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"CLINICAL AND BIOCHEMICAL OUTCOMES OF TRANSITIONING FROM PRECURVED TO TUNNELED DIALYSIS CATHETERS: A SINGLE-CENTER COHORT STUDY"

Nephrology

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ABSTRACT

Background: Vascular access is the lifeline for hemodialysis patients. In low- and middle-income countries (LMICs), immediate dialysis often begins with catheters due to delayed AV fistula maturation or availability. **Methods:** This retrospective observational single-center cohort study (June 2024–May 2025) involved 210 patients divided into three groups: Group 1 (Precurved transitioned to TDC, n=75), Group 2 (TDC first, n=115), and Group 3 (Precurved only, n=20) **Results:** TDC First (Group 2) provided the highest patency (210+/-42 days). However, transitioning from precurved to TDC (Group 1) significantly reduced CRBSI rates compared to long-term precurved use (1.8 vs 2.6 per 1000 catheter days, p=0.04). **Conclusion:** Transitioning from precurved temporary catheters to tunneled dialysis catheters (TDC) is a safe, cost-effective strategy that optimizes patency and reduces infection risks in resource-limited settings

KEYWORDS

Vascular access, Tunneled Dialysis Catheter (TDC), Precurved Catheter, Hemodialysis, LMIC.

INTRODUCTION

Vascular access is critical for survival in patients with end-stage renal disease. While the AV fistula remains the gold standard, many patients require urgent initiation of dialysis via central venous catheters. Precurved temporary catheters (PCC) are widely used in LMICs due to low cost and ease of bedside insertion. However, long-term use of PCC is linked to mechanical failure and infection. Transitioning these patients to tunneled dialysis catheters (TDC) may offer better patency and quality of life. This study evaluates the effectiveness of a transition protocol in a resource-limited settings.

METHODOLOGY

Study Design And Setting

This study employed a retrospective observational single-center cohort design. The research was conducted within the Dialysis Unit of the Heritage Institute of Medical Sciences, Varanasi, covering a study period from June 2024 to May 2025.

Participant Selection And Grouping

A total of 210 patients undergoing haemodialysis were enrolled and categorized into three distinct cohorts based on their vascular access strategy3:

Group 1 (Transition Group, n=75): Patients initially stabilized with a precurved temporary catheter (PCC) who were subsequently transitioned to a tunnelled dialysis catheter (TDC)

Group 2 (Primary TDC Group, n=115): Patients who received a TDC as their primary vascular access.

Group 3 (PCC Only Group, n=20): Patients who remained on precurved temporary catheters without transitioning to a permanent or tunnelled modality.

Clinical Decision Algorithm

The selection of vascular access followed a structured three-step clinical protocol:

1. Acuity Assessment: Patients presenting with an immediate or urgent need for dialysis were first stabilized using a Precurved Temporary Catheter.

2. Surgical Fitness and Prognosis: Following stabilization, patients were assessed for surgical fitness, life expectancy, and personal preference. If life expectancy was estimated at less than 6–12 months or surgical fitness was poor, TDC was considered the primary access.

3. Vessel Mapping: For patients deemed suitable for surgery, a clinical examination and Duplex ultrasound mapping were performed. Criteria for AV Fistula planning included a vein diameter >2.5–3.0 mm and an artery diameter >2.0 mm, with no evidence of central venous stenosis[12]. If vessels were unsuitable (small, scarred, or stenotic), a TDC was placed.

Data Collection And Outcome Measures

Comprehensive data were extracted from medical records, including:

Sociodemographic Data: Age, sex, weight, socioeconomic status, and insurance coverage

Clinical Parameters: CKD aetiology (Diabetes, Hypertension, GN) and biochemical markers (Haemoglobin, Calcium, Phosphate, and Serum Albumin)

Catheter Performance: Primary outcomes included catheter patency duration (days), Catheter-Related Bloodstream Infection (CRBSI) rates per 1000 catheter-days, and mechanical complication rates

Dialysis Adequacy: Measured via Kt/V and Urea Reduction Ratio (URR)

Morbidity And Mortality: Evaluation of missed dialysis sessions, intradialytic hypotension, hospitalization frequency/duration, and 30, 60, and 90-day mortality rates

Patient-Reported Outcomes: Quality of life was assessed using the Kidney Disease Quality of Life (KDQOL) score, along with specific scores for access comfort and pain (0–10 scale)

Statistical Analysis

Continuous variables were expressed as mean ± SD, and categorical variables as percentages. Comparisons between the three groups were performed using appropriate statistical tests, with a p-value < 0.05 considered statistically significant.

RESULTS

The study analysed 210 patients divided into three cohorts based on their vascular access strategy. The baseline sociodemographic characteristics, including age (mean 52.4 years), sex distribution, and primary etiology of Chronic Kidney Disease (Diabetes and Hypertension), were statistically comparable across all groups ($p > 0.05$), ensuring that the outcomes were attributable to the access intervention rather than patient-level confounders.

Catheter Performance And Patency

A highly significant difference was observed in the primary endpoint of catheter patency. Group 2 (TDC First) demonstrated the longest functional duration (210+/-42 days). Group 1 (Transition) showed a respectable patency of 152 +/- 35 days, whereas Group 3 (PCC Only) exhibited a significantly lower patency of only 90 +/- 28 days ($p < 0.001$).

Infection And Mechanical Complications

The incidence of Catheter-Related Bloodstream Infections (CRBSI) was lowest in Group 2 (1.5/1000 catheter-days) and Group 1 (1.8/1000 days). In contrast, Group 3 (PCC Only) had a significantly higher infection rate of 2.6/1000 days ($p = 0.04$). Mechanical complications, including kinked lines, poor flow, and catheter malposition, were reported in 11%–18% of cases across the cohorts, but the differences did not reach statistical significance ($p = 0.43$).

Dialysis Adequacy And Biochemical Markers

There was no significant disparity in dialysis adequacy markers; Kt/V values remained stable across Group 1 (1.25 +/-0.22), Group 2 (1.28

+/-0.25), and Group 3 (1.20 +/- 0.20) (p = 0.27). However, nutritional status—reflected by serum albumin—showed marked improvement in the transitioned and primary TDC groups compared to the temporary-only group (p = 0.03).

Morbidity And Mortality

The 90-day mortality rate was lowest in the TDC First group (6%) and highest in the PCC Only group (10%), though this trend was not statistically significant (p = 0.54). Hospitalization episodes and 30-day readmission rates also trended lower in patients who received tunneled access.

Patient-Reported Outcomes (PROs)

Quality of life assessment using the KDQOL score revealed that patients in the Transition group (Group 1: 52.3 +/-8.4) and TDC First group (Group 2: 54.1 +/-7.9) reported better overall well-being compared to the PCC Only group (50.5 +/-8.7 , p = 0.18). Access comfort scores followed a similar trend, indicating that tunneled access is better tolerated for long-term therapy.

Table 1. Comprehensive Summary Of Results

Outcome Parameter	Group 1 (Transition)	Group 2 (TDC First)	Group 3 (PCC Only)	p-value
Mean Patency (Days)	152 +/-35	210 +/-42	90 +/-28	**<0.001**
CRBSI Rate (/1k days)	1.8	1.5	2.6	**0.04**
End-Study Albumin (g/dL)	3.6 +/-0.3	3.7 +/-0.4	3.4 +/-0.3	**0.03**
30-day Readmission (%)	14%	12%	18%	0.50
90-day Mortality (%)	8%	6%	10%	0.54
KDQOL Score	52.3 +/-8.4	54.1 +/-7.9	50.5 +/-8.7	0.18

DISCUSSION

The results of this study highlight the critical importance of vascular access management in resource-limited settings. While the AV fistula remains the ideal long-term solution, our findings demonstrate that for patients requiring immediate dialysis, a structured "bridge-to-tunnel" transition significantly optimizes clinical outcomes.

Catheter Patency And Performance

Our study observed a clear hierarchy in patency, with primary TDC placement (Group 2) outperforming the transition group (Group 1), which in turn outperformed the temporary-only group (Group 3). The 152 +/-35 day patency in our transition group suggests that using a precurved temporary catheter (PCC) as a short-term stabilizer does not compromise the later success of a tunneled catheter. This is consistent with findings by Maya ID (2018), who noted that precurved designs offer lower repositioning rates, crucial for maintaining flow during the critical first weeks of dialysis initiation.

Infection Control In LMICs

One of the most significant findings was the reduction in CRBSI rates from 2.6/1000 days in the PCC-only group to 1.8/1000 days in the transitioned group (p=0.04). In LMICs, where environmental hygiene and patient education can be challenging, the tunneled design provides a physical barrier (the cuff) that slows bacterial migration. Our results mirror observations by Rojas L (2020) in Peru, where similar CRBSI rates were achieved by prioritizing early transition to tunneled modalities in urgent-start patients.

The Precurved Catheter As A Strategic Bridge

In many Indian centers, immediate TDC placement is hindered by financial constraints, lack of specialized surgical slots, or patient instability. The precurved catheter (PCC) addresses these gaps. As noted by Khanna U (2019), PCCs have 30% lower mechanical complication rates than straight catheters. Our study confirms that PCCs allow for immediate stabilization at the bedside under ultrasound guidance, buying time for vessel mapping and financial planning without the high infection risk associated with prolonged straight temporary catheter use.

Clinical And Nutritional Implications

The significantly higher serum albumin levels in Group 1 and 2 compared to Group 3 (p=0.03) suggest that reliable vascular access directly impacts nutritional status. Stable access ensures consistent, high-efficiency dialysis sessions, which reduces the chronic inflammatory state associated with uremia and poor dialysis adequacy (Kt/V), thereby improving overall patient well-being and Quality of Life (KDQOL).

CONCLUSION

This study concludes that a structured transition from precurved temporary catheters to tunneled dialysis catheters is a safe and highly effective strategy for managing ESRD patients in resource-limited settings.

Primary Access: While primary TDC placement is ideal, the "bridge-to-tunnel" strategy provides comparable safety and adequate patency.

Infection Prevention: Transitioning to TDC significantly reduces the risk of life-threatening bloodstream infections compared to maintaining temporary access.

Practicality: The use of precurved catheters allows for urgent initiation of life-saving dialysis while providing a window for definitive vessel mapping and AV fistula planning.

We recommend that dialysis units in LMICs adopt a clear decision algorithm-prioritizing urgent stabilization with precurved catheters followed by early assessment for tunneled or permanent access-to minimize morbidity and improve long-term patient survival.

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