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HEMODIALYSIS CATHETER DESIGN AND CATHETER PERFORMANCE: A RANDOMIZED CONTROLLED TRIAL

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Promotor: Dr. An De Vriese

Masterproef voorgedragen in de master in de specialistische geneeskunde

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VOORWOORD

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ABSTRACT:

Background: Long-term use of tunneled cuffed catheters (TCC) for hemodialysis is complicated by a high rate of infection and thrombus-related dysfunction. Specific mechanical features of TCC may improve hemodynamic performance and decrease thrombosis and infection rates. However, there is currently no proven advantage of one design over another.

Study Design: Single-center randomized clinical trial

Setting & Participants: 302 hemodialysis patients who required a TCC as temporary or definite vascular access

Intervention: Palindrome Symmetric Tip Dialysis Catheter™ or HemoStar Long-Term Hemodialysis Catheter™

Outcomes and Measurements: The primary endpoint was infection- and thrombosis-free catheter survival, measured as primary assisted patency and incidence of catheter-related blood stream infections (CRBI) and thrombosis. The secondary endpoint was rheological performance, measured as effective blood flow rate and urokinase use.

Results: Mean primary assisted patency was 135.9 days for Palindrome™ and 136.5 days for Hemostar™ (P=0.8). Definite CRBI occurred in 0.24 and 0.10/1000 catheterdays for Palindrome™ and Hemostar™, respectively (P=0.3). Removal rate for thrombosis that could not be resolved with thrombolysis was 0.53 and 0.43/1000 catheterdays for Palindrome™ and Hemostar™, respectively (P=0.7). Urokinase use was lower for Palindrome™ than Hemostar™, as evidenced by a lower number of urokinase infusions/1000 catheterdays (17 and 35, P<0.001) and a higher number of catheters that never required thrombolysis (58% and

45%, P=0.03). Mean effective blood flow rate was higher for Palindrome™ than for Hemostar™ (333 ml/min and 304 ml/min, P<0.001).

Limitations: This is a single-center non-blinded trial.

Conclusions: Primary assisted patency and incidence of infection and thrombosis were similar for both catheters types. The Palindrome™ catheter required less thrombolysis and achieved higher blood flow rates than the Hemostar™ catheter. These findings suggest that mechanical catheter design may improve catheter rheology, but does not affect the risk for thrombosis and infection, and hence catheter survival.

INTRODUCTION

The use of tunneled cuffed catheters (TCCs) is discouraged in the Kidney Disease Outcomes Quality Initiative (K-DOQI) clinical practice guidelines (1) because of their propensity for infection, thrombosis and fibrin sheath formation causing inadequate and/or irregular blood flow rates and the risk of damaging large central veins. Multiple studies suggest that patients with catheters have a greater mortality than patients dialyzed with native fistulae (2). Nevertheless, TCCs are still frequently used in the hemodialysis population (3), either because of documented inadequate vascular access anatomy or as a bridge to a functional native fistula or to recovery of renal function.

A large number of TCCs are currently available on the market. They differ mainly with respect to material type, lumen diameter, tip design, as well as presence and design of side holes. Many features of catheter design are claimed to improve rheological performance, decrease thrombosis and infection rates and prolong catheter survival. At the moment, there is no proven advantage of one mechanical catheter design over another, although this area is undergoing a great deal of study.

The design of the catheter tip may affect the propensity for fibrin sheath formation and thrombosis and hence intraluminal infection, since fibrin sheaths and associated thrombi provide an intravascular medium for bacterial colonization (4,5). The tip design also influences the percentage of recirculation, especially when arterial and venous blood tubing are reversed. Commonly used long-term catheters have a staggered tip design (outflow tip extends >2.5 cm beyond the inflow tip to prevent recirculation) or split-tip design. The more recently designed Palindrome™ catheter has a symmetrical spiral end tip, where arterial and venous tracts are of the same length and a spiral separator is incorporated allowing either lumen to be used as the arterial port. Inflow occurs through the side slot and the most

proximal portion of the end hole, outflow occurs as a jet directed away from the catheter tip (6).

Most long-term dialysis catheters today have multiple side holes reflecting the belief that backup inflow is necessary in case of obstruction of the end hole by a fibrin sheath or a blood clot (7). However, side holes can promote thrombosis due to the irregularity of their cut surfaces, which may provide anchor sites for clots (8). In a computational fluid dynamics analysis, distal side holes were found to comprise a low-flow zone with an increased clotting risk at the catheter tip (9). In a comparative study, side hole catheters were associated with higher infection rates than non-side hole catheters (10). The Palindrome™ catheter has laser-cut side slots, which are thought to have a smoother surface and thus theoretically a lower tendency to cause thrombosis, and hence infection.

The present randomized controlled trial was designed to evaluate (1) the infection- and thrombosis-free catheter survival and (2) the rheological performance of the Palindrome™ (Covidien) catheter, with a symmetrical tip and laser-cut side slots, compared with the Hemostar™ (Bard) catheter, with a 3 cm staggered tip and standard machine-punched distal side holes (Online supplementary material, Figure 1-2). The overall similarity in design and material of the Palindrome™ and the Hemostar™ catheter offers the opportunity to discriminate with little additional confounding variables whether the tip and side hole design affects the long-term performance of the TCC.

METHODS

1. Trial design

The present study was a single-center, non-blinded, randomized controlled trial with a parallel-group design and 1:1 allocation ratio. The study was performed in accordance with the ethical standards of the responsible institutional committee on human experimentation and with the Helsinki Declaration of 1975 (and as revised in 1983). The study was registered on ClinicalTrials.gov Identifier (NCT01649102).

2. Participants

The study was conducted in the general hospital AZ Sint-Jan in Bruges, Belgium. All patients (male or female, age ≥ 18 years) on hemodialysis who required a TCC as temporary or definite vascular access were eligible. Written informed consent was obtained from each subject. Exclusion criteria were pregnancy or breast-feeding, life-expectancy of < 1 month due to major co-morbid conditions, inability to provide informed consent, and occlusion or inaccessibility of the right internal jugular vein.

3. Interventions

3.1. *Catheter insertion and maintenance*

Only the right internal jugular vein site was used. Patients were randomized to receive either a Palindrome Symmetric Tip Dialysis Catheter™ (Covidien, Dublin, Ireland) or a HemoStar Long-Term Hemodialysis Catheter™ (Bard, Salt Lake City, Utah, USA). Both catheter types have a Double-D lumen design, an outer diameter of 14.5 Fr and a single Dacron cuff, and are made of carbothane. The catheter was inserted under general anesthesia by a vascular surgeon. At the time of placement, the tip of the catheter was positioned in the midatrium, confirmed by fluoroscopy, with the arterial lumen (for the Bard catheter) facing the

mediastinum. When catheters were exchanged, the old catheter was removed and a new catheter was inserted (no rewiring).

Dialysis nurses were trained at regular intervals to apply the correct aseptic techniques when accessing the catheter and changing the dressings. Catheters and skin were disinfected with chlorhexidine 2% in 70% alcohol, according to the Centers for Disease Control and Prevention (CDC) recommendations for the prevention of intravascular catheter-related infections (11). A continued vigilance to potential breaks in technique was organized. Patients were regularly educated about the requirement to wear masks during catheter manipulation. Patients were screened for nasal carriership of *Staphylococcus aureus* at the initiation of dialysis and at 6-month intervals thereafter. In case of confirmed nasal carriage, nasal mupirocin was applied weekly, until the patient tested negatively at 3 screenings.

Blood flow rates were set as high as possible with a maximum of 400 ml/min and prepump pressures not more negative than -250 mmHg, unless there was a confirmed disequilibrium syndrome. Sodium citrate 30 % was used as the catheter lock solution in all catheters.

3.2. Stepwise approach to salvage a presumed mechanical catheter dysfunction.

Mechanical catheter dysfunction was defined in accordance with K-DOQI guidelines (1), as the inability to achieve pump blood flow rate > 300 ml/min for > 30 min, with arterial pressure < -250 mmHg or venous pressure > 250 mmHg or a decrease in blood flow rate by > 10%; a decrease in conductance (ratio of blood flow rate to prepump pressure) to <1.2; or inability to aspire blood freely. Dialysis nurses were trained to apply a stepwise approach when confronted with a possible catheter dysfunction. First, the blood lines and dialysis machine were inspected, the catheter was flushed with 10 ml saline and the patient was repositioned. Target dry weight was assessed and increased when hypovolemia was suspected. When these measures were unsuccessful and there were no contraindications for

thrombolysis (recent surgery, recent cerebrovascular accident), a standard protocol of urokinase infusion was applied. Urokinase 100.000 IU (Actosolv®, Eumedica, Manage, Belgium) was infused over 30 min in each of the obstructed lumina and dialysis was resumed thereafter. When lumen patency was not satisfactorily restored, the catheter was locked with urokinase 100.000 IU dissolved a volume of aqua calculated as the sum of the internal volumina of the catheter lumina plus 0.4 ml, and dialysis was rescheduled. When this protocol was applied thrice within a time frame of 2 weeks and the catheter was still dysfunctional, catheter replacement was considered. Line reversal was discouraged.

3.3.Approach to catheter-related bloodstream infection (CRBI)

In patients with clinical suspicion of infection (presenting with systemic inflammatory symptoms such as fever with or without chills, or with an elevated WBC or CRP), blood cultures were drawn from both the catheter and a peripheral vein. A composite definition of CRBI was made, based on 2009 IDSA practice guidelines for the diagnosis and management of CRBI, the 2006 K-DOQI guidelines on vascular access management and key publications on the topic (12-14).

Definite CRBI: A patient was considered to have definite CRBI if (1) the same organism grew from at least one blood culture and from the catheter tip and (2) the patient presented with systemic inflammatory symptoms such as fever (with or without chills), elevated WBC or CRP and (3) no clear other primary focus of infection was present.

Probable CRBI: A patient was considered to have probable CRBI if (1) the same organism grew from at least two different blood cultures or in case of *Staphylococcus aureus* or *Candida species* from at least one blood culture and (2) the patient presented with systemic inflammatory symptoms such as fever (with or without chills) and elevated WBC or CRP and (3) no clear other primary focus of infection was present.

Non CRBI: A patient was considered to have non-CRBI if (1) blood cultures were positive without fulfilling the definitions of definite or probable CRBI and/or (2) a clear other focus of infection was present.

All patient records were independently reviewed by two investigators and every case of bacteremia was classified as definite, probable or non CRBI.

4. Outcomes and definitions

Each dialysis session, patients were evaluated by the attending nephrologist and all events were recorded in the electronic patient chart. Primary assisted patency was defined as the interval from time of access placement to removal of the catheter expressed in days, with censoring for non-catheter related removal. Incidence of catheter-related blood stream infections (CRBI) and thrombosis was defined as the number of events per 1000 catheterdays. Mean effective blood flow rate (ml/min) was calculated for each individual dialysis session as the volume of blood processed by the dialysis machine divided by the duration of the dialysis session and averaged for all dialysis sessions during the life span of the catheter. Urokinase use was recorded by the dialysis nurses in the electronic patient chart. The number of dialysis sessions during which urokinase was used per 1000 catheterdays was calculated.

5. Sample size and randomization

The sample size required to demonstrate with a power of 80 % (α=0.05) a relative decrease in incidence of catheter removal for infection or thrombosis of 50 % over 180 days, taking into account a 30 % dropout by maturation of vascular access, transfer to peritoneal dialysis or recovery of renal function and a 20% mortality and taking into account an expected incidence of catheter removal for infection or thrombosis of 2 to 3 per 1000 catheterdays, was calculated to be 190 to 102 in each treatment arm.

Patients were randomly assigned to receive either a Palindrome Catheter™ or a HemoStar Catheter™ with 151 catheters being allocated to each group.

7. Statistical methods

To compare the distributions of baseline characteristics and endpoints, the Fisher's exact test was used for proportions and the Mann-Whitney U test for continuous variables. Event-free survival was estimated by the Kaplan-Meier method and differences were evaluated statistically using the Log-rank test. Cox proportional hazards models were fitted to compare incidence rates and to estimate hazard ratios and their 95% confidence interval. The assumption of proportionality of hazards was checked by plotting log[- log(S(t))] against time, where S(t) represents the Kaplan-Meier survival estimate. Two-tailed tests of significance are reported. For all comparisons, a p-value of <0.05 was used to indicate statistical significance. All analyses were performed using SAS software, version 9.2 (SAS Institute).

RESULTS

A total number of 302 TCCs (Palindrome™, n=151 and Hemostar™, n=151) used in 239 hemodialysis patients (Palindrome™ as first or only catheter, n=118 and Hemostar™ as first or only catheter, n=121) were included in the study (Figure 1). The same patient could be recruited more than once. The baseline clinical characteristics of the patients did not differ between the study groups (Table 1).

A total number of 41.127 catheterdays was evaluated, 20.522 catheterdays for the Palindrome™ and 20.605 catheterdays for the Hemostar™. Mean follow up period was 135.2 days. In the majority of patients (n=239), the study catheter was their first catheter, while in the other instances (n=63) there was a history of one or more catheters. In 139 patients, the catheter was removed electively, either because of recovery of renal function, transfer to peritoneal dialysis or maturation of the native AV-fistula (Figure 1). Dropout was recorded in 90 patients, owing to death, kidney transplantation, transfer to another center, or accidental removal or damage of the catheter (Figure 1).

Mean primary assisted patency was 135.9 days for the Palindrome™ catheter and 136.5 days for the Hemostar™ catheter (P=0.8). When censoring for catheter design-unrelated removal, catheter survival at 6, 12 and 24 months was 77.3%, 72.0% and 71.3% for the Palindrome™ and 87.8%, 84.0% and 76.4% for the Hemostar™ catheter. Survival was not significantly different between both catheter types (Figure 2).

Catheter removal for infection occurred in 10 patients (6.6%) with a Palindrome™ catheter, resulting in a total infection rate of 0.48/1000 catheter days, whereas removal for infection was done in 3 patients (2%) with a Hemostar™ catheter, resulting in a total infection rate of 0.14/1000 catheterdays (P=0.09) (Table 2,3). When only the definite catheter-related

bloodstream infections (CRBI) were considered, 5 catheters (3.3%) in the Palindrome™ group and 2 catheters (1.3%) in the Hemostar™ group were removed, yielding a CRBI rate of 0.24/1000 catheterdays and 0.10/1000 catheterdays, respectively (P=0.5) (Table 2,3).

Removal for thrombosis, that could not be resolved with thrombolysis occurred in 11 patients (7.3%) with a Palindrome™ catheter, resulting in a thrombosis rate of 0.53/1000 catheterdays, while the Hemostar™ catheter was removed for thrombosis in 9 patients (6.0%), resulting in a thrombosis rate of 0.43/1000 catheterdays (P=0.8) (Table 2,3).

Urokinase use was significantly lower for the Palindrome™ catheter as compared to the Hemostar™ catheter, as evidenced by a lower number of urokinase infusions/1000 catheterdays (17 and 35, P<0.001) and a higher number of catheters that never required a urokinase infusion (88 versus 68, P=0.03) (Table 2,3). The time to first urokinase infusion was not different between both groups. Mean effective blood flow rate was significantly higher for the Palindrome™ catheter than for the Hemostar™ catheter (333.1 versus 308.3 ml/min, P<0.001) (Table 2).

DISCUSSION

The Palindrome™ catheter, with a symmetrical spiral end tip and laser-cut side slots, has the potential theoretical benefit of improved rheological performance, reduced propensity for thrombosis and CRBI, and hence enhanced catheter survival (6,15-17). When compared with the Hemostar™ catheter, characterized by a staggered tip and machine-punched side holes, catheter survival was not different. Incidence rates of CRBI and thrombosis requiring removal of the catheter were similar and very low in both catheter types. However, the Palindrome™ catheter achieved better blood flow rates and required less thrombolysis for patency.

In line with the K-DOQI Guidelines for Prevention and Treatment of Catheter Complications (1), mechanical catheter dysfunction (defined as blood flow rate 300 ml/min or less for 30 min, with arterial pressure < -250 mmHg or venous pressure > 250 mmHg, a decrease in blood flow rate by > 10%; a decrease in conductance to <1.2 or inability to aspire blood freely) is managed at an early stage in our centre, in order to prevent the progression of a partially occluded lumen to a full occlusion. Line reversal is discouraged and nurses are instructed to implement a stepwise catheter salvage protocol, favoring early use of urokinase infusions and locks. The preemptive use of this catheter salvage protocol proved to be highly efficient. Thrombotic occlusions leading to flow delivery problems that could not be solved with thrombolysis occurred in only 20 patients (3.98%) over a mean observation period of 135.2 days, a proportion that was not different between the Palindrome™ and Hemostar™ catheters. In a study of 225 hemodialysis patients (18), the weekly preventive use of tissue plasminogen activator (tPA) as a catheter locking solution reduced the incidence of catheter malfunction (defined as peak blood flow 200 ml/min or less for 30 min, mean blood flow of 250 ml/min or less during two consecutive dialysis treatments or inability to initiate dialysis owing to inadequate blood flow) from 34.8% to 20.0% over 6 months. In our study, the

urokinase use to achieve patency was relatively low: 17 to 35 episodes/1000 catheterdays, which is the equivalent of once every 4 to 8 weeks. About half of the catheters (58% of the Palindrome™ and 45% of the Hemostar™) never required thrombolysis. We therefore contend that the pre-emptive use of thrombolysis according to the K-DOQI guidelines is efficient and cost-effective. No high-quality head-to-head trials have compared the effectiveness of urokinase and tPA in resolving mechanical catheter dysfunction.

CRBI has been reported to be a leading cause of catheter removal and morbidity in dialysis patients. In our center, we never attempt to salvage the catheter in case of definite CRBI, since antibiotics do not eradicate the bacteria in the biofilm, and the risk of subsequent treatment failure and metastatic infection is deemed too high. In accordance with the Infectious Diseases Society of America catheter guidelines, we also remove TCC in case of documented bacteremia with virulent organisms that predispose to secondary catheter infections, such as *Staphylococcus aureus*, Enterococci, fungi and Enterobacteriaceae, even when a site of entry alternative to the catheter has been revealed. Even with these stringent measures, the total rate of catheter removal for infection was low in our study (0.31/1000 catheterdays). The rate of definite CRBI was even lower (0.17/1000 catheterdays). In several large series, the incidence of CRBI has been reported as high as 1.0 to 5.5/1000 catheterdays (19). In the recent study by Hemmelgarn, there were 1.37 and 0.40 episodes of CRBI per 1000 catheterdays in the heparin and tissue plasminogen activator groups, respectively (18).

Although the mechanisms responsible for the finding of low CRBI rates cannot be settled from the present experiments, several hypotheses may be advanced. Since nasal carriage of *Staphylococcus aureus* has been identified as an important risk factor for CRBI (20,21), the standard eradication protocol with mupirocin employed in our unit may have contributed to the observed low rates. Previous studies have shown that nasal decolonization of *Staphylococcus aureus* effectively reduces CRBI in the hemodialysis population (22,23). In

addition, we opted to use a trisodium citrate 30% lock, for its documented antimicrobial effect and prevention of biofilm formation without the risk of emergence of bacterial resistance during long-term use (24-26). Trisodium citrate at low concentrations (2-15 %) has antimicrobial activity against staphylococci, but higher concentrations (30 %) are required for gram-negative bacteria (27). In a RCT of 291 hemodialysis patients, the use of a trisodium citrate 30% lock substantially reduced the occurrence of CRBI when compared to a heparin 5000 IU/ml lock (28). Further, disinfection of the catheter exit-site with chlorhexidine 2% in 70% alcohol solution was used in our study, as advocated by Centers for Disease Control and Prevention (CDC) in their 2011 recommendations (grade IA) for the prevention of intravascular catheter-related infections (11). In a single-center before-after study, switch from alcoholic povidone iodine to a chlorhexidine-based antiseptic solution was associated with a reduction in catheter colonization and a pronounced decline in catheter-related bacteremia (29). Training of staff on infection control topics, including access care and aseptic techniques, was organised on a regular basis. Finally, more aggressive prevention of fibrin sheath formation with the stepwise catheter salvage protocol, using urokinase in an early stage, may have reduced the rate of CRBI, since a catheter tip fibrin sheath is known to be a nidus for infection and site of microbial seeding (4,5).

Taken together, the low rates of removal for thrombosis and infection yielded an excellent catheter survival. When censoring for non-catheter related removal, long-term catheter survival was high and not different between both catheter types (71.3% for the Palindrome™ and 76.4% for the Hemostar™ catheter at 24 months). Our findings are at odds with those of two smaller studies comparing the Palindrome™ catheter with other catheter types. In a retrospective comparison of the Palindrome Ruby™ (n=100) and a split-tip catheter (Bard Bioblock™, n=100), the frequency of malfunction or thrombosis was lower and primary assisted patency was significantly better for the Palindrome Ruby™ (15). A short-term

randomized comparative study of the Palindrome™ catheter (n=47) with a staggered tip catheter (Hemo-Flow™, n=50) showed lower dysfunction rates and a higher short-term catheter survival rate in the Palindrome™ group (17). We submit that the disparity in outcome with our study can be attributed to differences in centre-related practices of handling catheter dysfunction. Hwang *et al.* found a difference in catheter survival rate (90.6 and 68.8% survival at 2 months for the Palindrome™ vs. step-tip catheter group), since a dysfunction that did not recover with repositioning resulted in exchange of the TCC (17). In our study, we attempted to salvage the catheter with thrombolysis first, which was successful in the majority of cases.

Our study was also performed to evaluate a potential hemodynamic benefit of catheter design. The Palindrome™ catheter achieved a 30 ml/min or 9% higher average blood flow rate than the Hemostar™ catheter and may thus prove value as a means to optimize hemodialysis efficiency.

The main limitation of our study is that investigators and dialysis nurses were not blinded for catheter assignment.

In conclusion, urokinase use was lower and blood flow rates were higher for the Palindrome™, but catheter survival, and removal for thrombosis and infection were very low compared to literature data and similar for both catheters. Although mechanical catheter design can slightly improve catheter rheology, it has little if any influence on catheter survival and complications such as thrombosis and infection. A composite of other measures, including the early use of a mechanical catheter dysfunction salvage protocol, disinfection protocols, type of catheter lock, nurse and patient education and eradication of nasal carriage of *Staphylococcus aureus*, may be more important in reducing the rates of thrombosis and infection of TCCs.

DISCLOSURE

The authors report no interests to disclose.

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TABLES

Table 1: Baseline characteristics of the Hemostar™ and Palindrome™ study groups

	Hemostar™(n=151)	Palindrome™(n=151)	Significance*
Age, year) Mean (SD)	70.4 (13.1)	69.2 (16.2)	P=0.9
Male Number (%)	86 (56.9%)	80 (53%)	P=0.6
Vintage, days Median (IR)	15 (0-175)	15 (0-413)	P=0.7
Past history of TCC Number (%)	30 (19.9%)	33 (21.9%)	P=0.8
Medication			
-Antiplatelets Number (%)	62 (41%)	64 (42.4%)	P=0.9
-LMWH Number (%)	26 (17%)	27 (17.9%)	P=0.9
-Vitamin K antagonists Number (%)	19 (12.6%)	20 (13.2%)	P=0.9
Diabetes Number (%)	51 (33.8%)	55 (36.4%)	P=0.6
Nasal carriage of *Staphylococcus aureus* Number (%)	27 (20.0%)	34 (26.8%)	P=0.3

*according to Fisher's exact test or Mann-Whitney test

Note. SD= standard deviation. IR= interquartile range. TCC= tunneled cuffed catheter. LMWH= low-molecular-weight heparins

Table 2: Number of end-points in each study arm

	Hemostar™ (n= 151)	Palindrome™ (n= 151)	Significance*
Primary assisted patency, days Mean	136.5	135.9	P=0.8
Catheter removal for total infection, number (%)	3 (2.0%)	10 (6.6%)	P=0.09
Catheter removal for definite CRBI, number (%)	2 (1.3%)	5 (3.3%)	P=0.5
Catheter removal for thrombosis, number (%)	9 (6.0%)	11 (7.3%)	P=0.8
Mean effective blood flow, ml/min Mean (SD)	303.8 (32.3)	333.1 (24.2)	P<0.001
Never need of urokinase, number (%)	68 (45.0%)	88 (58.3%)	P=0.03
Time to first urokinase use, days Median (IR)	10 (5-36)	15 (5-42)	P=0.2

*according to Fisher's exact test or Mann-Whitney test

Note. CRBI= catheter-related bloodstream infection. SD= standard deviation. IR= interquartile range.

Table 3: Incidence rates of end-points in each study arm

	Hemostar™ (n= 151)	Palindrome™ (n= 151)	Hazard ratio (95% CI)*	Significance*
Total infection rate, number/1000 catheterdays	0.15	0.49	3.15 (0.87-11.46)	P=0.08
Definite CRBI rate, number/1000 catheterdays	0.10	0.24	2.26 (0.44-11.96)	P=0.3
Thrombosis rate, number/1000 catheterdays	0.43	0.53	1.20 (0.50-2.89)	P=0.7
Urokinase use, number/1000 catheterdays	35	17	0.58 (0.49-0.68)	P<0.001

*according to Cox proportional hazard modeling

Note. CRBI= catheter-related bloodstream infection.

TITLES AND LEGENDS

Figure 1: Flow diagram of the number tunneled cuffed catheters (TCC) in each study arm and their outcome.

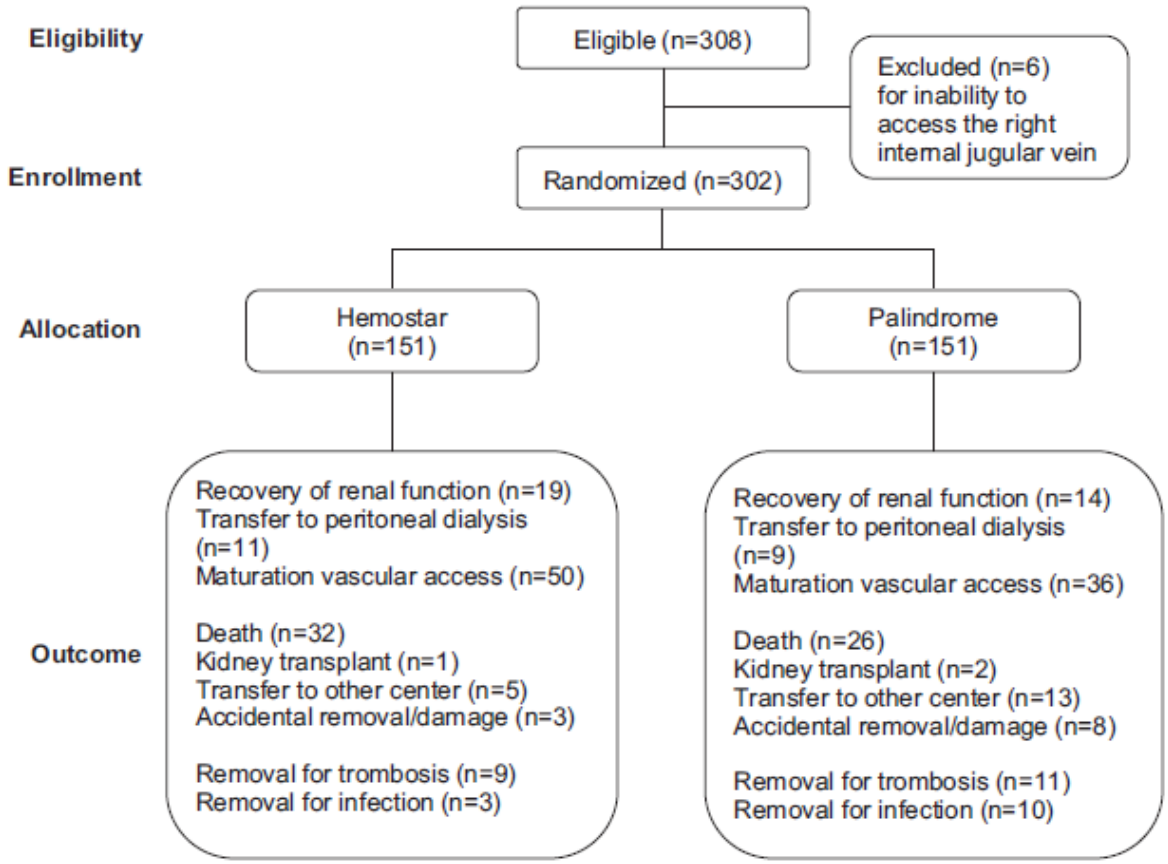
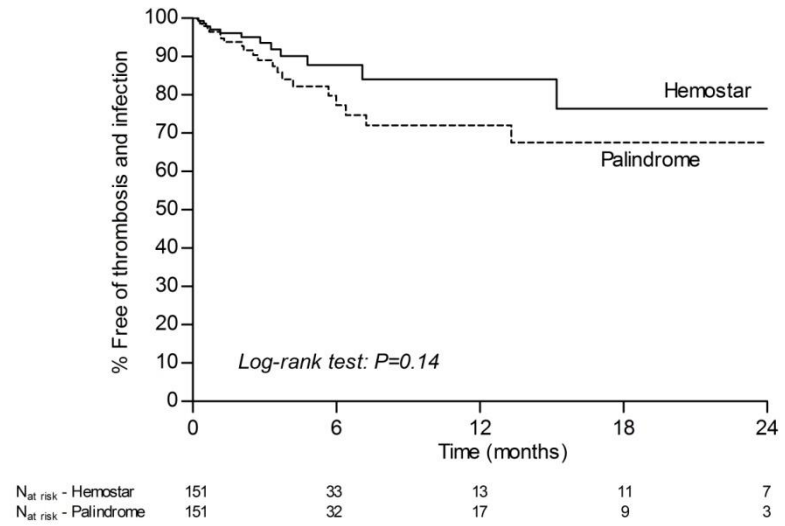


Figure 2: Kaplan-Meier curve of the infection- and thrombosis-free catheter survival for the Hemostar™ and Palindrome™ catheter.



ONLINE SUPPLEMENTARY MATERIAL

Figure 1: Hemostar™ catheter. The insert shows a detail of the staggered tip viewed from two different angels. The venous lumen extends 3 cm beyond the arterial lumen. Three machine-punched side holes are present.

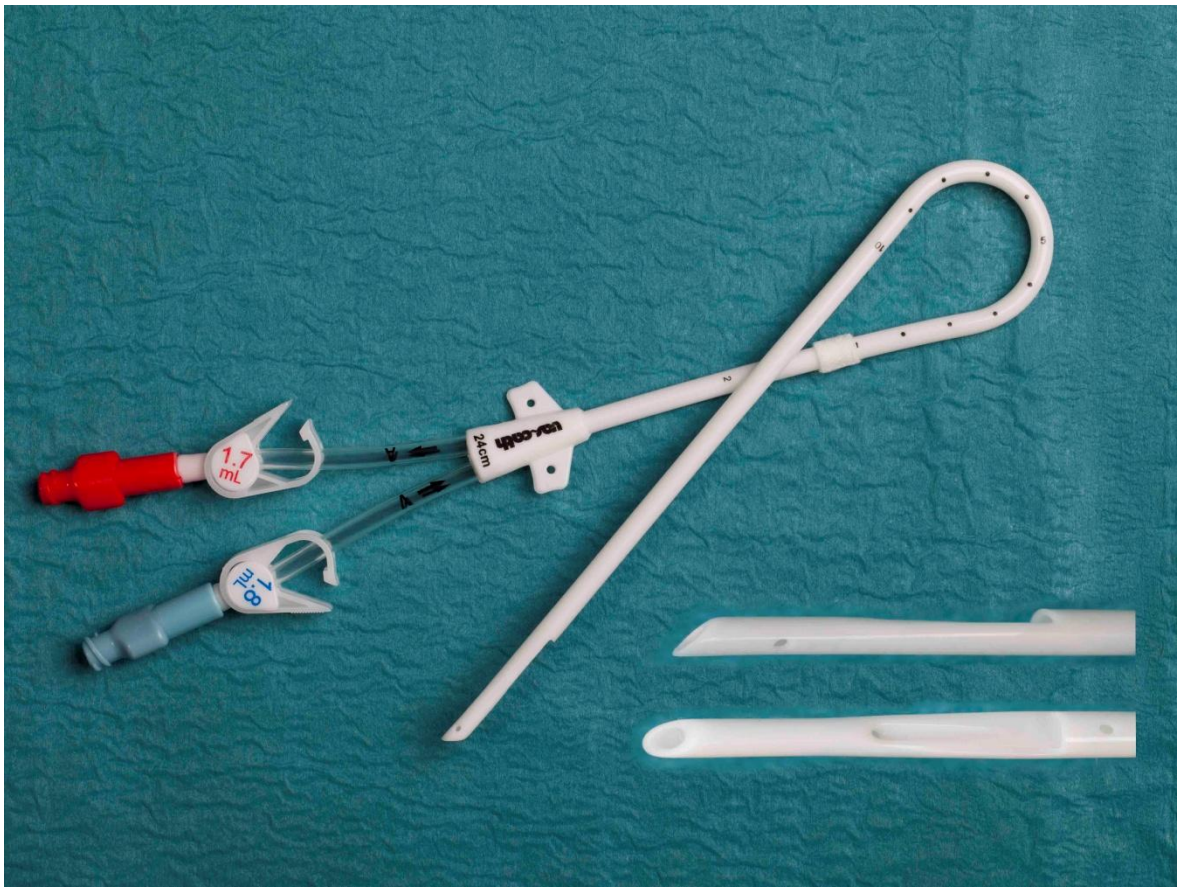
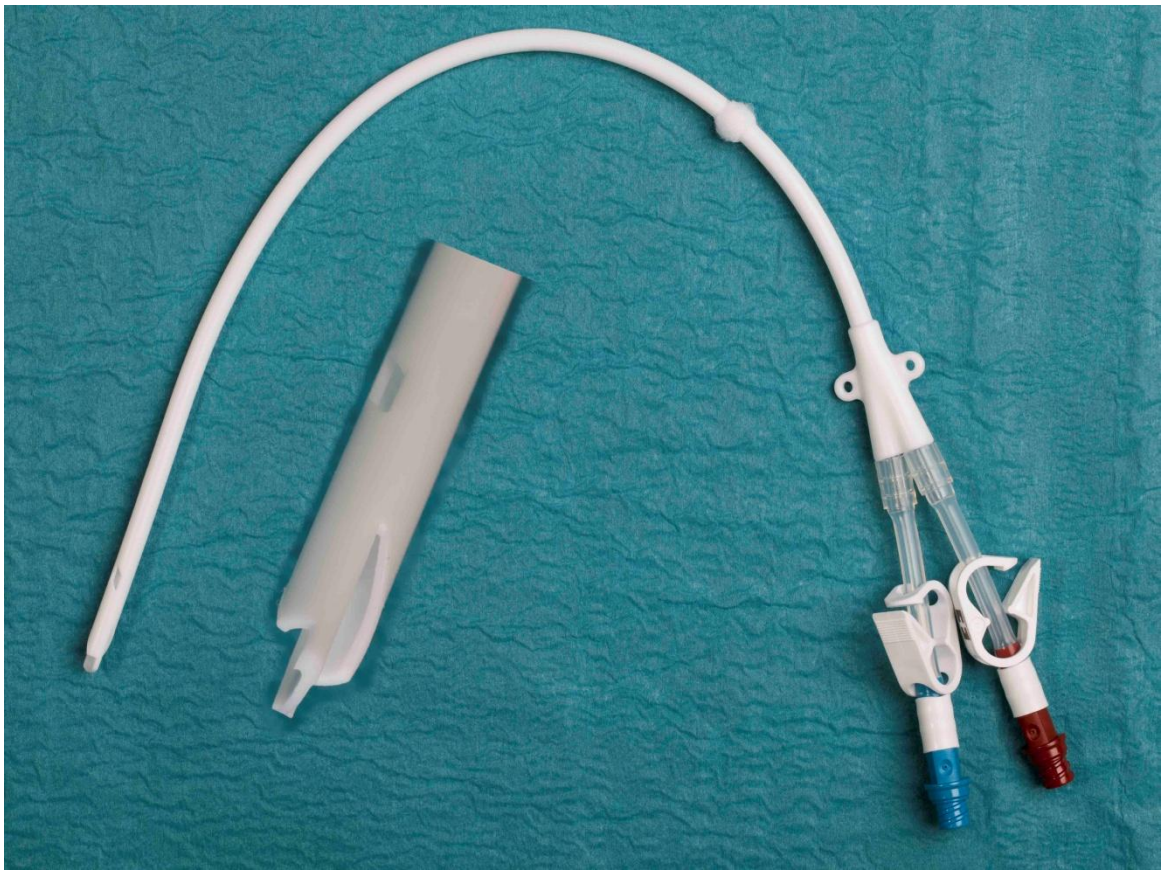


Figure 2: Palindrome™ catheter. The insert shows a detail of the symmetrical tip. The arterial and venous lumina are of the same length and configuration. A spiral separator is incorporated allowing either lumen to be used as the arterial port. Two laser-cut side slots are present.



Bewijs van publicatie

AJKD
Original Investigation

Hemodialysis Catheter Design and Catheter Performance: A Randomized Controlled Trial

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Background: A complication of long-term use of tunneled cuffed catheters for hemodialysis is the high rate of infection and thrombus-related dysfunction. Specific mechanical features of tunneled cuffed catheters may improve hemodynamic performance and decrease thrombosis and infection rates. However, there currently is no proven advantage of one design over another.

Study Design: Single-center randomized clinical trial.

Setting & Participants: 302 hemodialysis patients who required a tunneled cuffed catheter as temporary or definite vascular access.

Intervention: Palindrome Symmetric Tip Dialysis Catheter or HemoStar Long-Term Hemodialysis Catheter.

Outcomes & Measurements: The primary end point was primary assisted patency. Secondary end points were incidence of catheter-related bloodstream infections (CRBSIs), thrombosis, and 2 indicators of rheologic function: mean effective blood flow rate and urokinase use.

Results: Mean primary assisted patency was 135.9 days for Palindrome and 136.5 days for HemoStar ($P = 0.8$). Definite CRBSI occurred in 0.24 and 0.10/1,000 catheter-days for Palindrome and HemoStar, respectively ($P = 0.3$). Removal rates for thrombosis that could not be resolved with thrombolysis were 0.53 and 0.43/1,000 catheter-days for Palindrome and HemoStar, respectively ($P = 0.7$). Urokinase use was lower for Palindrome than for HemoStar, as evidenced by a lower number of urokinase infusions/1,000 catheter-days (17 and 35; $P < 0.001$) and higher number of catheters that never required thrombolysis (58% and 45%; $P = 0.03$). Mean effective blood flow rate was higher for Palindrome than for HemoStar (333 and 304 mL/min; $P < 0.001$).

Limitations: Single-center nonblinded trial.

Conclusions: Primary assisted patency and incidence of infection and thrombosis were similar for both catheter types. The Palindrome catheter required less thrombolysis and achieved higher blood flow rates than the HemoStar catheter. These findings suggest that mechanical catheter design may improve catheter rheology, but does not affect risks for thrombosis and infection and hence catheter survival.

Am J Kidney Dis. 64(6):902-908.

Nederlandse samenvatting

Het gebruik van getunnelde dialysecatheters als vasculair acces wordt afgeraden door zowel de Kidney Disease Outcomes Quality Initiative (K/DOQI) als de European Renal Best Practice (ERBP) guidelines. Een arterioveneuze fistel is de eerste keuze omwille van de morbiditeit geassocieerd met het gebruik van hemodialyse catheters: verhoogd infectierisico, thrombose en fibrinesheat vorming met onvoldoende bloodflow en inadequate dialyse tot gevolg. Observationele studies tonen hiernaast een verhoogde mortaliteit wanneer patiënten met een getunnelde catheter vergeleken worden met patiënten met een AVfistel als vasculair access.

Ondanks deze richtlijnen worden in de dagelijkse praktijk om verschillende redenen catheters frequent gebruikt. Dialysis Outcomes and Practice Patterns Study (DOPPS) data tonen dat ongeveer 35% van de prevalente hemodialyse patiënten in België een getunnelde dialysecatheter hebben als vasculair acces.

Momenteel zijn meerdere types getunnelde dialysecatheters beschikbaar op de markt met verschillende karakteristieken (materiaal, diameter, tip design…). Op heden is er geen overtuigende evidentie dat een bepaald type catheter superieur is.

De recent ontwikkelde 'Palindroom' catheter heeft enkele theoretische voordelen en hiernaast veelbelovende resultaten in observationele studies en een kleine gerandomiseerde studie.

In dit kader wordt een gerandomiseerd studie opgestart met als doel te onderzoeken of deze veelbelovende gegevens zich bevestigen. Deze nieuwe Palindroom catheter wordt vergeleken met de klassiek gebruikte Hemostar catheter. Elke hemodialyse patiënt in het AZ Sint Jan te Brugge die een getunnelde dialysecatheter nodig heeft, wordt na informed consent, gerandomiseerd naar één van beide groepen.

Als eindpunten wordt catheter overleving en infectie- en trombose risico vergeleken. Hiernaast wordt ook gekeken of het verschil in design een impact heeft op rheologische parameters: 'blood flow rate' en nood aan trombolyse.

Als voornaamste conclusie weerhouden we dat er geen statistisch significant verschil in overleving is tussen beide catheters. Echter, op hemodynamisch vlak is er wel een belangrijk 29ml/min (333 vs 304 ml/min) hoger bij de Palindrome catheter in vergelijking met de Hemostar catheter. Tevens is er minder urokinase nodig 'to salvage' de catheter.