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Tip Design of Hemodialysis Catheters Influences Thrombotic Events and Replacement Rate

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WHAT THIS PAPER ADDS

Appropriate vascular access is required for the growing population of patients needing hemodialysis. This cohort and observational study of 183 patients with end stage renal disease compares two different types of central venous tunnelled hemodialysis catheters. To date, it is not clear what type of catheter tip is preferred to guarantee optimal dialysis efficacy and to minimise complication rates. This study revealed that patients might benefit from shotgun-tip catheters over split-tip catheters where replacement rates and thrombolytic events are concerned. This might translate into clinical practice if vascular surgeons or interventional radiologists decide on catheter type for patients undergoing hemodialysis.

Objective/Background: Central venous tunnelled hemodialysis catheters (CVTC) are used for initial vascular access in patients with renal failure. Tip design of the CVTC may play an important role in catheter function and complication rates, influencing adequate hemodialysis treatment of these patients.

Methods: This prospective, observational cohort study compared the function and complication rates of two CVTCs in patients with end stage renal disease (ESRD) within a follow-up period of 24 months. The study included patients with ESRD who received either a CVTC with a split tip (ST) or a shotgun tip (SG). All patients underwent dialysis within 24 h of intervention. Blood flow was documented initially (Qb_0) and was followed up after 6 (Qb_6), 12 (Qb_{12}), and 24 (Qb_{24}) months. Analysis of blood flow and complication rates within the follow-up period was performed by questionnaires.

Results: In total, 185 patients were included, of whom 93 received a ST CVTC and 92 a SG CVTC. Baseline parameters did not differ significantly between groups. CVTC blood flow was not significantly different between the two devices. Thrombolytic therapy with Alteplase was used significantly more often in the ST group (29%) than in the SG group (16%) ($p < 0.05$). The CVTC replacement rate was significantly higher in the ST group (19.3%) compared with the SG group (8.7%) ($p < 0.05$).

Conclusions: The tip design of CVTC (split or shotgun) appears to be irrelevant for long-term blood flow during dialysis treatment. However, patients may benefit from SG catheters over ST catheters where replacement rates and thrombolytic treatment are concerned.

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INTRODUCTION

About 80, 000 patients with end stage renal disease (ESRD) are treated with renal replacement procedures in Germany every year. More than 90% of the patients are treated with hemodialysis.[1] To achieve adequate effectiveness during an average dialysis treatment of 4 hours, a blood pump velocity (Q_b) of a minimum of 250 mL/minute has to be set.[2,3] Owing to the negative pressure (suction) that is generated by the blood pump, pump velocity cannot be increased arbitrarily. High negative pressure is produced when a catheter's lumen is too small, a thrombus is occluding the catheter, or the catheter is wrongly positioned.[4] If the negative pressure is too high, suction of the catheter onto the central venous wall occurs, setting off the unit's alarm and the blood pump flow must then be reduced. This leads to a severe reduction in the quality of the dialysis.[2–4]

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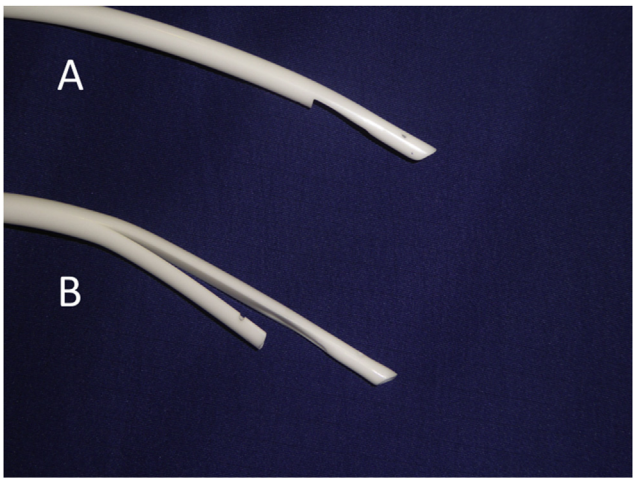

Figure 1. Photographs of (A) the shotgun-tip and (B) the split-tip catheters.

Blood pump velocity highly depends upon the vascular access, which withdraws blood for extracorporeal circulation and then returns it. Ideally, an arteriovenous fistula or an arteriovenous graft should be placed a few weeks before beginning dialysis, so that the fistula can develop and be punctured by two needles to deliver sufficient blood flow for extracorporeal circulation.[2–4] Unfortunately, many patients cannot be dialysed via an arteriovenous fistula, and a tunnelled dialysis catheter has to be implanted.[5] Reasons for catheter implantation include insufficient vessel quality for arteriovenous fistula,[6] urgent indication for an acute dialysis before development of an arteriovenous fistula is adequate,[7] or severe cardiac insufficiency. Moreover, central venous catheters (CVC) serve as bridges until operative revascularisation, when thrombosis of an existing shunt has occurred.[3,4,7] Therefore, various catheter devices have been developed in the last few years, to ensure a high blood flow and a long lasting catheter.[2,5–7]

Currently, CVCs are used in $>$ 40% of patients as the first device to initiate chronic hemodialysis,[8] whereas arteriovenous fistulae or prosthetic grafts are used in 42% and 6% of patients, respectively.[8] The tunnelled catheters are associated with certain disadvantages such as thrombosis, infection, low blood flow rates, risk of central venous stenosis, or occlusion;[9] however, they possess several advantages over arteriovenous fistula dialysis. They are available at low cost, can be inserted at multiple sites, are able to provide access for 2 months, thrombotic complications can be treated easily, and they do not require maturation time.[10] The present study aimed to compare two different tunnelled CVC designs, one with a split tip (ST) and the other with a shotgun tip (SG), which were implanted by the same consultant in $>$ 95% of patients.

MATERIALS AND METHODS

Study design

This was a prospective observational study comparing ST and SG designed, tunnelled, hemodialysis catheters for a follow-up period of 24 months. Interim analysis was performed after 12 months.

Study characteristics

Catheter implantation was performed in a sterile operating room setting by a consultant radiologist using a retrograde, minimally invasive Seldinger technique. More than 95% of the implantations were performed by the same consultant; the remainder were carried out by other colleagues. Only 16 Fr catheters were used: 92 patients with ESRD were given a SG central venous tunnelled hemodialysis catheters (CVTC [Hemostar; Bard Access Systems, Salt Lake City, UT, USA]) (Fig. 1A), and 93 patients with ESRD received a CVTC with a ST design (Hemosplit; Bard Access Systems) (Fig. 1B). The choice of catheter type was dependent on availability but not randomised. As contracts between the hospital and the manufacturer allowed an order of 50 catheters of one type at time, the order of 50 ST or 50 SG catheters was alternated. This resulted in a semi-annual change of catheter type, independent of the patient's characteristics or the preference of the radiologist. The primary target vessel for implantation was the right internal jugular vein, followed by left internal jugular vein. A subclavian vein approach was only conducted in cases when jugular veins were not available (e.g., previous cervical radiotherapy or thrombosis of both internal jugular veins). The catheter tip was placed in the right atrium. Sodium citrate (4%) was recommended as the standard blocking solution, but local protocols in outpatient care were allowed.

Within 24 hours of catheter implantation, every patient received hemodialysis treatment in the nephrology department at University Hospital Lübeck, Lübeck, Germany. Further hemodialysis treatments, after discharge from the hospital, were performed in an outpatient setting by local nephrologists in northern Germany. Data were collected via questionnaires sent to the local nephrologists at appropriate intervals.

Ethical statement

The study was approved by the local ethics committee of the University of Lübeck. Written informed consent was obtained from all the patients.

Inclusion/exclusion criteria

The study included patients who were in renal failure for at least 4 weeks, aged 18 and older, with dialysis catheter implantation carried out at the Clinic of Radiology at the University Hospital of Lübeck, and who had at least one dialysis within 24 h of catheter implantation at the Clinic of Internal Medicine, Department of Nephrology, University of Lübeck.

Outcomes assessed

Vital parameters, blood pump velocity, and pressure course of the dialysis unit were routinely documented as per standardised protocol. Initially, after implantation the

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