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Cannulation technique influences arteriovenous fistula and graft survival

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Hemodialysis patient survival is dependent on the availability of a reliable vascular access. In clinical practice, procedures for vascular access cannulation vary from clinic to clinic. We investigated the impact of cannulation technique on arteriovenous fistula and graft survival. Based on an April 2009 cross-sectional survey of vascular access cannulation practices in 171 dialysis units, a cohort of patients with corresponding vascular access survival information was selected for follow-up ending March 2012. Of the 10,807 patients enrolled in the original survey, access survival data were available for 7058 patients from nine countries. Of these, 90.6% had an arteriovenous fistula and 9.4% arteriovenous graft. Access needling was by area technique for 65.8%, rope-ladder for 28.2%, and buttonhole for 6%. The most common direction of puncture was antegrade with bevel up (43.1%). A Cox regression model was applied, adjusted for within-country effects, and defining as events the need for creation of a new vascular access. Area cannulation was associated with a significantly higher risk of access failure than rope-ladder or buttonhole. Retrograde direction of the arterial needle with bevel down was also associated with an increased failure risk. Patient application of pressure during cannulation appeared more favorable for vascular access longevity than not applying pressure or using a tourniquet. The higher risk of failure associated with venous pressures under 100 or over 150 mm Hg should open a discussion on limits currently considered acceptable.

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Vascular access (VA) has been justly described as both the lifeline and the Achilles' heel of hemodialysis therapy, making blood purification itself possible while simultaneously often constituting a limiting factor in treatment adequacy. The ultimate quality indicator is the effect of the access on patient mortality and morbidity. In terms of patient survival, there is a preponderance of evidence for the superiority of arteriovenous fistulas (AVFs) or arteriovenous grafts over catheters and, to a lesser extent, for AVFs over arteriovenous grafts.¹⁻⁶ Complications associated with the VA constitute the most common cause of patient hospitalization,⁷ the risk of which is particularly relevant to the type of VA.⁸⁻¹⁰ Therefore, in addition to choosing the best access type, prevention of access complications has high priority in dialysis therapy, and various official recommendations exist aiming at maintaining access patency for long-term use.^{11,12} These guidelines devised and published by various working groups focus primarily on aspects of VA management pertaining to the choice of VA type, timing of the access surgery, methods for monitoring of access function, and aseptic techniques. Recommendations for the cannulation procedure are fewer and chiefly focus on needle size, angle of needle insertion, direction of needle bevel (the slanted part of a needle, which creates a sharp pointed or rounded tip; see Figure 1), and rotation of needles after insertion.

However, the evidence level for these limited guidelines is poor and, in practice, these aspects of VA cannulation are known to vary from clinic to clinic, mainly because of historical training approaches in the individual settings. It is widely accepted in dialysis field that the rotation of the needle influences the degree of endothelial trauma, the size of the puncture orifice, and, in turn, exposure to bacterial pathogens and bleeding time. The orientation of the bevel (up or down) has been reported to influence the degree of pain level.¹³ Despite the recommendation for bevel-up cannulation of AVFs and arteriovenous grafts, bevel-down orientation of cannulation needles is performed today. The use of arterial needles with a back-eye, as recommended by the NKF KDOQI guidelines (2006),¹¹ has reduced the need for flipping or twisting the needle.

In addition, the choice of needle size is not strictly specified. During the initial access use, the application of 17- or 16-G

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Figure 1 | Bevel of a needle in the 'up' position, that is, the slanted part of the needle tip faces upward upon puncture of the access. Picture with the courtesy of Bionic Medizintechnik GmbH, Friedrichsdorf, Germany.

needles and low blood flow rates of 200–250 ml/min are generally recommended, particularly in AVFs. In mature accesses, larger 15- or 14-G needles are required to support the higher blood flow rates of ≥ 350 ml/min needed for high-efficiency dialysis or convective treatments. There is some concern that high blood flow may have a negative impact on access survival. Thus, the influence of needle size on access patency remains an open subject.

Various other aspects of cannulation are not addressed in the guidelines, and there exist a variety of options to choose from. For example, standard double-needle cannulation involves inserting two large bore needles into the fistula or graft vessels, whereby three distinctly different methods for puncture site selection exist: area, rope-ladder, and button-hole. Area cannulation refers to puncturing of the same general area session after session. In the rope-ladder technique, the cannulator changes the needle placement sites for each dialysis, choosing sites at a defined distance along the VA line from the previous puncture sites. In the buttonhole method of cannulation, hemodialysis needles are inserted in the exact same spot and at the same angle and depth of penetration for consecutive dialyses. The venous needle returns the blood from the extracorporeal circuit to the body and must always point in the direction of blood flow (antegrade direction). The arterial needle is used to withdraw blood from the vasculature to the extracorporeal circuit and may point either in the same direction of blood flow (i.e., antegrade direction) or in the opposite direction (i.e., retrograde direction) (Figure 2). The optimal direction of arterial access needles in fistulas and grafts remains a subject of some controversy.^{14,15}

Whether or not to exert arm pressure at the time of cannulation, either using a tourniquet or manual pressure, is a further subject of debate, although application of a tourniquet is recommended by KDOQI.¹¹

Despite previous studies having addressed the issue of VA techniques and associated access survival, to date, there is a lack of convincing evidence supporting one particular cannulation procedure or a combination of procedures.^{16,17} The primary aim of this study is to investigate whether diverse aspects of AVF and arteriovenous graft cannulation have an

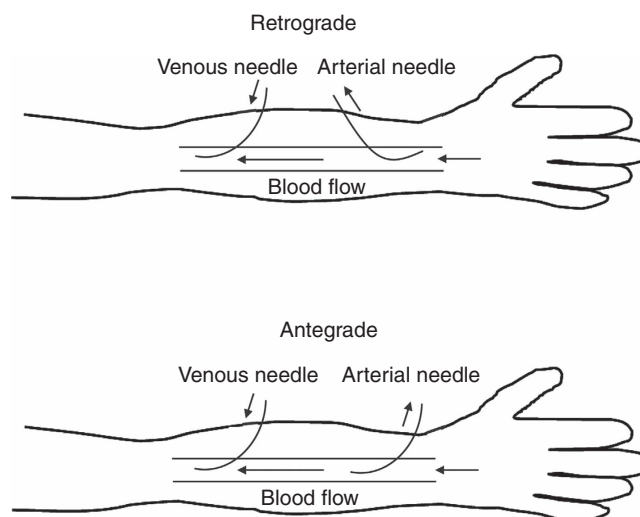


Figure 2 | Retrograde and antegrade positioning of arterial and venous access needles.

effect on access longevity and are consequentially more or less recommendable. Furthermore, as blood flow, venous pressure, and location of the access (e.g., right or left arm, distal or proximal) have been discussed in association with access patency, the relationship between these and access survival is also addressed as a secondary aim.¹⁸

RESULTS

Out of the 10,807 patients enrolled for the original survey, access survival data were available for 7058 (65%) patients. These patients resided in Portugal, the United Kingdom, Ireland, Italy, Turkey, Romania, Slovenia, Poland, and Spain. The mean age was 63.5 ± 15.0 years, 38.5% were female, 27.1% were diabetic, 90.6% had a native fistula, and 9.4% had a graft. Median dialysis vintage was 43.2 months (minimum: 0.1 months; maximum: 419.6 months). Access location was lower arm for 51.2% of patients. During the follow-up, 51.1% were treated with antiaggregants and 2.8% with anticoagulants. Local anesthesia was commonly exercised in the United Kingdom and Ireland only. Prevalent needle sizes were 15 and 16 G for 63.7% and 32.2% of the patients, respectively (14 G: 2.7%; 17 G: 1.4%). In Spain, 98% of patients were treated with 15-G needles, and in Romania 75% of patients were treated with 16-G needles. Cannulation technique was area for 65.8%, rope-ladder for 28.2%, and buttonhole for 6% of patients, with some country preferences clearly visible: area technique was applied in as much as 77% of patients in Romania, and rope-ladder was more common in Poland than in the total study population (44%). The direction of arterial puncture was antegrade for 57.3% of patients; this was the preference for 99% of patients in Poland. The bevel orientation was upward for 70.2% of the patients, peaking in Poland with 95%. The practice of needle rotation after insertion was practiced for 42% of patients, with a much higher percentage in Italy (82%). The prevalent

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