Successful Long-Term Central Venous Access

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Daily home hemodialysis (DHHD) requires simple, vascular access to minimize patients' discomfort but also to guarantee tolerance and long-term efficiency. The arteriovenous fistula is not ideal for DHHD because of the double puncture required every day; in addition, the rate of dysfunction is probably greater because of the more frequent use. Central venous catheters may be a good alternative to the arteriovenous fistula as long-term vascular access for DHHD. In this study we report our experience with the internal jugular vein two-catheter access for long-term dialysis and evaluate its possible use for DHHD.

Since 1988, Tesio's twin catheters have been positioned in 908 patients with exhausted peripheral vascular bed. In all patients hemodialysis could be performed a few minutes after the surgical procedure.

The survival rate of catheters, in a selected group of 46 patients, at 1, 2, and 5 years was, respectively, 92%, 87%, and 82%. The mean blood flow was 282±29 mL/min at 1 month, 286±36 mL/min at 1 year, and 274±37 mL/min at 5 years. Venous pressure in the inlet side was 102±31 mm Hg at 1 month, 126±36 mm Hg at 1 year, and 132±58 mm Hg at 5 years. Catheter clotting was treated either with thrombolytic agents or with catheter (one or both) replacement. Sepsis was treated with systemic antibiotic therapy or catheter removal.

Data support the potential role of the internal jugular vein two-catheter system for DHHD.

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Key words

Central venous catheter, jugular vein, daily home hemodialysis

Introduction

Daily home hemodialysis (DHHD) requires permanent vascular access that allows frequent use and is also well tolerated by patients. The arteriovenous fistula (AVF) presents a high early exhaustion risk if the puncture, made twice a day, is not performed properly. Moreover, there still remain a few problems related to internal AVF: (1) An interval of a few days is required between insertion and actually using an AVF. Therefore, it cannot be used as an emergency vascular access. (2) Patients affected by degenerative vascular disease, or who previously underwent multiple vascular procedures, do not have an adequate vascular bed to build an AVF. (3) The double puncture required every day is a potential source of stress to patients. (4) Cardiovascular overload due to proximal AVF should not be underestimated in patients with an already compromised cardiovascular system.

Therefore, the ideal vascular access for long-term hemodialysis should have all the advantages of an AVF (easy to prepare, good long-term survival, low infection and thrombotic rates) and should avoid all its disadvantages and problems.

Among many options developed over the last three decades (external shunts, artificial grafts, artificial accesses such as Hemasite's and central venous catheters), only artificial grafts and central venous catheters are currently used. Artificial grafts, however, have the same problems as AVFs. At the present time, the best vascular access for dialysis, as an alternative to AVF, is central cannulation, although this access is also subject to problems: mainly sepsis, long-term catheter patency, and thromboembolism complications (1).

Of the central venous approaches, subclavian vein cannulation was abandoned because of important side effects. These are mainly due to reactive processes in the vein wall at the puncture site as well as a mechanical inflammatory injury in the vein wall due to catheter indwelling (2). When a catheter lies inside the subclavian vein for a long time, stenosis and thrombosis are almost inevitable, thus compromising venous blood return from the ipsilateral arm (3).

The two-catheter ipsilateral internal jugular vein system (4) could be important in DHHD because of its advantages: the possibility of long-term indwelling use, while providing a high blood flow rate and still being well tolerated by patients. Avoiding needle puncture at each dialysis session is an advantage for both patients and home dialysis partners.

Both catheters are made of medically treated silicone, which enhances biocompatibility and biostability. They are placed over the pectoralis muscle with a downward exit site, parallel to the sternum, after a long tunnelization. This reduces pericannular microbial migration. Hence of the different systems and types of catheters used for central venous catheterization, this system, in our opinion, represents the best choice when accurate insertion techniques and proper daily nursing care are observed.

Material and methods

From May 1988 to December 1997, 908 patients underwent internal jugular vein catheterization using two Silastic

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catheters. Fifty-six percent of the patients were male, and 44% were female. The mean age was 57 years. Of these patients, 62% were on chronic hemodialysis for which central venous catheterization represented the priority access to the vascular bed. Other indications were acute kidney failure and access for plasmapheresis.

Our system (Tesio's Twin-Cath, Medcomp, Harleysville, PA) (5,6), a modification of Canaud's idea, consists of percutaneous insertion, using Seldinger's technique, of two catheters in the ipsilateral internal jugular vein, approaching it from the upraclavicular Sedillot's triangle. To protect the extravascular segment of the cannulas, subcutaneous tunnelization is carried out under local anesthesia. With the tip of a scalpel, the skin incision is enlarged around the catheters, and with Pean forceps the subcutaneous tissue is dissected for 2–3 cm over the clavicle and downward. Using a Redon needle, two tunnels, 8–10 cm long, are then prepared downward, parallel to the sternum with an adjacent exit site.

To anchor the system, we use a silicone olive enlargement already built on each cannula, located at 18 and 22 cm from the internal tip for the right jugular vein approach, and 22 and 26 cm from the internal tip for the left jugular vein approach. The point of anchoring should be located approximately at the middle of the subcutaneous tunnel. Fifteen to 20 days following the procedure, fibrotic tissue will organize around the cannulas. The olive enlargement will provide a strong anchor sufficient to prevent accidental extraction, but not strong enough to resist a firm withdrawal in case removal or replacement of the cannula is needed.

Results

From this large number of patients we had the opportunity to follow up directly 46 patients residing in our area for 2 years. Of this selected group, 37 patients were observed for over 5 years. The survival of the vascular access in this group after 1, 2, and 5 years was, respectively, 92%, 87%, and 82%. The mean blood flow was 282±29 mL/min at 1 month, 286±36 at 1 year, and 274±37 at 5 years. Venous pressure in the inlet side was 102±31 mm Hg at 1 month, 126±36 at 1 year, and 132±58 at 5 years. During the 5-year period, nine accesses were removed because of causes not related to cannulas (3 patients had renal transplant, 2 deceased, 2 had AVF, and 2 patients were transferred to continuous ambulatory peritoneal dialysis). In 8% of the cases the blood flow decreased to less than 250 mL/min and replacement of the "arterial" cannula was required. In 6% of the cases the inlet blood pressure increased to over 180 mm Hg, and replacement of the cannula in question was performed. In two cases one cannula and in one case both cannulas had to be replaced due to thrombotic obstruction. A laceration of the catheter due to an incorrect nursing maneuver was observed in 4 cases, followed by catheter replacement. Because of sepsis or even suspected infection, replacement of one cannula was done in 14 cases, whereas only in 2 cases replacement of both cannulas was warranted.

Discussion

After abandoning the subclavian access because of specific complications (7), we adopted the internal jugular vein catheterization method using two catheters according to the technique described by Canaud. The method used to anchor the system and the type of silicone rubber were modified to reduce the risk of sepsis. Although this method is considered relatively safe and efficient according to many authors (8,9), including Canaud's long experience (10) as well as ours (11), it sometimes exposes patients to complications that are common to all central venous cannulation methods. In our experience, these complications were never fatal. Most of the complications were related to the insertion procedure, but the number of these tyes of complication fell dramatically after the introduction of the ultrasound-guided method of insertion.

We point out the very low percentage of long-term complications, mainly thrombus formation and infection. The favorable outcome could be attributed to the following:

1. The correct surgical procedure in the positioning of the silicone cannulas. Silicone catheters are soft and follow the vein shape, thus preventing vessel and atrium damage.
2. Long subcutaneous tunneling with the external exit pointed downward reduces the risk of sepsis (12). According to some authors (13), the exit site is the most common determinant favoring bacterial contamination. There is considerable controversy (14) concerning the efficacy of subcutaneous tunnelization. The literature provides poor information about the position, the length of the tunnel, and the material of which the catheter is made. According to our experience, microbial migration is mechanically avoided by pointing the external exit downward after a tunnelization of at least 8 cm (15). However, subcutaneous tunnelization appears to be ineffective when the cannula is made of a material with poor biological affinity. Therefore, the type of material that the catheter is made of is very important. When the catheter is tunneled, healthy subcutaneous tissue acts as an efficient wall against bacterial migration, provided that a biocompatible material such as silicone is used (16). Few papers have been published dealing with catheter material biocompatibility and its role in long-term survival. We prefer a special, medically treated silicone for its low coefficient of static and kinetic friction, thus reducing thrombus formation (17) and increasing surface energy. Energy of 20–30 dyne/cm^2 makes the surface "minimally bioadhesive" and helps to prevent adhesion of platelets, fungi, and bacteria (18).
3. The implantation of two separate catheters allows us to replace one in case of dysfunction, without interrupting the dialysis session, which can be continued using the remaining catheter and a double-head blood pump.
4. The 2-mm internal diameter and the large loop around the clavicle prevent kinking and allow an arterial flow

rate of up to 450 mL/min with a venous return pressure lower than 200 mm Hg.

5. A meticulous maintenance program is warranted for long-term catheter survival. An occasional follow-up 2 years after the end of our study (December 1997) showed that only 30% of accesses were still functioning. This could be attributed in part to the lack of care following the end of the study.

Although this type of access requires more attention, our experience has confirmed that the ipsilateral catheterization of the internal jugular vein with two cannulas is effective, it is easy to insert, has good long-term survival, and has low infectious and thrombotic complication rates. Since no time is needed between insertion and use, it can be considered as an emergency access. It can be prepared in all patients regardless of the primary disease or the condition of the peripheral vascular bed, thus providing an adequate blood flow for modern dialytic strategies. In case of dysfunction of one of the two catheters, replacement is easy and does not interfere with the dialysis session.

In conclusion, catheterization of the ipsilateral internal jugular vein with two separate silicone catheters provides safe and reliable short- and long-term vascular access for both hospital and home hemodialysis patients. The outcome depends on the appropriate positioning of the cannulas, the long subcutaneous downward tunnelization, the good bio- and histocompatibility degree of the material, and a meticulous maintenance program. Although we have no direct experience in daily home hemodialysis adopting this central vascular method, it is reasonable, for the moment, to assume that this system represents the best alternative to the AVF as vascular access for daily home hemodialysis.

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