Open Access

Original Article

# An Analysis of Potential Predictors of Tunneled Haemodialysis Catheter Infection or Dysfunction

**Raja Jibran Akbar, Sohail Sabir, Khalid Mehmood Raja, Sajid Ali Shah*, Umair Ijaz Malik, Wajiha**

Department of Nephrology, Pak-Emirates Military Hospital, Rawalpindi/National University of Medical Sciences (NUMS) Pakistan, *Department of Peads, Combined Military Hospital, Mardan/National University of Medical Sciences (NUMS) Pakistan, **Armed Forces Institute of Rehabilitation Medicine, Rawalpindi/National University of Medical Sciences (NUMS) Pakistan

## ABSTRACT

***Objective:*** To assess various factors contributing to infection and dysfunction of tunneled double lumen catheter in patients with End Stage Renal Disease.

***Study Design:*** Cross-sectional study.

***Place and Duration of Study:*** Nephrology Department, Pak-Emirates Military Hospital (PEMH) Rawalpindi, Pakistan from Jan 2022 to Jan 2023.

***Methodology:*** All patients with chronic kidney disease having tunneled double lumen (TDL) catheter for hemodialysis were included in the study. Line infection was defined by either clinical picture of infection or by culture and sensitivity or both. Reasons for dysfunction included bleeding (BL) and thrombosis / clotting (TH) of the catheter. TDL was considered successful if it remained in situ without infection (IN) or dysfunction till establishment of fistula.

***Results:*** Most of the patients were male compared to female i.e. 129(64.5%) vs 71(35.5%). Right internal jugular vein (IJV) was used for insertion in 174(87%) whereas left IJV was used in 26(13%) patients. The line was infected in 14(7%) patients, thrombosis of the line occurred in 6(3%) patients while bleeding was observed in 3(1.5%) patients. Absolute neutrophils count, platelets count and site of insertion were significantly related with infection and dysfunction of TDL catheter.

***Conclusion:*** In most patients, TDL catheter was successful. Reason for failure included infections, thrombosis and bleeding. Absolute neutrophils count, platelets count and site of insertion were significantly related with infection and dysfunction of tunnel catheter.

**Keywords:** Chronic Kidney Disease, Infection, Thrombosis, Tunneled Double Lumen Catheter.

***How to Cite This Article:*** *Akbar RJ, Sabir S, Raja KM, Shah SA, Malik UI, Wajiha. An Analysis of Potential Predictors of Tunneled Haemodialysis Catheter Infection or Dysfunction. Pak Armed Forces Med J 2026; 76(7): 909-912. DOI: https://doi.org/10.51253/pafmj.v76i7.11511*

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by-nc/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

## INTRODUCTION

Renal impairment persisting for more than 3 months is termed as chronic kidney disease (CKD). This is measured in the form of glomerular filtration rate (GFR) and urine albumin creatinine ratio (UACR).[1] The prevalence of CKD varies in different parts of the world; with certain areas reporting up to 10% of prevalence.[2] In China, the reported incidence of CKD is about 10% with the global prevalence approaching up to 14%.[3] CKD is a multifactorial disease.[4] In most cases, CKD is asymptomatic. Symptoms and signs of disease are due to uremia. Pallor and fatigue may be due to anemia. Fluid overload may result in edema and shortness of breath.[5]

Treatment of CKD may be conservative or renal replacement therapy (RRT). RRT may be in the form of peritoneal dialysis (PD), hemodialysis (HD) or kidney transplantation.[6] Hemodialysis needs catheter insertion. There are different types of catheters in use; tunneled and non-tunneled being the most common types. Non-tunneled catheters are used for short duration while for long term use tunneled (TDL) catheters are preferred.[7] TDLs have wider lumen to allow better blood flow and are of softer material to avoid vessel injury. Further innovations in TDL catheters include coating with anti-microbial or anti thrombogenic materials. TDL catheters are available in different designs however, in term of durability, no one is preferred over the other. Contraindications to tunnel catheter include severe coagulation disorder, sepsis, chronic infections or unstable patients.[8]

Though central venous catheterization is not recommended for hemodialysis it is needed for time gain to establish arteriovenous fistula (AVF). Also, some patients opt for it instead of AVF. The rationale for this study was to know about complications related to this procedure.

## METHODOLOGY

This cross-sectional study was conducted in the Nephrology Department of Pak-Emirates Military Hospital (PEMH) from 15 Jan 2022 to 14 Jan 2023, after approval from the Institutional Ethical Review

**Correspondence: Dr Raja Jibran Akbar,** Department of Nephrology, Pak-Emirates Military Hospital, Rawalpindi Pakistan

*Received: 23 Jan 2024; revision received: 22 Feb 2024; accepted: 23 Feb 2024*

Committee (ERC approval letter no. A/28/EC/507/23).

**Inclusion Criteria:** Patients of either gender with age above 30 years, presenting to the Department of Nephrology with end stage renal disease (chronic kidney disease-5 on dialysis) were included.

**Exclusion Criteria:** Patients having functional arteriovenous fistula and those with non-hemodialysis dependent CKD patients were excluded.

Sample size was calculated using WHO sample size calculator keeping anticipated population proportion of 0.30 for catheter related complications came to 200.[9]

Non-probability consecutive sampling was used to recruit participants, and informed consent was taken prior to data collection.

Infection was defined by clinical signs and symptoms of infection or culture proven sepsis. Dysfunction was defined by either blockage of catheter by clot or bleeding from catheter site. Procedure for TDL catheter insertion was as follows: Most catheters and other central venous devices are placed using the Seldinger technique, which refers to the use of a guidewire placed into a vessel to provide a conduit for intravascular device placement. Seldinger first described the guidewire technique for arterial cannulation in 1953, and it was afterwards adopted for venous access procedures.[10] First, we properly cleaned the overlying skin with 2% chlorhexidine skin preparation solution and applied a drape sheet. After this, we gave local anesthesia under ultrasonographic guidance. Then, venous puncture was done using ultrasound guidance and guidewire placement by Seldinger guidewire technique and preferably using a central approach, followed by tunneling the catheter and dilation of overlying soft tissues. Because of the large diameter of hemodialysis catheters, a valved introducer peel-away sheath is needed to deliver the catheter into the vein. Fixing and antiseptic dressing were applied. Post-procedure chest X-ray was obtained for the catheter location.

Data analysis was done using Statistical Package for Social Sciences (SPSS) version 23. For qualitative variables like whether or not diabetes mellitus (DM) was present or not, site of insertion (left or right) and gender (male or female) frequencies and percentages were used. For quantitative variables like age, duration of insertion, platelets count and absolute neutrophils count, mean and standard deviations were used. To find the significance of different variables on tunnel infection and dysfunction, Chi-square test was applied. A $p$-value ≤0.05 was taken as statistically significant.

## RESULTS

Total number of patients included in the study were 200. Most patients were male compared to female i.e. 129(64.5%) vs 71(35.5%). Right IJV was used for insertion in 174(87%) whereas left IJV was used in 26(13%) patients. Total number of patients with DM were 111(56%) whereas, 89(44%) patients were nondiabetic. The line was infected in 14(7%) patients, thrombosis of the line occurred in 6(3%) patients while bleeding was observed in 3(1.5%) patients. The mean age of patients at the time of TDL insertion was 53.2±10.6 years. Whereas, average duration of insertion in TDL patients was 78.6±33.2 days. Patients were having a mean total leucocyte count (TLC), neutrophil count and platelet count of 6.03X109/L, 4.50X109/L and 223.50X109/L respectively during TDL insertion.

A comparison of various variables to the causes of TDL removal are shown in Table-I.

**Table-I: Comparison of variables and causes of Tunneled Double Lumen (TDL) removal (n=200)**

| Variables | Categories | Reason of TDL removal n (%) | | | | Total n (%) | $p$-value |
|---|---|---|---|---|---|---|---|
| | | Bleeding | End of Treatment | Infection | Thrombosis | | |
| Diabetes | Yes | 2(1.0) | 98(49.0) | 6(3.0) | 5(2.5) | 111(55.5) | 0.500 |
| | No | 1(0.5) | 82(41.0) | 5(2.5) | 1(0.5) | 89(44.5) | |
| Gender | Male | 2(1.0) | 74(37.0) | 6(3.0) | 2(1.0) | 84(42.0) | 0.600 |
| | Female | 1(0.5) | 106(53.0) | 5(2.5) | 4(2.0) | 116(58.0) | |
| Platelet count (109/L) | <150000 | 3(1.5) | 23(11.5) | 7(3.5) | 0 | 33(16.5) | <0.001 |
| | >150000 | 0 | 157(78.5) | 4(2.0) | 6(3.0) | 167(83.5) | |
| Absolute neutrophil count(109/L) | <3 | 0 | 52(26.0) | 0 | 1(0.5) | 57(28.5) | <0.001 |
| | 3-6 | 1(0.5) | 96(48.0) | 2(1.0) | 1(0.5) | 110(55.0) | |
| | >6 | 2(1.0) | 32(16.0) | 9(4.5) | 4(2.0) | 47(16.5) | |
| Age (Years) | 30-60 | 2(1.0) | 123(61.5) | 9(4.5) | 4(2.0) | 138(69.0) | 0.800 |
| | >60 | 1(0.5) | 57(28.5) | 2(1.0) | 2(1.0) | 62(31.0) | |

## DISCUSSION

Chronic kidney disease is one the most common non-communicable disease. It has no specific treatment. The available treatment options include preservative management, hemodialysis or peritoneal dialysis or kidney transplantation.[11] The best available measure against progression of CKD is strict monitoring and control of hypertension and diabetes; the two most common causes of CKD. Most CKD patients are managed by dialysis.[12] Arteriovenous (AV) fistula establishment is a pre-requisite for hemodialysis. Two to three months are required for a fully functional fistula. This duration is covered with passing dialysis catheters and carrying out dialysis with the help of catheter. Different types of catheters are available, each having its advantages and disadvantages. TDL catheters are available for long term use and are claimed to be safe, and most were successful, with only 23(11.5%) patients experiencing complications.[13,14]

In a study by Mohazzab *et al*. recruited 466 patients with mean age of 54±15.5 with most of the patients being female.[15] Mean age of our study population is comparable with their study i.e. 53.2±10.6 but unlike their study most patients in our study were male. Most patients in their study experienced infections and thrombosis of the catheters as compared to our study; infections observed in 52% of patients and thrombosis of catheter occurred in 26% of the patients. These figures were much less in our study; infections in 7% and thrombosis in 3% patients only. In their study DM was a significant risk factor for catheter related infections, however, in our study the disease did not contribute significantly to catheter related infections. Poinen *et al*. reported 30% patients who experienced catheter related complications.[9] The most common complication in their study observed was infection, which occurred in 10% patients. However, this figure was 7% in our study. Four patients in their study died due catheter related infections. In our study none of the patients died. Thrombosis rate was almost similar to our study. In their study, increasing age had a protective effect on complications, a fact also noted in our study.

Coker *et al*. enrolled 177 patients with mean age of patients in their study comparable to ours; about 55 years in their study and in our study mean age was about 53 years.[16] Most patients in their study were female in contrast to our findings. In 98% of patients, the catheter was placed on the right side and in our study, right sided placement was done in 87% patients. Catheter placement was successful in 90% of our patients, this figure was 52% in their study. Only one patient experienced minor bleeding in their study, however, in our study bleeding resulted in removal of catheter in 3 patients. Left sided catheter and female sex were related to significant catheter dysfunction in their study and no relation was established with line infections and different variables. In our study too, infection and dysfunction were common in left sided line as compared to right sided placement however, female gender was not significantly related to any of these complications in our study.

Lee *et al*., who recruited 182 patients for TDL catheter placement, complications rate observed was 0.76/100 catheter days.[17] The observed complications in their study were infection and thrombosis. Similar to our study, DM did not significantly contribute to infection or thrombosis. Martin *et al*. included 227 patients.[18] In 62% of the patients the catheter was removed successfully when it was no more required. Complications were observed in 22 patients. Eight percent of patients experienced non-function and 16% suffered from catheter related infections. Similar to our study, no significant relation was established with complications and age and diabetes mellitus. Ex-smoking had a protective role with regards to complications in their study, however, in our study we did not include this variable. Similar to our study, left sided catheter insertion was related with higher rate of complications. The overall mortality in their study was 5%, in our study we did not observe any deaths.

Arterio-venous formation for dialysis has long been in practice. Different types of grafts are in use, including biological and synthetic. Initially, fistula-first approach was stressed. Recently, changes have been made in management of chronic kidney failure. Arterio-venous fistula was claimed to be safe and long lasting. But this approach has been challenged for many reasons. Maturation of fistula requires time. Also, failure of fistula and complications result in more wasting of time. At times, the decision about which one to avail from different options like fistula or central access become difficult. The physician's job is to work on urgent vascular access, and to work proactively on other options if one option fails. Patient's input in this regard is also valuable. Similarly, in acute conditions some authorities claim peritoneal dialysis is to be the best option. A lot of modifications have been made in catheter formations

to decrease complications. The need of the hour is to get the right access in right patients at the right time for the right reason.

## LIMITATIONS OF STUDY

The primary limitation of this study is its single-center design at a military hospital, which restricts the generalizability of the findings to broader civilian populations. Additionally, the cross-sectional nature of the study makes it difficult to establish definitive causal relationships between variables like absolute neutrophil counts and catheter complications. Furthermore, the male-dominant sample introduces gender bias, and restricting the follow-up period strictly until fistula creation limits insights into long-term catheter outcomes.

## CONCLUSION

In most patients, TDL catheter was successful. Reasons for failure included infections, thrombosis and bleeding. Absolute neutrophils count, platelets count and site of insertion were significantly related with infection and dysfunction of tunnel catheter.

**Conflict of Interest:** None.

**Funding Source:** None.

**Authors Contribution**

Following authors have made substantial contributions to the manuscript as under:

RJA & SS: Conception, study design, drafting the manuscript, approval of the final version to be published.

KMR & SAS: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

UIM & W: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## REFERENCES

1. Inker LA, Astor BC, Fox CH, Isakova T, Lash JP, Peralta CA, et al. KDOQI US commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD. Am J Kidney Dis 2014; 63(5): 713-735.https://doi.org/10.1053/j.ajkd.2014.01.416
2. Chen W, Zhou ZQ, Ren YQ, Zhang L, Sun LN, Man YL, et al. Effects of long non-coding RNA LINC00667 on renal tubular epithelial cell proliferation, apoptosis and renal fibrosis via the miR-19b-3p/LINC00667/CTGF signaling pathway in chronic renal failure. Cell Signal 2019; 54(1): 102–114. https://doi.org/10.1016/j.cellsig.2018.10.016
3. Dai P, Chang W, Xin Z, Cheng H, Ouyang W, Luo A. Retrospective Study on the Influencing Factors and Prediction of Hospitalization Expenses for Chronic Renal Failure in China Based on Random Forest and LASSO Regression. Front Public Health 2021; 9: 678276. https://doi.org/10.3389/fpubh.2021.678276
4. Ammirati AL. Chronic kidney disease. Rev Assoc Med Bras 2020; 66(suppl 1): s03–09. https://doi.org/10.1590/1806-9282.66.S1.3
5. Centers for Disease Control and Prevention, US Department of Health and Human Services. Chronic kidney disease in the United States. Atlanta, GA: US department of health and human services, centers for disease control and prevention 2021 [Internet]. (cited March 25 2024). Available from: https://www.cdc.gov/kidney-disease/php/data research/index.html
6. Dias DB, Mendes ML, Caramori JT, Falbo dos RP, Ponce D. Urgent-start dialysis: comparison of complications and outcomes between peritoneal dialysis and haemodialysis. Perit Dia Int 2021; 41(2): 244-252. https://doi.org/10.1177/0896860820915021
7. van Oevelen M, Abrahams AC, Weijmer MC, Nagtegaal T, Dekker FW, Rotmans JI, et al. Precurved non-tunnelled catheters for haemodialysis are comparable in terms of infections and malfunction as compared to tunnelled catheters: A retrospective cohort study. J Vasc Access 2019; 20(3): 307-312. https://doi.org/10.1177/1129729818805954
8. Sohail MA, Vachharajani TJ, Anvari E. Central venous catheters for hemodialysis—the myth and the evidence. Kidney Int Rep 2021; 6(12): 2958-2968. https://doi.org/10.1016/j.ekir.2021.09.009
9. Poinen K, Quinn RR, Clarke A, Ravani P, Hiremath S, Miller LM, et al. Complications from tunneled hemodialysis catheters: A Canadian observational cohort study. Am J Kidney Dis 2019; 73(4): 467-475. https://doi.org/10.1053/j.ajkd.2018.10.014
10. Zou Y, Ma Y, Chao W, Zhou H, Zong Y, Yang M. Assessment of complications and short-term outcomes of percutaneous peritoneal dialysis catheter insertion by conventional or modified Seldinger technique. Ren Fail 2021; 43(1): 919-925. https://doi.org/10.1080/0886022X.2021.1925296
11. Kalantar-Zadeh K, Jafar TH, Nitsch D, Neuen BL, Perkovic V. Chronic kidney disease. Lancet 2021; 398(10302): 786-802. https://doi.org/10.1016/S0140-6736(21)00519-5
12. Ebert T, Neytchev O, Witasp A, Kublickiene K, Stenvinkel P, Shiels PG et al. Inflammation and oxidative stress in chronic kidney disease and dialysis patients. Antioxid Redox Signal 2021; 35(17): 1426-1448. https://doi.org/10.1089/ars.2020.8184
13. Faponle AE, Olatise OO, Igbokwe M, Asaolu SO. Outcomes of tunneled and nontunneled internal jugular catheters for hemodialysis at Zenith Medical and Kidney centre, Nigeria. Niger J Med 2020; 29(3): 455-459. https://doi.org/10.4103/NJM.NJM_77_20
14. Asif A. Reducing Tunneled Hemodialysis Catheter Morbidity: Reducing the Morbidity of Tunneled Hemodialysis Catheters-A Symposium. Semin Dial 2008; 21(6): 503. https://doi.org/10.1111/j.1525-139X.2008.00493.x
15. Mohazzab A, Khavanin ZM, Dehesh P, Abdolvand N, Rahimi Z, Rahmani S. Investigation of risk factors for tunneled hemodialysis catheters dysfunction: competing risk analysis of a tertiary center data. BMC Nephrol 2022; 23(1). https://doi.org/10.1186/s12882-022-02927-z
16. Coker MA, Black JR, Li Y, Varma R, Almehmi A, Abdel AAK, et al. An analysis of potential predictors of tunneled hemodialysis catheter infection or dysfunction. J Vasc Access 2019; 20(4): 380-385. https://doi.org/10.1177/1129729818809669
17. Lee O, Raque JD, Lee LJ, Wivell W, Block CA, Bettmann MA. Retrospective assessment of risk factors to predict tunneled hemodialysis catheter outcome. J Vasc Interv Radiol 2004; 15(5): 457-461. https://doi.org/10.1097/01.RVI.0000124942.24134.62
18. Martin K, Lorenzo YSP, Leung PYM, Chung S, O'flaherty E, Barker N, et al. Clinical Outcomes and Risk Factors for Tunneled Hemodialysis Catheter-Related Bloodstream Infections. Open Forum Infect Dis 2020; 7(6): ofaa117.https://doi.org/10.1093/ofid/ofaa117
19. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis 2020; 75(4): S1–164. https://doi.org/10.1053/j.ajkd.2019.12.001