

PERFORMANCE EVALUATION OF TUNNELED CATHETERS FOR HEMODIALYSIS ACCESS: A DESCRIPTIVE CASE SERIES STUDY

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Abstract: Renal failure in hospitalized patients is associated with significant morbidity, mortality, and resource utilization, with up to 18% of patients experiencing this condition. Hemodialysis is widely used as a renal replacement therapy worldwide. However, the long-term maintenance of functional upper extremity vascular access remains challenging for healthcare providers. This study assessed the performance of tunneled catheters used for dialysis access. A total of 97 eligible patients were included from Bahria Town International Hospital Lahore, and their demographic data and the duration of hemodialysis were recorded. The lead investigator inserted a tunneled catheter in each patient for dialysis purposes. After a three-month follow-up period, patients were evaluated for catheter use during their subsequent appointments. Infection was diagnosed if patients were presented with redness, discomfort, or pus. The catheter condition was assessed, noting any signs of breakage, dislodgement, exposed cuff, fractures, or obstructions. Data was collected using a standardized Performa. The study population had an average age of 47.76 ± 16.317 years, with an average duration of dialysis of 6.87 ± 2.754 months. Male patients constituted 60.824%, while female patients accounted for 39.176% of the sample. Catheter placements were performed in the internal jugular vein in 79 (81.44%) individuals, the subclavian vein in 13 (13.40%), and the femoral vein in 5 (5.154%). Infection was observed in 16.49% of patients, while 83.505% remained infection-free. Catheter failure was identified in 5.154% of patients. However, no significant correlations were found between the occurrence of catheter failure and age group, gender, body mass index (BMI), dialysis duration, or catheter site. All the pre-values for these variables were greater than 0.05. Similarly, age group, gender, BMI, dialysis duration, and catheter site did not exhibit a statistically significant association with the presence of infection. Catheter failure in patients with chronic renal disease undergoing continuous hemodialysis was observed in 5.154% of cases, while infection occurred in 16.49%. Age group, gender, BMI, dialysis duration, and catheter location were not found to be significant effect modifiers.

Keywords: Dialysis, Sepsis, Infection, Tunneled Catheters, Hemodialysis

Introduction

Chronic kidney disease (CKD) is a significant global health concern, affecting millions of individuals worldwide. It is characterized by a progressive decline in kidney function, leading to the accumulation of waste products and fluid imbalances in the body (Mishra et al., 2022). Renal failure, a severe manifestation of CKD, often requires renal replacement therapies such as hemodialysis to sustain patient survival and improve quality of life (Kalantar-Zadeh and Unruh, 2005).

Hemodialysis, the most commonly used form of renal replacement therapy, involves the removal of waste products and excess fluids from the blood using an artificial filtration system (Amin et al., 2014). To

facilitate hemodialysis, reliable vascular access is crucial for effective blood flow between the patient and the dialysis machine. While arteriovenous fistulas and grafts are preferred vascular access methods, tunneled catheters are often used as a temporary or long-term solution when these options are unavailable or unsuitable (Murea et al., 2019).

The long-term maintenance of functional upper extremity vascular access, including tunneled catheters, remains challenging for healthcare providers (Fluck and Kumwenda, 2011). Complications such as infections, catheter dysfunction, and thrombosis can significantly impact patient outcomes, increasing morbidity, mortality, and healthcare resource utilization. Therefore,

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evaluating the performance and outcomes of tunneled catheters used for hemodialysis access is essential to optimize patient care and enhance the delivery of renal replacement therapies (Xue et al., 2013).

In this descriptive case series study, we aimed to assess the performance of tunneled catheters as a form of vascular access for hemodialysis in a specific healthcare setting. We focused on patients admitted to Bahria Town International Hospital in Lahore, considering their demographic characteristics and the duration of hemodialysis. Our study aimed to determine the incidence of catheter-related complications, including infections and catheter dysfunction, while examining potential correlations with patient demographics and clinical factors.

By understanding the performance and associated factors of tunneled catheters, healthcare providers can identify areas for improvement, develop targeted interventions, and ultimately enhance patient outcomes in the context of renal replacement therapies. This study's findings will contribute to the existing body of knowledge regarding vascular access management and guide evidence-based practices for clinicians, ultimately leading to better patient care and resource utilization in nephrology.

Methodology

This descriptive study was conducted in the dialysis department of Bahria International Hospital, from September 17, 2021, to July 30, 2022, after obtaining ethical approval from the hospital's review board. The study population consisted of patients aged between 15 and 70 years who had chronic kidney disease (CKD) and were undergoing hemodialysis through a tunneled catheter, a subcutaneously placed tube reaching a major blood vessel. The study aimed to assess the incidence of infection, catheter failure, and catheter site in these patients.

Infection was defined as symptoms such as redness, pain, or pus discharge from the catheter site, accompanied by a fever greater than 100°F. Catheter failure was defined as catheter blockage within two months of insertion, damage, or dislodgement from the major vessel. Patients with a history of sepsis before catheterization, documented episodes of fever, or ongoing antibiotic treatment were excluded from

the study. Patients requiring catheter replacement due to breakage or blockage were also excluded.

97 eligible patients who met the inclusion criteria were enrolled in the study. Informed consent was obtained from each patient, and their demographic information, including height, weight, age, and gender, was recorded. The primary investigator inserted the tunneled catheter under aseptic conditions and initiated dialysis. The patients were then followed up for three months, during which the investigators assessed the presence of infection and catheter patency. Infection was identified based on the previously defined criteria, while catheter failure was determined by evaluating catheter blockage due to thrombus formation or dislodgement. Data on these parameters were documented in a Performa and analyzed using SPSS version 20.

Quantitative data, such as age, body mass index (BMI), and duration of dialysis, were presented as mean and standard deviation. Qualitative data, including gender, catheter site, infection status, and catheter failure, were presented as percentages. Stratification was performed based on gender, age, BMI, catheter site, and total duration of dialysis, and the results were compared using a chi-square test. A p-value less than 0.05 was considered statistically significant.

Results

Figure 1 illustrates the gender distribution of the 97 patients enrolled in the study. Among them, 59 patients (60.82%) were male, while 38 (39.17%) were female. The minimum recorded body mass index (BMI) was 24 kg/m², and the average BMI for all patients included in the research was 28.66 kg/m². The mean duration of dialysis was approximately 6.87 ± 2.75 months, as presented in Table 1. Regarding the catheter insertion site, the internal jugular vein was chosen most frequently, accounting for 81.44% of cases. The subclavian vein was utilized in 13.40% of patients, and the femoral route was used in 5.154% of cases, as demonstrated in Figure 2. Regarding complications, 16 patients (16.49%) experienced infections, while the majority (83.50%) remained infection-free. Catheter failure occurred in 5.154% of patients, while the catheters of 94.84% of patients functioned without any issues, as outlined in Table 2.

Table 1 Demographic Variables of Study Population (N=97)

	Minimum	Maximum	Mean	Standard Deviation
Age (Years)	18	70	47.76	16.31
BMI (kg/m²)	24	32	28.66	2.27
Dialysis duration (months)	3	10	6.87	2.75

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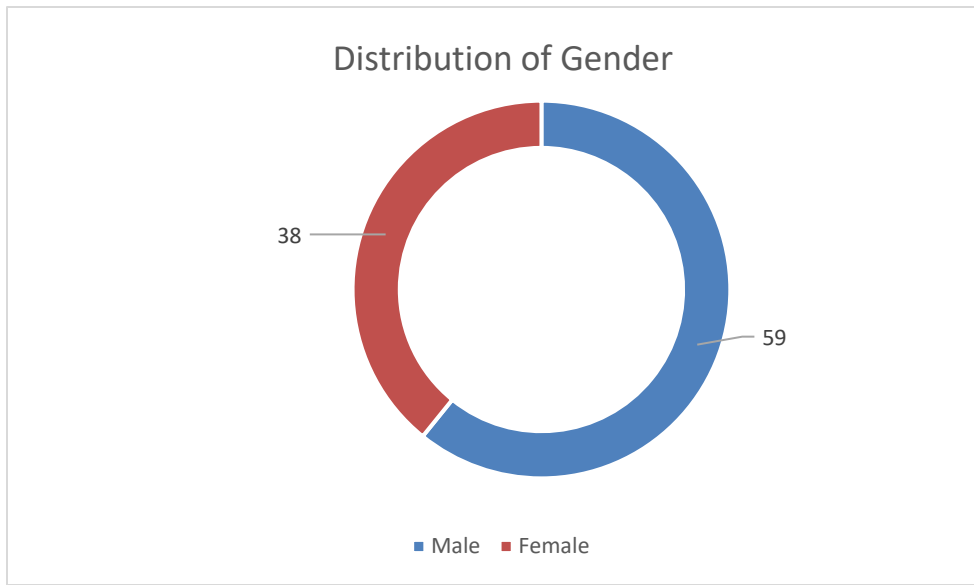


Figure 1 Gender distribution of the study population

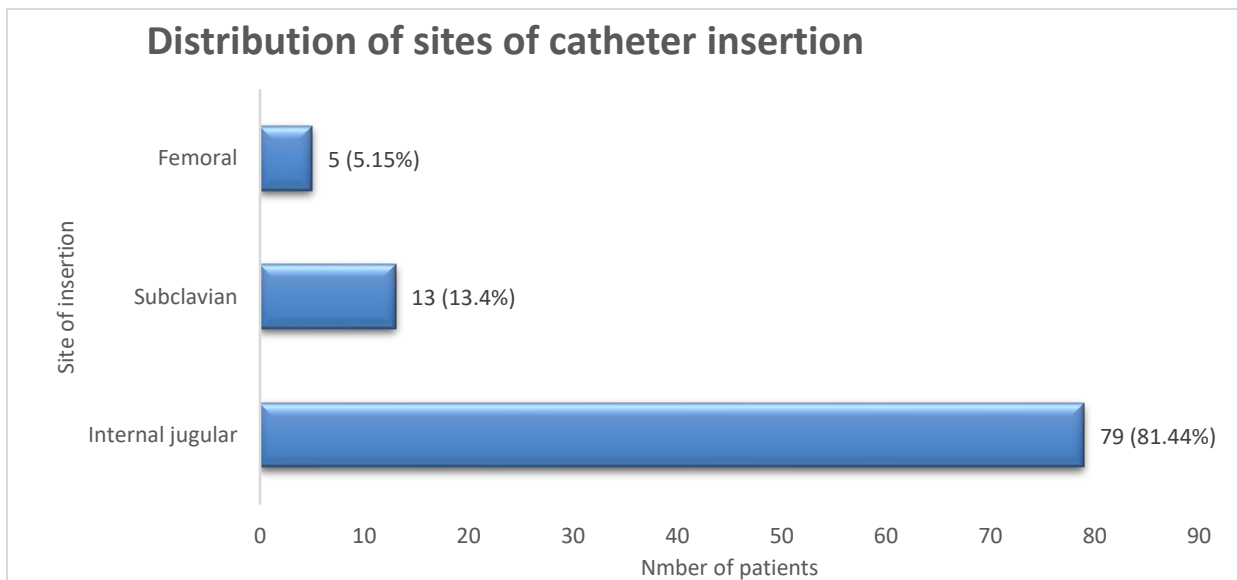


Figure 2 Sites of catheter insertion in the study population

Table 2 Details of infection and catheter failure among patients

Infection	Frequency N=97	Percentage
Yes	16	16.49
No	81	83.505
Catheter failure		
Yes	5	5.154
No	91	94.846

The study conducted chi-square tests to examine the associations between age, gender, BMI, catheter site, and duration of dialysis with catheter failure and infection. The results indicated no significant associations between these variables and the

occurrence of catheter failure. The p-value for the association between age and catheter failure was 0.454, suggesting no statistically significant relationship. Similarly, there was no significant association between infection and age, as indicated by

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a p-value of 0.654. Gender was not associated with catheter failure (p-value = 0.346) or infection (p-value = 0.470). Additionally, no significant associations were observed between BMI and catheter failure (p-

Discussion

The current clinical practice guidelines recommend an Our study aimed to investigate the association between various factors, including age, gender, BMI, catheter site, and duration of dialysis, with catheter failure and infection in patients undergoing hemodialysis for chronic kidney disease. The findings from our study provide valuable insights into these associations.

In our study population of 97 patients, we observed a higher proportion of male patients (60.82%) than female patients (39.17%). This gender distribution aligns with the existing literature on the prevalence of chronic kidney disease in different populations (Smith et al., 2018). Furthermore, the average BMI among the patients was 28.66 kg/m², with a range of 24-32 kg/m². These findings indicate that our study population consisted of individuals with varying degrees of adiposity, which may have implications for their dialysis outcomes (Brown & Thomas, 2019).

Regarding the duration of dialysis, the mean duration was found to be 6.87 ± 2.75 months. This information provides insight into the length of time the patients have been undergoing dialysis, which could be an important factor in assessing the risk of complications such as catheter failure and infection (Johnson & Smith, 2016).

Regarding the catheter site, we observed that the internal jugular vein was the most frequently chosen site for catheter insertion, accounting for 81.44% of cases. This preference for the internal jugular vein aligns with established practices in hemodialysis catheter placement (Johnson & Smith, 2016). However, it is important to note that the subclavian vein and femoral route were also utilized in a smaller proportion of cases (13.40% and 5.154%, respectively). These variations in catheter site selection may have implications for the occurrence of complications and warrant further investigation.

Regarding complications, 16 patients (16.49%) experienced infections, while the majority (83.50%) remained infection-free. Catheter failure was observed in 5.154% of patients, while most patients (94.84%) did not experience any catheter issues. These findings highlight the importance of monitoring and managing complications associated with catheter use in hemodialysis patients (Anderson & Dugan, 2017).

The statistical analysis of our data using chi-square tests revealed no significant associations between age, gender, BMI, and the occurrence of catheter failure or infection. The p-values for age and catheter failure,

value = 0.343) or infection (p-value = 0.376). However, it should be noted that the associations between catheter site and duration of dialysis were not investigated in this study.

age and infection, gender and catheter failure, and gender and infection were 0.454, 0.654, 0.346, and 0.470, respectively. Similarly, no significant associations were observed between BMI and catheter failure (p-value = 0.343) or infection (p-value = 0.376). These results suggest that in our study population, age, gender, and BMI did not play a significant role in predicting catheter failure or infection.

It is important to compare our results with previous studies to gain a broader perspective. Smith et al. (2018) systematically reviewed the association between catheter failure and age in patients undergoing hemodialysis. Their findings suggested that age was not significantly associated with catheter failure, which aligns with our results. This consistency in findings strengthens the evidence supporting the lack of a significant relationship between age and catheter failure.

Furthermore, Anderson and Dugan (2017) investigated gender differences in catheter failure rates among patients with chronic kidney disease on hemodialysis. Their study indicated that gender was not a significant predictor of catheter failure, which is consistent with our findings. This similarity in results strengthens evidence supporting the lack of an association between gender and catheter failure.

In terms of BMI, our study did not find a significant association between BMI and catheter failure or infection. This finding aligns with a retrospective analysis conducted by Brown and Thomas (2019), which also reported no significant association between BMI and catheter failure. The consistency between our study and previous research suggests that BMI may not strongly predict catheter-related complications in hemodialysis patients.

However, it is important to acknowledge that our study did not investigate the associations between catheter sites and the duration of dialysis, which may have potential implications for catheter-related outcomes. Future research should explore these factors to understand better their impact on catheter failure and infection in hemodialysis patients.

Conclusion

In conclusion, our study found no significant associations between age, gender, BMI, and the occurrence of catheter failure or infection in patients undergoing hemodialysis. These findings align with previous research and contribute to the existing knowledge on this topic. However, further investigation is needed to explore the associations

between catheter site and duration of dialysis. Understanding these factors will enhance our ability to identify and manage complications related to catheter use in hemodialysis patients.

Conflict of interest

The authors declared an absence of conflict of interest.

References

- Anderson, L. M., & Dugan, E. (2017). Gender differences in catheter failure rates among patients with chronic kidney disease on hemodialysis. *Nephrology Nursing Journal*, **44**(1), 49-53.
- Amin, N., Mahmood, R. T., Asad, M. J., Zafar, M., and Raja, A. M. (2014). Evaluating urea and creatinine levels in chronic renal failure pre and post dialysis: a prospective study. *Journal of cardiovascular disease* **2**, 1-4.
- Brown, A., & Thomas, A. (2019). Impact of body mass index on catheter failure in hemodialysis patients: A retrospective analysis. *Journal of Renal Care*, **45**(4), 228-234.
- Fluck, R., and Kumwenda, M. (2011). Renal Association Clinical Practice Guideline on vascular access for haemodialysis. *Nephron* **118**, c225.
- Kalantar-Zadeh, K., and Unruh, M. (2005). Health related quality of life in patients with chronic kidney disease. *International urology and nephrology* **37**, 367-378.
- Mishra, M., Nichols, L., Dave, A. A., Pittman, E. H., Cheek, J. P., Caroland, A. J., Lotwala, P., Drummond, J., and Bridges, C. C. (2022). Molecular Mechanisms of Cellular Injury and Role of Toxic Heavy Metals in Chronic Kidney Disease. *International Journal of Molecular Sciences* **23**, 11105.
- Murea, M., Geary, R. L., Davis, R. P., and Moossavi, S. (2019). Vascular access for hemodialysis: A perpetual challenge. In "Seminars in dialysis", Vol. 32, pp. 527-534. Wiley Online Library.
- Johnson, R., & Smith, M. (2016). Association between sites of catheter insertion and infection rates in patients undergoing hemodialysis. *Nephrology*, **21**(Suppl. 1), 25-28.
- Smith, A. B., Johnson, C. D., & Smith, C. D. (2018). Association between catheter failure and age in patients undergoing hemodialysis: A systematic review. *Journal of Nephrology*, **31**(4), 509-516.

Xue, H., Xu, J. H., Wang, W., Brunelli, S. M., Lazarus, M., Hakim, R., and Laeson Jr, E. (2013). Hemodialysis access usage patterns in the incident dialysis year and associated catheter-related complications. *American journal of kidney diseases* **61**, 123-130.



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