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Dialysis Fistulae Patency and Preoperative Diameter Ultrasound Measurements

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Background. *This study was designed to investigate the possibility of defining a vascular diameter with a practical cut-off point, which predicts a successful patency for radiocephalic arteriovenous fistulae in dialysis patients.*
Methods. *This is a retrospective analysis of prospectively gathered data. Consecutive patients (*n = *148) with chronic renal failure, needing vascular access for haemodialysis, were included if they underwent duplex ultrasound examination to evaluate preoperatively the vascular status and diameters for radiocephalic arteriovenous fistulae (RCAVF) construction. The associations between the diameter of the radial artery and cephalic vein and primary failure at six weeks, primary and secondary patency at one year were investigated.*
Results. *There was no significant association between either radial artery diameter or dilated cephalic vein diameter and primary failure. There was an association between radial artery diameter and primary patency (Overall* P = *0.042). Males had a significantly larger mean radial artery diameter than females* (P = *0.005). Gender did not influence primary patency.*
Conclusion. *We recommend using radial artery diameters of* ≥*2.1 mm and* ≤*2.5 mm for RCAVF construction, this diameter category having the highest patency at 1 year. A single cut-off guideline cannot be recommended.*

Keywords: Arteriovenous fistulae; Duplex ultrasound; Vascular diameters.

Introduction

Duplex ultrasound is recommended in the preoperative strategy for placement of an arteriovenous haemodialysis fistula. Both the K-DOQI and European guidelines recommend a primary radiocephalic arteriovenous fistula (RCAVF) for haemodialysis as best practice. However, duplex ultrasound criteria of vascular diameters predicting good outcome vary.[1–3]

Duplex ultrasound examination has been described as a valid, accurate and useful diagnostic tool in the evaluation of blood vessels of the upper extremities. Duplex ultrasound examination has been compared to angiography with respect to visualisation, detection and quantification of stenotic lesions and occlusions in both native arterial- and venous segments as well as arteriovenous fistulae in upper extremities. From the subclavian artery down to the distal lower arm arteries, a sensitivity of 90% and a specificity of 99% have been reported. For the detection of vascular alterations in access fistulae a sensitivity of 89% and a specificity of 95% is reported.[4] Blood vessels and their diameters are assessed during preoperative duplex ultrasound prior to construction of an autogenous RCAVF.[5,6] The suggested minimum radial artery diameter varies from 1.6 mm to 2.0 mm or more and for the cephalic vein 1.7 mm to 2.5 mm or more is advocated.[3,5–9] Publications have suggested that small artery and vein diameters may be responsible for primary failure.[7,10,11] A recently published meta-analysis described a mean primary failure rate of 15.3% (6%–34%).[10]

The primary aim of this study was to explore whether there was a significant association between the pre-operative arterial and venous diameter values determined by duplex ultrasound and the patency and failure of RCAVFs. Another goal was to find an optimal range of arterial and/or venous diameter values for the successful construction of RCAVFs for haemodialysis patients.

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Subjects and Methods

Patients. The study group comprised 148 patients, 81 (55%) male and 67 (45%) female, with chronic renal failure. The mean age at operation was 65 years (range 23-85). Diabetes Mellitus was present in 31% of the patients. 134 (91%) of the RCAVFs were created in the left arm and 14 (9%) in the right arm. The arm of choice was based on manual dexterity and the quality of the vessels as a result of clinical and ultrasound examination: preference was given to the least dexterous arm.

Study design. A retrospective analysis of prospectively gathered data, collected from January 2000 until December 2003. 148 RCAVFs were created in this four-year period. Outcome parameters were primary failure, primary patency and secondary patency. The follow-up for primary and secondary patency was based at 1 year post-operatively. Duplex diameter measurements of the radial artery and cephalic vein were carried out at wrist level and were related to the outcome parameters. Primary failure was defined as thrombosis of the RCAVF or inadequate maturation, which resulted in inadequate dialysis access at 6 weeks after surgery. Primary patency was defined as the interval between the date of operation and the first intervention irrespective whether this involved surgery or percutaneous transluminal angioplasty (PTA). Secondary patency was defined as the total interval between the date of operation and definite access failure. Interventions for access thrombosis or other complications were admissable during this period.[3,10,11] A pneumatic cuff inflator (Hokanson E20, Hokanson, Bellvue, USA) was used to accomplish maximal dilatation of the cephalic vein by means of occlusion.

Duplex ultrasound examination. The vascular diameters of the patient population were determined preoperatively using duplex ultrasound performed by experienced and registered vascular technologists. A 10-5 MHz broadband transducer (Aloka, ProSound SSD-5500, Aloka, Tokyo, Japan) and a 12-5 MHz broadband transducer (Philips HDI 5000, Philips, Eindhoven, The Netherlands) were used. Anter-posterior internal diameter measurements of the radial artery and cephalic vein were made in the transverse plane in close proximity to the wrist.

Physical properties of arm arteries such as vascular wall irregularities and calibres were examined as well as haemodynamic properties, such as the doppler waveform and the peak systolic velocities measured using an angle correction of 60° or less. (Fig. 1) The examination started with the subclavian artery continuing along the different arm branches terminating at the ulnar and radial artery at wrist level. In cases of pathology such as a stenotic lesion or occlusion, alternative suitable locations were considered for the creation of an arteriovenous fistula.[1–3] In accordance with Gardner *et al*. patients were examined in a seated position with extended arm supported on a trolley at heart level. The venous system was occluded using a standard 10 cm cuff placed on the arm as proximal as possible. The occlusion cuff was inflated to 80 mmHg, preventing venous outflow.[12] Verification of maximal venous dilatation during the proximal venous occlusion was determined by ultrasound.

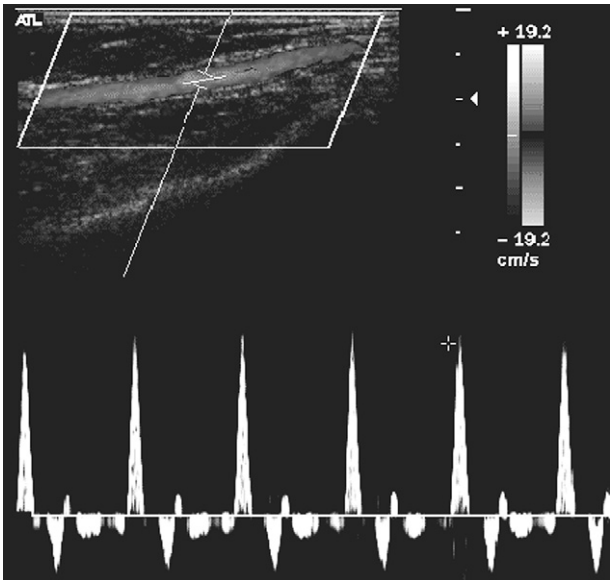

Fig. 1. Radial artery. Longitudinal plane with color-doppler and pulsed-doppler. Peak systolic velocity: 52 cm/sec. The bone structure in B-mode is used as an important landmark.

Once maximum venous dilatation was established, the diameter was measured and noted (Fig. 2). Venous compression was avoided by using ample ultrasound gel between the transducer and skin surface. The

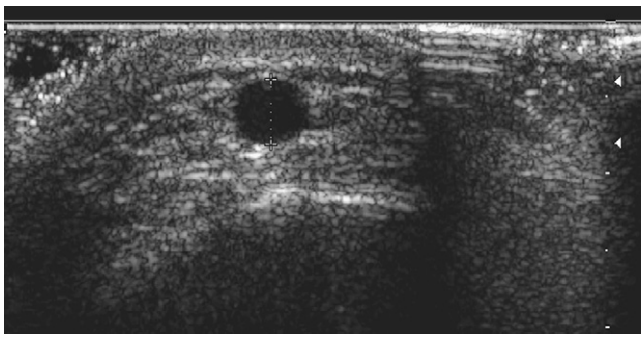

Fig. 2. Cephalic vein. Cross-section. The dilated internal vein diameter is 4.3 mm, in this patient.