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CLINICAL STUDY

Using Cuffed and Tunnelled Central Venous Catheters as Permanent Vascular Access for Hemodialysis: A Prospective Study

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ABSTRACT

Background. Adequate care of a hemodialysis patient requires constant attention to the need to maintain vascular access (VA) patency. VA complications are the main cause of hospitalization in hemodialysis patients. The native arteriovenous fistula (NAVF), synthetic arteriovenous grafts fistula (GAVF) and silastic cuffed central venous catheters (CVCs) are used for permanent vascular access (PVA). CVCs are primary the method of choice for temporary access. But using this access modality is increasing more and more for PVA in elderly hemodialysis patients and when other PVA is not possible. The primary aim of this study is to investigate survivals and complications of the CVCs used for long-term VA. *Methods*. We prospectively looked at 92 CVCs (Medcomp Ash Split Cath, 14 FR × 28 cm (Little, M.A.; O'Riordan, A.; Lucey, B.; Farrell, M.; Lee, M.; Conlon, P.J.; Walshe, J.J. A prospective study of complications associated with cuffed, tunnelled hemodialysis catheters. Nephrol. Dial. Transplant. **2001**, *16* (11), 2194–2200) with Dacron cuff) inserted in 85 (50 females, 35 males)

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chronic hemodialysis patients (the mean age: 56.6 ± 14.1 years) from July 1999 to January 2002. The overall survival and complications were followed up. Furthermore, the patients were evaluated for demographic and clinical characteristics. Data were analysed by chi-square, Wilcoxon rank and Kaplan–Meier survival tests. *Results*. The median duration of CVC survival was 289 days (range: 10–720). Eleven (11.9%) CVCs were removed due to complications. In 79 (92.9%) patients, 1, in 5 (5.8%) patients, 2 and in 1 patient, 3 CVCs were inserted. Of the 85 patients, 56 have CVCs functioning. In addition, 27 (31.76%) patients have CVCs functioning for over 12 months, 17 (20%) patients have CVCs functioning for 6 months. The total incidence of CVC related infections was 0.82 episodes/1000 catheter days. Besides, thrombosis was occurred in 10 (10.8%) CVCs. The most frequent indications for CVC removal were patient death (69.4%), thrombosis (16.6%) and CVC-related infections (13.8%). *Conclusions*. CVCs are primarily used for temporary access. But this study indicates that CVC may be a very useful alternative permanent vascular access for hemodialysis patients when other forms of vascular access are not available.

Key Words: Hemodialysis; Central venous catheter; Permanent vascular access; Survivals and complications.

INTRODUCTION

In chronic hemodialysis patients, creating and maintaining a PVA are very important, because VA complications are major cause of morbidity and hospital admissions.[1,2] The NAVF, GAVF and CVCs are used for PVA. A flow rate adequate for the dialysis, a long use-life and a low rate of complication are necessary for an ideal PVA. But no current access type fulfils all of these criteria.[3–5]

Native arteriovenous fistula is the first preference for PVA because different studies demonstrate that NAVF have the best patency rates and require the fewest interventions compared to other VA modalities. But in recent years, using NAVF has been reduced according to using GAVF and CVCs in the United States, due to the increasing survival of patients with chronic renal failure treated with hemodialysis and the increasing quantity of diabetics and of elderly patients.[6–8]

Central venous catheters were initially developed as a temporary VA while a PVA, NAVF or GAVF, was maturing. In patients with vessels unsuitable for an arteriovenous fistula or there have been multiple failed attempts of creating PVA, CVCs have started to use as an alternative for PVA.[8–10]

Central venous catheters have advantages for VA as ability to insert into multiple sites, maturation time not required, venipuncture not required, no hemodynamic consequences, universally applicable and ease and cost of catheter placement and replacement. But CVCs have a higher incidence of thrombosis and infection. In addition, risk of permanent central venous stenosis or occlusion is frequently in CVCs according to other access types. Using CVCs is especially limited by these complications.[9–14]

Since July 1999 we have been using silastic tunnelled cuffed CVCs (Medcomp Ash Split Cath, 14 FR $\times$ 28 cm[11] with Dacron cuff) for long-term vascular access in the patients whom a PVA has been not created due to various factors. And we

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prospectively looked at CVCs. The overall survival and complications of CVCs and demographic and clinical characteristics of the patients have been followed up for 30 months.

The purpose of this study is to communicate our experience with survival and complications of the CVCs for used for long-term VA.

PATIENTS AND METHODS

Patients

We prospectively studied survivals, complications and failure rates of 92 CVCs on 85 (50 females, 35 males) chronic hemodialysis patients (the mean age: 56.6 ± 14.1 years) from July 1999 to January 2002 about 30 months. CVCs were inserted in patients in whom other VA modalities were unavailable or had been multiple failed attempts of creating PVA and ones with advanced congestive heart failure or malignancies. Twenty-five (29.4%) patients were diabetic, 43 (50.5%) patients were older than 60 years and 11 (12.9%) patients were younger than 40 years. CVCs were used, as a first PVA, in 48 (56.4%) patients. Thirty-six (42.3%) patients had a cardiovascular disease. Demographic and clinical characteristics of the patients are shown in Table 1.

The Catheter

We used tunnelled cuffed CVCs (Medcomp Ash Split Cath, 14 FR $\times$ 28 cm[11] with Dacron cuff). The catheters are 28 cm length and 5.9 mm $\times$ 3.3 mm external diameter. Each CVC has two parallel lumens. The lumen's internal diameter is 2 mm. The proximal lumen has 1.3, distal lumen 1.4 mL priming volume. The proximal lumen ends 2.5 cm from the tip point of catheters. The outside of body, the catheters consist of two channel, ending in color-coded luer locks; red for arterial and blue for venous.

All of catheters were inserted by cardiovascular surgeon with the aid of fluoroscopy in operation room. Local anaesthesia was used during process. Right internal jugular vein was generally chosen as a first preference for catheter insertion. Hemodialysis nurses were trained to use CVCs and only trained nurses, utilising sterile gloves and povidone iodine disinfection, opened CVCs. And after each hemodialysis session, first CVCs were flushed with sterile saline solution and then were locked with using pure heparin (arterial lumen: 1.3 mL and venous lumen: 1.4 mL).

Table 1. Demographic and clinical characteristics of the 85 patients.

Age (years)	Gender (female/male)	Diabetes mellitus	Cardiovascular disease	Malignancy
56.6 ± 14.1	50/35	25 (29.4%)	36 (42.3%)	5 (5.8%)

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During 30 months, all of CVCs were followed up complications (including inadequate flows for dialysis, catheter related infections, catheter obstructions, hemorrhage) and survival.

CVCs were removed if catheter related infections, which can not be treated by suitable antibiotics, catheter obstructions which can not be opened by a suitable process occurred or if the patients with CVC were no longer needed. Data were noted for each CVC until it was removed due to any reasons.

STATISTICAL ANALYSIS

Using SPSS 9.0 software, data were analysed by chi-square, One-way ANOVA, Wilcoxon runk-sum, Kaplan–Meier survival and and Cox-regression test. A p-value of <0.05 was considered statistically significant.

RESULTS

Ninety-two CVCs were inserted in 85 chronic hemodialysis patients. Fifty-five (59.7%) CVCs in 50 (58.8%) female and 37 (40.2%) CVCs in 35 (41.2%) male patients were used ($\chi = 3.52$, $p < 0.05$). Of the 92 CVCs studied, 60 (65.2%) were inserted in patients older than 55 years ($\chi = 8.52$, $p < 0.05$). The causes of end-stage renal disease (ESRD) were diabetic nephropathy ($n = 25$), chronic glomerulonephritis ($n = 21$), chronic pyelonephritis ($n = 18$), amyloidosis ($n = 5$) and other diseases ($n = 16$) (Table 2). Thirty-six (42.3%) patients had a cardiovascular disease. CVCs were used in 48 patients as first PVA. In 79 patients, first catheterizations were successfull. Five patients needed second catheterizations. In 1 patient, a third catheterization was necessary. No patient died from catheter-related complications. Twenty-two patients died during study (12 from cardiovascular disease, 5 from malignancy, 3 from cerebrovascular disease, 5 from other diseases). The site of CVC placement was right internal juguler vein in 66, right subclavian vein in 12, left internal jugular vein in 10 and left subclavian vein in 4.

Table 2. Causes of ESRD in our patients.

Causes of ESRD	*n*	%
Chronic glomerulonephritis	21	24.6
Chronic pyelonephritis	18	21.1
Diabetes mellitus	25	29.3
Amyloidosis	5	6.5
APCKD	2	2.3
Unknown	10	11.6
Other	4	4.6
Total (*n*)	85	100

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CVC Survival

We followed up 92 CVCs duration 24120 catheter days (804 catheter months). The median duration of CVC survival was 289 days (range: 10–720). Overall CVC survivals are shown in Fig. 1. Eleven CVCs were removed from catheter-related complications (6 thrombosis and 5 catheter-related infections). The median duration of these CVCs survival was 113 days (range: 7–210). The most frequent indications for CVC removal were patient death (69.4%), thrombosis (16.6%) and CVC related infections (13.8%) (Table 3).

The estimated CVC survival rates were 65.2% at 6 months and 35.8% at 12 months. In addition, 27 (31.8%) patients have CVCs functioning for over 12 months, 17 (20%) patients have CVCs functioning for 6 months. CVC survivals were 298 days (range: 15–720) in female patients and 233 days (range: 10–690) in male patients ($p > 0.05$). CVC survivals were similar according to side of CVC ($p > 0.05$). The presence of diabetes mellitus was found as an independent risk factor for CVC removal by Cox proportional hazards test ($p < 0.05$).

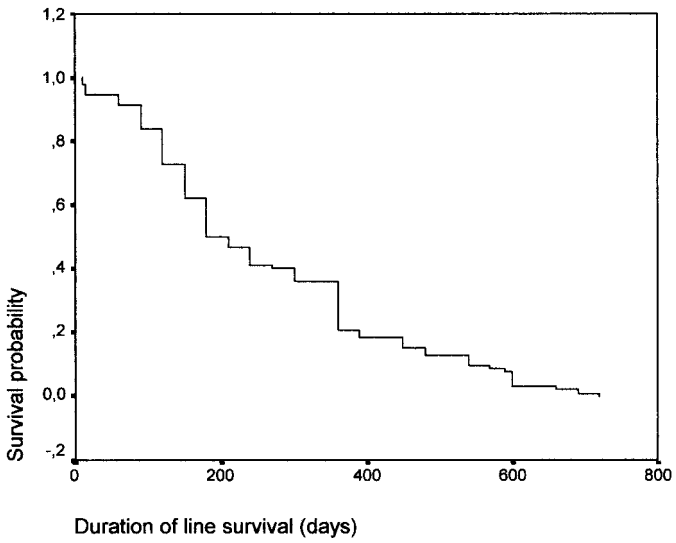


Figure 1. CVC survivals (Kaplan–Meier).

Table 3. Indications for CVC removal.

Indications	*n*	%
Patient death	25	69.5
Catheter related infections	5	13.9
Catheter thrombosis	6	16.6
Total removal (*n*)	36	100

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CVC Complications

The total incidence of CVC-related infections was 0.82 episodes/1000 catheter days. Besides, thrombosis occurred in 10 CVCs. Of the 10 CVCs, 6 were removed and 4 were opened by using fibrinolytic drugs. The most frequent indications for CVC removal were patient death (66.6%), thrombosis (19.4) and CVC related infections (14%). Twenty CVC-related infections episodes occurred on 16 CVCs. Of the 16 CVCs, 5 were removed due to catheter related infections. The most common agent was staphylococcus aureus (75%). There were not vancomycin resistance in these bacteria. In 2 catheter infections, Pseudomonas, in 2 catheter infections, Enterobacter were isolated (10%). In 1 catheter infection, agent can not be isolated. Five CVCs were removed due to catheter-related infections. There was not any difference significant between diabetic–non diabetic and male–female patients in terms of catheter-related infection ($p > 0.05$, $p > 0.05$, respectively). In addition 2 exit-site infections in 2 CVCs and 1 tunnel infection were seen and were was successfully managed by antibiotic therapy.

DISCUSSION

In Europe, the NAVF is most frequently used vascular access, in agreement with the general consensus. Although CVCs initially were conceived as a form temporary vascular access, recently there has been a progressive in their use despite the associated morbidity such as infections, dysfunctions, recirculation and causation of central vein stenosis. Undoubtedly, it is a major advantage of the vascular catheter that it is technically simple to insert and permits immediate access to the vascular system. With 24120 catheter-days (80 catheter-months) of follow-up, we believe that our study provides important information on the longevity of CVCs. The results presented in this report (a median catheter survival of 289 days and an estimated over 12 months survival of (31.76%)) compare favorably with results of other workers. Although we do not recommend use of the catheter as a first choose in patients requiring long-term access, in cases where other forms of access have failed, it should be considered an important alternative. All of catheters were placed with local anesthesia under scopy. During replacement of the CVCs, local complications such as hemothorax, pneumothorax, hemotoma and nerve damage may be seen. No such complications were encountered during the course of this study.

The most frequent reason of the CVCs removal was patient death (69.4%). No patient died from catheter related complications. The second and third complications we encountered were obstructions (16.6%) and infections (13.8%). Complete obstruction of the catheter due to catheter thrombosis led to catheter failure on 6 occasions, and these catheters were removed. Little et al.[11] reported that the most powerful predictor of CVCs failure was whether or not the patient had required a semi-permanent catheter previously. Canaud et al.[15] reported that median CVCs survival was 2.5 years with a cumulative incidence of CVCs failure of only 7.6% at 4 years. The patients were felt to represent an elderly cohort with a mean age 58.4 years and 46.6% of patients >65 years that are similar to our patient population.

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Twenty catheter related infections occurred in 16 CVCs during our study: Of the 16 CVCs, 5 were removed due to catheter related infections. In addition, 2 exit-site infections in 2 CVCs and 1 tunnel infection were seen. But these 3 catheter-related complications were managed by antibiotic therapy without catheter removal. An interesting finding from our study was the extremely high percentage (75%) of staphylococcus aureus isolated from our 20 episodes of catheter-related infections. Gram negative organisms were isolated in only 10%. This is different other reports of catheter-acquired bacteremia. Marr et al.[16] isolated gram-negative organisms in 24% of isolates from 62 episodes of bacteremia and Saad[17] reported this percentage 45%.

In conclusion, while the CVCs are not the ideal form of vascular access for hemodialysis, when other forms of vascular access are not available, it may offer a very useful alternative. Also this manuscript concluded with the assertion that CVCs were excellent long-term vascular access alternative for hemodialysis in the patients with exhausted vascular access sites, no suitable vessels, failed peritoneal dialysis or short life expectancy due to different end-terminal disease.

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