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Patency and complications of translumbar dialysis catheters

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Abstract

Background—Translumbar tunneled dialysis catheter (TLDC) is a temporary dialysis access for patients exhausted traditional access for dialysis. While few small studies reported successes with TLDC, additional studies are warranted to understand the short and long-term patency and safety of TLDC.

Methods—We conducted a retrospective analysis of adult patients who received TLDC for hemodialysis access from June 2006 to June 2013. Patient demographics, comorbid conditions, dialysis details, catheter insertion procedures and associated complications, catheter patency, and patient survival data were collected. Catheter patency was studied using Kaplan-Meier curve; catheter functionality was assessed with catheter intervals and catheter related complications were used to estimate catheter safety.

Results—There were 84 TLDCs inserted in 28 patients with 28 primary insertions and 56 exchanges. All TLDC insertions were technically successful with good blood flow during dialysis (>300 ml/min) and no immediate complications (major bleeding or clotting) were noted. The median number of days in place for initial catheter, secondary catheter and total catheter were 65, 84 and 244 respectively. The catheter patency rate at 3, 6 and 12 months were 43%, 25% and 7% respectively. The main complications were poor blood flow (40%) and catheter related infection (36%), which led to 30.8% and 35.9% catheter removal respectively. After translumbar catheter, 42.8% of the patients were successfully converted to another vascular access or peritoneal dialysis.

Conclusion—This study data suggests that TLDC might serve as a safe, alternate access for dialysis patients in short-term who have exhausted conventional vascular access.

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Keywords

End stage renal disease; Vascular access; Dialysis catheter; Clinical outcome

Introduction

At the end of 2011, approximately 430,000 patients were on hemodialysis in the United States (1). With the slight improvement in the life expectancy of dialysis patients and the shortage of available kidney donors, maintenance of vascular access is critical and often challenging. About 5% of dialysis patients withdraw from dialysis, secondary to lack of vascular access for hemodialysis (2). Some of these patients had exhausted traditional vascular access such as arteriovenous fistula (AVF), AV graft (AVG), and central venous catheters (CVC) using internal jugular, subclavian and common femoral veins. Extensive surgeries, such as surgical reconstruction of the central vein in those with superior vena cava (SVC) syndrome and arteriovenous circuit with the interposition of prosthetic graft material to bypass stenosis are potential options, but are associated with significant morbidity burden (3, 4). On the other hand, CVC's using unconventional accesses such as innominate, cephalic, hepatic, trans-lumbar, hemiazygous, azygous, and trans-renal veins have been tried with limited success (5 - 10).

Translumbar tunneled dialysis catheter (TLDC) were first described by Lund et al. in 1995 (11). Since TLDC might offer a relatively safe and effective dialysis access both in adults and children, it was considered a potential option for patients with limited central venous access (12-15). While few small studies reported successes and complications associated with TLDC placement, additional studies are needed to estimate the long-term patency and safety of TLDC in this high-risk population. Herein, we report our experience with the patency and complications of TLDC at our institution.

Subjects and Methods

Study participants—We retrospectively reviewed the records of adult patients at the Cleveland Clinic who had received TLDCs for hemodialysis access from June 2006 to June 2013. All patients who exhausted conventional options such as AVF, AVG and upper extremity dialysis catheters for long term dialysis were considered for inclusion. Patient demographics, comorbid conditions, dialysis details (etiology of ESRD, hemodialysis time, catheter procedure, and previous access site), catheter insertion procedures and associated complications, catheter patency, and patient survival were retrieved from the electronic medical records. This study was approved by Cleveland Clinic's Institutional Review Board.

Procedure details—TLDC insertion was performed under moderate sedation and local anesthesia. Prophylactic antibiotics (Ciprofloxacin 200 mg intravenously for penicillin-allergic patients and Ancef 1g or Zosyn 2.25g intravenously for others) were administered before catheter exchanges. In 21 of 28 patients, the IVC was punctured using fluoroscopy by angling towards the lateral edge of L3 from the right as previously described (11). In 7 patients, IVC access was expedited by placing a 4-F micropuncture sheath into the popliteal vein (2/28) or femoral vein (5/28) and advancing a guidewire into the IVC to assist targeting

(Figure 1). With the patient in prone position, an 18-21 gauge Chiba needle was advanced anterior to the third lumbar vertebra (L3) directly toward the IVC, and the Chiba needle was exchanged over a 0.18 guidewire for an Amplatz Super Stiff guidewire. Over the Amplatz wire, the tip of a 14.5 F peel-away sheath was advanced into the IVC. A catheter of appropriate length was pulled through the subcutaneously tunnel from the right flank (approximately 5–8 cm from puncture site) and inserted into the IVC via the sheath. Blood was aspirated from each lumen of the catheter to confirm good flow, and then the catheter lumens were locked with 4% sodium citrate. Final radiographic examination demonstrated the catheter position in the inferior right atrium. Contrast material (Isovue 300; Bracco Diagnostics, Princeton, NJ) was injected, if necessary. Alteplase (1 mg/ml) was used to salvage the catheter with poor blood flow (blood flow restored in 80.4% of patients) after mechanical reasons were excluded. On those who had contrast injections, fibrin sheath formation around a malfunctioning catheter was diagnosed by demonstration of contrast trapped adjacent to the catheter. Most of the catheters were exchanged over a guidewire except for those with CRI for whom a new subcutaneous tunnel and exit site was performed. If the patient was bacteremic, the patient had catheter-free holiday and was treated for bacteremia. Typically there was a 48-72 hours catheter-free day for the recurrent catheter-related bacteremia.

Definitions—We used the definitions proposed by the Society of Interventional Radiology Reporting Standards for Central Venous Access (CVS) (16). Initial (primary) device service interval is defined as the number of catheter days from TLDC insertion until device failure or removal at the completion of therapy, patient death, or conclusion of the study with the catheter still functioning. Revised (secondary) device service interval is defined as the service interval that begins after device replacement or salvage, without abandonment of the access site. Total access site service interval is defined as the sum of all device service intervals at a single access site. Device failure is defined as any limitation in catheter function, despite a technically successful placement. The target blood flow for CVC's is 350 ml/min. CVC dysfunction is defined as failure to attain a sufficient extracorporeal blood flow of >300 mL/min with a prepump arterial pressure less negative than –250 mmHg (17). Device failure can be due to multiple reasons, including mechanical reasons, such as kinking, retraction, or dislodgment, thrombosis, formation of a fibrin sheath, infection, and poor blood flow (18). Catheter related infection (CRI) include phlebitis, exit site infection, pocket infection, and catheter related blood stream infection (CRBSI). Exit site infection is defined as the presence of new erythema, pain at the exit site and/or purulent drainage around the catheter. CRBSI was defined as a positive blood culture in a febrile patient and absence of clinical signs of a non-catheter-related source of infection (16). Complications occurring within 30 days of the procedure were classified as early complications, while those occurring after 30 days were classified as late. Overall complications included all complications occurring at any time during the study follow up.

Statistical analysis

Study data were collected and managed using RedCap electronic data capture tools hosted at Cleveland Clinic Foundation (19). Measured values are reported as means and standard

deviation or frequency and percent. The Kaplan-Meier method was utilized to analyze catheter patency based on primary service interval censoring for death with functioning TLDC, new permanent accesses, completion of therapy, conclusion of the study, or lost to follow-up. Data analyses were performed by employing Unix SAS 9.2 (SAS Institute, Cary, North Carolina) and graphics were created using R 3.0.1 (The R Foundation for Statistical Computing, Vienna, Austria).

Results

Patient characteristics

There were 84 TLDCs (28 primary insertions and 56 exchanges) inserted in 28 patients during the study period. Mean age of the study population was 53.6 ± 13.6 years with 53.6% being males and 75% African Americans. The majority of patients were either overweight (36%) or obese (36%). Patients were on dialysis for an average of 7.8 ± 5.5 years before they required a translumbar catheter with diabetes (50%) and glomerulonephritis (25%) as the leading causes of ESRD. Superior Vena Cava (SVC) syndrome was present in 96% of patients. While both aspirin and warfarin were administered to six patients, eight patients were on aspirin alone and six patients were on warfarin alone. Type of dual-lumen catheters included Ash Split (Medcomp, Harleysville, Pennsylvania, n=47), Equistream (Bard Access Systems, Salt Lake City, n=20), Hemosplit (Bard Access Systems, Salt Lake City, n=11), and Decathlon (Spire Corporation Ultem, n=6). Catheter length ranged from 28-55cm and was positioned with the catheter tip in the mid-right atrium. Other clinical details are outlined in Table 1.

Catheter outcomes

All TLDC insertions were successful with good blood flows during the first session of dialysis (>300 ml/min) and no peri-procedural complications (major bleeding or clotting) were noted. There were 56 catheter exchange procedures which were performed over a guidewire in all cases. If the tunnel was infected then the entry site was opened and the catheter was exchanged over a guide wire with the creation of a new tunnel as previously described in 28 patients, with a mean of 3.0 ± 2.3 catheters per patient (range from 1 to 10). Alteplase have safely restored 80.4% (41/51) of blood flow through poorly functioning catheters. At the end of the follow-up period, 6 patients (21%) had functioning catheters still in site, 6 (21%) had maturing AV grafts or fistulae and 4 (14.3%) with new upper central vein catheters, 2 (7%) converted to peritoneal dialysis, 3 (10.7%) were lost to follow-up and 1 (43%) patient died.

Catheter patency

Mean total access patency was 381 catheter-days with total access site interval of 4 to 1,948 days. The initial device interval ranged from 2 to 431 catheter days with a mean of 110 catheter days (Table 2). Initial catheter patency at 3-, 6- and 12 months was 43 %, 25%, and 7%, (Figure 2). Sixty four percent of patients in the study retained the initial TLDC beyond 30 days, and 32% of patients retained a TLDC with exchanges beyond 1 year.

Early and overall complications during follow up

The most common overall complications were poor blood flow (40.2%) followed by CRBSI (36%). The main clinical presentations of catheter related infection were fever without purulent discharge or hypotension (52.8%), fever with hypotension (11.1%), fever with purulent discharge (13.9%) and purulent discharge alone from the catheter exit site (11.1%). Figure 3 displays the percentage of catheters with various complications (during early and overall study period) warranting further interventions. Poor blood flow occurred within 30 days of placement in 25% of catheters (9% related to fibrin sheath) and in 40% of catheters overall. CRBSI occurred within 30 days in 11% of catheters and in 36% of catheters overall. Catheter related bleeding and pain were also observed, and were treated symptomatically.

Reasons for catheter exchange

The leading indication for catheter exchange was catheter related infection (36%), followed by poor blood flow (31%) and mechanical reasons (19%). The catheter removal causes are listed in Table 3. About 69.6% of the bacteria isolated from blood culture were *Staphylococcal* sub-species. Sixteen catheter tips were cultured and 6 grew *Staphylococcus* sub-species.

Discussion

Among patients who have been on dialysis for an extended period, the conventional accesses for dialysis might fail, especially, for African American patients with peripheral vascular disease and multiple comorbidities. In this large series of TLDCs, they were placed successfully in all such patients and functioned well. The most common complication of TLDC was poor blood flow, and the leading cause of catheter failure was catheter related bacteremia. Our data suggested that translumbar catheter is an acceptable alternative in patients who required long-term hemodialysis, with occluded SVC and limited peripheral veins for dialysis catheters. However, due to associated complications, these catheters cannot be expected to last more than 2 months without replacement.

In our series, no procedure-related complications were observed and all catheters were inserted and exchanged without immediate complications after the procedure. Catheters functioned well in the earlier period for most of our patients. Previous studies have shown that translumbar catheters carried low procedure-related complications, which were similar to other catheters placed in the SVC via the subclavian or internal jugular routes (11, 13,20). We noted that among 42.8% of the patients, another access for dialysis after translumbar catheters was successfully obtained. Similar to ours, a recent study showed that 36.4 % of the patients transitioned to another permanent access (15). In contrast to older reports, the relatively high conversion frequencies in these studies are the result of use of unconventional arteriovenous grafts for subsequent access placement. Cumulatively, these data suggest that translumbar catheter can be used as a bridge to a new permanent or more effective access for patients who have exhausted traditional access for dialysis. In any case, subclavian veins should be avoided to prevent the occurrence of central stenosis and decrease further complications. Hence every attempt should be made to create and utilize AV fistula and

avoid peripherally inserted central catheters (PICC) in those with advanced chronic kidney disease (21).

As a hemodialysis access, translumbar catheters functioned well in a number of patients. The median initial catheter interval of TLDC was 64 days, which was similar to the transhepatic hemodialysis catheter survival ranging from 27-141 days (22, 23, 24). While 64% of our patients had initial catheter interval for >30 days, 32% retained catheters for >12 months with reinsertions/exchanges. The reported cumulative catheter patency of translumbar catheter at 12 months ranged from 17% to 73.2% (11, 12). The relatively low 12 month patency in our study is probably related to the catheter related complications such as poor blood flow and CRBSI. Also, the comorbidities including obesity and vascular disease that lead to vascular endothelial dysfunction or procoagulant states could predispose them to increased rates of access loss (25).

Compared with traditional CVCs, because of poor blood flow and infections, TLDC is expected to have higher complications, exchanges, including removals (26). We found that poor blood flow was the main complication and led to 30.8% catheter removal. The most common reported complications of translumbar catheter were catheter related infection and thrombosis (12, 15). Few studies showed that low-dose (1 mg/ml) one-time alteplase was effective in restoring catheter function in 72-82.1% of non-functioning catheters (27,28) and our results extend these to TLDCs.

Another most common complication was CRBSI. The long-term indwelling tunneled catheter is associated with five- to ten-fold increased risk of bacteremia, which remains a leading complication of hemodialysis patient (22). Our CRI rate was within the preferred range for all TLDCs from 0.16 to 0.55/100 catheter days according to reported TLDC value from 0.22/100 to 0.51/100 catheter days (11, 12, 15, 29) and higher than K-DOQI guidelines. The related higher infection rate could be due to the anatomical site of insertion where the patient lies on the exit site and it is subject to more mechanical stress (12). CVCs are recommended to be exchanged or removed if patients had fever for more than 48h after systemic antibiotic therapy (30). This practice could eliminate the biofilm and sequestered organisms from all surfaces of the infected catheter, including the outer and luminal surfaces of both extravascular and intravascular catheter segments (31). However, in our practice, TLDCs were not routinely withdrawn as the first move in case of infection; as translumbar catheter was always the last vascular access for our patients, and 35.7% (10/27) of the catheters were salvaged with more than two weeks after systemic antibiotic treatment. Furthermore, prior study found catheter salvage was successful in two thirds of the tunneled hemodialysis catheters (32). Thus, TLDC catheter exchange or removal was only performed in case of serious infection or infection recurrence nonresponsive to antimicrobial therapy.

Mechanical complications rate was within the reported rate of 0.08/100 to 0.19/100 catheter days (12, 15). Catheter dislodgment is noted to be the leading cause of catheter failure for translumbar catheters, as excess adipose tissue is concentrated in the tunnel area. Furthermore, the exit site of catheter located around the level of the waist may predispose to accidental catheter dislodgment by arm motion or the catheter catching on adjacent objects (14, 20). The fibrin sheath rate in our study was 0.07/100 catheter days lower than previous

reports. Access failure because of fibrin sheath has been reported as one of the most common reasons that led to 48 to 82% hemodialysis catheter removal (33). However, it is important to note that not all patients had contrast injected to diagnose this. Catheter sheaths may be disrupted by infusion of thrombolytic therapy, stripping, and disruption during guide wire exchange (34,35). In our center, angioplasty balloon sheath disruption has been used to maintain the access once fibrin sheath was identified by angiography. Catheter thrombosis rate was within the range of the reported rate of 0.01 to 0.33/100 catheter days (15, 22). No special prophylaxis against thrombosis was recommended by other reports because of the high flow within IVC (14). Several studies have also indicated that TLDC has higher rates of retroperitoneal hemorrhage or fibrosis complications compared with traditional access because of the location (20). No retroperitoneal hemorrhage or fibrosis has been noted in our study.

Despite the large numbers, our study has several limitations which include the retrospective nature of the analysis. Further, we did not directly compare TLDC with other conventional central venous access. However, comparing outcomes between the catheters is difficult, especially for patients that require a TLDC who have limited conventional vascular or have SVC syndrome, involves the increased rates of access loss (12). Since our institution is not a closed health care system, these patients could have been seen at other institutions for other complications relating to the catheter and hence our complication rates might be falsely low. Despite these limitations, our study reported in detail the translumbar catheter patency, complications and reasons for catheter failure.

In summary, radiologic placement of tunneled translumbar hemodialysis catheters is a safe and technically successful procedure in those who exhausted conventional dialysis access. These catheters function well in the short-term while patients are awaiting maturation of fistula or grafts for long-term maintenance dialysis.

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Figure 1.
Picture showing TLDC placement
Translumbar catheter insertion procedure (IVC access was expedited by femoral vein directing)

Figure 2.

Survival of translumbar dialysis catheters with 95% CI (censoring for removal at the completion of therapy, patient death, conclusion of the study with the catheter still functioning, or lost to follow up)

Figure 3. Reasons and rates of various catheter-related complications (during early and overall study period)

Table 1

Characteristics of the study population

	All patients (N=28)
Age (y)	53.6 ± 13.6
Male, <i>n</i> (%)	15 (53.6)
Race, <i>n</i> (%)	
Caucasian	7 (25.0)
African American	21 (75.0)
Weight (Kg)	89.8 ± 27.2
BMI (Kg/m ²)	31.9 ± 9.9
Causes of ESRD, <i>n</i> (%)	
Diabetes	14 (50.0)
Glomerular disease	7 (25.0)
Hypertension	5 (17.9)
Systemic Lupus Erythematosus	2 (7.1)
Comorbidities, <i>n</i> (%)	
Coronary vascular disease (%)	12 (42.9)
Deep vein thrombosis (%)	19 (67.9)
Peripheral vascular disease (%)	16 (57.1)
Laboratory data (at time of first catheter insertion), (mean± SD)	
Hemoglobin (g/dL)	9.7 ± 1.8
Platelet (×10 ⁹ /L)	226.2 ± 88.9
Albumin (g/dL)	3.1 ± 0.5
PT/INR	1.2 ± 0.5
APTT (sec)	47.5 ± 58.7

Table 2

Catheter intervals and patency

	Mean±SD	Minimum	Median	Maximum	Total
Initial Device interval days (n=28)	110 ± 123	2	65	431	3091
Revised Device interval days (n=56)	135 ± 136	3	84	569	7576
Total Site interval days (n=28)	381 ± 449	4	244	1948	10667

Table 3

Reasons for Catheter failure or Removal (n=78)

Reasons For Removal	Reasons For catheter failure	Total frequency N (%)	Complication leading to removal Rate (per 100 catheter days)
Infection related	Site infection	4 (5.1)	0.04
	Bacteremia	24 (30.8)	0.22
	Overall	28 (35.9)	0.26
Blood-flow related	Poor blood flow	14 (17.9)	0.13
	Stenosis	1 (1.3)	0.01
	Fibrin sheath	7 (9.0)	0.07
	Thrombosis	2 (2.6)	0.02
	Overall	24 (30.8)	0.22
	Dislodgment	8 (10.3)	0.07
	Retract	4 (5.1)	0.04
Mechanical reasons	Curl	2 (2.6)	0.02
	Migration	1 (1.3)	0.01
	Overall	15 (19.2)	0.14
Others	Rupture catheter limb.	1 (1.3)	0.01
	Cracked hub	1 (1.3)	0.01
	Other reasons	2 (2.6)	0.02
	Overall	4 (5.1)	0.04
Death New permanent access		1 (1.3)	0.01
		6 (7.7)	