Outcomes of Tunneled Dialysis Catheter In Hemodialysis Patients In A Tertiary Care Hospital

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Abstract

BACKGROUND: To evaluate tunnel dialysis catheter (TDC) patency and its outcome among patients receiving TDC in a tertiary care hospital.

METHODS: Retrospectively patients' records were reviewed who underwent TDC placement during February 2016 to November 2020 at Department of Interventional Radiology, Liaquat National Hospital, Karachi, Pakistan. Patients' age, gender, residence, comorbidity, catheter placement site, use of antibiotics before catheter insertion, reasons for catheter removal and total catheter days were retrieved from patients' medical record file.

RESULTS: 130 patients received TDC with a median follow-up of 148 (inter-quartile range: 60.8 – 274.3) days. 94(72.3%) catheters were electively removed whereas 18(13.8%), 16(12.3%) and 2(1.5%) catheters were removed due to infections, blockage and physical damage respectively. None of the mortality was observed due to catheter related complication. The incidence of overall infection, bacteremia and other infections during one year was 7.3, 5.01 and 3.19 per 10,000 patient-days respectively. Infection free survival rate was 68% with mean time to infection was 676.63 (95% CI: 593.87 – 759.39) days. During the study, total catheter patency was 53.2%. None of the patients' characteristics was associated with catheter related infections and catheter patency.

CONCLUSION: TDCs are the best available alternative for short to intermediate term use for hemodialysis when all preventive measures are taken to avoid catheter related complications either infectious or non-infectious until permanent dialysis access is achieved or renal transplant is done. It may also serve as long term hemodialysis mode in patients in whom permanent access or transplant is not preferred.

Introduction

Globally the chronic kidney disease (CKD) burden is rising and as a consequence nearly 10-15% world's population is affected with higher burden in developing regions with an estimated prevalence of 21.2% in adult population [1, 2]. The ultimate outcome of CKD is end stage renal disease (ESRD) and estimates suggests that there will be rise in ESRD prevalence in next decades possibly due to increasing age, rising prevalence of diabetes mellitus and hypertension [3, 4]. Developing world is dealing with silent epidemic of ESRD in existing worldwide CKD burden [5]. There is time to time requirement of replacement therapy in ESRD patients such as dialysis. The rising load of ESRD brings a challenge for permanent vascular access for the hemodialysis [6].

Arteriovenous graft (AVG), arteriovenous fistula (AVF) or catheters are used to achieve dialysis for ESRD patients [7, 8]. The only option left for dialysis is tunnel dialysis catheter (TDC) in patients who cannot achieve AVG or AVF due to multiple causes including inaccessibility of vessels, older age and low ejection fraction [9]. The shift to tunneled cuffed catheters from non-tunneled ones was pushed by "AVF first drive" in the Western part. It takes quite longer time for fistulae maturation which varies from 4 to 8 weeks

and meanwhile tunneled cuffed catheters are good alternate to provide an unfailing vascular access for hemodialysis [10].

Unfortunately these catheters may lead to complications that may be infectious and/or non-infectious which cause increased burden of morbidity and mortality [11]. Such complications may developed at the time of placement or any time following the catheter insertion. Complications linked to TDCs ranges from mild to severe which includes sepsis, occlusions, catheter related infections, dislodgments, thrombosis and central venous stenosis. Complications linked to TDC are not merely linked to higher morbidity but also with higher hospital admissions and healthcare cost [12]. Catheter dysfunction and infections are the frequently seen complications that cause catheter removal, if both are not timely identified and managed [13]. The frequent catheter related complication that cause hospital admissions after TDC placement is catheter-related infections (CRIs) which may develop either through the lumen or nearby by the catheter placement site [14].

The National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) prohibited the long term use of TDC without planning the creation of permanent access. Recently, further advancements have been suggested by NKF-KDOQI to become more patient centered. These suggestions permit the rational use of TDCs in case of multiple access failures without having further dialysis access choices as well as with limited arteriovenous (AV) access and/or life expectancy [10]. A vast literature is reported from Western countries on the patency of TDC but there is limited published literature from our country. Therefore, we planned to evaluate TDCs patency and its outcome in our settings for patients receiving TDC for dialysis.

Methods

Study design, setting and duration

This retrospective, observational study was conducted at Department of Interventional Radiology, Liaquat National Hospital, Karachi, Pakistan. All patients who received tunneled dialysis catheter for the purpose of hemodialysis during February 2016 to November 2020 were included in the study. Patients who were not reporting to the department after giving multiple reminders on their given contact numbers were excluded from the study. Patients were followed up from placement of TDC till the removal of catheter due to any reason. Data concerning regarding patient's age, gender, residence, comorbidity, catheter placement site, use of antibiotics before catheter insertion, reasons for catheter removal and total catheter days were retrieved from patient's medical record file.

Catheter insertion method

A written informed consent was taken from patient/attendant before TDC placement. All TDCs were placed by interventional radiologist having at least one year of experience, using real-time ultrasound and fluoroscopic guidance in an angiography suite under proper aseptic technique under local anesthesia. Pre-procedure 1.2 grams of Inj Co-Amoxicilan was given intravenously (I/V). Appropriate vein was

selected for TDC's. Patency of the vein was confirmed using doppler ultrasound (DUS). We placed 14.5 French (Covadian plandrome, Medcomp and Bard) catheters with lengths of 19 cm for right internal jugular and right subclavian vein, 23 cm for left internal jugular and 28 cm for femoral veins. Vein was punctured using seldinger technique. Fluoroscopy was used to confirm the tip of catheter. The tip of the catheter was placed in the right atrium for bilateral internal jugular and subcalvian catheters, and in the proximal inferior vena cava for femoral catheters. Approximate length of the tunnel was 7-10 cm in supra-clavicular region for jugular veins, anterolateral aspect of thigh for femoral and anterior chest wall for subclavian vein catheters. Catheter is flushed by heparinized saline and stitches applied in routine fashion and were removed three weeks post procedure. Patients were allowed to dialyze from TDC at least 24 hours after procedure to reduce the risk of hemorrhage.

Outcome variables

Tunnel infection was defined as when erythema and purulent discharge occurred >2cm away from the catheter exit site without positive blood cultures. Catheter-related bacteremia was defined as when systemic signs and symptoms of infection, such as fever or chills, in combination with positive blood cultures, were observed. Physical damage was considered when catheter was non-functional due to tear/puncture (Figure 1). Catheter was considered blocked secondary to fibrin sheath or thrombus around the catheter tip. The dialysis could not be performed due to slow flow rate i.e. less than 350ml/min even after flushing the catheter by heparinized saline. Catheter patency (catheter survival) was the period between the TDC placement and the TDC removal due to catheter malfunctioning either due to infection, blockage or physical damage. Functional catheters were those that were removed due to death, fistula formation or there was no need for dialysis.

Statistical analysis

The collected data was analyzed using statistical package STATA version 16. Categorical variables were summarized as frequency and percentage. Quantitative variables were presented as mean $\pm$ standard deviation or median with inter-quartile range (IQR) as appropriate. Incidence rate was computed as dividing total number of events by total catheter days. Kaplan-Meier curves were constructed to calculate survival rates which were compared among different sub-groups using Log-rank test. A two-tailed p-value ≤ 0.05 was considered as statistically significant throughout the study.

Results

Patients' characteristics:

Total 130 patients received tunnel dialysis catheter during the study. Table 1 depicts patients' characteristics who were placed with tunnel catheter. Median follow-up of the patients in this study was 148 (IQR: 60.8 – 274.3) days. Majority of the patients were older than 50 years (n=111, 85.4%). Few patients received catheter insertion in site other than right internal jugular vein (RIJV) which included left internal jugular vein (LIJV) (n=14, 10.8%), right femoral vein (RFV) (n=1, 0.8%) and right subclavian vein

(RSV) (n=1, 0.8%). Among 94 (72.3%) patients with functional catheter at the time of removal, 56 (59.6%) were alive and 38 (40.4%) were dead. The most frequent reason for removing catheter was death (n=38, 29.2%), fistula formation (n=33, 25.4%), blockage (n=16, 12.3%), infection (n=18, 13.8%), no need for dialysis (n=11, 8.5%) and physical damage (n=2, 1.5%). None of the mortality was due to catheter related complication.

Table 1
Descriptive statistics for patients' characteristics

Variables	Frequency (%)
Age (in years) [#]	65 (56.75 - 70.25)
Gender	
Male	74 (56.9)
Female	56 (43.1)
Comorbidity	
Hypertension	89 (68.5)
Diabetes	70 (53.8)
IHD	18 (13.8)
Hypothyroidism	3 (2.3)
Insertion site	
RIJV	114 (87.7)
Others	16 (12.3)
Catheter status	
Functional catheter at the time removal	94 (72.3)
Non-functional at the time of removal	36 (27.7)
Causes of malfunctioning catheters	
Catheter related infections	18(50)
Blockage	16(44.4)
Physical damage	2(5.6)
[#] : Expressed as median (1st quartile – 3rd quartile)	

Infection-free survival:

Out of 130 patients, total 18 (13.8%) developed infections and 11(8.5%) and 7(5.4%) patients were cases of bacteremia and other tunnel infections respectively. Infection free survival rate was 68% with mean time to infection was 676.63 (95% CI: 593.87 – 759.39) days (Figure 2). The incidence of overall infection during one year was 7.3 per 10,000 catheter-days, bacteremia incidence during one year was 5.01 per 10,000 catheter-days whereas one year incidence of other infections was 3.19 per 10,000 catheter-days. Infection free survival was not significantly different among age groups ≤ 50 and >50 years (45.5% versus 72.3%, $p=0.270$). Infection-free survival rate among males and females was 82.8% and 48% respectively and there was no statistical difference ($p=0.059$). Rural and urban groups also did not differ on the basis of infection free survival rate (75% versus 67%, $p=0.189$). Infection free-survival rate among patients who received tunnel catheter in RIJV and other site was almost equal (67.4% versus 64.9%, $p=0.638$). Survival rate among patients with and without comorbidity was 64.4% and 82.2% respectively which was not significant ($p=0.333$). Infection free survival rate for patients who received and did not receive antibiotics was not significantly different. (67.9% versus 66.9%, $p=0.237$). Table 2 represents infection free survival during 6 months and one year and its comparison among sub-groups of patients' characteristics.

Table 2
Infection-free survival and catheter survival from malfunctioning at 6 months and 1 year

Variables	Infection-free survival		Catheter survival	
	6 months (%)	1 year (%)	6 months (%)	1 year (%)
Survival rate	84.2	77.3	66.2	60.5
Age				
≤50 years	81.8	45.5	58.9	38.2
>50 years	84.7	82.5	67.3	63.9
p-value	0.989	0.251	0.941	0.646
Gender				
Male	88.0	82.8	75.7	66.5
Female	78.8	70.0	53.6	53.2
p-value	0.319	0.181	0.064	0.125
Residence				
Rural	100	100	88.9	88.9
Urban	81.1	73.1	62.2	55.7
p-value	0.093	0.063	0.094	0.073
Comorbidity				
Yes	81.5	76.3	61.3	57.1
No	92.5	82.2	81.8	72.7
p-value	0.375	0.449	0.172	0.237
Received antibiotics				
Yes	86.1	79.9	67.6	60.9
No	78.1	66.9	61.2	59.9
p-value	0.211	0.132	0.536	0.645
Placement site				
RIJV	84.9	78.8	67.6	60.7
Others	77.9	64.9	55.8	55.8

Variables	Infection-free survival		Catheter survival	
	6 months	1 year	6 months	1 year
	(%)	(%)	(%)	(%)
p-value	0.680	0.441	0.517	0.684

Catheter patency:

During the follow-up time, total catheter patency was 53.2% (Figure 3) During the study period, cumulative catheter survival rate among patients with age ≤ 50 and >50 years age groups (38.2% versus 56.1%, $p=0.664$), males and females (66.5% versus 36.5%, $p=0.053$), belonging to rural and urban areas (66.7% versus 51.1%, $p=0.153$), with and without comorbidity (48.2% versus 72.7%, $p=0.184$), catheter placement in RIJV and other sites (43.4% versus 50.9%, $p=0.916$), received and did not receive antibiotics (51.7% versus 59.9%, $p=0.777$) were not significantly different. Table 2 displays the catheter patency during 6 months and one year and its comparison among patients' features.

Discussion

Dialysis catheters play essential role in ESRD patients requiring dialysis for long period. Different types of dialysis catheters are used depending upon the patient's need. It can be temporary or permanent (tunneled), depending on their purpose and usage time. Tunneled dialysis catheter enters the skin, courses approximately 6 to 10cm within subcutaneous tissue prior entering into the desired vein which reduces the risk of infection as compared to double lumen catheter which enters directly into the vein. TDCs have traditionally been placed by surgeons using palpation/anatomical landmark methods. In the last few years, there is an increased trend of placement of TDC by interventional radiologist due to their improved expertise and ability to handle complications [15].

The site of vascular access has significant influence on patient's clinical outcomes. Various veins may be nominated for the TDC placement depending upon vein patency, however with repeated passage of catheter the vein gets thrombosed and stenosed [16]. NKF-KDOQI states that RIJV is the ideal vascular access site due to its straight course with a single turn. LIJV, the external jugular veins, the femoral veins, the subclavian veins, transhepatic accesses, and translumbar accesses are further access alternatives in order of preference [10]. In 5–18% of patients, there is anatomical variations of jugular veins, hence ultrasound guided puncture and fluoroscopic guided insertion results in considerably reduced unsuccessful attempts, hematoma formation and arterial puncture [17]. During the study period, most of the patients received catheters in RIJV (87.7%) which is an established practice worldwide [18–20].

Tunneled cuffed catheters may be more suitable for medium to long-term usage where there is the expectation of a continuing need for renal transplant or arteriovenous fistula formation over weeks to months. In the present study, mean time to catheter removal due to malfunctioning was 557 (95% CI: 474 – 640.6) days. The mean duration of catheter use greatly varies among studies. Another Pakistani study

reports a median catheter duration of 62.5 (IQR=46 – 89.5) days [20]. Sampathkumar et al reported a median catheter usage of 213 days [19]. Yalvac et al reports a relative a longer mean duration of 729.6 ± 58.4 days for catheter use as compared to other studies [21]. Mean catheter duration of 122 days was reported from Egypt [22]. Forauer et al reported a mean catheter time for elderly and younger group was 137.4(range= 2–622) days and 139.7(range =1-944) days respectively [23]. There may be many possible factors that caused variation in catheter usage time such as infection rate, different approaches for patient care and patients' handling as well.

The progressively imperative TDC role for delivery of haemodialysis in inadequate resource settings in contrast to the AV fistula or graft use is of high concern and could be a causative factor to the compromised quality of life and adverse patients' outcomes. Catheters are accountable for half of the infections in hemodialysis patients, and catheter-related bloodstream infections (CRBSIs) are considered as the second most cause of expiry, also a chief cause of catheter removal and metastatic infection in hemodialysis population [24–26]. In our study, during one year period total 8.5% developed CRBSI which yielded an incidence rate of 5.01 per 10,000 catheter days. Another Pakistani study reported that 19.8% of patients developed CRBSI during the study period and catheter removal was required in 63.6% of these patients [20]. A risk of 9% at one year was reported for bacteremia and 30% for any CVC related complication during first year follow-up [27]. In contrast to our findings, an alarming infection rate was reported from India, the study documented that 30.4% patients had positive blood culture during six months follow-up after placement of TDC [28]. Another study from Saudi Arab reported that CRBSI was 23.6% per year [29]. The CRBSI incidence rate of 6 cases per 1000 catheter days was also reported from Egypt [30]. Variation in infection rate among different studies could be due to multiple causes, mainly because of differed health settings and patients' attitude. Previously conducted studies reported that risk of CRBSI was significantly higher among patients with catheter placement from left internal jugular vein, diabetes, increasing catheter duration [31, 32]. However, in the current study no significant association of any factor was determined with CRI.

In the present study, majority of the catheters were electively removed (72.3%) as the patients were dead, gained permanent access through fistula formation or they had no further need of dialysis and remaining were non-functional at the time of removal which were removed due to complications including infection, blockage and physical damage. In contrast to our findings, a study from Turkey reported that TDCs were electively removed in nearly one third of the patients (31.1%) [21]. Forauer et al demonstrated that 28% catheters were electively removed due to functioning AV access, renal transplantation, conversion to peritoneal dialysis, or return of adequate renal function [23]. A similar study from India reported that during three years period total 45% catheters of which majority were electively removed due to death with functioning catheter, switch to AVF and renal transplant [19]. Increasing age and diabetes were documented as independent factors negatively affecting catheter patency but our data did not suggest any such association [21, 33].

The current study shed light on the experience of a single center tertiary care hospital regarding the TDC patency. The results cannot be generalizable to all of the Pakistani patients receiving TDC as it is single

center experience study. It is quite difficult to make comparisons for various institutes owing to the differences in placement methods, catheter types and patients' features. However, these factors may be minimized in terms of negatively affecting patients' outcomes with a highly experienced multi-disciplinary team.

Conclusion

TDCs are the best available alternative for short to intermediate term use for hemodialysis when all preventive measures are taken to avoid catheter related complications either infectious or non-infectious until permanent dialysis access is achieved or renal transplant is done. It may also serve as long term hemodialysis mode in patients in whom permanent access or transplant is not a preferred option.

List Of Abbreviations

AV: Ateriovenous

AVF: Arteriovenous fistula

AVG: Arteriovenous graft

CKD: Chronic kidney disease

CRBSI: Catheter-related bloodstream infections

CRI: catheter-related infections

CVC: Central venous catheter

DUS: Doppler ultrasound

ESRD: End stage renal disease

IQR: Inter-quartile range

LIJV: Left internal jugular vein

NKF-KDOQI: The National Kidney Foundation Kidney Disease Outcomes Quality Initiative

RFV: Right femoral vein

RIJV: Right internal jugular vein

RSV: Right subclavian vein

TDC: Tunnel dialysis catheter

Declarations

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

The study complied with the Declaration of Helsinki and was approved by Ethics Committee of Liaquat National Hospital on 24th August, 2021 (0671-2021-LNH-ERC). The data was retrospectively collected from patients' medical record file with the written permission of Ethics Committee and the need of patients' consent for participation into the study was waived by Ethics Committee of Liaquat National Hospital as data was retrospectively collected.

CONSENT FOR PUBLICATION

For this type of study consent for publication is not required

AVAILABILITY OF DATA AND MATERIALS

Corresponding author may be contacted for data sets analyzed in this study with a reasonable request.

COMPETING INTEREST

None

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This study was not supported by any funding.

AUTHORS' CONTRIBUTIONS

MT conceptualized the study. MT and Muhammad A developed the study protocol. DKS and KM supervised the data collection and entry. ND performed data analysis, interpreted and wrote the results. DKS and JI prepared an initial draft of the manuscript. MT and MA critically revised it. All authors read and approved the manuscript.

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Figures

Figure 1

Figure shows iatrogenic injury of the blue port during dialysis. This had to be exchanged over the guidewire

Figure 2

Infection free survival during the study period

Figure 3

Catheter survival during the study period