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Original article

A comparative study of peripherally-inserted and Broviac catheter complications in home parenteral nutrition patients

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SUMMARY

Background & aims: Peripherally inserted central venous catheters (PICC) have become increasingly popular for medium to long-term parenteral nutrition (PN) but there is limited data on the complication rates in this sub-group. We aimed to compare the rates of complications associated with tunneled catheters (Broviac) and PICC in home PN (HPN) patients.
Methods: All adult patients in an HPN program with a new Broviac or new PICC between 2009 and 2011 were included in this prospective observational study. Complication rates were compared by using Poisson regression and Kaplan Meier survival curves were used to compare the first complications that occurred.
Results: 204 catheters (133 Broviac and 71 PICC) were inserted in 196 adult patients. Mean follow-up from catheter insertions to their removal was 276 ± 219 days for Broviac ($n = 86$) *vs.* 74 ± 140.70 days for PICC ($n = 56$); $p < 0.001$. Complications were similar between Broviac and PICC (91/133 vs. 26/71). Catheter infection rate was lower in PICC (1.87 vs. 1.05 per 1000 catheter-days; $p = 0.01$). Catheter obstruction rates were similar for both catheters. Only PICC experienced venous thrombosis (0.4/1000). The proportion of catheters removed was lower in the Broviac group than in the PICC group (62.4% *vs.* 78.8%; $p = 0.01$) but those removed for complications were not different (28.6.7%vs. 25.3%; $p = 0.64$).
Conclusions: In HPN patients, overall complications were similar in both the PICC and the Broviac groups. However, the Broviac catheter could be associated with an increase in catheter infection.

1. Introduction

Providing home parenteral nutrition (HPN) allows patients with chronic intestinal failure to have an active life in their own community at a reduced health care cost.[1,2] A reliable intravenous access is required for the safe administration of parenteral nutrition (PN). Tunneled central venous catheters inserted in a central venous vein such as the Broviac catheters are the most commonly used catheters in these patients. However, in the last few years, peripherally inserted central venous catheters (PICC) have been increasingly used in hospitalized and home care patients as alternatives to centrally inserted venous catheters.[3–5] A PICC is a central venous catheter inserted in a peripheral vein. It has the advantage of limiting the risk of accidents during insertion and is easy to remove.[6] Its use in HPN patients remains debated owing to possible complications such as infection and thrombosis. Data to guide the decision to place a central venous catheter (CVC) inserted in central vein vs. a PICC based on cumulative complication in HPN are therefore limited. Although PICCs have shown a diminished rate in catheter-related infections in some hospitalized patients, such as intensive care unit patients and children, this has not yet been proven for HPN.[4,5,7,8] This prospective observational study aimed to compare the complication rates associated with the use of Broviac and PICCs in HPN patients.

2. Materials and methods

All patients followed up in an approved unit for long-term HPN at Lyon University Hospital in whom a PICC or a Broviac catheter was inserted between January 1, 2009 and December 31, 2011 were prospectively included in this study. PICCs (Cook Incorporated, Bloomington, Indiana, USA) were inserted by radiologists and Broviac (BARD Access systems, Salt Lake City, Utah, USA) were inserted by a physician on the nutrition team. All catheters were inserted in an angiography room with fluoroscopic guidance under strict

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conditions. The choice of CVC was not randomized but was made by the patient's physician. A PICC catheter was preferred for patients initially expected to have HPN for fewer than 6 months and Broviac was preferred for those patients initially expected to need HPN for more than 6 months after insertion. These patients were, for the majority of patients, with a temporary stoma with restoration of continuity provided in 6 months or patients with a temporary indication of PN such as Crohn's disease with digestive stenosis before surgery, refeeding of malnourished patients, etc. Exceptionally, it is an evolutive cancer patient. The nurses in charge of PN management of patients at home were trained for catheter manipulations.

All incidents and complications occurring on the catheters were collected prospectively by the medical service team responsible for monitoring patients at home. These patients always had weekly laboratory tests at home and consultation in our unit with a variable frequency (monthly to quarterly) as required by the patient. The results of laboratory tests were sent to our unit. Local catheter infections were defined as an exit site infection (defined as redness, swelling, tenderness, with an erythema of more than twice the diameter of the catheter), tunnel infection, or pocket infection.[5] Catheter-related sepsis was defined by the presence of clinical signs (fever, shivering) associated with positive blood culture in patients without other obvious infection sites, in particular, intra-abdominal, respiratory or urinary infections.[1] For each CVC-related infection, diagnosis required two positive blood cultures for the same microorganism taken from CVCs and peripheral blood, with a 120-min differential time of growth in favor of CVC. Catheter-related venous thrombosis often heralded by symptoms such as arm swelling, pain, loss of function, head or neck swelling was diagnosed by Doppler.

The following data were collected: patient and catheter characteristics, including demographic data, body mass index (BMI), underlying diseases, indications for HPN, catheter insertion sites, dates of catheter insertions, dates and nature of complications, date of removal, and the reason for catheter removal. Catheters with a complication occurring in the hospital after catheter placement and before leaving the hospital were excluded from this study.

2.1. Statistical analyses

Descriptive statistics with mean ± SD, median and interquartile range, and proportion were used to characterize the study population. Comparisons were made by chi-square test or Fisher's exact test for categorical variables, and by the Mann–Whitney test for continuous variables. The catheter-days meant the duration of presence of catheter in the study period. It permitted to estimate the duration of exposition at catheter complications. The number of catheter-days was calculated from the day of insertion to the day of complications in patients with complications and from the day of insertion to the date of catheter removal or the date of the end of the study for uncomplicated patients. The incidence rate of complications was calculated as the number of complications for 1000 catheter-days, with a 95% confidence interval (95% CI). Incidence rates were compared using Poisson regression. Kaplan–Meier analysis and the log-rank test were used to compare cumulative first complication-free catheter survival in the two patient groups.

For all tests performed, 2-tailed $p < 0.05$ values were considered as statistically significant. Analyses were undertaken with SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

3.1. Patient and home parenteral nutrition characteristics

When appropriate, results were always given as Broviac patients *vs.* PICC patients.

A total of 196 patients (77 men) were included. The mean age of patients was 55.6 ± 16.5 years and the mean of BMI was 21.4 ± 5.5 at catheter insertion. Eighty-four patients had an ileostomy (53.5%) and 32 (16.3%) had an active cancer. Short gut syndrome and Crohn's disease were the main reasons for HPN (Table 1).

Before catheter insertion and inclusion in this study, 77 patients with Broviac had already been on HPN for 1247 ± 2144 days and 35 patients with PICC for 553 ± 1423 days ($p = 0.01$). Patients received 5.7 ± 1.5 *vs.* 5.9 ± 1.4 ($p = 0.36$) bags per week. Industrial parenteral bags were used in 64.0% *vs.* 73.0% patients ($p = 0.19$). The characteristics of administered PN during the study period were: volume: 2145.5 ± 720.2 ml *vs.* 1879.2 ± 606.9 ml ($p = 0.009$); total calories: 1539.2 ± 464.4 *vs.* 1468.8 ± 381.5 ($p = 0.27$); total calories per kg weight: 27.2 ± 10.4 *vs.* 28.1 ± 11 ($p = 0.57$).

3.2. Catheter characteristics

Two hundred and four CVCs, including 133 Broviac and 71 PICC were inserted into 196 patients. Forty percent of Broviac and 51% of PICC were the first catheters placed in patients ($p = 0.14$). Broviac catheters were inserted in the left internal jugular vein ($n = 15$), the right internal jugular vein ($n = 37$), the left subclavian vein ($n = 37$), the right subclavian vein ($n = 41$), and the left femoral ($n = 2$). PICCs were either 4F ($n = 23$) or 5F ($n = 49$) and were inserted in the left basilic vein ($n = 33$), the right basilic vein ($n = 11$), the left brachial vein ($n = 20$), and the right brachial vein ($n = 7$).

Cumulative follow-up was 36,812 catheter-days for patients with Broviac and 12,322 catheter-days for patients with PICC. Catheter manipulations were made by the patients themselves in 18.0% and 4.2%, or nurses in 82.0% and 95.8%, respectively. In order to prevent catheter infections from the day of catheter insertion, taurolidine-citrate locks were injected in 35.34% vs. 36.62% ($p = 0.49$) respectively in Broviac and PICC. Oral Antivitamin K or subcutaneous heparin injection were prescribed in 26% vs. 25% for thrombosis or cardiovascular indications ($p = 0.88$).

3.3. Catheter complications

The first complication occurred later in Broviac catheters than in PICC catheters (180.2 ± 154.7 days *vs.* 118.1 ± 129.3 days; $p = 0.09$), but the difference was not statistically significant (Fig. 1). The overall incidence of complications was 2.36 (116/49,134) per 1000 catheter-days. The number of complications was higher in the Broviac group. However, when we took the duration of exposure into account, i.e. catheter-days. There were 91/133 (2.47/1000 catheter-days) Broviac complications and 26/71 (2.03/1000) PICC complications ($p = 0.12$). Catheter infection rate was lower in PICC

Table 1
Indications for home parenteral nutrition in patients with tunneled catheters (Broviac) and peripherally inserted central venous catheters (PICC).

Indication	Patients with Broviac %	Patients with PICC %	*p*
SBS[a]/ischemic vascular disease	42 (31.6)	13 (18.3)	0.04
SBS/volvulus	7 (5.3)	0 (0.0)	0.10
SBS/Crohn's disease	10 (7.5)	3 (4.2)	0.45
SBS/radiation enteritis	15 (11.3)	7 (9.9)	0.76
SBS/neonatal disease	2 (1.5)	1 (1.4)	1.00
Postoperative complications	27 (20.3)	10 (14.1)	0.27
Crohn's disease	6 (4.5)	11 (15.5)	0.007
CIPO[b]	6 (4.5)	6 (8.5)	0.35
Malnutrition	11 (8.3)	15 (21.2)	0.009
Villosity atrophy	3 (2.3)	3 (4.2)	0.42
Miscellaneous	4 (3.0)	2 (2.8)	1.00

[a] Short gut syndrome.
[b] Chronic intestinal pseudo-obstruction.