

Clinical Predictors of Arteriovenous Fistula Revision in Chronic Kidney Disease: The Role of Diabetes and Renal Function

Kronik Böbrek Yetmezliğinde Arteriyovenöz Fistül Revizyonunun Klinik Öngörücüleri: Diyabet ve Renal Fonksiyonların Rolü

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Abstract

Objective: This study aimed to identify clinical and biochemical risk factors associated with the need for arteriovenous fistula (AVF) revision in patients with chronic kidney disease (CKD).

Method: This retrospective cohort study reviewed 80 patients with CKD who underwent AVF creation between January 2023 and June 2025. Patients were categorized into revision (n=26) and non-revision (n=54) groups. Comparative analyses evaluated variables, including diabetes, hypertension, preoperative creatinine, duration of CKD, smoking, peripheral artery disease, and anticoagulant use.

Results: No significant differences were observed between groups with respect to age, gender, hypertension, CKD duration, or fistula type ($p>0.05$). However, diabetes incidence (69% vs. 41%; $p=0.02$) and mean creatinine levels (7.2 ± 3.8 vs. 6.0 ± 3.1 mg/dL; $p=0.04$) were significantly higher in the revision group. Diabetes increased the risk of revision 3.2-fold (odds ratio: 3.2, 95% confidence interval: 1.2-8.6). Furthermore, a subgroup analysis (n=44) with preoperative Doppler ultrasound data revealed no significant differences in mean arterial (2.39±0.72 vs. 2.70±0.91 mm; $p=0.308$) or venous diameters (2.26±0.53 vs. 2.63±0.85 mm; $p=0.224$) between non-revision and revision groups.

Conclusion: Diabetes and elevated creatinine levels significantly increase the need for AVF revision in CKD patients. A preoperative creatinine level >5.8 mg/dL is an important indicator of high risk of fistula dysfunction. These patients should be more closely monitored, and proactive approaches should be adopted during AVF planning and follow-up.

Keywords: Arteriovenous fistula, creatinine, diabetes, revision, risk factors

Öz

Amaç: Bu çalışma, kronik böbrek yetmezliği (KBY) hastalarında arteriyovenöz fistül (AVF) revizyonu ihtiyacı ile ilişkili klinik ve biyokimyasal risk faktörlerini belirlemeyi amaçlamıştır.

Yöntem: Bu retrospektif kohort çalışmasında, Ocak 2023 ile Haziran 2025 arasında AVF açılan 80 KBY hastası incelenmiştir. Hastalar revizyon yapılan (n=26) ve revizyon yapılmayan (n=54) gruplara ayrılmıştır. Karşılaştırmalı analizlerde diyabet, hipertansiyon, preoperatif kreatinin, KBY süresi, sigara kullanımı, periferik arter hastalığı ve antikoagülan kullanımı gibi değişkenler değerlendirilmiştir.

Bulgular: Gruplar arasında yaş, cinsiyet, hipertansiyon, KBY süresi veya fistül tipi açısından anlamlı fark saptanmamıştır ($p>0,05$). Ancak revizyon grubunda diyabet insidansı (%69'a karşı %41; $p=0,02$) ve ortalama kreatinin seviyeleri ($7,2\pm3,8$ 'e karşı $6,0\pm3,1$ mg/dL; $p=0,04$) anlamlı olarak daha yüksektir. Diyabet, revizyon riskini 3,2 kat artırmıştır (olasılık oranı: 3,2, %95 güven aralığı: 1,2-8,6). Ayrıca, preoperatif Doppler ultrasonografi verisi olan 44 hastalık alt grup analizinde, revizyon yapılmayan ve yapılan gruplar arasında ortalama arteriyel (2,39±0,72'ye karşı 2,70±0,91 mm; $p=0,308$) veya venöz çaplar (2,26±0,53'e karşı 2,63±0,85 mm; $p=0,224$) açısından anlamlı bir fark saptanmamıştır.

Sonuç: Diyabet ve yüksek kreatinin seviyeleri, KBY hastalarında AVF revizyon ihtiyacını anlamlı ölçüde artırmaktadır. 5,8 mg/dL üzerindeki preoperatif kreatinin değeri, fistül disfonksiyonu açısından yüksek riskin önemli bir göstergesidir. Bu hastalar daha yakından izlenmeli, AVF planlaması ve takibinde proaktif yaklaşımlar benimsenmelidir.

Anahtar kelimeler: Arteriyovenöz fistül, diyabet, kreatinin, revizyon, risk faktörleri

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Introduction

Chronic kidney disease (CKD) has become a significant public health issue with increasing global prevalence (1). Effective renal replacement therapy is essential for these patients to maintain their quality of life and long-term survival. Hemodialysis is one of the most commonly used treatment methods, and its success depends on the availability of reliable and sustainable vascular access. An arteriovenous fistula (AVF) is the preferred initial vascular access method for CKD patients due to its low infection rates, long patency, and relatively low risk of complications (2).

However, a significant number of AVFs either fail to mature initially or develop dysfunction during long-term use (3). Complications such as delayed fistula maturation, thrombosis, inadequate blood flow, or venous stenosis can necessitate surgical revision (4). This can delay patients' access to hemodialysis, prolong the use of temporary or permanent catheters, and consequently increase the risk of infection, hospitalization, and mortality. Therefore, the early identification of factors that may lead to fistula revision is critically important for reducing patient-specific risks and alleviating the burden on the healthcare system.

Numerous clinical and biochemical factors potentially predictive of fistula failure have been identified. Diabetes mellitus (DM), in particular, has a direct effect on AVF patency because it is a disease that affects the systemic vascular structure (5). In diabetic patients, vascular endothelial dysfunction, inflammation, and microvascular changes make it difficult to maintain fistula patency. Similarly, serum creatinine level is considered an important indicator of both overall kidney function and the circulatory load of toxic metabolites, reflecting the resilience and healing potential of the vascular structure. However, the relationship between these parameters and the need for AVF revision has been described in a limited number of studies, often with heterogeneous results.

Most studies in the literature on AVF dysfunction focus on fistula patency duration or primary patency rates (6,7). However, identifying cases that require surgical revision is a practical outcome that directly affects clinical management. If simple clinical and laboratory data obtainable in the preoperative period can identify patients at higher risk of revision, strategies can be developed for these patients. This would both enhance patient safety and contribute to a more effective use of healthcare resources.

In this study, the clinical and biochemical characteristics of CKD patients who underwent AVF creation at our hospital and subsequently required surgical revision were

retrospectively analyzed. The relationships of the presence of diabetes and of preoperative serum creatinine levels with AVF revision were specifically evaluated. The data obtained from this study are expected to provide insights that will contribute to the management of vascular access in hemodialysis patients.

Materials and Methods

Study Design and Patient Population

This study was designed as a single-center, retrospective, observational cohort study of risk factors. The Strengthening the Reporting of Observational Studies in Epidemiology Guidelines were followed for research reporting. Ethical approval for the study was obtained from the Clinical Research Ethics Committee of Batman Training and Research Hospital (decision no: 436, date: 30.09.2025). The research was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent for the surgical procedures and potential use of anonymized medical records for research purposes was obtained from all participating patients.

CKD patients who underwent AVF creation at our clinic and who were followed for hemodialysis between January 2023 and June 2025 were included in the study. A total of 80 patients were evaluated. Two main groups were formed from these patients: Those who required AVF revision during follow-up (n=26) and those who did not (n=54). Various demographic, clinical, and biochemical variables were examined in a comparative analysis between groups.

Inclusion and Exclusion Criteria

Patients who underwent AVF creation at our hospital between January 2023 and June 2025, with or without revision, were included in the study. Inclusion criteria were: Age 18 years or older, diagnosis of CKD, prior AVF surgery, and complete pre-operative laboratory data.

Exclusion criteria included patients with incomplete medical records, patients who received temporary or permanent catheters or other vascular access (e.g., grafts) other than an AVF, patients whose fistula was closed because they no longer needed it, and patients who required fistula revision for reasons other than technical issues (e.g., trauma-related damage, external compression).

Data Collection Process

Clinical information on patients, such as age, gender, comorbidities [DM, hypertension (HT), peripheral arterial disease (PAD)], smoking status, preoperative creatinine

level, duration of CKD, and type of fistula used was recorded retrospectively from their medical files.

For patients who underwent revision surgery, the timing of fistula dysfunction, the reasons for revision (thrombosis, maturation failure, bleeding, aneurysm), and additional morbidities were recorded. All surgical procedures were performed by the same cardiovascular surgery team.

Additionally, due to the retrospective nature of the study, preoperative vascular Doppler ultrasound mapping data (arterial and venous diameters) were available for a subset of 44 patients. To assess the impact of baseline anatomical factors on AVF revision, a subgroup analysis was performed exclusively in these patients.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics (version 29, IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, median, minimum-maximum) were calculated for continuous variables. The Mann-Whitney U test was applied to non-normally distributed data, and Fisher's exact test was used for categorical variables.

Logistic regression analysis was performed to identify variables predicting the risk of revision. The independent effects of diabetes, creatinine level, and other variables were evaluated. In addition, an receiver operating characteristic (ROC) curve was plotted to assess the discriminatory power of the creatinine level in predicting revision. The area under the curve (AUC) value, sensitivity, specificity, and optimal cut-off level were calculated. A significance level of $p < 0.05$ was accepted for all statistical tests.

Surgical Approach

All AVF procedures included in the study were performed by the same cardiovascular surgical team following standardized surgical protocols. All operations were carried out under local anesthesia or an axillary nerve block. The choice of anesthetic method was individualized based on the patient's clinical status and comorbidities, following a multidisciplinary assessment by the anesthesia and surgical teams.

The surgical approach was planned specifically for each patient. The fistula configuration (radiocephalic, brachiocephalic, or brachio basilic) was determined by considering the anatomical characteristics of the vessels, including vessel diameter and flow patterns, the patient's dominant extremity, and procedural history. Surgical

techniques aimed at improving vascular integrity and long-term patency rates were adopted for all AVF surgeries.

In cases requiring revision surgery, the timing of fistula dysfunction, the underlying causes (thrombosis, maturation failure, early bleeding, aneurysmal changes), and the associated morbidities were analyzed in detail. The revision technique was chosen based on the vascular structure, the local pathology of the existing fistula, and its potential for renewed access. The revision procedures included thrombectomy, re-anastomosis, and segmental fistula excision.

Following all surgical interventions, patients were closely monitored for early postoperative complications and access function. In the postoperative period, all patients were monitored in the intensive care unit or on the ward to assess their hemodynamic stability and fistula function. The need for antithrombotic therapy was individualized based on the patient's systemic condition and surgical findings.

In cases of maturation failure, surgical revision strategies were tailored to the underlying anatomical pathology. The predominant surgical interventions included precise ligation of competitive venous tributaries (accessory veins), limited venous superficialization, and proximal re-anastomosis to augment inflow.

Results

A total of 80 patients were included in the study. Of these, 26 patients (32.5%) underwent revision surgery after the primary AVF procedure, while 54 (67.5%) did not require revision. Demographic, clinical, and laboratory variables were compared between the groups.

Demographic and Clinical Characteristics

The mean age of patients who underwent revision was 55.8 ± 16.3 years, while it was 58.9 ± 14.1 years in the non-revision group ($p = 0.35$). The gender distribution was similar between groups (female ratio: 65% vs. 63%, $p = 0.85$). No statistically significant differences were observed in variables such as HT (77% vs. 67%, $p = 0.34$), smoking status (23% vs. 13%, $p = 0.23$), and PAD (27% vs. 17%, $p = 0.28$) (Table 1).

In contrast, the presence of DM was significantly associated with the revision group (69% vs. 41%; $p = 0.02$). This suggests that diabetes may be an important factor adversely affecting fistula maturation or longevity.

Renal Parameters

The mean serum creatinine level in the revised group was 7.2 ± 3.8 mg/dL, which was significantly higher than in the non-revision group (6.0 ± 3.1 mg/dL) ($p=0.04$). No difference was observed between the groups in terms of CKD duration (5.4 ± 4.2 years vs. 4.5 ± 3.7 years; $p=0.32$) (Table 2).

Predictive Modeling and Diagnostic Accuracy

A multivariate logistic regression model was constructed to systematically elucidate independent clinical and biochemical predictors of the need for AVF revision. The multivariate analysis revealed that the presence of DM was a highly significant and independent predictor, elevating the risk of AVF revision by more than threefold [odds ratio (OR) =3.21; 95% confidence interval (CI): 1.18-8.73; $p=0.022$]. Conversely, while elevated preoperative serum creatinine levels exhibited a trend toward increased revision risk, this parameter did not reach statistical significance in the multivariate regression model (OR =1.12 per 1 mg/dL increment; 95% CI: 0.98-1.28; $p=0.092$) (Table 3).

To further evaluate the diagnostic and discriminatory capacity of preoperative serum creatinine levels for predicting fistula dysfunction, ROC curve analysis was performed. The AUC was calculated to be 0.618 (95% CI: 0.491-0.746; $p=0.081$). A preoperative creatinine cut-off value of >5.8 mg/dL was established by maximizing the Youden index to identify the optimal prognostic balance. At this precisely defined clinical threshold, the parameter demonstrated a sensitivity of 69% and specificity of 54% for predicting AVF dysfunction requiring surgical revision (Figure 1).

Fistula Types

No significant relationship was found between the type of fistula and the need for revision ($p=0.82$). Radiocephalic fistulas were the preferred method in both groups (67% in the non-revision group and 62% in the revision group). Brachiocephalic fistulas were used in 22% and 23% of cases, respectively, while other fistula types (e.g., brachiobasilic) were used in 11% and 15% of cases (Table 4).

Table 1. Demographic and preoperative characteristics of patients

Characteristic	Revision group (n=26)	Non-revision group (n=54)	p-value
Age (mean $\pm$ SD)	55.8 $\pm$ 16.3	58.9 $\pm$ 14.1	0.35
Female sex, n (%)	17 (65%)	34 (63%)	0.85
HT (%)	20 (77%)	36 (67%)	0.34
DM (%)	18 (69%)	22 (41%)	0.02*
Presence of PAD (%)	7 (27%)	9 (17%)	0.28
Smoking status (%)	6 (23%)	7 (13%)	0.23

SD: Standard deviation, HT: Hypertension, DM: Diabetes mellitus, PAD: Peripheral arterial disease, *: Statistically significant difference ($p<0.05$)

Table 2. Renal functions and disease duration of patients

Characteristic	Revision group (n=26)	Non-revision group (n=54)	p-value
CKD duration (years)	5.4 $\pm$ 4.2	4.5 $\pm$ 3.7	0.32
Creatinine (mg/dL)	7.2 $\pm$ 3.8	6.0 $\pm$ 3.1	0.04*

CKD: Chronic kidney disease, *: Statistically significant difference ($p<0.05$)

Table 3. Multivariate logistic regression analysis for predictors of AVF revision

Variables	Odds ratio	95% confidence interval	p-value
Diabetes mellitus (present vs. absent)	3.21	1.18-8.73	0.022
Creatinine (per 1 mg/dL increase)	1.12	0.98-1.28	0.092

AVF: Arteriovenous fistula

Table 4. Distribution of patients by fistula type

Characteristic	Revision group (n=26)	Non-revision group (n=54)	p-value
Radiocephalic AVF (%)	16 (62%)	36 (67%)	
Brachiocephalic AVF (%)	6 (23%)	12 (22%)	
Brachiobasilic AVF (%)	4 (15%)	6 (11%)	
Total	26 (100%)	54 (100%)	0.82

AVF: Arteriovenous fistula

Antiplatelet Use

In our study, 50.5% of patients (42/80) were using an antiplatelet agent. This rate was 62% (16/26) in patients who underwent revision surgery and 48% (26/54) in the non-revision group. Although the use of antiplatelet agents was generally higher in patients who underwent revision, this difference was not statistically significant ($p=0.25$, OR: 1.7; 95% CI: 0.7-4.4) (Table 5).

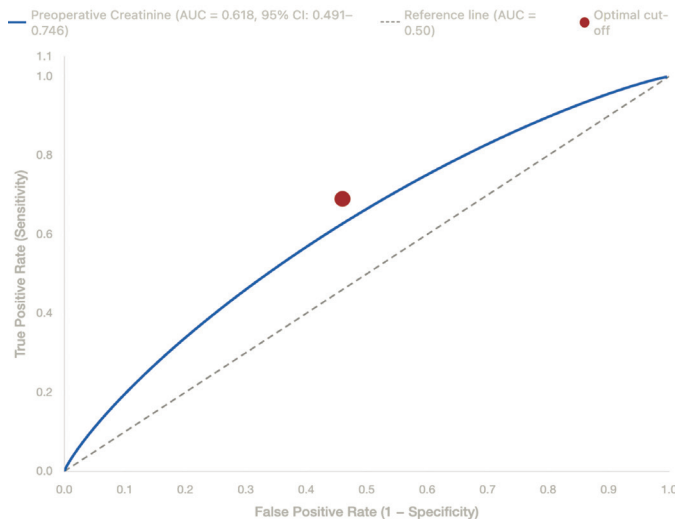


Figure 1. ROC curve analysis of preoperative serum creatinine for predicting AVF revision

AVF: Arteriovenous fistula, ROC: Receiver operating characteristic, AUC: Area under the curve, CI: Confidence interval

Preoperative Doppler Ultrasound Findings (Subgroup Analysis)

A subgroup analysis of 44 patients with available preoperative Doppler USG data was conducted to evaluate the anatomical predictors of AVF revision. The analysis revealed no statistically significant differences in vascular anatomy between the groups. The mean preoperative arterial diameter was 2.39 ± 0.72 mm in the non-revision group compared to 2.70 ± 0.91 mm in the revision group ($p=0.308$). Similarly, the mean preoperative venous diameter was 2.26 ± 0.53 mm in the non-revision group and 2.63 ± 0.85 mm in the revision group ($p=0.224$). These findings suggest that anatomical vessel diameter prior to surgery was not a significant predictor of the need for revision in our study population (Table 6).

Revision Indications

Among the 26 patients who underwent revision surgery, the most common indication was failure of maturation, observed in 9 patients (34.6%). Thrombosis accounted for 7 cases (26.9%), followed by bleeding or hematoma formation in 6 patients (23.1%) and aneurysmal degeneration in 4 patients (15.4%) (Table 7).

Table 5. Relationship between antiplatelet use and revision surgery

Antiplatelet use	Revision (n=26)	Non-revision (n=54)	p-value	OR (95% CI)
Yes	16 (62%)	26 (48%)	0.25	1.7 (0.7-4.4)
No	10 (38%)	28 (52%)		

OR: Odds ratio, CI: Confidence interval

Table 6. Preoperative Doppler ultrasound findings in the subgroup analysis (n=44)

Variables	No revision (n=32)	Revision (n=12)	p-value*
Arterial diameter (mm)	2.39 ± 0.72	2.70 ± 0.91	0.308
Venous diameter (mm)	2.26 ± 0.53	2.63 ± 0.85	0.224

*: Data are presented as mean $\pm$ standard deviation. The Mann-Whitney U test was used for statistical analysis

Table 7. Indications for revision surgery in AVF patients (n=26)

Revision indication	Number of patients (n)	Percentage (%)
Thrombosis	7	26.9
Failure of maturation	9	34.6
Bleeding/hematoma	6	23.1
Aneurysm formation	4	15.4
Total	26	100

AVF: Arteriovenous fistula

To evaluate the clinical efficacy of the surgical interventions, we analyzed the outcomes of patients with AVF maturation failure. Within the revision cohort, 9 patients underwent surgical salvage procedures for immature fistulas. Following targeted interventions, functional hemodialysis access was successfully established and maintained in 5 of these cases (55.5%). Conversely, the salvage procedures were unsuccessful for the remaining 4 patients (44.5%), who subsequently required alternative strategies, such as central venous catheterization or the creation of a new vascular access, to continue hemodialysis.

Discussion

The data obtained from this study show that the basic demographic and clinical characteristics of patients with AVF revision and those without are largely similar, and that age, the presence of HT, and the duration of CKD do not have a significant effect on fistula revision. This finding suggests that the success of AVF surgery, especially in older patients, is not solely dependent on age, but other physiological and anatomical factors may play a more determining role. Lomonte et al. (8) similarly reported that age is not a determinant factor for AVF patency and that successful fistula maturation is more related to vessel diameter and hemodynamic properties.

On the other hand, a statistically significant relationship was found between the presence of DM and the need for revision. That most patients who underwent revision had DM suggests that microvascular damage, endothelial dysfunction, accelerated atherosclerotic processes, and chronic inflammation associated with this disease can negatively affect AVF patency. The literature has reported an association between DM and AVF failure, demonstrating that rates of thrombosis, maturation failure, and early dysfunction are higher among the diabetic population. Furthermore, it is well known that diabetic nephropathy, either alone or with hypertensive nephropathy, is the most common cause of end-stage renal failure in developed and developing countries (5).

Therefore, effective DM management is critical not only for preserving kidney function but also for maintaining AVF patency and reducing the risk of revision. Detailed evaluation of vascular structures in the preoperative period, ensuring perioperative glycemic control, and implementing close postoperative follow-up strategies are recommended as key approaches to improve fistula success in diabetic patients (9,10).

Our study also found a significant association between high creatinine levels and revision. This suggests that factors such as hemodynamic fluctuations, volume overload, and increased inflammatory response, which can develop in advanced CKD, may negatively affect fistula integrity. However, the literature also reports that low creatinine levels may be associated with AVF failure, often linked to conditions such as low muscle mass, malnutrition, and old age (11). Thus, in different clinical scenarios, both high and low creatinine values can contribute to AVF failure through different mechanisms. These findings reveal that the creatinine level is more than an indicator of kidney function; it can also provide indirect information about the patient's overall metabolic status and vascular integrity.

The evaluation of fistula types showed that radiocephalic AVFs were the most common in both groups, and that there was no significant difference in revision rates. This supports successful patient selection and surgical planning. The absence of a significant difference between brachiocephalic and brachio basilic fistulas underscores the importance of tailoring the surgical technique to the patient's anatomy. Previous studies of patients with CKD stages 4-5 have also shown no significant relationship between the type of AVF and primary failure rates. A cohort study published in 2019 found no statistically significant difference in the incidence of early-stage failure based on fistula location type (12).

In our analysis of antiplatelet therapy, while the overall use rate was higher in the revision group, this difference was not statistically significant. This result suggests that the effect of antiplatelet therapy on maintaining AVF patency may be limited and that the treatment response can vary depending on patient characteristics. The results in the literature on this topic are heterogeneous. A large-scale retrospective study using the vascular quality initiative database between 2011 and 2023 reported that the risk of primary patency loss was significantly reduced in the group treated with single antiplatelet therapy (13). However, the Kaplan-Meier analysis in the same study found no significant difference within the AVF group, suggesting that the effect of antiplatelet therapy cannot be generalized to all patients. While our study did not achieve statistical significance, differences in antiplatelet use rates may yield clinically significant results in larger samples.

A critical finding of our study, demonstrated by the subgroup analysis of preoperative Doppler USG measurements, is that baseline vessel diameters were not significantly smaller in patients requiring revision. This finding is highly clinically relevant. It emphasizes that while adequate anatomical

vessel size is a well-known prerequisite for initial AVF creation, the subsequent failure and the need for surgical revision are more heavily driven by systemic metabolic and microvascular factors, such as diabetes and uremia, the latter of which is reflected by elevated creatinine levels. Endothelial dysfunction, accelerated atherosclerosis, and chronic inflammation caused by these systemic conditions appear to override the baseline vessel size in determining long-term fistula success.

Furthermore, no significant relationship was found in our study between classical systemic vascular risk factors such as peripheral artery disease and smoking and the need for revision. This finding indicates that, while these factors are general determinants of vascular health, they are not sufficient on their own to ensure AVF success. It appears that local vascular structure, hemodynamic conditions, surgical technique, and postoperative care processes are critically important, in addition to systemic risk factors, for maintaining AVF patency. Therefore, fistula failure is a multifactorial process and should be evaluated not only by classical risk factors but also by metabolic and structural parameters.

Study Limitations

Our study has several notable limitations that must be acknowledged. First, the retrospective single-center design inherently limits our ability to establish definitive causal relationships and may restrict the generalizability of the findings. Second, the limited sample size may have constrained the statistical power to detect minor differences in predictive value among certain clinical variables. Third, the evaluation of both early and late AVF dysfunctions under a composite “revision” endpoint poses a pathophysiological constraint. While early interventions primarily influence primary patency and late revisions dictate secondary patency rates, stratifying the limited revision cohort into temporal subgroups would have critically compromised the statistical robustness of our multivariate predictive models. Consequently, large-scale, prospective, multi-center studies are warranted to independently delineate the risk factors for early versus late patency loss and to further validate our clinical conclusions.

Conclusion

DM and elevated creatinine levels independently increase the risk of AVF revision in patients with CKD, highlighting the need for closer preoperative assessment and postoperative monitoring.

Ethics

Ethics Committee Approval: Ethical approval for the study was obtained from the Clinical Research Ethics Committee of Batman Training and Research Hospital (decision no: 436, date: 30.09.2025).

Informed Consent: Written informed consent for the surgical procedures and potential use of anonymized medical records for research purposes was obtained from all participating patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.A., T.C., B.Y., Concept: A.A., Design: A.A., T.C., B.Y., Data Collection or Processing: A.A., T.C., B.Y., Analysis or Interpretation: A.A., T.C., Literature Search: B.Y., Writing: A.A.

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