. Alternate approaches such as an arteriovenous graft may be considered. Skin excoriations and poor patient hygiene pose risk for surgical site infection followed by fistula failure within a month of procedure [10].

Clinical examination at our institute emphasizes on pulse volume of the radial and ulnar arteries, assessment of completeness of the palmar arch by Allen's test and distensibility of the veins by augmented palpation in the arm (arm veins are occluded and the patient is asked to clench his fist upto ten times). The Barbeau test (which utilizes the return of waveform on pulse oximeter to establish the vessel patency after occlusion) is considered less objective than the Allen's test, but the ultrasound is considered most objective in evaluating arch competency.

Recent venepuncture sites must be noted as they increase the risk of thrombosis/thrombophlebitis. The non dominant upper limb is preferred and must be examined in its entirety for previous trauma.

Cardiovascular assessment: since poor ejection fraction may be worsened by AV access. It may also contribute to failure of access.

Vessel mapping

Vessel mapping is beneficial in patients who cannot be examined adequately due to obesity, edema or poor skin integrity and in those at a high failure risk: elderly, pediatric, small, female, peripheral or coronary artery disease, history of trauma to vessels.

Duplex Ultrasound study has become an indispensable tool in the armamentarium of a plastic surgeon who wants to plan an autogenous fistula creation. The vessel diameter, calcification and compressibility are the parameters assessed. Additional data that could be gathered include abnormalities of arterial inflow and outflow as well as pre-existing cardiovascular disease [9].

In our institution vessel mapping is performed by a radiologist who conducts a Duplex Ultrasound study. Parameters that are assessed include, but are not limited to peak systolic velocity and calibre of the radial, ulnar and brachial arteries and the cephalic venous system at the wrist, midforearm and the cubital region.

We continue to prefer vein diameter of 2.5mm and artery of diameter 2 mm, but we do perform trial endovascular fistulas on a case by case basis if the clinical examination is satisfactory and as per nephrologist recommendation, with equivocal results.

Pratama et al in 2019 studied 71 patients and noted that a peak systolic velocity of 40cm/s was significant predictor for AVF maturation [11]. Undue reliance on Duplex Ultrasound mapping may be inadvisable in view of high variability due to operator, patient hydration, ambient temperature etc.

A venogram is needed in cases of suspected central venous stenosis. MR angiography using Ferumoxytol contrast (iron oxide nanoparticle as a safe alternative to gadolinium) shows more inter-operative repeatability and better predictive value, in addition to better identification of vessel pathology [12].

Blood investigations

Patients undergo the same investigations as for other cases planned under local anesthesia. Coagulation parameters must be particularly optimized in order to reduce risk of intraoperative bleeding as well as the chances of post operative hematoma formation that can compress the fistula, thereby impeding the flow. CKD patients suffer from anemia. We try to attain a Hemoglobin level of at least 8 gm% through transfusion. Studies have also pointed towards greater risk of primary AVF failure in patients with hemoglobin levels lesser than this [13].

Studies around the world - additions and differences

A study in New Jersey of 108 patients by B. Silva et al in 1998 first proposed the criteria of minimal vein and arterial diameter (2.5 mm and 2 mm respectively) by the use of duplex ultrasound, in order to improve the success rates of autogenous fistulas at a time when bridging grafts were rising in popularity. They did not detail the rationale behind the selection criteria [14]. Later studies such as the 2018 study in Romania by Oprea et al put forth a minimum arterial diameter of 1.5 mm and vein diameter of 2 mm [15].

A study in Lisbon by Fernandes et al in 2023 noted the significantly positive correlation between handgrip strength (as measured by a hand dynamometer) and well developed distal vasculature (artery diameter at least 2 mm on Duplex) which could potentially have a bearing on the outcomes [16].

The Kidney CARE Network International has developed a free mobile device application - My Vascular Access. This is supported across a several mobile platforms - Android and iOS. This has made the KDOQI guidelines for vascular access available at the fingertips of clinicians. It also provides a user friendly interface to enter patient data and clinical scenarios to facilitate decision making regarding the best access route.

Conclusion

End stage kidney disease exacts a huge toll on the patient and the healthcare system. No two patients are alike and neither is their management. The constellation of accompanying concerns preclude standardized controlled trials resulting in a dearth of high quality evidence. A 2013 survey by Nica et al of 134 surgeons across North America and Canada reflected a variety of surgeon preferences and practices with regard to choice of access methods, clinical examination, reliance on ultrasound and ultrasound criteria [17]. In the absence of rigorous studies, surgeons are advised to adopt a collaborative approach with the vascular access team and exercise their best clinical judgement while staying abreast of developments in the ever expanding realm of AVF creation.

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