Nephrol Dial Transplant (1998) 13: 1360–1361

Does pre-operative duplex examination improve patency rates of Brescia–Cimino fistulas?

M. Susan Lemson, Karel M. L. Leunissen[1] and Jan H. M. Tordoir

Departments of Surgery and [1]Nephrology, University Hospital Maastricht, The Netherlands

Introduction

A well-functioning vascular access remains the lifeline for patients with end-stage renal failure, who are being treated by chronic haemodialysis. Since 1966, the radiocephalic arteriovenous (AV) fistula, initially described by Brescia and Cimino, has been employed as a vascular access in many dialysis patients [1]. The Brescia–Cimino AV fistula has a low rate of complications and a high patency rate. Usually, the successful creation of this type of AV fistula depends on the quality and diameter of the radial artery and cephalic vein at the level of the wrist. Before the AV fistula actually can be punctured and is able to deliver a sufficient amount of blood to the artificial kidney, a certain period of time (usually 3–6 weeks) is needed for so-called fistula maturation. During this time period, a substantial increase in blood flow and vessel dilatation must occur. The chance of a successful maturation is difficult to predict and depends on the ability of the arterial and venous vessels to dilate under the influence of the increased shear rates (vessel remodelling). Major negative factors determining vessel quality are diabetes mellitus, older age and also the number of previous infusions, which may harm cephalic vein continuity.

The failure rate of fistulas

In the literature, high percentages of early failure of Brescia–Cimino AV fistulas, ranging between 8 and 30% percent, have been cited [2–5]. Also, a not insignificant number of native fistulas fail to mature, resulting in a prolonged period of time awaiting initiation of dialysis treatment [6]. Many of these patients need central vein catheters to bridge this period.

Standard pre-operative assessment

This high failure rate for the native AV fistula is unacceptable, and one may wonder whether the pre-operative assessment of the arterial and venous arm vessels is sensitive enough to select patients suitable for native AV fistula creation. Until recently, pre-operative evaluation was performed by physical examination, palpating the wrist arteries and testing the collateral circulation by the Allen test. The superficial arm veins were usually inspected with a tourniquet placed on the upper arm to induce venous congestion. When there was doubt about arterial inflow or the presence of adequate superficial veins, arteriography and/or phlebography were performed.

Non-invasive investigation of arm vessels by Duplex scanning

Recently, several reports assessed non-invasive investigation of the arm vessels by means of Duplex scanning. This method uses imaging techniques to identify and measure the diameters of vessels and Doppler ultrasound to determine flow characteristics. In the first studies, Duplex was used particularly to visualize and measure arterial and venous vessel diameters, and it showed a good correlation between pre-operative determination and peri-operative findings [7,8]. Later on, quantitative measures such as vessel diameter and flow volumes were used to assess the vessels before native fistula creation. In a prospective study, Wong *et al.* demonstrated that patients with an arterial and/or venous diameter of <1.6 mm, failed to mature their fistulas. They used a technique called pulsed generated run-off to induce flow in the cephalic vein. This technique may facilitate the imaging of small calibre veins [9]. Yerdel *et al.* [10] reported recently in this journal on the effect of haemodynamic variables on blood flow in surgically created AV fistula. They found that a pre-operatively measured subclavian vein flow of <400 cm^3/min was highly predictive of early fistula failure. A correlation between haemodynamic variables and the quantity of post-operative fistula flow, measured by colour Doppler scanning, was not found. However, an arterial inflow of >40 cm^3/min was associated with higher fistula flow rates. They concluded that the immediate success and flow of a newly created AV fistula depend on arterial inflow and subclavian venous flow.

Correspondence and offprint requests to: Dr J. H. M. Tordoir, Division of Vascular Surgery, Department of Surgery, University Hospital Maastricht, PO Box 5800, 6202 AZ Maastricht, The Netherlands.

The Maastricht experience

In the Department of Surgery of the University Hospital Maastricht, an intensive programme of Duplex examination of haemodialysis access operations has been executed since 1989. As an integral part of this programme, pre-operative assessment of the arm vessels is done in every new patient who needs primary vascular access and in patients with complicated or failed access, in order to determine the site for secondary access surgery. Arterial and venous parameters, such as vessel diameter, peak systolic velocities and volume flow in cm^3/min are calculated and, in addition, the visualization and continuity of the cephalic vein are determined (Figures 1 and 2). Comparison of pre-operative Duplex assessment and fistula function suggests that visualization and/or continuity of the cephalic vein are important predictors of subsequent early fistula failure and failure to reach sufficient maturation. The diameter and velocity of blood flow of the radial artery were significantly greater in patients with successful Brescia–Cimino fistulas compared with patients with failed AV fistulas [radial artery diameter 2.75 *vs* 1.9 mm ($P<0.02$); velocity 0.58 *vs* 0.32 cm/s ($P<0.005$)]. Also the primary and secondary patency rates in patients with adequate visualization of the cephalic vein were better compared with patients with insufficient cephalic vein visualization.

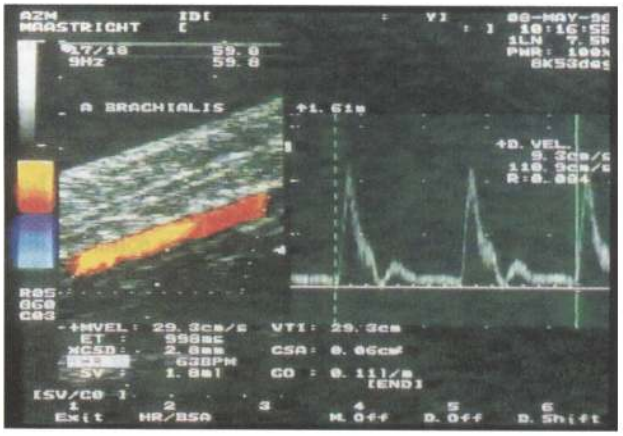

Fig. 1. Colour Duplex scan of the brachial artery at the elbow. The B-mode image (left-hand site) shows the artery, and a Doppler spectrum is obtained from the same vessel (right-hand site). From the cross-sectional area and mean velocity, the volume flow has been calculated. (0.11 l/min).

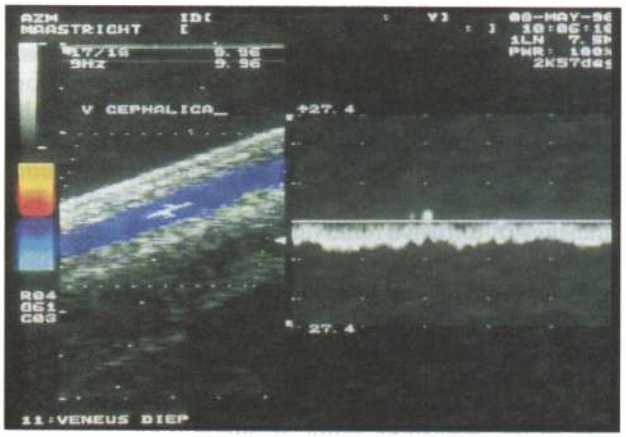

Fig. 2. Colour Duplex scan of the cephalic vein in the forearm. The B-mode image (left-hand scan) shows the vein, and the Doppler spectrum is obtained from the same vein (right-hand site).

The current state of affairs

From published data and our own results, it appeared that certain vessel and haemodynamic parameters predict whether native AV fistulas will fail or succeed after surgery. It has not yet been established, however, which parameter has the highest positive and negative predictive value for successful native AV fistula performance. Regarding the persistent high early failure rate of Brescia–Cimino AV fistulas, it seems justified to perform a prospective, randomized study on the impact of pre-operative Duplex ultrasound examination in patients who need primary vascular access.

References

1. Brescia M, Cimino J, Appel K, Hurwich B. Chronic hemodialysis using venipuncture and a surgically created arteriovenous fistula. *New Engl J Med* 1966; 275: 1089–1092
2. Leapman SB, Boyle M, Pescovitz MD, Milgrom ML, Jindal RM, Filo RS. The arteriovenous fistula for hemodialysis access: gold standard or archaic relic? *Am Surg* 1996; 62: 652–656
3. Kherlakian G, Roedersheimer L, Arbaugh J, Newmark K, King L. Comparison of autogenous fistula versus expanded polytetrafluoroethylene graft fistula for angioaccess in hemodialysis. *Am J Surg* 1986; 152: 238–243
4. Lazarides MK, Iatrou CE, Karanikas ID, Petras DI, Zirogiannis PN, Dayantes JN. Factors affecting the lifespan of autologous and synthetic arteriovenous access routes for haemodialysis. *Eur J Surg* 1996; 162: 297–301
5. Burger H, Kluchert B, Kootstra G, Kitslaar P, Ubbink D. Survival of arteriovenous fistulas and shunts for hemodialysis. *Eur J Surg* 1995; 161: 327–334
6. Sands J, Miranda CL. Increasing numbers of AV fistulas for hemodialysis access. *Clin Nephrol* 1997; 48: 114–117
7. Katz M, Comerota A, DeRojas J, Bowman G, Czeredarczuk M, White J. B-mode imaging to determine the suitability of arm veins for primary arteriovenous fistulae. *J Vasc Tech* 1987; 9: 172–174
8. Tordoir JHM. Duplex scanning of hemodialysis vascular access operations. In: Bernstein E, ed. *Vascular Diagnosis*. Mosby, 1994: 661–667
9. Wong V, Ward R, Taylor J, Selvakumar S, How T, Bakran A. Factors associated with early failure of arteriovenous fistulae for haemodialysis access. *Eur J Vasc Endovasc Surg* 1996; 12: 207–213
10. Yerdel MA, Kesenci M, Yazicioglu KM, Doseyen Z, Turkcapar AG, Anadol E. Effect of haemodynamic variables on surgically created arteriovenous fistula flow. *Nephrol Dial Transplant* 1997; 12: 1684–1688