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Research Article

Outcomes, Patency, and Complication Rates Following Arteriovenous Fistula Creation for Hemodialysis Access

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ABSTRACT

Background

Arteriovenous fistula (AVF) remains the preferred vascular access for maintenance hemodialysis; however, real-world outcomes vary according to patient characteristics, vascular anatomy, and care pathways. Contemporary South Korean data describing patency and complication profiles after AVF creation at the institutional level remain limited.

Objective

To evaluate clinical outcomes, 12-month patency rates, and access-related complications following arteriovenous fistula creation for hemodialysis access in a South Korean tertiary-care center.

Methods

This retrospective observational study included adult patients who underwent autogenous AVF creation for hemodialysis access. Demographic, clinical, and access-related data were collected. The primary outcome was 12-month primary patency, defined as time from AVF creation to first intervention, thrombosis, or access abandonment. Secondary outcomes included assisted primary and secondary patency, maturation rate, complications, and predictors of patency loss. Patency was analyzed using the Kaplan–Meier method, and predictors were assessed using multivariable Cox proportional hazards regression.

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Results

A total of 184 patients were included (mean age 62.4 ± 11.8 years; 60.9% male). The overall AVF maturation rate was 80.4%, and early failure occurred in 19.6%. At 12 months, primary patency was 69.6%, assisted primary patency 82.1%, and secondary patency 88.6%. Stenosis requiring intervention was the most common complication (22.8%), followed by thrombosis (11.4%). On multivariable analysis, age ≥65 years (hazard ratio [HR] 1.62), diabetes mellitus (HR 1.74), and preoperative venous diameter <2.5 mm (HR 2.09) was independently associated with loss of primary patency.

Conclusions

Arteriovenous fistula creation in this South Korean cohort was associated with favorable 12-month patency and acceptable complication rates. Early patency loss was predominantly influenced by patient age, diabetes, and venous anatomy. These findings support a risk-stratified, patient-centered approach to vascular access planning with emphasis on early surveillance and timely intervention to optimize AVF outcomes.

Keywords: Arteriovenous fistula; Hemodialysis; Vascular access; Patency; Complications

INTRODUCTION

End-stage kidney disease (ESKD) remains a major and growing public health burden worldwide, with hemodialysis (HD) representing the dominant renal replacement therapy in many health systems [1]. The delivery of effective maintenance HD depends fundamentally on durable, high-flow vascular access that can be repeatedly cannulated with minimal complications. Among available access types—arteriovenous fistula (AVF), arteriovenous graft (AVG), and central venous catheter (CVC)—autogenous AVF has historically been favored because it is associated with lower infection risk and better long-term access survival than prosthetic grafts or catheters. Nevertheless, AVF creation is not a uniformly successful solution: failure to mature, early thrombosis, access-related ischemia, aneurysmal degeneration, and recurrent stenosis requiring frequent interventions remain common barriers that compromise patency and patient outcomes. Contemporary clinical research, therefore, increasingly emphasizes a balanced evaluation of outcomes, patency, and complication rates following AVF creation—particularly within specific national contexts where patient demographics, comorbidity patterns, and healthcare delivery structures differ [2].

South Korea has experienced a steady rise in ESKD prevalence over recent decades, supported by robust national reporting systems. The Korean Society of Nephrology (KSN) established an end-stage renal disease registry decades ago, providing an important platform for monitoring dialysis epidemiology, practice patterns, and outcomes at the national level [3]. As the dialysis population expands and ages, the case-mix of patients undergoing vascular access procedures continues to shift toward greater comorbidity—especially diabetes mellitus, peripheral arterial

disease, and cardiovascular disease—each of which can adversely affect AVF maturation and long-term patency. In parallel, the expansion of interventional options (e.g., angioplasty, thrombectomy, endovascular salvage) has changed the "natural history" of access survival, making patency increasingly dependent on timely surveillance and reintervention rather than on surgical creation [4].

International observational programs such as the Dialysis Outcomes and Practice Patterns Study (DOPPS) demonstrate that vascular access use varies substantially by country and center characteristics, reflecting differences in guideline adoption, surgical expertise, timing of nephrology referral, and resource availability [2]. Even when "fistula-first" strategies are endorsed, the real-world balance between AVF, AVG, and CVC use may differ depending on local barriers such as delayed referral, limited vessel quality in older patients, and patient preference [5]. This context is particularly relevant in South Korea, where universal health coverage and strong tertiary-care infrastructure can facilitate access creation and salvage, yet disparities may still emerge by socioeconomic status and care pathways. Recent Korean data suggest that non-medical determinants—including socioeconomic gradients—can be associated with differences in vascular access patency and mortality, despite broad insurance coverage [6]. Such findings underscore the need for institution- and system-level studies that quantify patency and complications after AVF creation and identify modifiable predictors.

Autogenous AVF is widely regarded as the preferred HD access when feasible because it generally offers superior long-term patency and fewer infectious complications than AVG or CVC [7]. Infections are particularly consequential in ESKD because bloodstream infection increases hospitalization, cardiovascular events, and mortality risk. Catheters are strongly linked to bacteremia and central venous stenosis, while grafts, though often easier to cannulate earlier, carry higher infection and thrombosis rates than autogenous fistulas [4]. For these reasons, evidence-based guidance has traditionally promoted AVF when patient anatomy and expected dialysis needs support its use.

However, clinical practice has evolved beyond a simple "fistula-first" paradigm. The 2019 update of the Kidney Disease Outcomes Quality Initiative (KDOQI) vascular access guideline reframed decision-making around an individualized "ESKD Life-Plan", emphasizing the "right access, in the right patient, at the right time," rather than a single access type for all [8]. This shift was influenced by recognition that AVF non-maturation and early failure can be common—especially in older adults and patients with advanced vascular disease—leading to prolonged catheter dependence, repeated procedures, and patient dissatisfaction. A Korean perspective paper discussing the 2019 KDOQI update highlights how international guidelines influence local practice while acknowledging the need to tailor recommendations to Korean healthcare realities and patient profiles [9]. Therefore, in South Korea, where the dialysis population is increasingly older, a critical clinical question is not merely whether AVF is preferred, but which patients achieve durable patency with acceptable complication rates after AVF creation, and what perioperative or follow-up strategies optimize outcomes.

Clinical outcomes after AVF creation are multidimensional. "Success" is often initially defined as technical feasibility of anastomosis and postoperative thrill; yet, from the patient and dialysis-

unit perspective, the clinically meaningful endpoint is reliable cannulation for prescribed HD with minimal interventions. Accordingly, studies typically report patency using standard definitions such as:

- Primary patency: time from access creation to first intervention intended to maintain or restore flow, or access thrombosis/abandonment.
- Assisted primary patency: time from creation to thrombosis/abandonment, including interventions to maintain patency before thrombosis.
- Secondary patency: time from creation to final access abandonment, including interventions after thrombosis.

These definitions reflect the reality that access survival increasingly depends on surveillance, timely imaging, and endovascular or surgical salvage. KDOQI further encourages consideration of intervention burden and patient experience—recognizing that an access that remains patent but requires frequent angioplasty may not represent optimal care [10]. The relevance of this framework is supported by contemporary discussions of guideline targets and intervention rates aimed at maintaining patency without excessive procedure burden [3].

Complications after AVF creation can be grouped into early and late events, each influencing patency and patient safety:

1. Early failure and non-maturation:
   Early thrombosis, juxta-anastomotic stenosis, and inadequate venous remodeling can prevent maturation and prolong catheter dependence. Non-maturation is clinically important because prolonged catheter exposure increases infection risk and central venous stenosis, potentially limiting future access options [4]. Predictive models and institutional studies increasingly focus on identifying high-risk patients and modifiable surgical/technical factors, including vessel diameter, anastomotic configuration, and perioperative blood pressure management.
2. Stenosis, thrombosis, and intervention burden:
   Neointimal hyperplasia and venous outflow stenosis are major drivers of dysfunction requiring angioplasty or surgical revision. Recurrent stenosis can lead to thrombosis and access abandonment, and it increases overall healthcare utilization. Korean national-data analyses have reported favorable AVF performance compared with AVG at the population level and also identified patient and center factors linked to access patency, emphasizing that outcomes are shaped by both biology and system-level practice patterns [11].
3. Infection:
   Although AVF infection is less common than graft or catheter infection, it can still occur—particularly with repeated cannulation injury or poor hygiene practices. Guidelines emphasize prompt recognition and management to prevent metastatic complications [6].
4. Ischemic complications and high-flow physiology:
   Dialysis access–induced ischemia (“steal syndrome”) can present with hand pain, numbness, or tissue compromise, particularly in patients with diabetes or peripheral arterial disease. High-flow AVF can also contribute to high-output cardiac failure in susceptible

individuals. These complications, while less frequent, have high clinical impact and may necessitate flow-reduction procedures or access ligation.

5. Aneurysm, pseudoaneurysm, and bleeding risk:
   Repeated cannulation can contribute to aneurysmal dilation and skin thinning, increasing rupture or infection risk and complicating future cannulation. These structural complications are key components of long-term access monitoring programs.

Given these risks, reporting complication rates alongside patency is essential to avoid an overly simplistic interpretation of access survival. A fistula that persists but causes ischemia or requires frequent procedures may be less desirable than a graft with acceptable outcomes in certain patient subgroups—again aligning with the KDOQI "patient-centered" approach [12].

A growing body of Korean research has contributed to the global understanding of vascular access outcomes, particularly in older and comorbid patients. Large administrative-database studies in Korea have evaluated comparative outcomes between AVF and AVG, including patency and patient survival, supporting the continued role of AVF even in advanced age when appropriately selected [8]. Earlier Korean cohort data also suggested that initial vascular access choice is associated with survival in HD and that transitioning away from catheter dependence may be beneficial, particularly in older patients [9]. Together, these findings support the clinical importance of optimizing AVF creation pathways while carefully selecting patients most likely to benefit.

At the same time, Korean studies also highlight heterogeneity in outcomes and the influence of non-clinical factors. Evidence linking socioeconomic status to vascular access patency and mortality suggests that adherence, timely access to salvage interventions, and care coordination may affect outcomes even in a universal-coverage environment [13-14]. This reinforces the value of hospital-based clinical research that measures local patency and complication rates, maps care processes (referral timing, preoperative vascular mapping, postoperative surveillance), and identifies where targeted improvements can be implemented [15-19].

Despite extensive guideline recommendations and accumulating national data, important questions remain at the center level: What are the real-world patency rates achieved after AVF creation in a given institution? What proportion of patients experience early failure or non-maturation? Which complications (stenosis requiring intervention, thrombosis, infection, ischemia, aneurysm) occur most frequently, and at what time points? How does patient phenotype (age, diabetes, cardiovascular disease), vessel characteristics, and procedural approach relate to outcomes? Addressing these questions is not merely academic. Vascular access complications drive catheter dependence, hospitalizations, procedural burden, and costs, and they directly influence patient quality of life and dialysis adequacy [20].

Accordingly, a South Korea–based clinical study evaluating outcomes, patency, and complication rates following AVF creation is timely and clinically relevant. By quantifying patency using standardized definitions and systematically capturing complications and reinterventions, such research can: (1) benchmark institutional outcomes against Korean and international data; (2) identify high-risk subgroups for intensified planning and surveillance; (3) inform local protocols aligned with KDOQI's individualized access strategy; and (4) ultimately support improved HD delivery through durable, patient-centered vascular access care [21-23].

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METHODS

Study Design and Setting

This study was designed as a retrospective observational clinical study conducted at a tertiary-care referral center in South Korea. The institution serves as a regional hub for hemodialysis vascular access surgery and provides comprehensive nephrology and vascular surgical services. Medical records of patients who underwent arteriovenous fistula (AVF) creation for hemodialysis access were reviewed over a defined study period.

The study protocol was reviewed and approved by the Institutional Review Board (IRB) of the participating institution, and the requirement for informed consent was waived due to the retrospective nature of the study and anonymization of patient data, in accordance with the Declaration of Helsinki and local ethical regulations.

Study Population

Adult patients (≥18 years) with end-stage kidney disease who underwent initial or subsequent AVF creation for hemodialysis access during the study period were eligible for inclusion. Patients were identified through institutional surgical and dialysis registries.

Inclusion Criteria

- Patients aged 18 years or older
- Diagnosis of end-stage kidney disease requiring hemodialysis
- Surgical creation of an autogenous arteriovenous fistula (radiocephalic, brachiocephalic, or brachiobasilic)
- Availability of complete medical records and follow-up data

Exclusion Criteria

- Patients who underwent arteriovenous graft (AVG) placement
- Patients with tunneled or non-tunneled central venous catheters as the sole access
- Access procedures performed exclusively for peritoneal dialysis planning
- Inadequate follow-up data or loss to follow-up immediately after surgery

Preoperative Evaluation

All patients underwent standardized preoperative vascular assessment, which included physical examination and duplex ultrasonography. Vessel mapping evaluated arterial and venous diameter, patency, and compressibility. Selection of AVF type and anatomical location was based on vessel suitability, patient comorbidities, and anticipated dialysis needs, following contemporary international and Korean practice guidelines.

Surgical Technique

All AVF procedures were performed by experienced vascular surgeons under local or regional anesthesia. The choice of fistula configuration was determined according to preoperative vessel mapping and surgeon discretion:

- Radiocephalic AVF at the wrist was preferred when distal vessels were adequate
- Brachiocephalic AVF was selected when distal access was unsuitable
- Brachiobasilic AVF with or without transposition was performed in selected cases

An end-to-side anastomosis between the artery and vein was created using standard microsurgical techniques. Immediate postoperative assessment included evaluation of thrill and bruit to confirm technical success.

Postoperative Care and Follow-Up

Patients were followed in dedicated dialysis and vascular access clinics. Postoperative surveillance included clinical examination and duplex ultrasound when indicated. AVF maturation was assessed prior to cannulation, typically within 6–8 weeks after creation.

Interventions such as percutaneous transluminal angioplasty, thrombectomy, or surgical revision were performed when clinically indicated to maintain or restore access function.

Outcome Measures

Primary Outcomes

- Primary patency: time from AVF creation to first intervention aimed at maintaining or restoring patency, access thrombosis, or abandonment
- Assisted primary patency: time from AVF creation to access thrombosis or abandonment, including preemptive interventions
- Secondary patency: time from AVF creation to final access abandonment, including interventions after thrombosis

Secondary Outcomes

- AVF maturation rate, defined as successful cannulation for hemodialysis
- Early failure, defined as failure to mature or thrombosis within 90 days
- Complication rates, including:
    - Stenosis requiring intervention
    - Thrombosis
    - Infection
    - Dialysis access–induced ischemia (steal syndrome)
    - Aneurysm or pseudoaneurysm formation
- Intervention burden, defined as the number of procedures required to maintain patency

Data Collection

Demographic data, clinical characteristics, comorbidities (including diabetes mellitus, hypertension, cardiovascular disease, and peripheral arterial disease), laboratory values, and access-related variables were extracted from electronic medical records. Surgical details, postoperative outcomes, and follow-up data were systematically recorded.

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Sample Size Calculation

The sample size was calculated to estimate the 12-month primary patency rate after arteriovenous fistula (AVF) creation with adequate precision. Assuming an expected 12-month primary patency of 70% based on prior vascular access literature, using a 95% confidence level (Z = 1.96) and an absolute precision (margin of error) of ±7%, the required sample size for a single proportion was calculated as:

$$n = \frac{Z^2 \times p(1-p)}{d^2} \quad n = \frac{(1.96)^2 \times 0.70 \times 0.30}{(0.07)^2} = 164.7$$

Accordingly, a minimum of 165 patients was required. To account for approximately 10% incomplete records or loss to follow-up, the final target sample size was increased to 184 patients.

Statistical Analysis

Continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables were presented as frequencies and percentages. Patency rates were analyzed using the Kaplan–Meier method, and comparisons between groups were performed using the log-rank test. Multivariable Cox proportional hazards regression analysis was used to identify predictors of access failure and loss of patency.

A p-value <0.05 was considered statistically significant. Statistical analyses were conducted using standard statistical software.

RESULTS

Study Population

A total of 198 patients underwent arteriovenous fistula (AVF) creation during the study period. After exclusion of patients with incomplete follow-up data (n = 14), 184 patients were included in the final analysis.

The mean age of the study population was 62.4 ± 11.8 years, and 112 patients (60.9%) were male. Diabetes mellitus was present in 119 patients (64.7%), hypertension in 171 patients (92.9%), and documented cardiovascular disease in 58 patients (31.5%). Baseline demographic and clinical characteristics are summarized in Table 1.

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Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (N = 184)

Characteristic	Value
Age, years	62.4 ± 11.8
Age ≥65 years, n (%)	84 (45.7)
Male sex, n (%)	112 (60.9)
Body mass index, kg/m²	24.1 ± 3.2
Diabetes mellitus, n (%)	119 (64.7)
Hypertension, n (%)	171 (92.9)
*Cardiovascular disease, n (%)**	58 (31.5)
Peripheral arterial disease, n (%)	29 (15.8)
History of smoking, n (%)	67 (36.4)
Previous central venous catheter use, n (%)	101 (54.9)
Pre-dialysis AVF creation, n (%)	63 (34.2)
Hemoglobin, g/dL	10.1 ± 1.3
Serum albumin, g/dL	3.7 ± 0.5
Estimated glomerular filtration rate, mL/min/1.73 m²	8.6 ± 3.1
Preoperative arterial diameter, mm	2.6 ± 0.4
Preoperative venous diameter, mm	2.9 ± 0.5

Types and Location of Arteriovenous Fistulas

The most frequently created AVF type was radiocephalic AVF in 84 patients (45.7%), followed by brachiocephalic AVF in 71 patients (38.6%), and brachiobasilic AVF in 29 patients (15.8%). Immediate technical success, defined by the presence of a postoperative thrill and bruit, was achieved in 179 patients (97.3%).

AVF Maturation and Early Failure

Successful AVF maturation allowing regular cannulation for hemodialysis was achieved in 148 patients (80.4%). Early failure, defined as failure to mature or thrombosis within 90 days of creation, occurred in 36 patients (19.6%).

Early failure rates were higher among patients with diabetes mellitus (23.5% vs 12.1%, p = 0.041) and in those aged ≥65 years (26.2% vs 14.3%, p = 0.032).

Primary Outcome: 12-Month Patency Rates

At 12 months, the primary patency rate was 69.6% (128 of 184 patients). The assisted primary patency rate at 12 months was 82.1%, while the secondary patency rate was 88.6%.

Kaplan–Meier analysis demonstrated a gradual decline in primary patency over time, with most patency losses occurring within the first 6 months following AVF creation (Figure 1).

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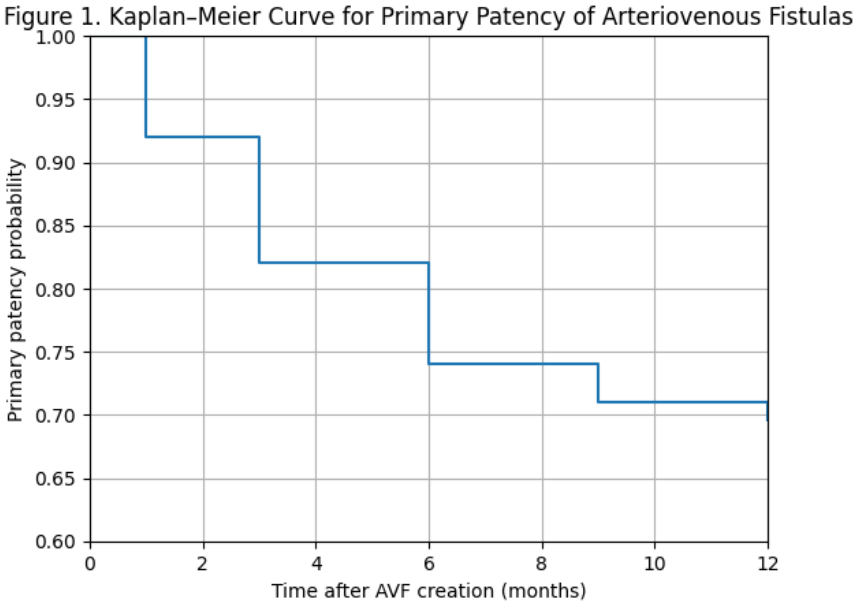

Figure 1. Kaplan–Meier Curve for Primary Patency of Arteriovenous Fistulas

When stratified by AVF type, 12-month primary patency rates were:

- Radiocephalic AVF: 65.5%
- Brachiocephalic AVF: 73.2%
- Brachiobasilic AVF: 75.9

Although brachial-based fistulas demonstrated numerically higher patency rates, the difference did not reach statistical significance (log-rank p = 0.087).

Secondary Outcomes and Complications

Access-related complications occurred in 67 patients (36.4%) during the follow-up period (Table 2).

The most common complication was stenosis requiring intervention, observed in 42 patients (22.8%). Percutaneous transluminal angioplasty was the primary intervention performed in these cases.

Thrombosis occurred in 21 patients (11.4%), of whom 14 underwent successful endovascular or surgical salvage. Access-related infection was uncommon, occurring in 6 patients (3.3%).

Dialysis access–induced ischemia (steal syndrome) was identified in 5 patients (2.7%), requiring surgical revision in three cases. Aneurysm or pseudoaneurysm formation developed in 9 patients (4.9%), none of whom experienced rupture.

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Table 2. Access-Related Complications and Interventions During Follow-Up (N = 184)

Complication / Intervention	n (%)
Any access-related complication	67 (36.4)
Stenosis requiring intervention	42 (22.8)
Percutaneous transluminal angioplasty	38 (20.7)
Surgical revision	4 (2.2)
Thrombosis	21 (11.4)
Endovascular thrombectomy	9 (4.9)
Surgical thrombectomy	5 (2.7)
Access abandonment	7 (3.8)
Access-related infection	6 (3.3)
Dialysis access–induced ischemia (steal syndrome)	5 (2.7)
Flow reduction or revision procedure	3 (1.6)
Aneurysm / pseudoaneurysm formation	9 (4.9)
Surgical repair	2 (1.1)
Total access-related interventions	58 (31.5)
Interventions per access-year	0.32

Intervention Burden

A total of 58 access-related interventions were performed in 49 patients, corresponding to an intervention rate of 0.32 procedures per access-year. Patients with diabetes mellitus required significantly more interventions compared with non-diabetic patients (0.41 vs 0.21 procedures per access-year, p = 0.018).

Predictors of Loss of Primary Patency

On multivariable Cox proportional hazards regression analysis (Table 3), the following factors were independently associated with loss of primary patency:

- Age ≥65 years (hazard ratio [HR] 1.62; 95% CI 1.08–2.44; p = 0.021)
- Diabetes mellitus (HR 1.74; 95% CI 1.12–2.71; p = 0.014)
- Smaller preoperative vein diameter (<2.5 mm) (HR 2.09; 95% CI 1.31–3.34; p = 0.002)

AVF type was not independently associated with primary patency after adjustment for confounding variables.

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Table 3. Multivariable Cox Regression Analysis of Predictors of Primary Patency Loss (N = 184).

Variable	Hazard Ratio (HR)	95% Confidence Interval	p value
Age ≥65 years	1.62	1.08–2.44	0.021
Male sex	1.11	0.73–1.68	0.624
Diabetes mellitus	1.74	1.12–2.71	0.014
Hypertension	1.29	0.62–2.68	0.495
Cardiovascular disease	1.38	0.89–2.14	0.147
Peripheral arterial disease	1.69	0.98–2.93	0.058
Preoperative venous diameter <2.5 mm	2.09	1.31–3.34	0.002
Preoperative arterial diameter <2.0 mm	1.46	0.91–2.35	0.118
Radiocephalic AVF (vs brachial-based)	1.27	0.84–1.92	0.258
Previous central venous catheter use	1.33	0.87–2.02	0.186

DISCUSSION

In this South Korea–based clinical study of 184 patients undergoing autogenous AVF creation for hemodialysis access, we observed a 12-month primary patency of 69.6%, with assisted primary and secondary patency of 82.1% and 88.6%, respectively. The maturation rate was 80.4%, while early failure occurred in 19.6%, and the most frequent access-related problem was stenosis requiring intervention (22.8%) [24]. Collectively, these findings reinforce two practical messages for contemporary Korean dialysis care: first, AVF remains a high-performing access option at the institutional level; second, outcomes are strongly shaped by early-period events (non-maturation and early patency loss) and by modifiable system processes (timely surveillance and intervention).

Our 12-month primary patency (69.6%) compares favorably with Korean national database reports. In a Korean National Health Insurance Service (NHIS) analysis spanning 2008–2019, the 1-year primary, assisted primary, and secondary patency for AVFs were approximately 62.2%, 80.7%, and 94.2%, respectively, with AVFs outperforming AVGs across patency metrics [25]. Another NHIS-based analysis (2008–2016) similarly emphasized the central role of AVF in Korea and highlighted patient and center-level determinants of access performance [26]. Taken together, these national data suggest that our center's slightly higher 12-month primary patency may reflect a tertiary-care environment with more structured preoperative mapping, experienced access surgeons, and ready access to endovascular salvage pathways—factors that were also identified as relevant at the national level (e.g., creation at tertiary vs general hospitals) [27].

At a population level, Korean registry data demonstrate high AVF utilization among hemodialysis patients, consistent with the country's long-standing emphasis on autogenous access when feasible [28]. The Korean Dialysis Registry has documented that a substantial proportion of Korean HD patients use autologous AVF, reinforcing that our institutional results are aligned with national practice patterns [3]. Importantly, the "quality" of AVF performance is increasingly judged not only by patency, but also by intervention burden and patient experience. In our cohort, the

overall intervention rate (0.32 procedures/access-year) and the predominance of stenosis-related angioplasty align with the broader Korean experience where access outcomes are frequently maintained through endovascular interventions—particularly during the first year, when lesions around the anastomosis and outflow segments are most clinically consequential [29].

Although long-term access durability is essential, most clinical frustration and cost in AVF programs often arise from non-maturation and early failure, which prolong catheter exposure and increase infection and central venous complications. Our early failure rate (19.6%) and maturation rate (80.4%) are broadly consistent with the real-world range reported in contemporary practice, especially within aging and diabetic populations. Korean and Korea-linked studies emphasize that maturation depends on a multi-factor interaction between patient phenotype (age, diabetes, peripheral vascular disease), vessel characteristics (arterial/venous diameter), and early hemodynamic adaptation [30].

In our multivariable model, age ≥65 years and diabetes mellitus were independently associated with loss of primary patency—findings that are congruent with Korean NHIS analyses where older age and diabetes were linked to reduced patency outcomes [31]. These associations likely reflect the vascular biology of ESKD: diabetic medial calcification and endothelial dysfunction, impaired venous remodeling, and higher prevalence of peripheral arterial disease, all of which can compromise inflow, outflow, and adaptive dilation. Importantly, Korean surgical literature increasingly supports an individualized approach to site selection rather than a rigid distal-first strategy in all patients. A recent Korean surgical study noted that insisting on distal forearm AVF attempts for every patient may increase time to successful cannulation and raise maturation failure, supporting an "anatomy- and patient-centered" strategy for access planning [32]. Our non-significant trend toward higher patency in brachial-based fistulas (with radiocephalic AVFs numerically lower) is directionally consistent with this notion, although the optimal approach remains patient-specific and must consider preservation of future access sites [33].

One of the most actionable findings in our study was the strong association between preoperative venous diameter <2.5 mm and primary patency loss. This aligns with the broader literature on AVF maturation and patency, including analyses highlighting vein size as a key determinant of successful maturation [34, 35]. Clinically, this reinforces the importance of standardized duplex mapping, careful target selection, and (where appropriate) strategies such as staged basilic vein transposition, selective use of more proximal options in poor distal anatomy, and intensified early surveillance in borderline vessel cases. Because this predictor is measurable preoperatively, it provides a practical basis for risk stratification and shared decision-making in Korean dialysis programs.

Stenosis requiring intervention was the most common complication (22.8%), and angioplasty constituted the predominant intervention. This pattern is typical of modern vascular access care and mirrors national trends in which patency is increasingly sustained through salvage and maintenance strategies [36, 37]. Notably, access-related infection was infrequent (3.3%), consistent with the recognized infection advantage of AVF compared with other access types and with Korean clinical experience that access infections remain a critical but comparatively less frequent AVF complication [38]. Meanwhile, ischemic complications (2.7%) and aneurysmal changes (4.9%)

were relatively uncommon but clinically important due to their potential severity and impact on quality of life.

From a systems standpoint, these complication patterns emphasize that an effective AVF program requires: (1) reliable detection of stenosis before thrombosis; (2) rapid access to endovascular intervention; and (3) close collaboration among nephrology, dialysis units, and vascular specialists. Korean evidence suggests that early hemodynamic indicators may predict long-term outcomes. For example, a Korean study in the *Journal of Korean Medical Science* reported that early vascular access blood flow measurements can help predict later patency and stenosis risk [38]. Integrating such objective surveillance into routine post-creation pathways—particularly for older and diabetic patients—may help reduce thrombosis and maintain primary patency.

Our findings also contribute to the Korean discussion on access choice in older adults. Although older age was associated with patency loss, our overall 12-month outcomes remained acceptable, and salvage pathways preserved assisted primary and secondary patency in many patients. Contemporary Korean nationwide evidence supports the continued benefit of AVF even in very elderly patients when appropriately selected. A recent nationwide Korean cohort reported superior patency and lower mortality with AVF compared with AVG in patients aged ≥80 years, arguing against age alone as a barrier to fistula creation [39]. This is clinically relevant in Korea, where the dialysis population is aging, and it reinforces the need to refine (rather than abandon) AVF strategies in older adults—by emphasizing vessel mapping, individualized site selection, and intensified early follow-up.

A notable recent Korean finding is that vascular access outcomes may be influenced by non-medical factors even within a broadly covered healthcare system. A 2025 Korean analysis reported that lower socioeconomic status was associated with poorer vascular access patency and higher mortality despite similar angioplasty counts, suggesting that adherence, timely presentation for dysfunction, and broader care coordination may contribute to disparities [40]. While our study did not directly measure socioeconomic variables, these data have important implications for institutional programs: improving patient education, strengthening follow-up pathways, and optimizing dialysis-unit surveillance may reduce preventable patency loss that is not explained solely by anatomy or comorbid disease.

Our results support several practical improvements that could be adopted or reinforced in Korean tertiary and regional centers:

1. Risk-stratified preoperative planning:
   Older and diabetic patients, and those with small-caliber veins, should be considered higher risk for early patency loss. Preoperative duplex criteria (including venous diameter thresholds) should trigger discussion of alternative sites or staged procedures and ensure expedited postoperative assessment.
2. Early surveillance focused on the first 6 months:
   Because most patency losses occurred early, structured follow-up within the first 4–12 weeks and continued monitoring through 6 months may yield the greatest benefit.

Incorporating objective parameters such as access flow where feasible may help identify impending stenosis [41].

3. Streamlined salvage pathways:
   Maintaining assisted primary and secondary patency depends on rapid access to angioplasty or thrombectomy. Institutional protocols should define referral triggers from dialysis units (e.g., rising venous pressures, reduced dialysis adequacy, difficult cannulation) and target timelines for assessment and intervention.
4. Patient-centered access selection:
   Korean surgical evidence supports individualized site selection rather than insisting on distal forearm AVF in all patients, particularly when distal vessels are marginal [7]. Preserving future access sites remains important, but so does minimizing prolonged catheter dependence due to non-maturation.

This study's strengths include clinically relevant endpoints (12-month patency with standard definitions), a pragmatic complication profile, and a multivariable analysis that identified actionable predictors (notably vein diameter). However, limitations should be acknowledged. First, the single-center retrospective design may limit generalizability to smaller hospitals or settings with different access to endovascular services. Second, surveillance strategies and intervention thresholds may vary across dialysis units and physicians, potentially influencing patency and intervention rates. Third, some potentially important predictors—such as detailed measures of arterial calcification, standardized access flow data across all patients, and patient-level social determinants—were not fully captured. Finally, while our analysis supports associations between risk factors and patency loss, causality cannot be established.

CONCLUSIONS

In this South Korea–based clinical study, arteriovenous fistula creation for hemodialysis access was associated with favorable short- to mid-term outcomes, with a 12-month primary patency rate of approximately 70% and high assisted primary and secondary patency supported by timely interventions. These findings reaffirm the central role of autogenous AVF as a durable and effective vascular access option within contemporary Korean dialysis practice.

Importantly, older age, diabetes mellitus, and smaller preoperative venous diameter were identified as independent predictors of primary patency loss, underscoring the need for risk-stratified preoperative planning and individualized access selection. While distal forearm fistulas remain desirable for access preservation, patient-specific anatomical and clinical factors should guide site selection to minimize early failure and prolonged catheter dependence.

Most patency losses occurred within the first 6 months after AVF creation, and stenosis requiring intervention was the predominant access-related complication. These observations highlight the critical importance of early postoperative surveillance, close collaboration between dialysis units and vascular specialists, and efficient access to endovascular or surgical salvage to maintain access function.

Overall, the results support a patient-centered, anatomy-guided AVF strategy in South Korea, emphasizing early identification of high-risk patients, structured follow-up during the early post-

creation period, and streamlined intervention pathways. Adoption of these principles may further improve clinically meaningful AVF success, reduce catheter dependence, and enhance long-term outcomes for patients receiving maintenance hemodialysis.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

CONSENT FOR PUBLICATION

Not applicable.

ETHICAL APPROVAL

This study was reviewed and approved by the Institutional Review Board (IRB) of the participating institution in South Korea. The requirement for written informed consent was waived due to the retrospective design of the study and the use of anonymized patient data, in accordance with the Declaration of Helsinki and local ethical regulations.

AUTHORS' CONTRIBUTIONS (CREDIT TAXONOMY)

- Min-Jae Kim, MD, PhD:
  Conceptualization; Methodology; Formal analysis; Data curation; Writing – original draft; Visualization.
- Sung-Ho Lee, MD:
  Investigation; Resources; Supervision; Writing – review & editing; Project administration.

All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

DATA AVAILABILITY STATEMENT

All data discussed in this review are derived from previously published articles and publicly available datasets. References to original data sources are provided throughout the manuscript.

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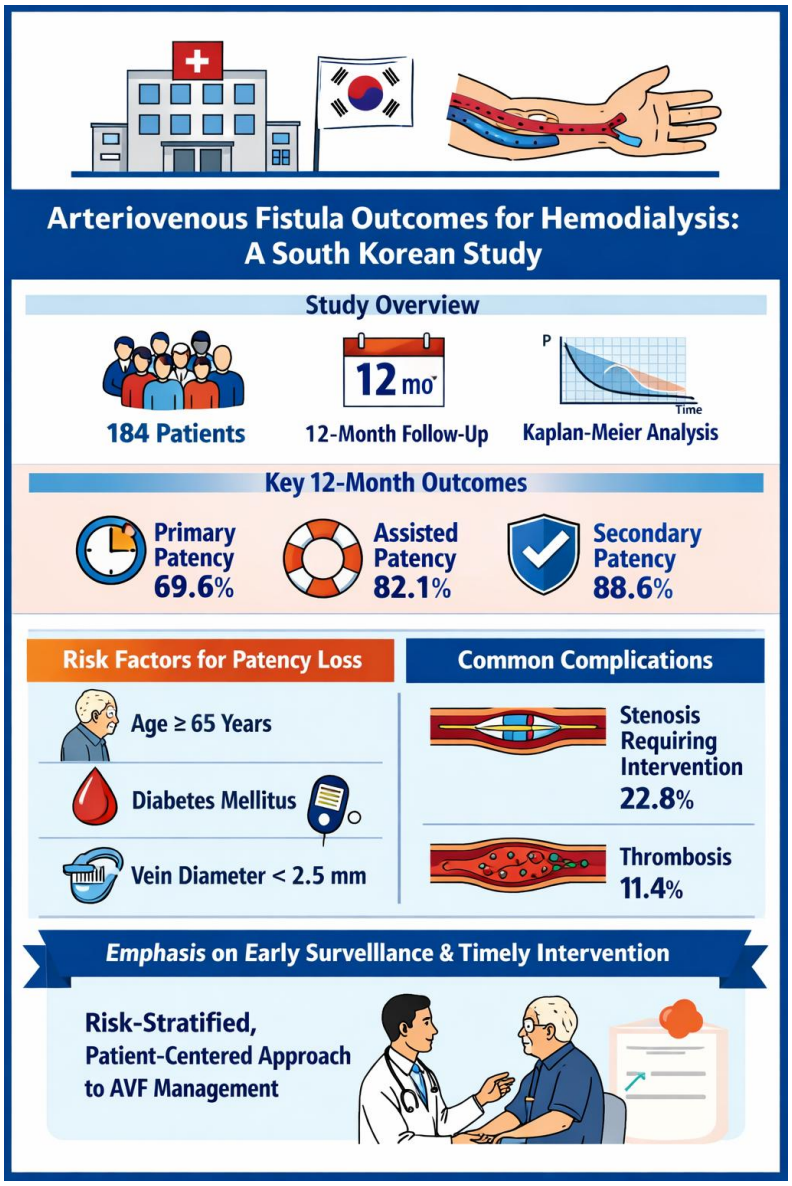

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