

Comparison of the Efficacy and Safety of Two Different Sizes of Temporary Hemodialysis Catheters in the Femoral Vein

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Abstract:

Background and Objective: Hemodialysis through temporary catheters in the femoral vein is essential for patients with End-Stage Renal Disease (ESRD) requiring urgent vascular access. This study evaluates the efficacy and safety of two different catheter lengths (20 cm and 24 cm) to determine the optimal clinical choice. The aim is to compare two catheters in an effort to identify one with lower malfunction rates, reduced infection incidence, and improved long-term efficacy in ESRD patients.

Materials & Methods: In this randomized controlled clinical trial, 80 ESRD patients in need of temporary hemodialysis were randomly assigned to receive either a 20 cm or 24 cm femoral catheter. Patients were monitored over two weeks for catheter performance and complications, including infection, thrombosis, and hematoma.

Results: Among 80 patients (53 men [66.25%], 27 women [33.75%]), the mean age was 52.5 ± 13.7 years in the 20 cm group and 56.0 ± 12.9 years in the 24 cm group. Demographics were statistically similar. The most common complication was thrombosis (23.75%); observed in 17.5% of the 20 cm group and 30% of the 24 cm group. Infections occurred in 20% of the 20 cm group and 12.5% of the 24 cm group. Hematomas were seen in 20% of the 20 cm group and 7.5% of the 24 cm group. Catheter functionality at two weeks was 65% in the 20 cm group and 60% in the 24 cm group ($P = 0.712$).

Conclusion: Both catheter lengths demonstrated similar performance and complication rates over the two-week period. Catheter selection can be individualized based on patient-specific factors, as both sizes offer acceptable efficacy and safety profiles.

Keywords: Hemodialysis, Femoral Vein, Catheter, Randomized Controlled Trial

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Background and Objective

Approximately 55,000 people in Iran live with End-Stage Renal Disease (ESRD).¹ The progression of chronic kidney disease (CKD) to ESRD significantly reduces quality of life and increases early mortality.² CKD is a debilitating condition requiring careful monitoring and early referral for dialysis or kidney transplantation.

Hemodialysis is a primary treatment method for patients with ESRD and advanced CKD.³ One common access route is the use of temporary catheters in the femoral vein, particularly in emergency settings due to their ease of insertion and rapid accessibility. However, these catheters are associated with complications such as infection, bleeding, and thrombosis, which may compromise patient safety.⁴

The length of femoral temporary catheters is a critical factor that can impact their efficiency and safety. Selecting the appropriate catheter length requires individual assessment of the clinical situation and potential risks. While longer catheters may offer better flow and drainage, they may also affect patient comfort and safety.^{5,6} Conversely, shorter catheters might have lower efficiency or higher complication rates. Proper catheter tip placement is crucial to effective dialysis and reducing thrombotic events.

Given these considerations, this study was conducted to compare the efficacy, complications, and safety of two different lengths of temporary hemodialysis catheters in patients with ESRD.

Materials and Methods

Study Design

This was a single-blind, randomized controlled clinical trial conducted to compare the efficacy and safety of 20 cm and 24 cm femoral catheters in patients requiring urgent hemodialysis. The study was approved by the ethics committee of Iran University of Medical Sciences and was conducted in two hospitals in Tehran (Rasoul Akram and Hasheminejad) during 2022–2023.

Sample size

Sample size (n=80) was determined using G*Power software with a power of 81%, effect size of 0.65, and significance level of 0.05. The study power was 0.81 and the effect size was 0.65. A minimum number of 80 samples in two equal groups of 40 were considered for the study.

Participants

A total of 80 patients with CKD who required hemodialysis were included. Eligible patients were aged 18 years or older, had no previous history of catheter insertion, and provided informed consent.

Randomization

Patients were randomly assigned in a 1:1 ratio to receive either a 20 cm or 24 cm catheter. Randomization was performed using a computer-generated sequence by an independent team member to ensure allocation concealment.

Intervention Procedure

All catheters were inserted by an experienced surgeon in a sterile outpatient surgical room using local anesthesia. Following insertion, patients underwent standard hemodialysis sessions based on hospital protocols. Over two weeks, catheter performance and complications were assessed via venography and physical examination. After the two-week period, catheters were removed, and follow-up venography was performed to assess vessel patency before permanent catheter placement. Infection was diagnosed by blood and intraluminal catheter cultures.

Data Collection

Demographic data and medical history were collected through patient records and interviews. Catheter-related complications were assessed at the time of permanent catheter insertion through clinical exam and venography.

Statistical methods

Data were analyzed using SPSS version 27. Quantitative data were reported as mean $\pm$ standard deviation; qualitative data as frequency and percentage. Chi-square tests

were used for categorical variables, and t-tests for continuous variables assuming normal distribution. Survival analysis was used to evaluate catheter performance.

Findings

All 80 patients completed the study, with 40 in the 20 cm group and 40 in the 24 cm group. The CONSORT flow diagram is presented in Figure 1. Participant characteristics are summarized in Table 1. The study population included 53 men (66.25%) and 27 women (33.75%). Mean age was 52.5 ± 13.7 years in the 20 cm group and 56.0 ± 12.9 years in the 24 cm group ($P = 0.240$). The average Body Mass Index (BMI) was 25.14 ± 3.37 kg/m² in the 20 cm group and 24.49 ± 3.33 kg/m² in the 24 cm group ($P=0.382$). No significant demographic differences were noted between groups.

Comorbidities included diabetes in 18 patients (45%) in the 20 cm group and 25 patients (62.5%) in the 24 cm group; hypertension in 15 patients (37.5%) vs. 22

patients (55%); and cardiovascular diseases in 27 patients (67.5%) vs. 23 patients (57.5%), respectively.

Hematoma occurred in 8 patients (20%) in the 20 cm group and 3 patients (7.5%) in the 24 cm group ($P = 0.633$). Prolonged bleeding (3–5 days) at the catheter site occurred in 4 patients (10%) in the 20 cm group and 5 patients (12.5%) in the 24 cm group ($P = 0.911$).

Infection was detected in 8 patients (20%) in the 20 cm group and 5 patients (12.5%) in the 24 cm group ($P = 0.733$). Thrombosis occurred in 7 patients (17.5%) in the 20 cm group and 12 patients (30%) in the 24 cm group ($P = 0.554$).

Minimum catheter duration was 7 days (20 cm) vs. 5 days (24 cm). After two weeks, 65% of catheters in the 20 cm group remained functional, compared to 60% in the 24 cm group ($P = 0.712$). This is illustrated in Figure 1.

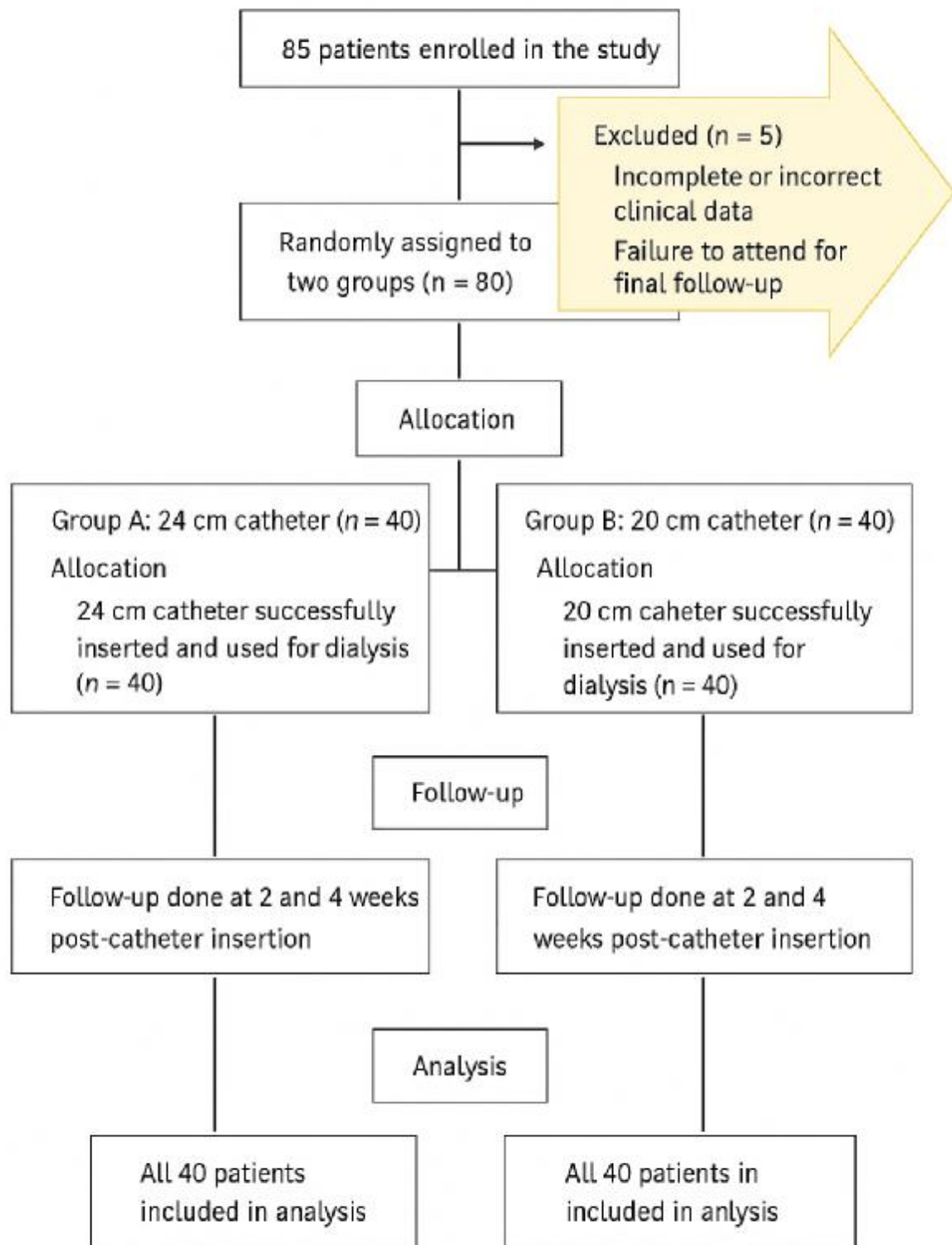
Figure 1. Flowchart of the Consort Process*Diagram 1 - Consort process flow*

Table 1: Demographic Characteristics, Comorbidities, and Catheter-related Complications

Variable	Group	First: 20 cm Group (n=40)	Second: 24 cm Group (n=40)	P-value
<i>Demographics</i>				
Gender, Male		27(67.5)	26 (65)	0.960
Age (years)		52.5±13.7	56.0±12.9	0.240
BMI (kg/m ²)		25.14±3.37	24.49±3.33	0.382
Smoking		11(27.5)	8(20)	0.713
Alcohol consumption		5(12.5)	2(5)	0.784
<i>Medical History</i>				
Diabetes		18(45)	25(62.5)	0.260
Hypertension ¹		15(37.5)	22(55)	0.300
Cardiovascular Disease ²		27(67.5)	23(57.5)	0.470
<i>Complications</i>				
Prolonged Bleeding ³		4(10)	5(12.5)	0.911
Hematoma ⁴		8(20)	3(7.5)	0.633
Infection ⁵		8(20)	5(12.5)	0.733
Thrombosis ⁶		7(17.5)	12(30)	0.554

The information presented in the table above is conveyed as counts (percentages) and as mean ± standard deviation. Statistical significance for all analyses is defined by a P-value threshold of less than 0.05.

1. Hypertension Disorder: This is a medical condition characterized by blood pressure measurements that exceed 140/90 mmHg.

2. Cardiovascular Disease: This condition pertains to impaired cardiac functionality, evidenced by symptoms such as cardiac-related dyspnea, cardiac pleural effusion, and a diminished ejection fraction (EF) of less than 35%.

3. Prolonged Bleeding: This term refers to any instance of bleeding that persists for more than 3 to 5 days.

4. Hematoma: This refers to an accumulation of blood resulting in skin discoloration and swelling at the site of catheter insertion. In this context, the term 'hematoma' specifically denotes the hematoma that develops at the site of Sheldon's catheter placement.

5. Infection: This is diagnosed through simultaneous blood cultures obtained from both peripheral blood and the catheter, evaluated after a period of two weeks.

6. Thrombosis Diagnosis Method: This is assessed using venography two weeks following catheter insertion.

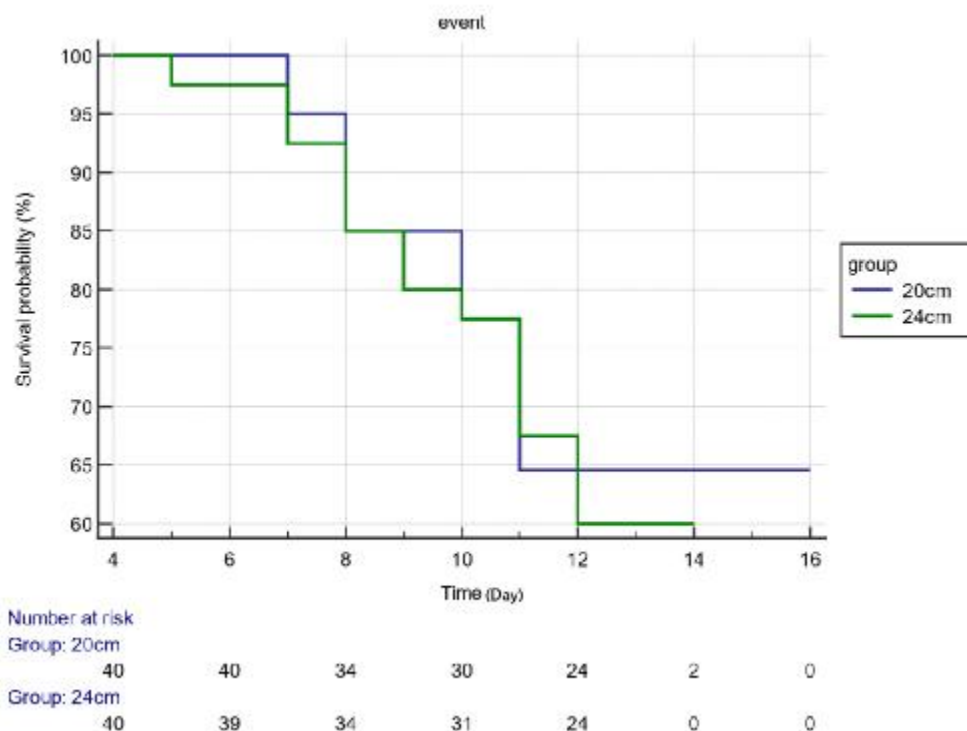


Figure 1. Kaplan–Meier comparison of catheter survival between the 20 cm and 24 cm femoral catheter groups. No statistically significant difference was observed ($P = 0.712$)

Discussion and Conclusion

This study evaluated the efficacy and complications of 20 cm and 24 cm femoral catheters in hemodialysis. Both groups had comparable demographics. Although comorbidities like diabetes and cardiovascular disease were slightly more common in the 20 cm group, no significant differences were observed.

Femoral vein access is considered safer compared to subclavian or jugular sites due to lower risks of pneumothorax and arterial injury. In this study, thrombosis (23.75%) was the most common complication, followed by infection (16.25%) and hematoma (13.75%), differing from previous studies that reported infection as the leading issue.⁷

For instance, Gill et al. observed a significant increase in infections with prolonged catheter use (>6 days), with femoral access contributing to 75% of such

cases.⁸ Similar findings were reported by Knuttinen (2009) and Rahmani (2022),^{7,9} emphasizing the susceptibility of the femoral site to bacterial contamination.¹⁰

In our study, infection was more common in the 20 cm group, while thrombosis was more frequent in the 24 cm group. Despite a slight functional advantage in the 20 cm group, this difference was not statistically significant. Short catheter survival compared to jugular access (41 days average) calls for further research.¹¹ Oliver et al. showed increased bacteremia in femoral catheters after just one week, while jugular catheters remained safe for up to three weeks.¹²

Longer catheters may enhance flow by positioning the tip in larger veins (e.g., inferior vena cava), but may also increase risk of thrombosis due to turbulent flow in curved sections. Thus, although longer catheters have theoretical advantages, fluid

dynamics and anatomical placement must be carefully considered.

This study is limited by its short follow-up period and small sample size, which may reduce statistical power. Also, lack of multi-center design limits generalizability.

This study compared two different femoral catheter lengths for temporary hemodialysis access. Both 20 cm and 24 cm

catheters showed comparable performance and complication rates over a two-week period. Thus, catheter length can be selected based on individual clinical context, as both are safe and effective options. Future studies should explore long-term outcomes and optimal catheter management strategies to minimize complications.

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