RESEARCH ARTICLE

Scheduled screening of patency of permanent central venous dialysis catheters

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ABSTRACT

Background: The number of hemodialysis patients is being increased year by year throughout the world, due to the increase in the life expectancy of the population, as well as the increase in incidences of hypertension and diabetes among them, but also due to the fact that many of the patients with heart and renal failure are now being dialyzed. Hemodialysis requires vascular access. But diabetics, hypertensives, as well as the elderly patients, usually have no vessels (arteries and veins) capable enough to give a satisfactory blood flow via a fistula, so the catheter is the only choice.

Objective-Design: A well-functioning catheter is a prerequisite for the quality of the clearance provided. In the present study, control of the catheter patency was performed in a monthly basis. If the blood supply remained high (at least >300 ml/min) the catheter was considered to function satisfactorily.

Participants-Results: The study examined the patency of permanent dialysis catheters in 34 patients (19F, 15M). The catheter survival was found to be good in all cases (100%) with a blood supply of at least >300 ml/min for 17 months. Furthermore, 75% of the catheters had a good blood supply for 20 months, while 6 catheters survived with good function for 25 months and continue to operate satisfactorily even now.

Conclusion: The study found out that the method of controlling the patency of permanent dialysis catheters was easy and efficient for the timely detection of those that were malfunctioning and that the results from their use were satisfactory, compared to those of other researchers in the literature.

Key words: hemodialysis catheter dysfunction, patency hemodialysis catheter, permanent hemodialysis catheter

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Date of submission: 15/03/2021
Publication date: September 2022

Editor's note: The authors are expressing their personal view in the present paper.

Citation: Giannaraki D. & Mavromatidis K. (2022). Scheduled screening of patency of permanent central venous dialysis catheters. Hellenic Journal of Nursing Science 15(3), https://doi.org/10.24283/hjns.202234

Highlights/key points

- **The catheter may be the only choice for hemodialysis patients such as diabetics, hypertensives, as well as the elderly patients, who usually have no vessels (arteries and veins) capable enough to give a satisfactory blood flow via a fistula**
- **The method of controlling the patency of permanent dialysis catheters was easy and efficient for the timely detection of those that were malfunctioning**
- **The results from their use were satisfactory, compared to those of other researchers in the literature**

INTRODUCTION

In the United States, due to inadequate planning in creating permanent vascular access (fistula), most patients (>80%) are begin dialysis using catheters. Similarly, in Canada over 70% of patients with end-stage renal disease (ESRD) are begin dialysis with central venous catheterization (while 33% continue to be dialyzed with double lumen catheters) (Mendelssohn et al 2006), despite the recommendations of K/DOQI that only 10% of patients should be dialyzed with a permanent dialysis catheter (Vascular Access 2006 Work Group 2006). For a variety of reasons, the number of catheterized patients has been increased, which is the cause of increased complications (thrombosis, infections and reduced provided clearance), as well as the cause of higher mortality and increased costs of ESRD (Allon et al 1998, Arnold 2000).

The aim of the study was to investigate each dysfunctional catheter in time, in order to mobilize the respective team of doctors/nurses and to restore the patient's vascular access as soon as possible, for the seamless continuation of extrarenal dialysis.

PATIENTS - METHODS

Patients

All dialyzed patients in our unit who had a permanent central venous catheter were included in the study. A total of 34 dialyzed patients (19F, 15M) with ESRD were studied. Their average age was 75.24 years (range 22-92 years).

Thirty (30) patients underwent conventional dialysis and four (4) were on on-line HDF, with polysulfone (n = 30) and polymerized polyester (n = 4) filters. The surface area of the filters was 2.1 m^2 (n = 4), 2 m^2 (n = 29) and 1.8 m^2 (n = 1), while the heparin that we used during the dialysis session was of low molecular weight (n = 33), at a dose of 2, 500-3, 500 IU/session or classic (n = 1), at a dose of 2, 000 IU at the begging followed by 1, 000 IU/hourly. The filter was heparinized with 5, 000 IU of classic heparin/L.

Methods

In patients, the catheter tubes were closed after the end of each session with classic heparin (1, 000 IU/ml). The patency of the catheters was checked every month (or when necessary in cases of emergency), in order to be on time determining the proper or improper function of the catheters. Setting the blood pump to 600 ml/min for 5 min, if the flow remained high (at least >300 ml/min and the [negative] blood pressure was <-250 ml/min), the catheter was considered to be in a good condition. This is a common procedure in the management of patients undergoing dialysis. As a result, potentially dysfunctional catheters were detected early (blood supply <300 ml/min), before low clearance problems occurred in the patient.

In cases of catheter dysfunction, suction was performed initially, followed by injection of 0.9% NaCl into the lumen to remove a possible clot. If patency was not restored, 1 mg of recombinant tissue plasminogen activator (tPA) (Actylise) was placed in the lumen, which was left to act for 1 hour. An attempt was then made to remove the solution and check the lumen patency and blood supply. If tPA could not be aspirated, the contents of the tube were injected into the circulation with a syringe and the catheter was closed again with tPA (1 mg/tube) until the next use (usually the following day).

The catheter that was malfunctioning and had a constant blood supply <300 ml/min, in a short time (usually within 1-2 days), was replaced with a new one in the same or a different vein.

Statistics

The statistical analysis was performed with SPSS 2019 V26. The viability of the catheter was checked over time (Kaplan-Meier). During the analysis, patients who ended up with a working catheter, patients that changed a dialysis method (peritoneal), those that had a transplant or those that were transferred to another renal unit with a working catheter, all were considered to have a good functionally catheter.

RESULTS

Satisfactory patency of all catheters (100%) with the method described above (blood supply at least >300 ml/

min) was confirmed for 17 months. Furthermore, 75% of the catheters had a good supply for 20 months, while 6 catheters survived with efficient operation for 25 months and continue to be in a satisfactory condition. Figure 1, shows the catheter survival in a Kaplan Meier format.

DISCUSSION

According to the K/DOQI guidelines, only 10% of patients under dialysis should have a permanent dialysis catheter (Vascular Access 2006 Work Group 2006). However, in clinical practice that is impossible. Therefore, many patients are dialyzed with permanent central venous hemodialysis catheters, for various reasons including inability to create a fistula due to lack of satisfactory veins or arteries, heart failure etc., shouldering the consequences of their use, which are plenty and serious.

Permanent venous dialysis catheter dysfunction is a common problem in dialysis patients with catheter infections being another very important complication of their use. The removal or replacement of 50% of the catheters is caused by these two complications.

A catheter is considered to malfunction if its blood supply is on average <300 ml/min during a dialysis session (Vascular Access 2006 Work Group 2006), so that adequate clearance is not provided (others consider catheter malfunction when the maximum blood flow is <200 ml/min for at least 30 min or when the maximum blood flow is <250 ml/min during two consecutive dialysis sessions) (Wang et al 2015).

Catheter dysfunction can be caused either by complete occlusion of the lumen (in which case the session is not possible to be completed as planned) or of partial occlusion (due to fibrin deposition in the lumen, occlusion of its lateral holes and nostrils by clots or due to pericatheter sheath). It is noted that clots form and are located, both in the lumen and the surroundings of the catheter (Besarab & Pandey 2011).

The most important causes of catheter dysfunction include the formation of a thrombus (intralumen or extralumen), pericatheter sheath or a combination of those causes. In particular, in cases of sheath in dogs, in the inner jugular vein of which a catheter was placed, it was found within 14-28 days, that all had a sheath, which of course did not reach to the tip of the catheter, and in some cases thickening of the inner layer of the vein was observed (Wang et al 2015). The sheath consists of endothelial cells, smooth muscle cells, fibrinogen, albumin, lipoprotein, collagen (Beathard 2001) and surrounds the catheter (Lee et al 2011). This appeared to be generated from the first 24 hours of implantation, entered from the exit point or the cuff and showed a tendency to migrate down the catheter, covering the catheter and the holes of tip within 3-7 days (Crain et al 1998), leading to malfunction and reduced clearance. This is responsible for 13-75% of dysfunctional catheters (Goldberg et al 1985, Terotosa et al 1997, Crain et al 1998).

The sheath is the response of the organism to the foreign body, which irritates the vascular wall (Schon & Whittman 2003). As a result, it surrounds the catheter, starting at the site of catheter entry till the tip (Dinwiddie 2004). In a randomized controlled trial by Oliver et al. 70% of patients with catheter dysfunction had a fibrous sheath (Oliver et al 2007), as was also observed by other researchers (Chan 2008).

Thrombi are the other most common cause of occlusion of dialysis catheters (some claim that they are responsible for 46% of malfunctioning catheters) (Terotosa et al 1997) and are an independent factor associated with the optimum dialysis clearance (Sehgal et al 1998). It is noted that thrombi can move to the right atrium and the superior vena cava, but can also reach the lung (pulmonary embolism) (Shapiro et al 2002). Risk factors for blood clots include hypovolemia, hypotension, hypercoagulopathy, injury of the vein from catheter entry, bad positioning of the catheter tip and administration of drugs through the catheter or parenteral nutrition (Deitcher et al 2002).

In a study of 75 patients, over a period of 26 weeks (6.5 months), 87% of catheters (CentrosFlo) had a blood supply >300 ml/min (Agarwal et al 2016). In another study (n=472 patients), where catheter dysfunction was defined as a mean blood flow <250 ml/min, it was shown that the catheters in the right internal jugular vein had a good blood flow of 51% for 26 weeks. The study also found satisfactory catheter patency for all catheters up to 202 days (Shingarev et al 2013). Furthermore, the study by Rocklin et al. reported that 50% of permanent dialysis catheters had a good mean catheter patency of 3 months (Rocklin et al 2001). In our study, 100% of the catheters had a good blood supply (>300 ml/min) for about 17 months. Finally, from all the studies in comparison to our results, it seems that the maintenance of catheter patency was significantly better in our patients.

Early detection of catheter dysfunction is important. Its purpose is to provide a safe and satisfactory blood supply. Thus, a dysfunctional catheter can be easily assessed in the patient's bed. Indications for its dysfunction are the reduction of blood supply (<300 ml/min) as well as negative blood arterial pressure (<-250 mmHg). In a malfunctioning catheter the monthly urea reduction rate (URR=urea reduction rate) is <65% and the Kt/V<1.2.

Of course, the catheter malfunction is perceived by the reduced blood supply, the frequent sound of alarms

(arterial or venous pressure) and the poor efficiency of dialysis based on the URR and Kt/V. As a result of those, reduced attributed clearance is observed, which in turn may affect the patient's quality of life and survival rate.

Although the blood supply achieved now with permanent dialysis catheters may increase, the doses of clearance they deliver continue to be lower than those achieved with fistula or vascular grafts. This may be related to a lower blood supply and a higher number of catheter-related complications (infections, malfunctions) (Moist et al 2006), causes that may reduce the survival rate of the patients.

In fact, it is known that an additional clearance time of 30-60 min is required after the completion of the session with a catheter in order to achieve the same Kt/V in comparison to a fistula (Maduell et al 2008). This is particularly important, given that the average age of hemodialysis patients is gradually increasing (80% of whom are over 65 years old), which means that there is a need for dialysis catheters to be used more frequently.

If though the blood supply from the catheter is not sufficient, then the given clearance is even lower. However, Moist et al. who studied 259 dialyzed patients with permanent catheters, found a reduced blood supply (<300 ml/min) in 22.2% of the cases, not all of whom had URR <65% (Moist et al 2006).

The study showed that the method of controlling the patency of permanent dialysis catheters is efficient for the timely detection of those that malfunction and that the results from their use are very satisfactory compared to those in the literature.

Conflict of interest: The authors declare that they have no conflict of interest.

Contribution of the authors: D. G.: conception and design of the study and analysis and interpretation of the data. K. M.: drafting the article and final approval of the version to be submitted.

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Figure 1:
Months of catheter survival

