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Research Article

Long Term Outcome of Permanent Hemodialysis Catheter in Minia University Hospital

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Abstract

Background: Tunneled dialysis catheters (TDCs) are commonly employed as a temporary solution for hemodialysis until permanent arteriovenous (AV) access is established. Nevertheless, certain patients may ultimately require prolonged catheter-based hemodialysis as a result of the absence of alternate options for accessing dialysis. **Objective:** The objective of this study was to assess the results of TDCs and the potential long-term issues that arise during its usage in our hemodialysis patients. **Patients and methods:** This study examines 86 patients who had TDC implantation for hemodialysis at the nephrology and urology Minia University Hospital from September 2021 to September 2022. The study recorded patients' age, gender, catheter implantation location, reasons for catheter removal, and total catheter days while monitoring for the occurrence of problems. Complications have been classified into early and late. **Results:** The average age of the patients was 48.8 years, with men comprising 51.2% of the population. The right internal jugular vein was the predominant location for TDC insertion, accounting for 75.6% of cases, while the left subclavian vein was the second most common site, representing 9.3% of cases. Operational TDCs were effectively extracted in over 60.5% of instances once their permanent access had reached maturity. Approximately 34.9% of the patients in the sample had experienced complications. Of all these consequences, infection has the largest proportion, accounting for 14%. The other individuals experienced complications such as catheter thrombosis, hematoma, and incorrect cannulation. Catheter-related bloodstream infection (CRBSI) occurred in 12 patients (14%), leading to catheter removal in 5 patients (5.8%). Eight patients (9.3%) experienced mechanical dysfunction that necessitated catheter removal. No deaths were detected as a result of complications associated to the catheter. **Conclusion:** TDCs serve as the optimal interim solution for hemodialysis until a permanent dialysis access is established or a kidney transplant is performed.

Keywords: Hemodialysis, tunneled catheter, vascular access, catheter related blood stream infection.

Introduction

Chronic kidney disease is a gradually worsening ailment that impacts more than 10% of the global population, which is equivalent to about 800 million people [(1).]

The worldwide prevalence of chronic kidney disease is estimated to be 13.4% (with a range of 11.7-15.1%). The number of patients with end stage kidney disease requiring renal replacement therapy is estimated to be between 4.902 and 7.083 million. By 2040, it is projected to become the fifth leading cause of years of life lost globally [(2).]

Dialysis is the primary method of replacing kidney function in the majority of nations, with hemodialysis (HD) being the most widely used approach globally[(3,4)]. An operational vascular access (VA) continues to be the primary lifeline for a satisfactory therapy and is regarded as the crucial element for patients undergoing

maintenance HD [5].

The optimal vascular access (VA) should possess distinct attributes, with significance ease of insertion, provision of sufficient blood flow for efficient dialysis, favorable primary patency rates, minimal occurrence of complications and side effects, enduring longevity, and cost-effectiveness [6].

The arteriovenous fistula (AVF) has been widely regarded as the most advantageous vascular access [7]. However, the prevalence of permanent dialysis catheters for hemodialysis vascular access has been steadily rising due to the aging of the dialysis population, high rates of diabetes, and peripheral vascular disease. Temporary dialysis catheters have shown strong patency and can serve as a viable alternative to AVF [8].

TDCs have dramatically reduced rates of malfunction, infection, and thrombosis compared to temporary catheters. TDCs represent the most optimal solution currently accessible for the short to intermediate duration of hemodialysis treatment [9]. Nevertheless, certain patients may undergo prolonged catheter-based hemodialysis due to the absence of alternate options for additional dialysis access [10].

TDCs are mostly employed in patients who suffer from severe VA induced ischemia, heart failure, or have a short life expectancy. They are also utilized in patients who are awaiting AVF maturation or have not yet made a decision between HD and peritoneal dialysis. Patients diagnosed with peritoneal dialysis peritonitis and individuals who have a planned live donor renal transplant can also undergo dialysis with a permanent central venous catheter (CVC) for a certain duration [11].

Regrettably, these catheters can result in both infectious and non-infectious problems, leading to a higher incidence of illness and death. These issues might arise either during the catheter implantation or at any point afterwards. The complications associated with TDCs span a spectrum from moderate to severe, encompassing sepsis, occlusions, catheter-related infections, dislodgments, thrombosis, and central venous stenosis. The complications associated with TDC are not only associated with increased morbidity, but also with greater rates of hospital admissions and healthcare expenses [10]. The three primary problems associated with CVCs are catheter-related bloodstream infections (CRBSIs), catheter malfunction, and central vein stenosis [12].

This study investigates the incidence of complications and death related to the prolonged use of TDCs in our hemodialysis patients.

Methods

Study design, setting and duration.

This descriptive study was done in the Nephrology unit of the Nephrology and Urology, Minia University Hospital. We evaluated the eligibility of 105 patients, of which 19 were rejected owing to their reluctance to participate. From September 2021 to September 2022, the remaining 86 patients were randomly assigned.

Each catheter was retained for the necessary duration, assuming no difficulties arose. Patients were monitored continuously from the time the TDC was inserted until the catheter was removed for any reason. Information pertaining to the patient's age, gender, place of residence, presence of other medical conditions, site of catheter insertion, occurrence of CRBSI, microbiological growth, length of catheter use, reasons for catheter removal, and total number of days the catheter was in place were documented.

Prior to the implantation of the TDC, a written informed permission was obtained from the patient or their attendant. An expert practitioner inserted permanent catheters. The recommended location for catheter insertion was the right internal jugular vein using the anterior or central approach. However, if there was thrombosis or stenosis resulting from previous catheterization, the left internal jugular vein was utilized instead. In cases when both jugular veins were not suitable for implantation, the femoral vein was utilized instead. The subclavian vein was cannulated just in the event that all other previously described veins were blocked. The catheter insertion procedure was

consistently carried out in an operating room under strict aseptic circumstances.

The venous patency was verified by Doppler ultrasonography (DUS). We inserted catheters of 14.5-16 French size, measuring 19 cm and 23 cm, into the right internal jugular and right subclavian veins, respectively. For the left internal jugular vein, we used catheters measuring 23 cm and 27 cm, and for the femoral veins, we used catheters measuring 31 cm and 50 cm. The vein was ruptured using the seldinger method.

X-ray were conducted on all patients with permanent catheters to assess the catheter's placement and identify any potential problems.

The catheter was intended to reach the atrio-caval junction of the right atrium. The distal end of the catheter was positioned in the right atrium to accommodate bilateral internal jugular and subclavian catheters, while the proximal end was put in the upper part of the inferior vena cava for femoral catheters. The tunnel's length was approximately 7-10 cm, extending from the anterior chest wall for jugular veins and subclavian vein catheters, to the anterolateral portion of the thigh for femoral catheters. The catheter is flushed with heparinized saline and stitches are placed using standard procedure.

We have surgically inserted a sterile cuffed Amecath catheter made of biocompatible tecoflex polyurethane material.

Data about demographic factors, comorbidities, catheter implantation sites, type of catheter, as well as early and late problems associated with catheter placement were gathered for all patients. Prior to catheter implantation, all patients had comprehensive blood count and coagulation parameter assessments, which were subsequently adjusted if necessary. The laboratory parameters were assessed in the hospital's own laboratory.

CRBSI refers to the occurrence of a positive blood culture taken from a symptomatic patient with a tunneled line, without any other source of infection. This definition is used to highlight the consistency of diagnostic processes. The therapy was reported based on the culture findings [13]. If there is an inadequate response to antibiotic treatment or a return of a CRBSI, the catheter is withdrawn and the observation period is terminated. Catheter dysfunction was characterized as inadequate blood flow during dialysis, specifically when the blood flow was less than 200 ml/min or more than 30% lower than the average of the previous 10 sessions. In cases where dysfunction was present before or during the dialysis session, corrective measures such as moving the patient or reversing the catheter lines were used [14]. In the event of failure, irrigate the catheter with 10 ml of saline solution. Subsequently, introduce 2.5 ml of Urokinase into each lumen and allow it to remain for 60 minutes. Finally, remove the solution before to the dialysis session as a means of release. If there was no response following many administrations of Urokinase, the catheter was subsequently removed.

The statistical analysis

An analysis was conducted on the compli-cations and outcomes of CVC in our department from September 2021 to September 2022.

The statistical analysis was conducted using SPSS for Windows version 28. The data were presented as the mean ±standard deviation (SD), with the lowest and maximum values representing the range for quantitative measures. Categorized data were reported as both the number and percentage. The student t-test was employed to compare two separate groups that are independent of each other. The Chi-square test or Fisher's exact test were employed to compare categorical variables. A p-value below 0.05 was deemed statistically significant.

Approval and registration

The Ethics Committee of Minia University has approved the study protocol. All study participants provided written informed consent.

Results

During the research period, a total of 86 TDCs were put by the intervention nephrology team utilizing the percutaneous seldinger method in the operating theater.

Table 1 displays the base line fundamental features of the research population. The average age was 57.09 years, ranging from 22 to 76 years, with 51.2% of the participants being male. CRP tested positive in 12 cases that developed CRBSI.

The duration of the catheter ranges from 1 to 24 months. In 75.6% of instances, the right internal jugular vein (IJV) was the most commonly chosen location for catheter implantation. Table 2 displays the data distribution based on the spot where the catheter was inserted.

Table (1): Baseline Characteristics of the study Patients

Variables	Total participants (n =86)
Age (years) **Range: *Mean* ± *SD:***	48.8±15.1 (22-76)
Sex: {no. (%)}	
Male Femal	44 (51.2%) 42 (48.8%)
CRP Positive Negative	12 (14%) 74 (86%)
Hemoglobin (g/dl) **Mean±SD** **(Range)**	9±1.2 (6-11)
TLC (x1000/mm3) **Mean±SD** **(Range)**	8.7±3.9 (3.2-27)
Platelet (x1000/mm3) **Mean±SD** **(Range)**	261.6±90.4 (100-433)
INR **Mean±SD** **(Range)**	1.07±0.08 (1-1.3)
Bleeding Time **Mean±SD** **(Range)**	3.2±1 (2-7)
Clotting Time **Mean±SD** **(Range)**	4.9±1.2 (2-13)
Urea (mg/dl) **Mean±SD** **(Range)**	143.5±45.8 (44-258)
Creatinine (mg/dl) **Mean ± SD** **(Range)**	7.8±2.9 (4-22)

Abbreviations: **CRP:** High sensitive C-reactive protein**; TLC:** Total leukocytic count**; INR:** International normalization ratio **Mean± SD; standard deviation**

Table (2): Anatomic locations and duration of inserted catheters

Variables	Total participants (n =86)
Anatomic location:	
Right internal jugular vein	65 (75.6%)
Left internal jugular vein	5 (5.8%)
Right subclavian vein	8 (9.3%)
Left subclavian vein	5 (5.8%)
Right femoral vein	1 (1.2%)
Left femoral vein	2 (2.3%)
Duration (month) *Mean ±SD* *(Range)*	5.4±3.7 (1-24)

Regarding the rationale for TDCs, the majority of patients (32.6%) needed TDC as a temporary solution until their permanent vascular access, such as AVF or arteriovenous bridge graft (AVBG), matured. 43% of the patients had a previous occurrence of AVF/AVBG failure, necessitating the use of TDCs. In 7% of cases, TDCs were utilized as the sole alternative for HD access, particularly in patients suffering from heart failure. TDCs were effectively extracted in nearly half of instances (52%) once their enduring accessibility AVF was fully developed and, as a result, catheters were no longer required. Out of the total number of deaths documented, 17 cases (19.7%) were associated with functional catheters. However, it is important to note that these deaths were not directly caused by issues linked to the catheter.

Table 3, CRBSI occurred in 12 patients (14%), resulting in hospitalization and catheter removal in 5 individuals (5.8%). 12 patients (14%) experienced mechanical difficulties, including catheter malfunction, resulting in catheter failure. Subsequently, eight patients (9.3%) had their catheters removed. Table 4

Among patients who experienced CRBSI, gram positive organisms were the most often identified (8.1%), with Staphylococcus aureus being the most prevalent (5.8%). Fungal infections, particularly candida species, accounted for 3.5% of the cases. The provided text is "(Figure 1)".

Table (3): Causes of Tunneled Dialysis Catheter Insertion and Removal

Variables	Total participants (n =86)
Causes of insertion	
Arteriovenous fistula obstruction	37(%43)
Arteriovenous fistula maturation	28(%32.6)
Until transplantation	10(%11.6)
Acute Kidney injury	5(%5.8)
Heart Failure	6 (7%)
Causes of removal	
Elective	52(% 60.5)
Death	17(%19.7)
Complicated	12(%14)
Slipped	5 (5.8%)

Table (4): Catheter-related Complications and Outcome of Catheter-related Complications

Variables	Total participants (n =86)
No complications	56 (65.1%)
Early complications:	
Bleeding	4 (4.7%)
Wrong cannulation	1 (1.2%)
Late complications:	
Catheter infection	12 (14%)
Catheter dysfunction	12 (14%)
Malposition	1 (1.2%)
Extracted by the patients	5 (5.8%)
Outcome of infection*:*	
Catheter-related infection	12 (14%)
Hospitalization for infection	5 (5.8%)
Outcome for catheter patency	
Catheter dysfunction	12 (14%)
Further secondary outcomes	5 (5.8%)
Catheter removal for infection	8 (9.3%)
Catheter removal for mechanical complications	

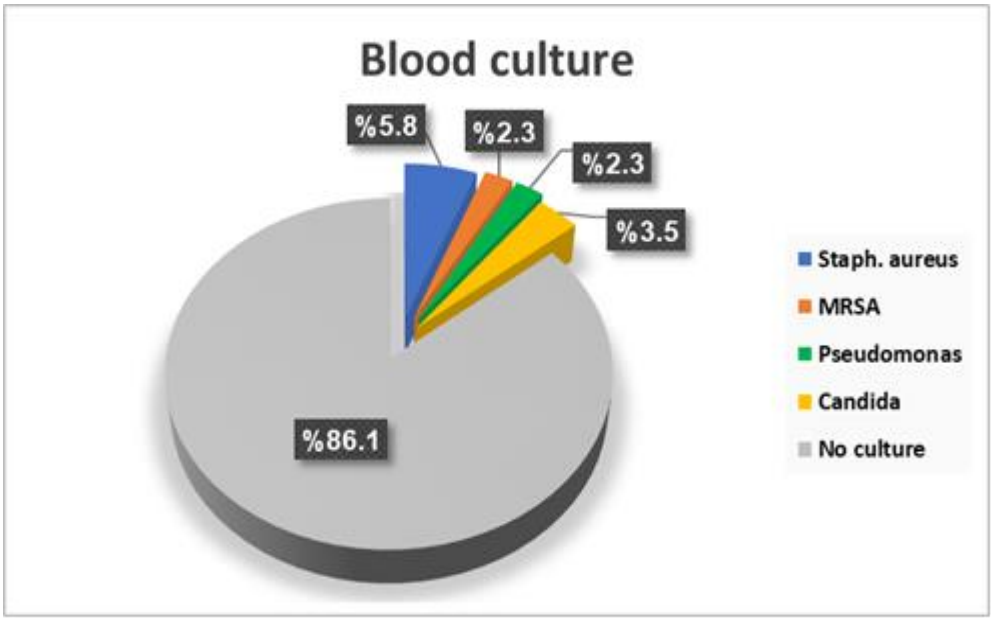

Figure (1): Organisms detected in blood culture.

Discussion

The AVF is the preferred method of vascular access for hemodialysis due to its superior performance, longer lifespan, and lower risk of complications. Nevertheless, acquiring a high-quality and long-lasting native arteriovenous fistula in individuals suffering from chronic renal failure might be challenging. TDCs serves as a viable option in cases when the creation of an AVF is not feasible or during the waiting period for maturation [15].

The primary cause for the insertion of most TDCs in our analysis was the inability to use an

existing access in patients who were already receiving maintenance HD. This was followed by the absence of a permanent HD access at the start of HD treatment. Prior research by Castro et al., [10] has documented similar findings.

Throughout the research period, the majority of patients (75.6%) had catheterization in the RIJV, a widely accepted procedure globally [16,17]. This is in reference to the research conducted by Wahaj et al., [18] which shows that the RIJV was largely used at various sites (85.6%) for catheterization, and that this procedure may be performed safely and successfully.

The IJV is the most favorable location TDCs insertion because of its generally straight anatomical path, ease of manipulation, lower infection rates, and less risk of central venous stenosis compared to the subclavian and femoral locations. According to Hyder et al., [19], the incidence of complications was minimal after placing a permanent HD catheter in the internal jugular vein. Furthermore, it is a straightforward and secure choice. Thus, the IJV might be considered the optimal choice for HD catheterization due to its reliability.

The prevailing complication seen was infection and malfunction of the catheter. Additional concerns encompass unsuccessful puncture and hematoma formation. Additionally, incorrect cannulation was also noted.

The occurrence of early problems, such as hematoma and arterial puncture during venous cannulation, was quite infrequent. These issues were mostly attributed to the use of ultrasound guidance and the expertise of the operators. Small, localized hematoma developed at the puncture site in four patients, accounting for 4.7% of the total. Compression was administered, leading to the resolution of the hematoma. Furthermore, the presence of catheter malposition was noted, which aligns with the findings of the study conducted by Premuzic et al., [20].

Our study revealed a prevalence of catheter malfunction in 12 individuals, accounting for 14% of the total sample. This rate is notably higher than the findings of Hyder et al., [19], who found a thrombosis rate of 2.35% among patients with failed hemodialysis. Streptokinase was employed to open the catheter in all patients. The procedure had positive results in four patients, however in eight patients, the catheter failed to open with the use of streptokinase, necessitating the removal of the catheter.

Prophylactic antimicrobial lock solutions, with or without an anticoagulant, have been proposed as a means of avoiding CRBSI. This is achieved by preventing the formation of biofilms, eliminating germs, and/or inhibiting bacterial growth. Presently, heparin-only lock solutions are employed in several hospitals to uphold the patency of CVC. Contrary to heparin locks, regular saline locks lack antibacterial qualities. Current data indicates that normal saline locks may be equally efficient as heparin locks in preserving the patency of CVC [21].

The most concerning late consequence of TDCs is infection, particularly CRBSI, which is linked to substantial morbidity and death. In addition, CRBSI is a significant factor leading to hospitalization and the need for catheter removal, resulting in a considerable rise in healthcare expenses [22].

Out of the individuals we evaluated, 12 instances (14%) suffered from catheter-related bloodstream infection, which led to hospitalization and the removal of the catheter in 5 patients.

Additional research has documented elevated infection rates. For instance, Castro et al., [10] revealed a substantial infection incidence of 29.6% linked to TDCs, while Yaqub et al., [17] discovered that around 19.8% of the cases they examined were connected with infection.

The variation in infection rate observed across different studies can be attributed to several factors, primarily include variations in health facilities, patients' attitudes, and the habitual utilization of antibiotic medicines. Prior research has indicated that the risk of CRBSI is notably elevated in patients who have had catheters placed in the left internal jugular vein, those with diabetes, and those with longer

catheter durations [23,24].

Our findings indicate that Gram-positive organisms are the primary cause of most central line-associated bloodstream infections related to TDCs, accounting for 8.1% of cases. Among the isolated bacteria, Staphylococcus aureus was the most commonly identified, affecting 5.8% of our study participants. These results align with a study by Martin et al., (23) which reported that Gram-positive organisms are responsible for the majority of CRBSI cases associated with TDCs, ranging from 40% to 84%.

Nevertheless, Candidemia was detected in three of our patients, accounting for 3.5% of the total. Two of the cases were administered antifungal medication and showed improvement. However, the remaining patient developed infective endocarditis, necessitating hospitalization, antifungal treatment, and the removal of the catheter. These findings align with the results of Yaqub et al., [17] which showed that gram positive organisms were the most often identified pathogens (60.4%) in patients who had CRBSI. Fungal infections, particularly candida species, accounted for 26% of the cases. This phenomenon can be elucidated by the findings of Al-Barshomy et al., [25] who determined that the rate of CRBSI is notably elevated among their HD patients, reaching 42.5%. Extended periods of use and diabetes are significant risk factors associated with infections.

In this study, the majority of the catheters were intentionally removed (60.5%) because the patients had obtained permanent access through fistula formation or no longer required dialysis. The remaining catheters were removed due to complications such as infection, blockage, physical damage, patient death, or slippage in 5 cases. In a research conducted by Yalvaç et al., [26], it was shown that TDCs were intentionally removed in around 31.1% of the patients owing to reasons such as working AV access, kidney transplantation, conversion to peritoneal dialysis, or the restoration of sufficient renal function.

The duration of TDC survival in our study patients was found to be much longer, with a mean survival time of 2 years. This finding aligns with the research conducted by Hu et al., [27] who also reported a similar mean survival period of around 2 years for TDCs, irrespective of age, sex, and the distribution of underlying disorders in their study population.

Conclusion

It is evident that TDCs are linked to certain problems, specifically CRBSI and dysfunction. Providing education to patients and HD staff on catheter management can effectively decrease the occurrence of these problems. Furthermore, it is important to make endeavors to reduce the length of time for TDCs by implementing all necessary actions to guarantee the prompt availability of a permanent vascular access for HD.

Disclosure

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