

INCIDENCE AND RISK FACTORS OF CATHETER-RELATED COMPLICATIONS AMONG PATIENTS WITH CENTRAL VENOUS AND HEMODIALYSIS CATHETERS PRESENTING TO THE NEPHROLOGY DIVISION, KHYBER TEACHING HOSPITAL, PESHAWAR, PAKISTAN

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Abstract

Background: There is a dearth of local, new information comparing the prevalence and risk factors of catheter-related problems between hemodialysis catheters (tunneled versus non-tunneled). Producing such data could enhance patient safety in our context, direct catheter selection, and inform preventative measures.

Objectives:

1) To estimate and compare the incidence of catheter-related bloodstream infection (CRBSI) within 30 days of insertion between double-lumen non-tunneled non-cuffed and double-lumen tunneled cuffed hemodialysis catheters.

2) To determine the incidence of catheter dysfunction, catheter related thrombosis, mechanical complications and risk factors for catheter related bloodstream infection

Methods: This descriptive comparative study was carried out at the department of Nephrology, KTH Peshawar. Male and female patients aging 18 to 80 years who underwent double lumen hemodialysis catheter (tunneled and non-tunneled type) were enrolled. The patients were compared for catheter related complications including bloodstream infection, catheter dysfunction, thrombosis and mechanical complications.

Results: A total of 180 patients (30 tunneled, 150 non-tunneled) were enrolled. CRBSI incidence was significantly lower in tunneled catheters (0.57 vs. 3.71 per 1000 catheter-days; $p=0.046$). Catheter dysfunction occurred in 3.3% vs. 10.0% ($p=0.480$) and catheter-related thrombosis in 3.3% vs. 1.3% ($p = 0.410$) tunneled versus non-tunneled catheters respectively. Tunneled catheters demonstrated markedly longer median survival (125 vs. 14 days; $p<0.001$). Univariable analysis showed no significant independent risk factors for CRBSI.

Conclusion: Compared to non-tunneled catheters, tunneled hemodialysis catheters demonstrated reduced infection rates and longer shelf life.

INTRODUCTION

For patients with end-stage renal disease (ESRD), hemodialysis is an essential therapy that requires vascular access to function. An arteriovenous fistula (AVF) is typically chosen among the various choices due to its longer lifespan and decreased risk of complications.(1) However, central venous catheters (CVCs) are frequently utilized in place of AVFs when immediate AVF creation is not feasible, particularly when dialysis must begin immediately. (2) Whether for acute or chronic kidney failure, patients requiring either short-term or long-term hemodialysis (HD) still frequently use central venous catheters (CVCs) as vascular access.(3) Nearly 80% of hemodialysis patients in North America started utilizing a CVC in 2016.(4) According to a recent research, 66.2% of 284 patients with chronic renal disease receiving hemodialysis were dialyzed via an AV fistula, 18.0% using a tunneled catheter, and 15.8% through a non-tunneled catheter.(5)

Instead of passing through the epidermis, nontunneled catheters are placed straight into a major vein. To assist dialysis and other treatments, they are often made with two or three lumens and have a cone-shaped tip. (6) Before inserting a tunneled hemodialysis catheter into the vein, a tiny subcutaneous tunnel is made, either along the thigh for femoral access or along the chest wall for internal jugular vein. This tunnel's polyester cuff promotes tissue development, which contributes to anchor the catheter, offers a stable fixation point, and reduces the risk of infection by decreasing the possibility of migration or unintentional dislodgement.(6) Two lumens with matching ports—one red and one blue—make up the dialysis circuit. The red port, also called the arterial lumen, is usually used to take blood from the patient, while the blue port, sometimes called the venous lumen, is used to return the blood after dialysis. (7) Dialysis catheters may be tunneled or non-tunneled. Non-tunneled hemodialysis catheters are utilized when immediate dialysis access is required. However, because femoral nontunneled catheters are more likely to cause femoral vein thrombosis and kinking, these catheters are intended for short-term hospital

usage just be retrieved within two weeks to reduce the risk of bacteremia.(8) Because of reduced risk of infection tunneled catheters are recommended when hemodialysis is anticipated to last longer than two weeks. A tunneled central venous catheter may be used as a long-term or even permanent access for hemodialysis in some patients, such as those with recurrent AV access failures or anatomical constraints preventing optimal artery-vein links.(8)

Complications related to dialysis catheter are numerous depending upon the type. Catheter failure, venous stenosis or thrombosis, and catheter-related infections. Complications from catheter placement itself, such as acute access-related injuries, may potentially occur over a longer period of time (beyond one week).(9) While infectious and thrombotic issues typically arise later, mechanical issues typically occur during the insertion procedure and are primarily dependent on the operator's expertise. The likelihood of mechanical problems is significantly reduced when real-time ultrasonography guiding is used. (10) One major possible side effect of central venous catheter implantation is pneumothorax..(11)

During central venous access, there is a known risk of arterial damage if the needle accidentally punctures an adjacent artery rather than the intended vein. Between 3.7% and 12% of operations result in an accidental artery puncture.(12) This danger can be greatly decreased, but not eliminated, by using ultrasound guidance during catheter insertion. After a carotid artery puncture, a hematoma may constrict the airway and develop into a potentially fatal situation.(13) During central venous catheterization, bleeding may come from the puncture site, the catheter tunnel, or the vein itself.(14) External bleeding typically manifests quickly and can be caused by either venous or arterial damage. It might happen when the first needle is inserted, when the vessel dilates, or when the device is positioned.(15) Internal bleeding can occur at the site of insertion, in the chest cavity when the jugular or subclavian vein is reached, or in the retroperitoneal area when femoral access is employed.(7) A potential side effect of venous access via the jugular or subclavian veins is hemothorax. (16) Rare yet dangerous side effects

of central venous catheter implantation include cardiac damage and pericardial effusion.(17) Pseudoaneurysm can develop as a complication following an accidental arterial puncture during central venous access.(18) Although rare, cardiac perforation can happen if a nontunneled central venous catheter is positioned too deeply in the right atrium or if its tip enters the right ventricle.(19)Tunneled hemodialysis catheter-related bloodstream infection (CRBSI) is a serious and potentially life-threatening complication of central venous catheter use. (20)

Local, prospective data comparing the incidence and determinants of catheter-related complications between tunneled and non-tunneled hemodialysis catheters were lacking in Pakistan. Generating such evidence would inform preventive strategies, guide catheter selection, and improve patient safety in our setting. The study aimed to estimate and compare the incidence of catheter-related bloodstream infection (CRBSI) within 30 days of insertion between double-lumen non-tunneled non-cuffed and double-lumen tunneled cuffed hemodialysis catheters and to determine the incidence of catheter dysfunction, catheter related thrombosis, mechanical complications and risk factors for catheter related bloodstream infection. It was hypothesized that 30-day incidence of CRBSI differs between tunneled and non-tunneled hemodialysis catheters.

MATERIALS AND METHODS

This descriptive comparative study was carried out at the department of Nephrology, KTH Peshawar during the period () till () after taking approval from research review board vide no: (), dated (). Male and female patients aging 18 to 80 years with chronic kidney disease on hemodialysis with double-lumen hemodialysis catheter insertion (tunneled or non-tunneled) were enrolled. Patients with single lumen central lines not intended for hemodialysis, catheter placed at other centers, documented bloodstream infection at the time of catheter insertion and patient lost to follow up were excluded. Catheter related blood stream infection was defined as clinical evidence of

infection (fever, rigors, or leukocytosis) plus positive blood culture with no other source OR paired catheter and peripheral cultures yielding the same organism. Catheter dysfunction was defined as inability to achieve prescribed dialysis blood flow (>300 mL/min) requiring intervention (e.g., thrombolysis, repositioning, replacement). Mechanical complications included pneumothorax, arterial puncture, major bleeding requiring transfusion, hemothorax, or arrhythmia requiring intervention. Catheter survival was measured in days from insertion to removal for any cause. The sample size was determined based on the total number of catheter insertions performed at the center which were estimated to be 30 tunneled catheter in three months period based on center volume of patients. Hence final study sample was 30 tunneled catheter which were compared with 150 non-tunneled catheters yielding total sample size of 180. Participants were enrolled using convenient non-probability sampling technique.

Participants were enrolled following approval from research review board of the hospital. Informed consent was obtained from all enrolled participants ensuring patients confidentiality and safety during the study. Baseline clinical and demographic data were gathered including age, gender, BMI, duration of chronic kidney disease (years), comorbidities (diabetes, immunosuppression), indication, site, operator grade, use of ultrasound, insertion attempts, immediate mechanical complications, dwell time, catheter-days, microbiology results, catheter dysfunction, and outcome (removal/replacement/death). Patients were followed for 30 days post-insertion or until catheter removal or death, whichever occurs first. Daily in-hospital checks and review of dialysis unit logs/microbiology records was performed to identify complications. When infection was suspected, paired peripheral and catheter lumen blood cultures was drawn according to hospital policy. Catheter tip cultures were obtained upon removal when feasible. Outcomes were measured as primary (CRBSI incidence rate within 30 days, expressed per 1000 catheter-days, stratified by catheter type and secondary (rates of catheter dysfunction, mechanical complications at

insertion, catheter-related thrombosis, catheter survival time, and 30-day all-cause mortality). Data analysis was carried out using SPSS v.26. Descriptive statistics included means/medians with SD/IQR for continuous variables; frequencies and percentages for categorical variables. Incidence calculation for CRBSI per 1000 catheter-days for each catheter type. Group comparisons was carried out using Chi-square or Fisher’s exact test for categorical variables; t-test or Mann-Whitney U for continuous variables as appropriate at 5% significance level. Survival analysis was measured using Kaplan-Meier curves and log-rank test for catheter survival. Risk factors were assessed using multivariable logistic regression for CRBSI if ≥ 10 events per predictor variable (otherwise univariable analysis). Significance level was set at $p < 0.05$.

RESULTS

A total of 180 patients were enrolled, including 30 with tunneled and 150 with non-tunneled

hemodialysis catheters. The mean age was 54.7 ± 12.8 years, with 58.9% males and no significant age or gender differences between groups. Diabetes mellitus was present in 54.4% of patients, with comparable prevalence across both groups ($p = 0.499$). CKD duration differed significantly ($p < 0.001$), as all tunneled catheter patients had established CKD, while 44.7% of non-tunneled patients were new diagnoses. Femoral insertions (8.3%) occurred exclusively in the non-tunneled group ($p = 0.040$). Indication for insertion also differed markedly ($p < 0.001$): tunneled catheters were primarily elective (86.7%), whereas non-tunneled catheters were mostly for emergency indications (63.3% AKI). Operator grade varied significantly ($p < 0.001$), with senior consultants placing 70% of tunneled catheters and residents placing 68.7% of non-tunneled catheters. Ultrasound guidance was used more frequently in tunneled catheter placements (100% vs. 81.3%, $p = 0.010$). (Table 1)

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants, (n = 180)

Characteristic	Total (N=180)	Tunneled Catheter (n=30)	Non-Tunneled Catheter (n=150)	Test Statistic	p-value
Age (years), mean \pm SD	54.7 \pm 12.8	58.3 \pm 9.1	54.0 \pm 13.3	t = 1.71 ⁱ	0.089
Age Groups, n (%)				$\chi^2 = 3.64$	0.162
18-40 years	32 (17.8)	2 (6.7)	30 (20.0)		
41-60 years	82 (45.6)	16 (53.3)	66 (44.0)		
61-80 years	66 (36.7)	12 (40.0)	54 (36.0)		
Gender, n (%)				$\chi^2 = 0.07$	0.787
Male	106 (58.9)	17 (56.7)	89 (59.3)		
Female	74 (41.1)	13 (43.3)	61 (40.7)		
BMI (kg/m ²), mean \pm SD	28.8 \pm 3.2	28.9 \pm 3.2	28.8 \pm 3.2	t = 0.16	0.877
BMI Categories, n (%)				FET	0.905
Underweight (<18.5kg/m ²)	0 (0)	0 (0)	0 (0)		
Normal (18.5-24.9 kg/m ²)	31 (17.2)	5 (16.7)	26 (17.3)		
Overweight (25.0-29.9 kg/m ²)	81 (45.0)	15 (50.0)	66 (44.0)		
Obese (≥ 30.0 kg/m ²)	68 (37.8)	10 (33.3)	58 (38.7)		
CKD Duration (years), median (IQR)	3.0 (0.0 - 5.0)	3.7 (2.5 - 5.1)	2.6 (0.0 - 4.8)	U = 1824.5 ⁱⁱ	0.081
CKD Duration Categories, n (%)				$\chi^2 = 23.81$	<0.001
New diagnosis (<1 years)	67 (37.2)	0 (0)	67 (44.7)		
1-5 years	78 (43.3)	20 (66.7)	58 (38.7)		
>5 years	35 (19.4)	10 (33.3)	25 (16.7)		

Diabetes Mellitus, n (%)	98 (54.4)	18 (60.0)	80 (53.3)	$\chi^2 = 0.46$	0.499
Immunosuppressed, n (%)	0 (0)	0 (0)	0 (0)	-	-
Insertion Site, n (%)				FET	0.040
Right Internal Jugular	152 (84.4)	27 (90.0)	125 (83.3)		
Left Internal Jugular	13 (7.2)	3 (10.0)	10 (6.7)		
Femoral	15 (8.3)	0 (0)	15 (10.0)		
Indication for Insertion, n (%)				FET	<0.001
Elective (Planned CKD)	41 (22.8)	26 (86.7)	15 (10.0)		
Failed AVF	39 (21.7)	4 (13.3)	35 (23.3)		
Emergency (AKI)	95 (52.8)	0 (0)	95 (63.3)		
Poisoning	5 (2.8)	0 (0)	5 (3.3)		
Operator Grade, n (%)				FET	<0.001
Senior Consultant	41 (22.8)	21 (70.0)	20 (13.3)		
Fellow	36 (20.0)	9 (30.0)	27 (18.0)		
Resident	103 (57.2)	0 (0)	103 (68.7)		
Ultrasound Guidance, n (%)	152 (84.4)	30 (100)	122 (81.3)	$\chi^2 = 6.55$	0.010
Insertion Attempts, n (%)				$\chi^2 = 2.41$	0.120
Single Attempt	129 (71.7)	25 (83.3)	104 (69.3)		
Multiple Attempts (>1)	51 (28.3)	5 (16.7)	46 (30.7)		

Catheter-related bloodstream infection (CRBSI) occurred in 14 patients (7.8%), with comparable event rates between tunneled (6.7%) and non-tunneled (8.0%) groups (p=1.000). However, when accounting for catheter-days, the incidence rate was significantly higher in non-tunneled catheters (3.71 vs. 0.57 per 1000 catheter-days; p=0.046). Catheter dysfunction was observed in 16 patients (8.9%), with a higher but non-significant trend in non-tunneled catheters (10.0% vs. 3.3%; p=0.480). Catheter-related thrombosis was rare, occurring

in only 3 patients (1.7%), with no significant difference between groups (p=0.410). Immediate mechanical complications occurred in 8 patients (4.4%), including arterial puncture (2.8%) and pneumothorax (1.7%), with comparable rates between groups (p=1.000). Catheter survival differed markedly, with tunneled catheters demonstrating a median survival of 125 days compared to only 14 days for non-tunneled catheters (p<0.001). No 30-day all-cause mortality was observed in either group as reported in table 2.

Table 2: Comparison of Catheter-Related Complications by Catheter Type, (n = 180)

Complication	Total (N=180)	Tunneled (n=30)	Non-Tunneled (n=150)	Test Statistic	p-value
Catheter-Related Bloodstream Infection (CRBSI)					
Events, n (%)	14 (7.8)	2 (6.7)	12 (8.0)	FET	1.000
Catheter-Days	6743	3510	3233	-	-
Incidence Rate (per 1000 catheter-days)	2.08	0.57	3.71	Poisson Reg	0.046
Catheter Dysfunction, n (%)	16 (8.9)	1 (3.3)	15 (10.0)	FET	0.480
Catheter-Related Thrombosis, n (%)	3 (1.7)	1 (3.3)	2 (1.3)	FET	0.410

Immediate Mechanical Complications, n (%)	8 (4.4)	1 (3.3)	7 (4.7)	FET	1.000
Arterial Puncture	5 (2.8)	1 (3.3)	4 (2.7)		
Pneumothorax	3 (1.7)	0 (0)	3 (2.0)		
Hemothorax	0 (0)	0 (0)	0 (0)		
Arrhythmia	0 (0)	0 (0)	0 (0)		
Catheter Survival Days, median (IQR)	18 (9 - 110)	125 (85 - 175)	14 (8 - 20)	U = 372.5	<0.001
30-Day All-Cause Mortality, n (%)	0 (0)	0 (0)	0 (0)	-	-

As reported in table 3, Kaplan-Meier analysis demonstrated significantly longer catheter survival in the tunneled group, with a median survival of 125.0 days (95% CI: 98.7-151.3) compared to only 14.0 days (95% CI: 12.3-15.7) in the non-tunneled group (Log-Rank test: $\chi^2 = 98.4, p < 0.001$). Cumulative survival at 30 days

was 96.7% for tunneled catheters versus 32.0% for non-tunneled catheters. The survival curves diverged early and remained separated throughout the follow-up period, confirming the superior longevity of tunneled hemodialysis catheters. (Figure 1)

Table 3: Kaplan-Meier Estimates of Catheter Survival

Catheter Type	Median Survival (Days)	95% Confidence Interval	Cumulative Survival at 30 Days (%)	Cumulative Survival at 90 Days (%)
Tunneled	125.0	98.7 - 151.3	96.7	86.7
Non-Tunneled	14.0	12.3 - 15.7	32.0	0

Overall Comparison

	Chi-Square	df	p-value
Log-Rank (Mantel-Cox)	98.4	1	<0.001

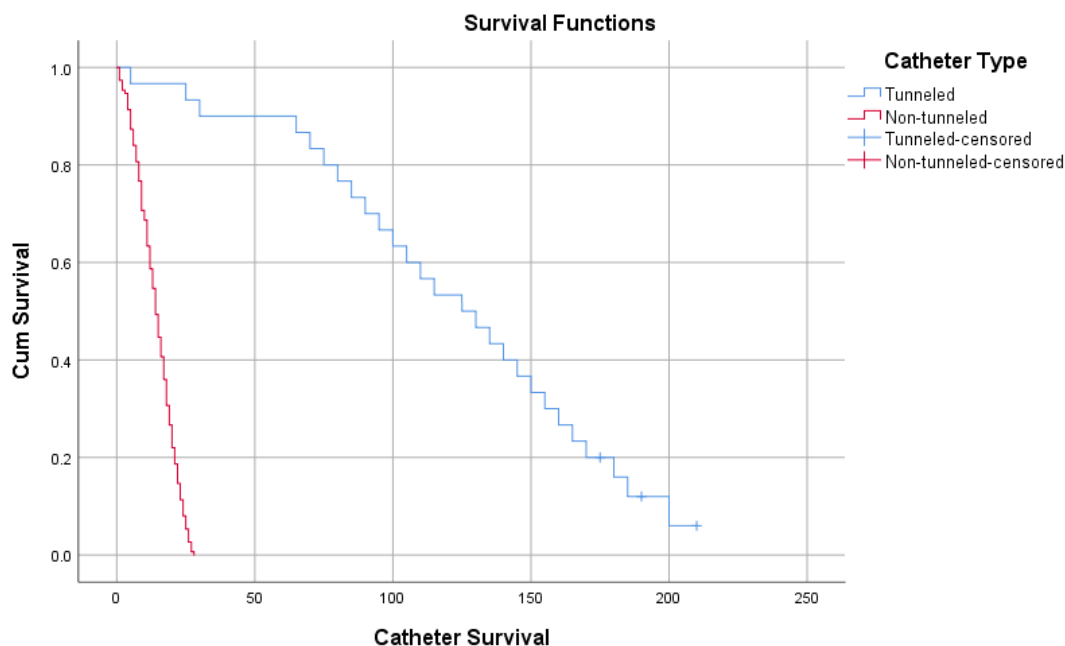


Figure 1. Kaplan-Meier curves for tunneled versus non-tunneled catheter survival

Univariable analysis did not identify any statistically significant risk factors for CRBSI, likely due to the low event rate (n=14). Non-tunneled catheters showed a non-significant increased odds of infection compared to tunneled catheters (OR: 1.22; 95% CI: 0.26-5.72; p=0.802). Femoral insertion site demonstrated a trend toward higher risk (OR: 1.96; 95% CI: 0.40-9.62; p=0.407), as did placement by resident operators (OR: 1.96; 95%

CI: 0.60-6.40; p=0.264). Absence of ultrasound guidance showed the strongest association with CRBSI (OR: 2.37; 95% CI: 0.70-8.03; p=0.164), though this did not reach statistical significance. Multiple insertion attempts also trended toward increased risk (OR: 2.02; 95% CI: 0.67-6.09; p=0.213). Diabetes, age, gender, BMI, CKD duration, and immediate mechanical complications were not associated with CRBSI. (Table 4)

Table 4: Univariable Analysis of Risk Factors for Catheter-Related Bloodstream Infection (CRBSI), (n = 180)

Risk Factor	CRBSI Group (n=14)	No CRBSI Group (n=166)	Odds Ratio (95% CI)	P-value
Catheter Type				
Tunneled	2 (14.3)	28 (16.9)	Reference	
Non-Tunneled	12 (85.7)	138 (83.1)	1.22 (0.26 - 5.72)	0.802
Age Groups				
18-40 years	2 (14.3)	30 (18.1)	Reference	
41-60 years	7 (50.0)	75 (45.2)	1.40 (0.27 - 7.15)	0.686
61-80 years	5 (35.7)	61 (36.7)	1.23 (0.22 - 6.73)	0.811
Gender				
Male	8 (57.1)	98 (59.0)	Reference	
Female	6 (42.9)	68 (41.0)	1.08 (0.36 - 3.24)	0.889
BMI Categories				
Normal (18.5-24.9 kg/m ²)	2 (14.3)	29 (17.5)	Reference	
Overweight (25.0-29.9 kg/m ²)	7 (50.0)	74 (44.6)	1.37 (0.27 - 7.01)	0.703
Obese (≥30.0 kg/m ²)	5 (35.7)	63 (38.0)	1.15 (0.21 - 6.30)	0.871
Diabetes Mellitus				
No	5 (35.7)	77 (46.4)	Reference	
Yes	9 (64.3)	89 (53.6)	1.56 (0.51 - 4.77)	0.436
CKD Duration				
New diagnosis (0 years)	5 (35.7)	62 (37.3)	Reference	
1-5 years	6 (42.9)	72 (43.4)	1.03 (0.30 - 3.55)	0.959
>5 years	3 (21.4)	32 (19.3)	1.16 (0.26 - 5.19)	0.844
Insertion Site				
Internal Jugular	12 (85.7)	153 (92.2)	Reference	
Femoral	2 (14.3)	13 (7.8)	1.96 (0.40 - 9.62)	0.407
Operator Grade				
Consultant/Fellow	4 (28.6)	73 (44.0)	Reference	
Resident	10 (71.4)	93 (56.0)	1.96 (0.60 - 6.40)	0.264
Ultrasound Guidance				
Yes	10 (71.4)	142 (85.5)	Reference	

No	4 (28.6)	24 (14.5)	2.37 (0.70 - 8.03)	0.164
Insertion Attempts				
Single Attempt	8 (57.1)	121 (72.9)	Reference	
Multiple Attempts (>1)	6 (42.9)	45 (27.1)	2.02 (0.67 - 6.09)	0.213
Immediate Mechanical Complications				
No	13 (92.9)	159 (95.8)	Reference	
Yes	1 (7.1)	7 (4.2)	1.75 (0.20 - 15.30)	0.614

DISCUSSION

Valuable real-world information on catheter-related challenges in a context with limited resources is provided by this prospective comparative research. Our results show that, in comparison to non-tunneled catheters, tunneled hemodialysis catheters are linked to noticeably longer shelf life and much reduced infection rates when time at risk is taken into account. These findings have significant ramifications for clinical practice in Pakistan and other comparable healthcare environments. Our cohort's total CRBSI rate was 2.08 per 1000 catheter-days, which is within the range shown in recent research. Results in a recent large retrospective investigation by Gubenšek et al., is significantly lower than our observation (21). The fact that their facility only employed pre-curved non-tunneled catheters, which have been demonstrated to have reduced rates of infection than straight catheters, as well as variations in patient demographics and infection control procedures, might account for this disparity (22). Our measured CRBSI rate is similar to the 1.8-5.2 per 1000 catheter-days that Alhussain et al. reported in ICU settings, indicating that our infection control procedures are in line with local norms (23).

The substantially higher incidence rate of CRBSI with non-tunneled catheters (3.71 vs. 0.57 per 1000 catheter-days, p=0.046) is consistent with existing recommendations and conventional teaching, which advise restricting the use of non-tunneled catheters to brief periods of time (24). Contemporary pre-curved non-tunneled and tunneled catheters did not vary in infection rates, according to a recent study that challenged this paradigm (21). Our use of straight non-tunneled catheters, which have a higher risk of infection, and the larger

percentage emergency placements in our non-tunneled group (63.3% for AKI), when sterile circumstances may not be ideal, might account for the disparity with our results.

In our cohort, 8.9% of our patients had catheter malfunction, with non-tunneled catheters showing a non-significant trend toward higher rates. This is in line with research showing that dysfunction rates differ significantly according on definitions and length of follow-up. According to Niyyar and Chan, up to 30% of catheters experience mechanical malfunction within a year, with thrombosis being the most common reason (25). According to Marques et al., late dysfunction is most frequently thrombotic, whereas early dysfunction is usually caused by malposition or kinking (26). Their finding that right internal jugular catheters last far longer than left-sided or femoral catheters is in good agreement with our median catheter survival of 125 days for tunneled catheters (26). The 7.5% incidence of catheter-related thrombosis for femoral non-tunneled catheters explicitly reported by Khan et al., is much higher than the 1.7% incidence in our investigation (27). This discrepancy probably results from the fact that internal jugular access is more common (84.4%) and that jugular sites are less thrombogenic than femoral ones. Early catheter removal or conversion to definitive access is crucial, as Khan et al. found that catheter dwell time ≥6 days was the sole independent predictor of thrombosis (OR 9.8) (27). Our rate of acute mechanical complications (pneumothorax 1.7%, arterial puncture 2.8%) is in line with reported rates. The use of ultrasound guidance during catheter placement reduced CRBSI risk (OR 2.37 for absence of ultrasound, p=0.164) support Marques et al.'s observation that

ultrasound guidance enhances success rates and reduces arterial puncture (26).

The desired application of each kind of catheter is reflected in the significant difference in catheter survival (median 125 vs. 14 days, $p < 0.001$). Since non-tunneled catheters are meant to be used for brief periods of time, our median of 14 days is in accordance with guidelines that suggest using them for no more than two weeks (24). Our research's 86.7% 90-day survival rate for tunneled catheters is similar to Sandeep et al.'s 70% 2-year survival rate for tunneled catheters in a seven-year cohort study (28). The significance of reducing catheter days is further supported by their discovery that non-tunneled catheters were linked to a five-fold greater mortality risk in comparison to AVF (AdHR 5.0) (28).

The low occurrence rate ($n=14$) in our univariable analysis is probably the reason why there were no significant risk variables for CRBSI. Nonetheless, the trends seen are clinically significant and in line with existing research, especially for femoral insertion (OR 1.96), repeated insertion attempts (OR 2.02), and lack of ultrasound guidance (OR 2.37). Although Sohail et al.'s investigation of 107 patients did not approach statistical significance for location as a risk factor, they did find that femoral insertion was linked to greater infection rates (29). Although diabetes revealed a non-significant correlation in our analysis (OR 1.56), its high incidence (54.4%) deserves concern. Lin et al. recently noted that diabetes mellitus and patient body habitus lead to catheter problems (22). Real-world practice is reflected in the high percentage of resident operators (68.7%) and emergency indicators (63.3% AKI) in our non-tunneled group. 66.2% of 284 incident hemodialysis patients were dialyzed via AVF, 18.0% via tunneled catheter, and 15.8% via non-tunneled catheter, according to a prior research (30). By offering comprehensive complication rates and risk factor analysis, our study expands on these findings.

Our study contains a number of shortcomings. Due to senior operators' preference for placing tunneled catheters in elective, stable patients, the non-randomized design adds selection bias. Although the high sample size and future follow-up enhance internal validity, the single-center

design restricts generalizability. Due to the short stay durations of non-tunneled catheters, we were unable to evaluate long-term outcomes beyond 30 days, and the low CRBSI event rate prohibited multivariate analysis of risk variables. Notwithstanding these drawbacks, this study offers useful baseline information for a Pakistani population. Future research should focus on identifying modifiable risk factors for CRBSI in Pakistani populations through larger multicenter studies, evaluating infection prevention bundles that include antibiotic locks and chlorhexidine dressings, and evaluating pre-curved non-tunneled catheters that may reduce infection rates. Studies looking at glycemic control and infection risk would be especially pertinent given the high incidence of diabetes in our population.

CONCLUSION

This study showed that, in comparison to non-tunneled catheters, tunneled hemodialysis catheters are linked to a considerably reduced incidence of catheter-related bloodstream infection and a noticeably longer life. Although non-tunneled catheters are still suitable for short-term emergency usage, current guidelines advocate tunneled catheters for projected dialysis beyond two to three weeks due to their greater risk of infection when time at exposure is taken into account. Although not statistically significant, the trends toward lower CRBSI with internal jugular insertion and ultrasound guidance highlight how crucial it is to follow recommended procedures when placing catheters. These results offer baseline information for creating local vascular access policies and infection control plans. Future initiatives should concentrate on reducing the number of non-tunneled catheter days, improving insertion methods, and encouraging prompt conversion to permanent arteriovenous fistulas.

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