Approach to patients with end-stage renal disease who need an arteriovenous fistula

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Abstract
Vascular access management is central to maintain the health and quality of life of end-stage renal disease (ESRD) patients. Early referral to a nephrologist for a decision about replacement therapy, preservation, clinical evaluation of vessels and planning for timely placement of an arteriovenous fistula (AVF) should be done. The number of patients with diabetes, peripheral vascular disease and older age continues to increase. In order to select the most functional vessels for the creation of an AVF, duplex ultrasound is recommended in this group of patients. Distensibility of the vein at proximal compression, measurement of the internal diameter of the artery, change of arterial resistance index at reactive hyperaemia and arterial blood flow are important parameters for the decision on the location and time of AVF construction in patients with marginal quality of vessels. Expansion of blood volume at the time of AVF surgery could be helpful in this group of patients. The consequences of such a procedure include fewer surgical interventions, earlier maturation of the AVF, less stress for the patients and, last but not least, lower costs of AVF surgery.

Keywords: arteriovenous fistula; blood flow; duplex sonography

Introduction
A native arteriovenous fistula (AVF) distally created is the gold standard for vascular access for haemodialysis treatment. Complications of central venous catheters are well known: high rate of infections and stenosis or even thrombosis of the host vein. Nevertheless, too high a proportion of patients initiate haemodialysis treatment via central venous catheters because the AVF had not been created previously or was not matured in time. At the initiation of haemodialysis treatment, 68% of patients used a dialysis catheter and 32% had vascular access (18% PTFE and 14% native AVF) [1]. The main explanations for this situation are late referral of patients to a nephrologist, more elderly patients and diabetics, and lack of venous preservation.

Placement and adequate maturation of an AVF before the initiation of haemodialysis treatment require the following.

(i) Timely patient education and counselling.
(ii) An aggressive policy of venous preservation early before the beginning of any renal replacement therapy (including peritoneal dialysis and renal transplantation).
(iii) Selection of the preferred renal replacement therapy.
(iv) Clinical examination of both upper arms.
(v) Non-invasive evaluation of arteries and veins, especially in those at risk, such as elderly patients and diabetics.
(vi) Selection of an access type and location.
(vii) Creation of an AVF at least several months in advance of its expected use.

Timely patient education and counselling
The first time that a patient is diagnosed with chronic renal disease with laboratory signs of diminished renal function, they potentially could be a candidate for chronic renal replacement therapy in the next 10 or 20 or even 30 years. This fact is very important for the initiation of education of patients about the importance of treatment (especially hypertension) and also about the importance of the most appropriate vascular access for haemodialysis treatment. Patients referred early to
nephrologists should be more likely to use an AVF as their first vascular access than patients referred late.

**An aggressive policy of venous preservation early before the beginning of any renal replacement therapy [2]**

- Strict avoidance of cannulation of veins of both forearms proximal to the wrist.
- When unavoidable, venipuncture should be performed on the dominant arm to preserve the non-dominant arm for AVF; or, alternatively, rotation of puncture sites/sides could be used.
- Phlebocatheters should not be threaded to central veins through cephalic or basilic veins at the elbow.
- Instead, central vein catheters should be inserted into jugular veins (preferably on the right side).
- Insertion via subclavian veins is to be avoided because of very frequent subsequent stenosis. The same applies to transvenously inserted pacemakers.
- In cases where vein diameter/flow is the critical factor influencing the decision to use the central vein (as when concentrated potentially caustic/toxic solutions are to be infused), one should consider using femoral veins.

**Selection of preferred renal replacement therapy**

There are two basic treatments of end-stage renal disease: haemodialysis and peritoneal dialysis. If there is no medical contraindication, patients should participate in the selection of which modality is to be used. This selection must be done early. Irrespective of the choice made, the forearm and upper arm veins should be preserved for future vascular access surgery. If a patient prefers haemodialysis, early preservation of veins is even more important and, if needed, training for increasing vessel size should also be performed.

**Clinical examination of both upper arms**

The clinical examination is always the first step necessary to determine any indication for surgery. First, clinical examination (veins without and with a tourniquet, arterial pulse) must be performed by a nephrologist and, on the basis of the findings, other methods could be indicated.

**Non-invasive evaluation of veins and arteries and selection of an access type and location**

Some studies demonstrate that routine pre-operative sonographic vascular mapping results in a dramatic increase in successful native fistula construction [3–6]. This improvement in outcomes is probably due to identification by ultrasound of suitable veins that were not apparent on physical examination. Many patients were found to have large calibre veins that were simply too deep to be visualized or palpated at physical examination. In our study, veins were clinically visible in 54/116 (46.5%), and from 62/116 (53.5%) veins were detected by ultrasound in 48/62 (77.4%) [6]. The ability of the vein to dilate after AVF construction is also important for AVF patency after surgery and for adequate AVF maturation. To determine the ability of the vein to dilate properly, an increase in the internal vein’s diameter after proximal vein compression should be shown, and Doppler vein signal (DVS) could be used to show the continuity of the shape. Outflow stenosis could be detected by pre-operative duplex ultrasound by evaluation of venous return with a deep breath (respiratory filling) [6]. In addition, Doppler waveform at the reactive hyperaemia, induced by opening of the clenched fist for 2 min, changes from triphasic high-resistance flow (peripheral resistance for peripheral arteries is normal high) to biphasic low-resistance flow (peripheral resistance becomes low for a short time), and the same reaction is expected after AVF construction when the peripheral resistance of the radial artery feeding the AVF decreases. In our study, we have shown that lack of an appropriate reaction at reactive hyperaemia indicates that even after AVF construction, the arterial blood flow (ABF) does not increase enough for AVF function. In our prospective study, the resistance index (RI) at reactive hyperaemia (RH) ≥0.7 is an indicator for AVF failure immediately after construction in almost 32%, and internal diameter of the artery (IDA) ≤1.6 mm is an indicator in 38% of constructed AVFs. A higher RI and lower IDA are associated with prolonged AVF maturation time.

In a group of patients with marginal vessels, expansion of blood volume could be used to increase blood flow through the feeding artery, and probably the occurrence of vasospasm could also be prevented. In our study, the group of patients with critical values (IDA < 1.6 mm, RI at RH > 0.7 and ABF < 24 ml/min) was divided into two groups by random sampling. One group received plasma expander during surgery and the other did not. A total of 102 AVFs were constructed from September 1999 to March 2001. In one group of 58 patients, 40 males and 18 females, mean age 59.5 ± 4.3 years, the mean IDA was 2.8 ± 0.4 mm, the RI at RH was 0.62 ± 0.07, ABF was 44 ± 9.2 ml/min, 40 AVFs was created at the wrist/forearm region and 18 AVFs at the elbow region. Primary patency rate was 96.5% (56/58). In another group of 44 patients, 28 males, 16 females, mean age 66 ± 4 years, the mean IDA was 1.9 ± 0.4 mm, the RI at RH was 0.83 ± 0.3, ABF was 20 ± 1.1 ml/min, 16 AVFs were created at the wrist/forearm region and 28 at the elbow region. During the surgical procedure, 22 patients with a mean age of 60.6 ± 1.7 years, 14 males, eight females, IDA 1.8 ± 0.5 mm, RI at RH 0.83 ± 0.5, seven wrist/forearm and 15 elbow region AVFs received a mean of 720 ml (range 320–870 ml) of plasma expander.
The patency rate in this group was 86.4% (19/22). In another group of 22 patients with mean age 62.8 ± 3.2 years, 13 males, nine females, IDA 2.0 ± 0.2 mm, RI at RH 0.87 ± 0.6, nine wrist/forearm and 13 elbow AVFs were created. During surgery, they did not receive plasma expander. The patency rate was 27.3% (6/22). In 16 patients of this group, plasma expander was given immediately after unsuccessful surgery in an average dose of 760 ml. The patency rate was 43.7% (7/16) [3,6].

**Conclusion**

Non-invasive assessment of veins by duplex ultrasound is very helpful in patients with inadequate clinical vein visibility. In this way, we can also obtain more information about functional characteristics of the veins and delineated venous outflow. Routine clinical evaluation is recommended to document the adequacy of arterial inflow. When indicated, especially in the elderly, in patients with diabetic and analgesic nephropathy, vascular renal disease, and in female patients, the clinician should also order a duplex evaluation of the arteries. In this group of patients, it is important to create an AVF early enough and, based on the results of duplex ultrasound, the optimal site of AVF construction should be selected [7]. On the basis of morphological and functional characteristics of the arteries determined by duplex ultrasound before surgery, the need for expansion of blood volume could be predicted. The consequences of such a procedure are fewer surgical interventions, earlier maturation of an AVF, less stress for patients and last, but not least, lower costs of AVF surgery.

**References**