COMPARISON OF COMPLICATIONS AND DIALYSIS ADEQUACY BETWEEN TEMPORARY AND PERMANENT TUNNELLED CATHETER FOR HAEMODIALYSIS

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Abstract

Number of hemodialysis patients each day is increasing. The quality of their lives is largely determined by the quality of hemodialysis treatment. One of the most important factors is the type of applied blood approach. The type of blood approach in the most case is artery venous fistula, permanent, temporary catheters, grafts. Any complications of blood strand approach inevitably leads to lower quality of hemodialysis treatment which is connected with not adequate dialysis and poorer general state of patients. Our research was carried out as a prospective study, for the period of 36 months. In the study were included 31 patients, which are on chronic haemodialysis treatment. During this study, we are followed all complications, which occurred at temporary, and permanent tunneled haemodialysis catheters. Complications have occurred in terms of thrombotic problems, low blood flow, occurrence of infection. All patients are divided in two groups, 16 patients with permanent and 15 patients with temporary catheters. In the course of the study was analyzed blood flow and dialysis adequacy (Kt/Vdp) as well as complications and results was compared with randomly selected 16 patients who haemodialysis treatment performed by artery venous fistula (AVF). Two patients were lost to further follow-up to the end of the study. 26 patients at the end of the study had functional catheters, while in the case of 3 patients the catheter was removed. Infection was found in 10 patients while thrombotic complications were observed in 27 cases regardless of catheter type. Mean blood flow in patients with permanent catheter was significantly higher (296,9±28,45 cm^3/min) compared to patients with temporary catheter (226,3±39,8 cm^3/min) ($p<0,001$). Kt/Vdp delivered was 1,22±0,15 on patients with permanent catheter and 1,30±0,18 for artery venous fistula (AVF) access respectively. The loss of dialysis efficacy using catheters was estimated at 6%. However, in all cases Kt/Vdp values remained above the recommended values (Kt/Vdp ≥ 1,2).

KEY WORDS: haemodialysis, permanent tunnelled catheters, temporary catheter, dialysis adequacy;

Introduction

Tunnelled permanent catheters are increasingly used as a permanent vascular access on haemodialysis (HD) patients. The use of tunnelled catheters for vascular access for hemodialysis is associated with a relatively high incidence of complications. The most frequently occurring complication is catheter dysfunction or poor blood flow (1, 2). Catheter dysfunction may be classified as early or late (3). This time distinction is important because the aetiology for the problems that result in these two categories is different. Early catheter failure is defined as that which occurs immediately. In other words, the catheter never functioned adequately (i.e., did not deliver the expected blood flow of ≥350 mL/min). Late dysfunction is defined as a catheter that initially functioned in an optimal fashion, but then became dysfunctional. Such difficulties are usually due to thrombosis. Hemodialysis catheters are frequently complicated also by dysfunction from fibrin sheaths. A randomized, controlled, pilot trial was conducted to investigate the impact of angioplasty sheath disruption on catheter patency and function. In that study was analyzed forty-seven long-term hemodialysis patients with secondary, refractory catheter dysfunction underwent guide-wire exchange to replace their catheters (3). According to the United States Renal Data System (USRDS) data, 28% of all haemodialysis patients perform their treatment directly via permanent tunnelled catheter (4), while the number in Europe is slightly smaller, namely 10-12%. According to recent guidelines, developed by The National Kidney Foundation Disease Outcomes Quality Initiative (NKF-KDOQI)™ (5), the usage of tunnelled permanent catheters should be limited to no more than 10% of patients of the total number of haemodialysis patients. Introduction of these catheters has become more popular in the Eastern Europe countries in the past 5 years. These catheters are used for patients who have exhausted all possibilities for the design of AV fistula (9), or as solution for vascular access for those patients who are waiting on the maturation of AV fistula to be actively used (6, 7). In order to improve functionality and eliminate late dysfunction of a permanent catheter until now some studies have analyzed different methods where double lumen dialysis catheters are routinely treated by heparin or citrate 'locked' to maintain patency. In conclusion of that study all double lumen dialysis catheters, have a substantial amount of leak even when the catheter 'lock' volumes were used, and leak ratio increases significantly with 20% overfill (8). In our institution the usage of tunnelled catheters, as a form of permanent access for haemodialysis treatment, began in June 2006 for those patients who had exhausted other options for vascular access. Introduction of these new techniques for the treatment of patients with end-stages renal disease give the required implementation and additional measures of care, prevent the appearance of infections, provide new methods of access and placement and ensure adequate conditions in which to place the permanent catheters (10). Thus the attention and monitoring of patients with this new kind of vascular approach has increased. The design and venous location of catheter devices bear intrinsic flow limitations that may negatively affect the adequacy of dialysis and the patient outcome (11, 12). There is limited data comparing the long-term dialysis adequacy delivered with permanent catheters vs. temporary catheters compared with artery-venous vascular access (AVA).

Aim

The aim of this study was to assess complications of temporary versus permanent haemodialysis catheters during the monitoring period of last 36 months and to evaluate dialysis adequacy in patients with temporary and permanent tunnelled catheter compared to patients with artery-venous vascular access.

Patients and Methods

Thirty-one patients with end stage renal disease (ESRD) starting HD in our dialysis unit without functional or usable AVA were enrolled in this study at the Clinics Centre University of Sarajevo. All patients were informed and signed consent was obtained. Therefore, 31 patients completed the 36-month comparative study: 16 males with the mean age 63±0,9 years and 15 females with the mean age 54±0,12 years. Out of 31 patients with catheters there were 16 patients with permanent catheter (mean age 63,39±9,43 years); 10 males and 6 females. There were 15 patients with temporary catheters (mean age 56,98±8,86 years); 6 males and 9 females. 9 patients had diabetes mellitus type 2. Causal nephropathies were as follows: primary chronic glomerulonephritis, 32%; hypertensive and vascular nephropathies, 28%; diabetes type II, 13%; polycystic kidney disease, 12%; and systemic disease and miscellaneous, 15%. Residual renal kidney function (RRF) was calculated every month based on mean urea and creatinine clearances obtained from a 48 h urea collection. To explore this problem, we conducted a prospective 36-month study comparing the flow performances and dialysis dose

(Kt/Vdp) deliveries of both access options in a group of 31 haemodialysis patients during the study. During the period of 36 months the patients completed a treatment period by means of permanent dual silicone catheters (which made the company Medcomp, models Splithcath II and Duoflow). Then they compared with a 16 patients that already have constructed native artery-venous fistula (AVF) and monitored for a 36-month period. Assessments of flow adequacy and dialysis quantification were performed monthly. The average length duration of haemodialysis was 32,73±26,54. The average length duration of temporary catheters was 4,53±3,85 months and average length duration of permanent catheters was 25,25±6,75 months.

Inclusion criteria:

- patients on haemodialysis treatment longer than three months
- patients with permanent catheter previously exhausted all other options for vascular access
- International Normalized Ratio (INR) and Activated Partial Thromboplastin Time (APTT) must be in the reference values before placement of permanent catheter
- no systemic disease that influence blood coagulation

Exclusion criteria

- Kidney transplantation
- Transferred of the patients to other dialysis unit
- Artery-venous fistula (AVF) created and used before the end of the first three months
- Different facilities (lost for follow-up)
- Lethal outcome

All patients, to whom the permanent tunnelled dual lumen catheter had been placed, have been submitted to Colour Doppler procedure. Firstly we took in the consideration possibility of the construction of AV fistula. The next step was to look for professional opinion of vascular surgeon regarding the patients with whom the possibility of construction of artery-venous fistula did not exist. 29 patients were alive at the end of the period of observation, of which 26 of them with a functional catheter. At 3 patients the catheter had to be explanted due to newly created AV fistula. From 31 patients included in this study 2 patients have died. All other patients from the study had fully functional catheter. At the end of the period of monitoring of patients in our dialysis centre there were 14 patients who performed dialysis treatment through double lumen tunnelled catheters, from a total number of 189 patients. An infection was performed by removing the existing catheter and placing a new catheter with a creation completely new tunnel. Infections at the strain catheter were treated with broad spectra antibiotics.

Catheters placement

31 dual lumen haemodialysis catheters were implanted in 31 haemodialysis patients who were on chronic haemodialysis treatment for a period longer than 3 months. 15 polyurethanes and 16 silicones dual lumen access permanent catheters were used. Most commonly used permanent catheters which made the company Medcomp, Splithcath II and Duoflow type. All catheters were introduced using a split-sheath technique. Permanent catheters were placed in the right internal jugular vein. This approach was not possible in five cases; access through the subclavia veins was necessary in one case, in the case of 3 patients access was made via the left internal jugular vein and in one case catheter is placed in right femoral vein. Post-procedural radiological control was used instead of fluoroscopy during the process of introducing catheters. 3 of 31 patients were lost to follow-up; the most common reason was the departure of patients to other dialysis centre. Prior to the placement of a catheter to all patients was taken a detailed medical history (family, epidemiological, morbid condition), also to all patients at least once a month and made dialysis-ambulance, which includes ECG, X-ray of the lungs, and detailed examination by a doctor of internal disease. They also take into account previous attempts and the number of different attempts of vascular access, as well as regular monitoring of therapy necessary for these patients. In patients who are on chronic hemodialysis program, it is necessary to regularly monitor the value of blood, urea and creatinine, calcium, phosphorus and potassium, the adequacy of dialysis treatment Kt/V carried out. In each catheter at the end of dialysis must include an anticoagulant to preserve the functionality of a catheter. Anticoagulant drugs are given in the course of dialysis treatment for the prevention of blood clotting during hemodialysis. Usually given standard heparin and low weight molecular heparin (LWMH). Therefore, for all patients is monitored value of INR and APTT.

Statistical analysis

Statistical analysis was performed using SPSS statistical software system (version 12.0, SPSS Inc, Chicago, Illinois, USA). Values are expressed as mean ± SD. Significant differences between continuous variables were tested using Mann-Whitney's test and Chi-square test for categorical variables. Two-tailed p values <0, 05 were considered statistically significant.

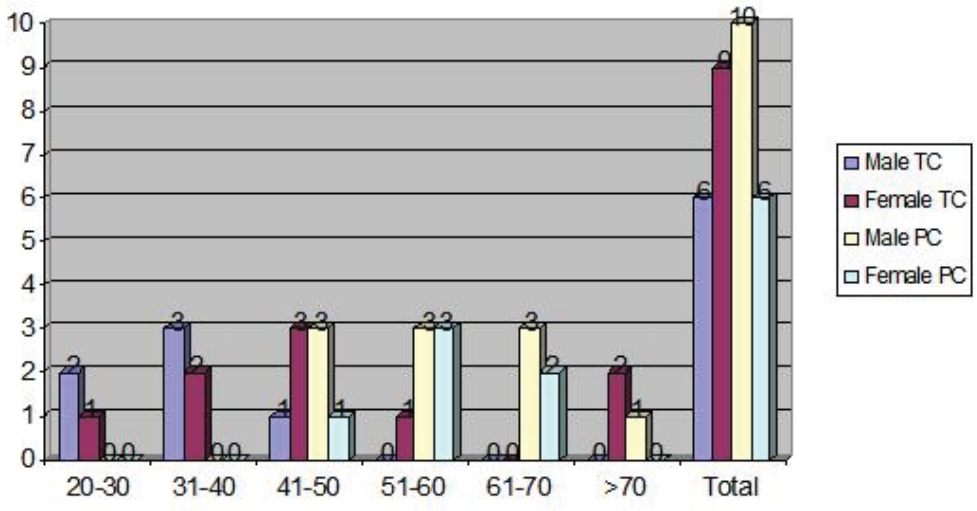

FIGURE 1. Age group of patients on haemodialysis.

Results

Age group of patients included in our study is shown on Figure 1. No significant difference in patient's distribution among age groups was observed. At the end of study period 2 patients died, both with a functional permanent catheter and the mortality rate was 6,45%. During the period of monitoring infection was detected in 10 subjects. In 5 subjects infection occurred around the tunnel of permanent catheter, in 2 patients infection occurred inside the tunnel, while in 3 patient infection was present at the output site of the catheter. Mean blood flow in patients with permanent catheter was significantly higher (296,9 ± 28,45 cm^3/min) compared to patients with temporary catheter (226,3±39,8 cm^3/min) ($p<0,001$). Significant difference was observed in blood flow rates in patients with permanent compared to temporary catheter. Higher blood flow rate (≥ 250 / min) was observed more frequently in patients with permanent (n=14) compared to patients with temporary catheter (n=3)($\chi 2=14,2$; $p<0,001$)(Table 1). Thrombotic complications were observed in 27 patients with temporary and permanent catheters. In patients with temporary catheter there were 24 catheter replacements while only 2 were needed for patients with permanent catheter (Table 2). The blood flow resistance of the Dual KT was slightly higher than with AVA as indicated by venous pressure differences. Kt/Vdp delivered was 1,22±0,15 and 1,30±0,18 with Dual KT and AVA access respectively (Table 3). The loss of dialysis efficacy using catheters was estimated at 6%. However, in all cases Kt/Vdp values remained above the recommended values (Kt/Vdp ≥ 1,2). Protein nutritional state, as well as conventional clinical and biochemical markers of dialysis adequacy, remained in the optimal range.

Blood flow (cm^3/min)	Temporary catheter	Permanent catheter
<200	3	0
200-250	9	2
250-300	3	10
>300	0	4

TABLE 1. Distribution of patients on temporary and permanent catheters across different blood flow rates.

	Permanent catheter (n=16)	Temporary catheter (n=15)	Artery-venous fistula (n=16)
Kt/V	1,22±0,15	0,97±0,15*	1,30±0,18

TABLE 3. Dialysis adequacy measured by Kt/V of permanent, temporary tunnelled catheters and artery-venous fistula.
Data shown as means; *p<0,05 compared to permanent and artery-venous fistula

	Jugular vein			Subclavia vein			Femoral vein			TC	CR
	Right TC	Left TC	CR	Right TC	Left TC	CR	Right TC	Left TC	CR		
Temporary catheter	8	9	14	7	0	7	3	0	3	27	24
Permanent catheter	19	8	2	0	0	0	0	0	0	27	2

TABLE 2. Comparison of thrombotic complications and a number of catheter replacement in patients with placed temporary and implanted permanent tunnelled catheters in different blood vessels.

TC- number of thrombotic complications; CR- number of catheter replacement

Discussion

According to data from the Renal Register of Bosnia and Herzegovina, more than 40% of patients on haemodialysis are older than 65 years of age (12). The minimum percentage of the male part of respondents is aged between 20 and 30 years. Most male and female respondents are under haemodialysis treatment since 2003. The analysis of our results indicates that the number of female patients with a temporary catheter is greater than the number of male patients (57% compared to 43%). The reason for this is because the maturation of AV fistula in female patients takes a longer period, which can be found in different studies (2). 10% of our haemodialysis population have placed permanent catheter that is in accordance with the literature (3). The same percentages of use of such vascular approaches have been reported and in other major studies so far conducted (4). In our study mortality rate of 6,45% during the 36 months was observed which is lower then mortality rate of 25% registered in the other countries (6, 8, 9). The morbidity and mortality in patients with permanent tunnelled haemodialysis catheter according to reports from other studies is greater than in the general dialysis population (5). A recent analysis from Australia and from New Zealand published in Dialysis Transplant Association Registry shows a significantly higher mortality rate for new dialysis patients who begin treatment through haemodialysis catheter or artery venous graft than in those patients who are at the beginning of treatment had designed AV-fistula (10). In the second study, among patients from the United States, found that mortality was higher in both groups, and in patients who have dialysis performed by the central venous catheter or artery venous graft compared with the A V-fistula (11). The possible reasons for our lower mortality rates compared to other countries could be due to the facts that our data refers only the prevalence, not incidence of haemodialysis patients with permanent and temporary catheters (7). The reason for this increased rate of mortality could be caused by specific complications of permanent tunnelled catheters, namely, infections and thrombosis. In our study nine cases with partial thrombosis and two cases with complete thrombosis have been observed, out of which 4 catheters were explanted. Most often the way the placement of tunnelled permanent catheters is in the right jugular vein (8, 10). In our study, the right jugular vein was used for placement catheters at 90% of male respondents, while for 10% of them the catheter was placed in the left jugular vein (12). The catheter is the placed in the right jugular vein at 67% of female respondents, while 33% of catheters were placed in the left jugular vein. The analysis of blood flow in patients on haemodialysis with both sexes usually starts at the borders between 200-250 ml/min in 65% of men and in 70% of women. In our group of respondents all thrombotic complications were present in the case of diabetic patients. The relationship between men and women was 2 to 1., which was confirmed by Colour Doppler ultrasound. From the total number of patients, diabetes type I and II is present in cases of 7 male and 2 female patients. According to data from the literature, diabetes mellitus is one of the risk factors not functional of AV fistula, which is also confirmed in our study (1). The infection is one of the most common complications that are present in permanent catheters and which are placed right behind thrombotic complication (4). With respect to the application of adequate preventive measures to preserve the catheter, one patient had fever and then the catheter was removed for a period of two days, after which it was placed again, but on the opposite side, in left jugular vein. Our observations and the results that we have are related to the group of patients with very small rate of transplantations and with a very long of duration of haemodialysis treatment. Therefore, the care about catheter-related complications such as infection and thrombosis was done quickly and adequately

Conclusion

Lifetime and co morbidity states are determined which of type vascular approach will be used for haemodialysis patients. In patients who have exhausted all other options for vascular access, the use of permanent catheters is more than welcome to conduct adequate hemodialysis treatment. In some patients which have expressed hyper coagulation and complications often occur in terms of thrombosis should consider other types of dialysis treatment. Permanent catheter show higher blood flow rate then temporary catheter. Application of permanent tunnelled catheter is a very useful alternative for the treatment of all patients who need haemodialysis and in those patients who are for various reasons cannot construct artery venous fistula or any other kind of vascular access.

List of Abbreviations

Kt/V	is one way of measuring dialysis adequacy. • In this measurement: • K stands for the dialyzer clearance, the rate at which blood passes through the dialyzer, expressed in millilitres per minute (ml/min) • t stands for time • Kt, the top part of the fraction, is clearance multiplied by time, representing the volume of fluid completely cleared of urea during a single treatment • Kt, the top part of the fraction, is clearance multiplied by time, representing the volume of fluid completely cleared of urea during a single treatment • V, the bottom part of the fraction, is the volume of water a patient's body contains
Kt/Vdp	Effective body clearances for urea, dialysis dose (KtuVdp)
Dual KT	Permanent dual silicone catheters
AVA	Artery venous access
AVF	Artery Venous fistula is anasthomosis between artery and vein which is use in haemodialysis treatment for vascular approach
ESRD	End Stage Renal Disease
SPSS	Analytical and statistical Software. Specializing in data mining, customer relationship management, business intelligence and data analysis.
INR	International Normalized Ratio - Since the Prothrombin time (PT) evaluates the ability of blood to clot properly, it can be used to help diagnose bleeding. When used in this instance, it is often used in conjunction with the PTT to evaluate the function of all coagulation factors. Occasionally, the test may be used to screen patients for any previously undetected bleeding problems.
APTT	Activated Partial Thromboplastin Time - As part of an investigation of a bleeding or thrombotic episode; to monitor standard heparin anticoagulant therapy.

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