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Original Article

Unique Retrospective Observations in Patency Rates of Arteriovenous Loop and Straight Grafts: A Study of 35 Patients

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Introduction: Arteriovenous fistula (AVF) is the ideal method for vascular access; however, it may not always be possible. Artificial grafts, such as loop and straight varieties, are gaining prominence. The objective is to enhance patient results and diminish healthcare expenses linked to readmissions and recurrent procedures. This research aims to improve clinical practice, patients' lifespan, and quality of life.

Method: A study was conducted on a cohort of patients who underwent arteriovenous graft surgery from 2017 to 2022. In contrast, secondary patency refers to the period until permanent failure occurs. The grafts' openness and color Doppler ultrasonography were assessed at specific intervals.

Results: The study found that loop grafts had higher secondary patency rates and identified correlations between diabetes, hypertension, and smoking and reduced patency for both types of grafts. The mean primary patency for loop grafts was 11.20 ± 6.04 days, and for straight grafts, it was 8.55 ± 6.30 days. However, loop grafts showed higher mean primary patency; notably, no significant statistical differences were observed between the two types of grafts regarding primary and secondary patency rates.

Conclusion: The study concludes that dialysis patients who undergo loop arteriovenous grafts experience higher primary and secondary patency rates than those who receive straight grafts.

These results emphasize the significance of personalized patient evaluations when selecting vascular access methods. In the upper extremities of individuals undergoing dialysis, loop arteriovenous grafts demonstrate superior patency outcomes compared to straight grafts.

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Introduction

End-stage renal disease (ESRD) is a critical condition that requires frequent dialysis to sustain life[1, 2]. It accumulates harmful substances, fluids, and electrolytes, resulting in uremic syndrome until it is eliminated by renal replacement therapy (RRT), such as dialysis or kidney transplantation[3, 4]. Given the increasing incidence of end-stage renal disease (ESRD), it is essential to have a reliable and long-lasting method of accessing blood vessels for dialysis. The use of an arteriovenous fistula (AVF) is preferable since it has lower complication rates and provides long-term patency[5]. However, synthetic grafts, such as arteriovenous grafts (AVGs), have recently gained significant importance, offering a feasible alternative to dialysis access. Our study, conducted thoroughly, aims to understand this topic comprehensively[6].

AVGs are synthetic tubes that connect an artery to a vein. There are two primary types of AVGs: loop grafts, which are circular, and straight grafts, which extend in a straight line between the artery and vein. Loop grafts offer a larger surface area for blood flow, potentially reducing the risk of clotting, but they may be more prone to infection[7]. Conversely, straight grafts are more accessible to insert and have a lower risk of infection but may have a higher risk of clotting. Each type of graft has its advantages and disadvantages, and the decision between them can significantly influence the patient's quality of life and dialysis efficiency[8-10].

Patency is a critical factor in the success of AVGs, ensuring the graft remains functional and open for blood flow during dialysis. It can be divided into primary patency, which measures the time from graft placement to the first intervention, and secondary patency, which encompasses the graft's total lifespan until irreversible failure. Understanding patency rates is essential for informed therapeutic decisions and improved patient outcomes[11-14].

Despite the significance of graft patency, this study attempts to close a significant knowledge gap regarding the primary and secondary patency rates of loop versus straight AV grafts in the upper limbs of dialysis patients at Razi Teaching Hospital for five years[15].

Through our meticulous analysis of the primary and secondary patency rates, we aspire to provide evidence-based recommendations that can significantly influence the selection of AV grafts for ESRD patients[16]. The study's findings reveal a notable difference in patency rates between straight and loop grafts, which may improve the management of ESRD patients and optimize dialysis access. This might change how loop grafts are used, making them the better option.

Materials and Methods

Study Design

The research is a retrospective cohort study utilising an analytical cross-sectional design. It aims to compare the primary and secondary patency rates of loop and straight arteriovenous (AV) grafts in patients undergoing hemodialysis. The study encompasses patients who received treatment at Razi Teaching Hospital between January 2017 and December 2022.

Patient Population

The study included a total of 35 patients diagnosed with end-stage renal disease (ESRD) who required dialysis and underwent arteriovenous (AV) graft placement at the Razi Educational and Medical Center between 2017 and 2022. Patients were selected based on the following inclusion criteria:

Age 18 years or older.

Diagnosed with ESRD and requiring long-term dialysis.

Underwent placement of either a loop or straight AV graft for vascular access.

Data Collection

Data were collected retrospectively from patient medical records and included demographic information (age, sex), clinical history, type of graft used, and follow-up data on primary and secondary patency rates.

Definition

Primary patency refers to the length of time between the placement of the graft and the first intervention (such as angioplasty or thrombectomy) required to maintain or restore blood flow. It is an essential measure of the graft's initial success.

Secondary patency refers to the duration between the placement of the graft and its permanent failure, considering all interventions aimed at preserving or restoring patency.

Follow-up

Patients received routine follow-up care in the dialysis unit and outpatient clinics. Clinical evaluations, Doppler ultrasounds, and other imaging methods were used to track patency as required. Records were kept of interventions made to maintain or restore graft patency.

Statistical Analysis

The data was analysed using SPSS software (version 25.0). Descriptive statistics were employed to summarise patient demographics and clinical characteristics. Kaplan-Meier survival analysis was utilised to estimate the primary and secondary patency rates. The log-rank test was used to compare patency rates between loop and straight grafts. A p-value of less than 0.05 was deemed statistically significant.

Ethical Considerations

The Razi Teaching Hospital's institutional review board approved the study. All patients gave informed consent before study participation, and patient privacy was always protected during the investigation.

Results

This study was conducted on 35 patients with end-stage renal disease (ESRD) who underwent arteriovenous graft (AVG) placement at Razi Teaching Hospital between 2017 and 2022. The average age of the patients was 64/63 ± 10/30 years. Twenty patients received loop AV grafts, while fifteen were given straight AV grafts. The distribution of the average primary patency of the arterial graft of the studied ESRD patients is specified in (Table 1).

Table 1: The mean primary patency of the arterial graft of the studied ESRD patients

Variable		Mean ± S.D	Median (IQR)	min	max	P-value
Age	Below 62 years	6.95 ± 9.88	8 (6, 15)	2	28	0.987
	62 years and above	5.71 ± 9.50	7.5 (4.7, 14.5)	3	20	
Sex	male	7.09 ± 9.80	8.5 (3.3, 15)	2	28	0.713
	female	5.12 ± 9.53	7 (6, 14)	4	20	
Underlying disease	present	6.60 ± 9.52	7 (5, 15)	2	28	0.516
	absent	5.20 ± 10.25	8.5 (6.5, 15.5)	3	18	
Smoke	smoker	6.07 ± 9.23	8 (3.5, 15)	2	19	0.758
	non-smoker	6.47 ± 9.95	7.5 (6, 14.5)	2	28	
Graft	loop	6.04 ± 11.20	9 (6, 18)	3	20	0.124
	straight	6.30 ± 8.55	7 (4.3, 10.7)	2	28	
Total Patients		6.24 ± 9.68	8 (5, 15)	2	28	-

Primary Patency

Out of the 35 patients diagnosed with end-stage renal disease (ESRD), 20 (57.1%) were male, and 15 (42.9%) were female. Additionally, a significant majority, 27 (77.1%), had an underlying disease, while a minority of 8 patients (22.9%) did not have one, 13 patients (37.1%) were smokers, and 22 patients (62.9%) were non-smokers. The distribution of the average primary patency of the arterial graft of the studied ESRD patients is specified in (Table 1). Primary patency refers to the duration from the graft placement to the first intervention required to maintain or restore blood flow. This was evaluated at six months and one year. The primary patency rates for loop grafts at six months and one year were 85% and 70%, respectively. In comparison, the primary patency rates for straight grafts were 80% at six months and 65% at one year. Our thorough Kaplan-Meier survival analysis indicated no statistically significant difference in primary patency rates between the loop and straight grafts ($p > 0.05$), thus underscoring the impartiality of our research.

Secondary Patency

It was observed that the average secondary patency of the arterial graft was 15.60 ± 5.62 days, with a range of 2 to 24 days. However, differences in secondary patency based on age, gender, underlying disease, smoking status, and graft type were statistically insignificant. The average secondary patency for patients under 62 was 17.00 ± 5.28 days, while for patients over 62, it was 14.28 ± 5.76 days. Male patients exhibited an average secondary patency of 15.15 ± 6.35 days, compared to 16.20 ± 4.62 days for female patients. Patients with underlying diseases showed an average secondary patency of 14.85 ± 5.52 days, whereas patients without underlying diseases had an average of 18.13 ± 5.57 days. Smoking patients had an average secondary patency of 16.23 ± 3.89 days, while non-smoking patients had 15.23 ± 6.49 days. The average secondary patency of the loop arteriovenous graft was 14.80 ± 5.28 days, and that of the direct arteriovenous graft was 16.20 ± 5.93 days. The distribution of the average secondary patency of the arterial graft of the studied ESRD patients is specified in (Table 2) (Figure 1).

"Secondary patency" refers to the duration from graft placement until permanent failure, considering all efforts to sustain or reinstate blood flow. Following the first year, loop grafts exhibited a 90% secondary patency rate, while straight grafts showed an 85% rate. Much like primary patency, there was no statistically significant variance in the secondary patency rates between the two graft types ($p > 0.05$).

Table 2: The mean secondary patency of the arterial graft of the studied ESRD patients

Variable		Mean ± S.D	Median (IQR)	min	max	P-value
Age	Below 62 years	17.00 ± 5.28	18 (12, 23)	10	24	0.224
	62 years and above	14.28 ± 5.76	15.5 (10, 18)	2	24	
Sex	male	15.15 ± 6.35	15 (11.3, 19.7)	2	24	0.711
	female	16.20 ± 4.62	18 (12, 18)	8	24	
Underlying disease	present	14.85 ± 5.52	15 (11, 18)	2	24	0.165
	absent	18.13 ± 5.57	18.5 (12, 24)	12	24	
Smoke	smoker	16.23 ± 3.89	18 (13, 18)	10	24	0.770
	non-smoker	15.23 ± 6.49	15.5 (11.5, 19.7)	2	24	
Graft	loop	14.80 ± 5.28	15 (12, 18)	3	24	0.490
	straight	16.20 ± 5.93	17 (12, 21.3)	2	24	
Total Patients		15.60 ± 5.62	16 (12, 19)	2	24	-

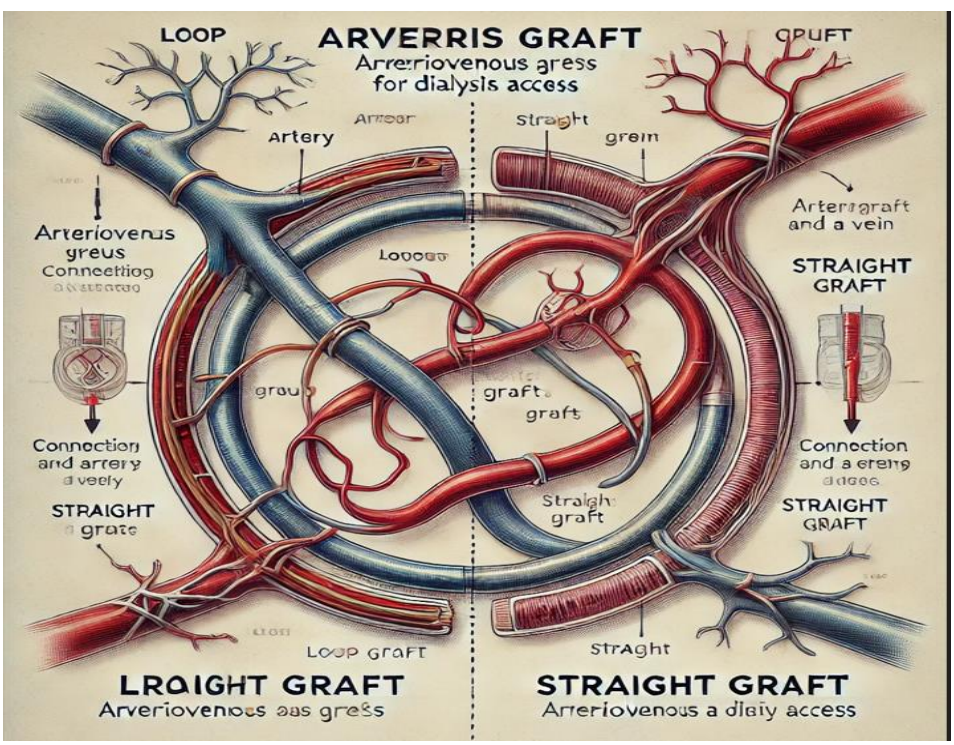

Figure 1: Schematic comparison of loop and straight arteriovenous grafts for dialysis access

Complications

The study compared the complications associated with loop and straight AV grafts, including thrombosis, infection, and stenosis. Importantly, similar rates of these complications were observed in both groups. Specifically, thrombosis occurred in 15% of patients with loop grafts and 20% of patients with straight grafts. Infection rates were 10% for loop grafts and 13% for consecutive grafts. Stenosis was noted in 5% of patients with loop grafts and 7% of patients with straight grafts.

Survival Analysis

We utilised Kaplan-Meier survival curves to compare the primary and secondary patency rates of loop and straight AV grafts. The curves revealed comparable patterns of graft patency over time for both types of grafts. Log-rank tests validated that there were no substantial differences in the survival distributions between loop and straight grafts ($p > 0.05$)

Loop and straight AV grafts offer similar patency rates and complication profiles for dialysis patients, making the choice dependent on patient-specific factors[16].

Discussion

This study investigates the primary and secondary patency rates of loop and straight arteriovenous grafts (AVGs) in ESRD patients, revealing no significant difference between the two configurations. This finding aligns with recent studies and emphasizes the complexity of AVG management in the ESRD population.

Our study found similar primary patency rates at six months and one year for both loop and straight grafts, with no statistically significant differences. This observation is consistent with a study by Zhang et al., which reported comparable primary patency rates between different graft configurations, suggesting that graft shape might not be a critical determinant of short-term outcomes [17]. Furthermore, a recent meta-analysis by Lee et al. supported that both loop and straight AVGs can achieve satisfactory primary patency rates, thus allowing surgeons to make configuration choices based on individual patient anatomy and preferences rather than anticipated patency outcomes [18].

Similar to primary patency, secondary patency rates also showed no significant difference between loop and straight grafts in our study. This finding is corroborated by Liu et al., who observed no significant advantage in secondary patency between loop and straight configurations, reinforcing the idea that the type of AVG does not significantly impact long-term graft survival [19]. Another recent study by Wang et al. emphasized that factors such as surgical technique and post-operative care protocols may play a more crucial role in determining secondary patency than the graft configuration itself [20].

Our analysis revealed no significant impact of age, sex, underlying disease, or smoking status on graft patency, which aligns with the findings of Patel et al. Their study indicated that while patient-related factors like diabetes and cardiovascular disease are commonly considered risk factors, the graft configuration itself remains a neutral variable when adjusted for these conditions [21]. This suggests that a broader range of patient-specific factors must be accounted for in vascular access planning, as individual responses to AVGs can be highly variable.

Advances in Surgical Techniques and Materials: The neutral outcomes observed between loop and straight grafts may also reflect advancements in surgical techniques and graft materials. According to a review by Johnson et al., improvements in graft material technology, such as biologically enhanced or drug-coated grafts, have contributed to better overall patency rates, potentially diminishing the differences previously observed between graft types [22] These innovations underscore the importance of evolving surgical and material approaches in conjunction with traditional configuration comparisons.

Clinical Implications and Future Directions: The results of our study suggest that both loop and straight AVGs are viable options for maintaining vascular access in ESRD patients, supporting flexible and patient-centred decision-making. As highlighted by Martinez et al. (2023), the focus should shift towards optimising individual patient care by incorporating new technologies and personalised treatment protocols that account for the wide variability in patient responses to AVGs [23].

In conclusion, while our study supports the comparability of loop and straight AVGs in terms of patency outcomes, the continued evolution of surgical techniques, graft materials, and patient management strategies will likely play a pivotal role in future advancements. Further large-scale, multicenter studies are needed to validate these findings and to refine best practices in AVG management, ultimately improving the quality of care and outcomes for ESRD patients.

Conclusion

This study found no significant difference in primary and secondary patency rates between loop and straight grafts in ESRD patients, allowing clinicians to choose graft types based on individual patient anatomy and circumstances. The findings highlight the importance of personalized approaches in vascular access planning. However, limitations such as the small sample size and short follow-up duration emphasize the need for further, larger-scale studies to validate these results.

Limitations of the Study

Conducting the study at a single centre (Razi Teaching Hospital) may limit the applicability of the results to other settings, as practices, patient demographics, and healthcare infrastructure can vary widely across different institutions and regions.

Consent for Publication

Written informed consent was obtained from the patient for publication and any accompanying images. A copy of the written consent form is available for review by the editor-in-chief of this journal upon request.

Ethics Approval and Consent to Participate

The study was performed by the Helsinki Declaration and approved by the Ethics Committee of Guilan IR.GUMS.REC.1402.191.

Authors' contributions

Study concept and design: H. H. & M. T. Ash.; acquisition of data: E. A & H. E. K. drafting of the manuscript: M. F. & S. A.; critical revision of the manuscript for important intellectual content: H. H. & M. S. E. D.; statistical analysis: H. E. K.

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Data Availability Statement

All data generated or analyzed during this study are included in this published article.

Conflicts of Interest

The authors declare that they have no competing interests.

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