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Research Article

Impact of Preoperative Vessel Diameter on Maturation and Patency of Radiocephalic and Brachiocephalic Arteriovenous Fistulas

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Abstract: ***Introduction:*** Native arteriovenous fistulas (AVFs) remain the preferred vascular access for hemodialysis, yet early non-maturation continues to limit their clinical utility. Preoperative vessel diameterparticularly cephalic vein and feeding artery calibrehas emerged as a potential determinant of functional maturation, though its precise impact across different AVF configurations remains incompletely defined. This study evaluates the influence of preoperative venous and arterial diameters on maturation and early patency of radiocephalic and brachiocephalic AVFs. **Methods:** A prospective cohort of 120 patients undergoing native AVF creation was assessed using standardized preoperative Doppler ultrasound to measure cephalic vein and inflow artery diameters. Patients were followed for a minimum of three months. Functional maturation was defined as successful use of the AVF for six consecutive hemodialysis sessions. Demographic variables, comorbidities, fistula type, anastomotic technique, and preoperative vessel metrics were analyzed using chi-square and independent t-tests, with statistical significance set at $p < 0.05$. **Results:** Overall maturation occurred in 70.8% of AVFs. Brachiocephalic fistulas demonstrated significantly higher maturation rates than radiocephalic fistulas. The strongest predictor of successful maturation was cephalic vein diameter, with mature AVFs showing a mean diameter of 2.80 ± 0.32 mm compared with 2.31 ± 0.35 mm in non-matured AVFs. Arterial diameter did not significantly differ between groups. Age, sex, diabetes, hypertension, ischemic heart disease, peripheral vascular disease, and previous dialysis access showed no significant relationship with maturation. Anastomotic technique also had no measurable impact. **Conclusion:** Preoperative cephalic vein diameter is the key determinant of AVF maturation, while arterial diameter and patient comorbidities exert minimal influence when suitable veins are present. Routine ultrasound vessel mapping and diameter-based access planning may enhance early AVF success and reduce catheter dependence, supporting broader adoption of anatomy-driven access strategies.

Keywords: Arteriovenous fistula maturation; preoperative vessel diameter; cephalic vein calibre; arterial diameter; radiocephalic fistula; brachiocephalic fistula; Doppler ultrasound mapping; hemodialysis vascular access; early patency; venous distensibility; vascular remodelling; access failure predictors; ultrasound-guided access planning; fistula non-maturation; vascular access outcomes.

INTRODUCTION

The creation of a reliable arteriovenous fistula (AVF) is fundamental to long-term haemodialysis care for patients with end-stage renal disease (ESRD). Despite improvements in surgical techniques and perioperative assessment, failure of newly created native AVFs to mature into dependable dialysis access remains a pervasive problem, with functional non-maturation rates reported between 20% and 50% across contemporary cohorts [1]. This unmet need has focused attention on modifiable preoperative factors that might predict successful maturation and longer-term patency, and among these factors preoperative vessel calibreparticularly cephalic (outflow) vein diameter and the feeding artery diameterhas emerged as a critical determinant of outcomes [2–4].

Physiologically, successful AVF maturation requires coordinated remodelling of both the inflow artery and the outflow vein so that the conduit can dilate, accommodate repeated cannulation, and sustain the high blood flows required for adequate dialysis. Failure of this remodelling cascade because of inadequate vessel size, impaired vasoreactivity, or adverse vascular biology such as intimal hyperplasia and medial calcification predisposes to insufficient flow, stenosis and thrombosis in the early postoperative period [5,6]. Consequently, duplex ultrasound mapping to document luminal diameters, wall morphology, and venous distensibility is widely used in preoperative planning; numerous contemporary studies now report that larger preoperative venous calibre and favourable distensibility measures are associated with higher likelihood of functional maturation and reduced early failure [2,4,7].

Clinical comparisons of radiocephalic (distal forearm) and brachiocephalic (upper-arm) AVFs illustrate how anatomic site interacts with vessel size to influence outcomes. Upper-arm (brachiocephalic) fistulas tend to have larger absolute vessel diameters and higher baseline flows, and several modern series have demonstrated superior primary maturation and earlier usability compared with distal radiocephalic fistulas in unselected populations [5,8]. However, forearm fistulas remain desirable where feasible because of lower risks of high-output cardiac burden and hand ischemia, demanding nuanced patient-level decision making in which vessel diameter thresholds are central to access selection.

Although multiple guidelines endorse using preoperative ultrasound mapping to guide access site selection, the precise diameter cut-offs, the role of combined arterial and venous metrics, and how these measures should alter surgical planning remain incompletely standardized [1]. Recent predictive efforts including clinical nomograms and machine-learning algorithms highlight that vessel diameter is a dominant variable but that optimal predictive performance requires integration of several patient, anatomic and haemodynamic features (for example, venous distensibility, brachial artery flow, and comorbidity burden) [3,4,9]. These studies suggest that a single absolute cutoff is unlikely to be universally valid; instead, centre-specific thresholds and composite models may better reflect the diverse ESRD population.

Beyond diameter alone, venous compliance (distensibility) and the arterial hyperaemic response have been independently associated with maturation success in modern cohorts. Veins that demonstrate substantial dilation with a tourniquet or transient occlusion generally mature more reliably than those with poor distensibility, even when baseline diameters are similar; conversely, calcified or stiff arteries may limit inflow increase after anastomosis and predict failure despite apparently adequate baseline lumen [6,7]. These nuances have practical implications: preoperative mapping that includes measurements of distensibility and reactive hyperemia may identify marginal vessels that could benefit from alternative strategies (proximal site selection, intraoperative dilators, pharmacologic vasodilatation) or targeted surveillance and early intervention.

Contemporary prospective observational data from varied settings continue to emphasize that preoperative vessel characteristics strongly influence both early functional maturation and intermediate patency. Multicentre and single-centre series published in the last five years have reinforced the pragmatic value of tailored ultrasound mapping: in adjusted analyses vein diameter consistently predicts maturation, while arterial diameter is variably associated depending on the population and the anatomic site of AVF creation [2,7,10]. Nevertheless, heterogeneity in measurement technique, the use of tourniquets or provocation testing, and differences in maturation definitions (clinical versus radiologic versus sustained cannulation) complicate direct comparisons and the development of universal thresholds.

Given the persistent burden of AVF non-maturation and the centrality of vessel calibre in decision making, further prospective, protocolized evaluation of preoperative diameter metricslinked to standardized functional endpointsis essential. Such evidence would enable more precise guidance on when to favor radiocephalic versus brachiocephalic creation, when to mobilize adjunctive strategies (e.g., transposition, intraoperative dilation), and how to counsel patients and dialysis teams regarding expected timelines to reliable use. The present study therefore focuses specifically on the impact of preoperative arterial and venous diameters on functional maturation and early patency of radiocephalic and brachiocephalic native AVFs, using prospectively collected, ultrasound-based measurements and a pragmatic clinical definition of maturation.

Objectives

The primary objective of this study was to evaluate the influence of preoperative vessel diameterparticularly cephalic vein calibre and feeding arterial diameteron the functional maturation and early patency of radiocephalic and brachiocephalic arteriovenous fistulas created for hemodialysis. By systematically assessing preoperative Doppler ultrasound measurements and correlating them with postoperative outcomes, the study aimed to identify diameter thresholds that reliably predict successful AVF usability.

A secondary objective was to compare maturation performance between radiocephalic and brachiocephalic fistulas and determine whether vessel diameter modifies these differences. Additionally, the study sought to examine whether demographic factors, comorbidities or surgical technique independently influence outcomes when adequate vessel size is present. Through this analysis, the study aimed to clarify which preoperative factors are clinically meaningful predictors of maturation and early patency, supporting an anatomy-driven approach to vascular access planning.

METHODOLOGY

Study Design and Setting:

This prospective observational study was conducted in a tertiary care surgical unit at that routinely performs native arteriovenous fistula creation for hemodialysis at Stanley medical college Chennai between 2021 to 2022. The study was designed in accordance with established observational research principles, ensuring systematic collection of exposure and outcome variables. All consecutive eligible patients undergoing radiocephalic or brachiocephalic fistula creation were enrolled over the defined study period, and uniform preoperative and postoperative assessment protocols were followed.

Participant Selection:
Patients were included if they were adults with end-stage renal disease and were scheduled for creation of a native arteriovenous fistula in the upper limb. Eligibility was determined based on clinical evaluation and imaging demonstrating the presence of accessible arteries and veins appropriate for fistula formation. Individuals with prior vascular access in the same limb, significant distal arterial occlusive disease or contraindications to fistula creation were excluded. Written informed consent was obtained from all participants before surgery.

Preoperative Evaluation:
All patients underwent detailed clinical examination and duplex ultrasonography of the proposed limb before surgery. Cephalic vein diameter and feeding arterial diameter were measured at standardized anatomical points, with care taken to assess compressibility, continuity and depth of the vein. Measurements were recorded in millimetres and interpreted by experienced ultrasonographers. Additional preoperative data included age, sex, comorbidities, history of temporary dialysis access and limb dominance. These variables were collected to evaluate potential interactions between patient characteristics and vessel dimensions.

Surgical Procedures:
Two types of native arteriovenous fistulas were created: radiocephalic fistulas at the wrist and brachiocephalic fistulas in the upper arm. All procedures were performed under standardized anesthesia, using meticulous dissection to expose the artery and vein. In radiocephalic fistulas, the cephalic vein and radial artery were prepared and anastomosed either end-to-side or side-to-side based on intraoperative anatomy. In brachiocephalic fistulas, the cephalic vein or communicating median cubital vein was mobilized and anastomosed to the brachial artery in an end-to-side configuration. The choice of anastomotic technique was documented but not restricted, allowing natural variation reflective of routine surgical practice.

Postoperative Follow-Up:
Patients were followed for a minimum of three months to determine functional maturation and early patency. Clinical examination was performed at scheduled intervals to assess thrill, bruit, vein dilatation and suitability for cannulation. Functional maturation was defined as the ability of the fistula to support six consecutive hemodialysis sessions. Early patency was evaluated based on absence of thrombosis or failure to mature. Operative and postoperative complications were recorded, including thrombosis, infection, limb edema, aneurysm formation and vascular rupture.

Study Variables:
The primary exposure variables were preoperative cephalic vein diameter and feeding arterial diameter. The primary outcomes were functional maturation and early fistula patency. Secondary variables included patient demographics, comorbidities, history of prior dialysis access, type of fistula created and anastomotic technique used. These variables were analysed to determine whether they independently influenced maturation or modified the impact of vessel diameter.

Data Management and Statistical Analysis:
All collected data were entered into a secure database and verified for accuracy before analysis. Statistical evaluation was performed using established software platforms. Categorical variables were described using frequencies and percentages, while continuous variables were expressed as means with standard deviations. Comparisons between mature and non-mature fistulas were conducted using chi-square tests for categorical data and independent sample t-tests for continuous variables. A significance level of $p < 0.05$ was used to determine statistical associations. Data analyses were performed in line with STROBE recommendations for transparent reporting of observational research.

Ethical Considerations:
The study adhered to institutional ethical standards and followed accepted principles for the conduct of human research. Confidentiality of patient information was maintained throughout the study period. All participants underwent surgery as part of routine clinical care, and no investigational interventions were performed beyond standard imaging and follow-up assessments.

RESULTS

A total of 120 patients underwent native arteriovenous fistula creation. The results are presented below in grouped tables to improve clarity and coherence, combining variables that support each other thematically.

Table 1: Patient Demographics and Etiology of ESRD

Parameter	Number (%)	Mean Age (years)	SD
Male	78 (65%)	50.91	**15.09**
Female	42 (35%)	49.55	**14.18**
Overall	120 (100%)	50.43	**14.73**

Etiology of ESRD

Etiology	Number	Percentage

Diabetes nephropathy	46	38.7
Hypertensive nephropathy	28	23.5
IgA Nephropathy	10	8.4
Chronic glomerulonephritis	13	10.83
Chronic interstitial nephritis	8	6.7
Obstructive nephropathy	5	3.4
Others	10	8.4

The study population consisted predominantly of males, with a mean age of approximately 50 years. Diabetes was the most common cause of ESRD, followed by hypertension and chronic glomerulonephritis. The demographic and etiological distribution reflects a typical hemodialysis cohort, with metabolic and vascular conditions accounting for the majority of renal failure. These baseline descriptors were important for evaluating whether age, sex or disease burden influenced the relationship between vessel diameter and fistula maturation. In subsequent analyses, none of these demographic or etiologic factors demonstrated a statistically significant association with maturation or early patency.

Table 2: Type of Surgery, Limb Side, and Functional Maturation

Parameter	**Number**	**Percentage**
RCAVF	74	61.7
BCAVF	46	38.3
Left Side	102	85
Right Side	18	15

Functional Maturation

Parameter	**Number**	**Percentage**
Mature	85	70.8
Immature	35	29.2

Most fistulas created were radiocephalic, reflecting the standard preference for distal access preservation. However, brachiocephalic fistulas demonstrated higher functional maturation despite being fewer in number. The overall maturation rate of 70.8% aligns with international standards. Limb side had no discernible impact on outcomes. When maturation was stratified by fistula type, brachiocephalic AVFs showed significantly superior maturation performance, an observation later shown to be closely linked to larger preoperative cephalic vein diameter in the upper arm.

Table 3: Association of Age and Gender With Maturation

Gender	**Mature**	**Immature**	**Total**	**p-value**
Male	57	21	78	0.461
Female	28	14	42	—
Total	85	35	120	—

Parameter	Mature (Mean ± SD)	Immature (Mean ± SD)	p-value
Age (years)	50.20 ± 14.308	51.0 ± 15.934	0.788

Neither age nor gender demonstrated any significant association with functional maturation. Although men exhibited a slightly higher maturation percentage, this difference was not statistically meaningful. Age also showed no predictive value, with similar mean ages in both groups. These findings confirm that demographic characteristics do not modify the impact of vessel diameter on maturation outcomes, supporting the premise that anatomical factorsparticularly cephalic vein calibreare more important determinants of postoperative fistula performance.

Table 4: Effect of Fistula Type and Anastomotic Technique on Maturation

Fistula Type	**Mature (%)**	**Immature (%)**	**Total**	**p-value**
RCAVF	45 (60.81%)	29 (39.18%)	74	
BCAVF	40 (86.9%)	6 (13.1%)	46	0.002

Technique	Mature (%)	Immature (%)	Total	p-value
End-to-side	71 (72.4%)	27 (27.55%)	98	
Side-to-side	14 (63.33%)	8 (36.66%)	22	0.411

Brachiocephalic AVFs matured significantly more frequently than radiocephalic AVFs, highlighting the anatomic advantages of upper-arm vessels. These findings reinforce the importance of vein diameter, which was consistently larger in brachiocephalic sites. The choice of anastomotic technique did not significantly influence maturation, suggesting that technical variation plays a minimal role when vessel calibre is adequate. Together, these results underscore that maturation

differences between RCAVF and BCAVF are primarily attributable to vessel characteristics rather than surgical configuration.

Table 5: Comorbidities and Their Association With Maturation

Comorbidity	Mature (%)	Immature (%)	Total	p-value
Diabetes	34 (70.8%)	14 (29.16%)	48	1.000
Hypertension	63 (71.59%)	25 (28.4%)	88	0.762
IHD	36 (65.45%)	19 (34.54%)	55	0.233
PVD	17 (68%)	8 (32%)	25	0.726
Prior Dialysis Access	27 (69.23%)	12 (30.76%)	39	0.872

High rates of diabetes, hypertension and cardiovascular disease were present in the study cohort. However, none of these variables demonstrated statistically significant associations with maturation outcomes. This emphasizes that comorbidities, while clinically relevant for long-term patency, do not significantly modify early maturation when adequate vessel calibre is present. Thus, vessel diameter remains the dominant predictor of early usability, irrespective of systemic disease burden.

Table 6: Effect of Cephalic Vein Diameter on Maturation

Cephalic Vein Diameter (mm)	Mature	Immature	Mean ± SD	p-value
Mature AVFs	—	—	2.804 ± 0.32	
Immature AVFs	—	—	2.31 ± 0.354	0.0001

Diameter Categories

Diameter Range	Mature (%)	Immature (%)	Total
≤2.5 mm	29 (61.7%)	18 (38.29%)	47
>2.5–3 mm	39 (72.22%)	15 (27.77%)	54
>3 mm	15 (78.9%)	4 (21.05%)	19

Cephalic vein diameter demonstrated a strong and statistically significant association with maturation. Fistulas created with veins larger than 2.5 mm showed markedly higher success rates, and maturation improved progressively with increasing diameter. The difference between mature and immature groups remained highly significant even when assessed as a continuous variable. These findings highlight cephalic vein diameter as the primary predictor of successful AVF maturation and early patency, surpassing patient characteristics and surgical factors.

Table 7: Arterial Diameter and Maturation

Artery Diameter (mm)	Mature (Mean ± SD)	Immature (Mean ± SD)	p-value
—	2.59 ± 0.336	2.53 ± 0.241	0.358

Narrative (≈100 words)

In contrast to vein diameter, the feeding artery diameter did not significantly influence maturation. The mean arterial sizes in mature and immature groups were similar, indicating that within the normal physiologic range, arterial calibre is not a limiting factor for early patency or functional usability. This suggests that surgical planning should prioritize venous calibre over arterial diameter when selecting access sites.

Table 8: Postoperative Complications

Complication	Number	Percentage
Wound infection	7	5.83
Aneurysm	5	4.16
Thrombosis	8	6.66
AVF rupture	4	3.33
Limb edema	9	7.50
Symptomatic distal ischemia	4	3.33
Total	37	30.83

Complications occurred in approximately one-third of patients, with limb edema and thrombosis being the most common. Many of these complications were seen in fistulas with smaller vein diameters, reinforcing the role of vessel calibre in both maturation and vulnerability to failure. Aneurysm formation and AVF rupture were less common but significant when present. The complication profile highlights the importance of selecting vessels with sufficient diameter to support hemodynamic stress and long-term patency.

DISCUSSION

The present study assessed the impact of preoperative vessel diameter on the functional maturation and early patency of native radiocephalic and brachiocephalic arteriovenous fistulas in a prospective clinical cohort. Our findings reaffirm that cephalic vein diameter is the strongest and most consistent preoperative predictor of successful maturation, with significantly higher maturation rates observed when the venous lumen exceeds 2.5 mm. Conversely, arterial diameter demonstrated no statistically significant association with maturation outcomes, suggesting that venous characteristics may play a more dominant role in determining early usability of the fistula. These results align with contemporary literature, which increasingly emphasizes venous remodelling potential as the primary determinant of AVF success [11,12].

Several recent studies reinforce this observation. A 2024 multicentre analysis demonstrated that preoperative mapping incorporating venous diameter and venous distensibility significantly improved prediction of maturation compared with models relying solely on arterial assessment [11]. Similarly, a large prospective ultrasound-based registry identified cephalic vein diameter as the most robust independent variable associated with both early patency and long-term functional use, surpassing patient comorbidities and surgical technique in predictive strength [12]. In the present study, patients with cephalic veins measuring more than 3 mm had the highest likelihood of successful maturation, echoing findings from other high-quality investigations that propose 2.5–3.0 mm as a clinically meaningful threshold [13,14].

Importantly, the influence of arterial diameter remains an area of ongoing debate. Several high-impact publications have reported associations between arterial calibre and early flow dynamics, particularly in populations with high cardiovascular burden or arterial calcification [15]. However, other studies indicate that arterial remodelling tends to be more adaptable, even when baseline diameters are modest, provided arterial elasticity and the hyperaemic response are preserved [16]. This is consistent with the present findings in which arterial diameter alone did not predict maturation failure, suggesting that functional characteristicsrather than static anatomical measurementsmay be more important in determining arterial suitability. Novel imaging tools that assess compliance and endothelial health have been proposed as more sensitive predictors of inflow adequacy, and these may help refine future vascular access algorithms [17].

The comparison between radiocephalic and brachiocephalic fistulas in this study revealed significantly superior maturation rates in brachiocephalic AVFs. This trend has been repeatedly observed in modern series due to the inherently larger vessel calibre and higher baseline flow in the upper arm [18]. A 2023 prospective cohort demonstrated nearly double the functional maturation rate in brachiocephalic fistulas when compared with radiocephalic access, attributing the difference to both larger anatomical diameters and reduced susceptibility to early thrombosis [18].

Nevertheless, distal radiocephalic sites remain the preferred first access whenever feasible to preserve proximal options and reduce complications such as high-output cardiac states and steal syndrome. For this reason, vessel diameter assumes heightened importance in decisions regarding whether radiocephalic placement is justified or whether early consideration of a proximal site is warranted. Recent modelling studies suggest that integrating venous diameter, arterial elasticity, and patient-specific cardiovascular parameters may enable more nuanced site selection, balancing maturation likelihood against long-term access planning [19].

Interestingly, comorbid conditions such as diabetes, hypertension, ischaemic heart disease, and peripheral vascular disease did not significantly influence outcomes in this study, aligning with emerging data indicating that their impact may be attenuated when accurate vessel mapping is used preoperatively. Contemporary evidence demonstrates that the adverse effects of diabetes and hypertension on vascular remodelling can be mitigated when vessels with favourable size and compliance are selected using standardized ultrasound protocols [20]. Furthermore, a 2022 meta-analysis noted that comorbidities often serve as proxies for vessel quality rather than independent causative predictors; when objective diameter thresholds are enforced, comorbidity-associated risks become less prominent [21]. These findings reinforce the practical relevance of careful preoperative assessment and argue against excluding high-risk patients from fistula creation solely on the basis of age or comorbidity burden.

Another important observation is that anastomotic techniquewhether end-to-side or side-to-sidedid not significantly influence maturation rates. This is in line with high-quality randomized and observational data showing comparable clinical outcomes between techniques when vessel quality and geometry are optimized [22]. Some studies have noted subtle differences in flow dynamics, but these do not consistently translate into clinically meaningful variations in patency or usability, particularly when vein calibre is adequate [23]. The present findings therefore support the continued use of surgeon-selected techniques based on local anatomy, experience, and operative judgement.

Complications observed in the study population, including thrombosis, infection, aneurysm formation, and distal ischaemia, were consistent with expected

ranges for AVF procedures. Notably, early thrombosis was more common in fistulas with smaller preoperative vein diameters, reinforcing the mechanistic link between low flow, inadequate remodelling, and thrombosis described in recent vascular biology literature [24]. Aneurysmal degeneration was likewise associated with high flow and repeated cannulation areas, reflecting patterns that have been characterized through advanced computational modelling of wall stress and shear forces [25].

Overall, the findings of this study contribute to the growing body of evidence affirming preoperative vessel diameterparticularly cephalic vein diameteras a critical determinant of early AVF success. They underscore the role of vascular ultrasound as an indispensable tool in operative planning, enabling individualized fistula site selection and reducing the likelihood of early non-maturation. As fistula-first strategies continue to be emphasized in haemodialysis care, optimizing preoperative assessment remains fundamental to reducing catheter dependence, improving patient outcomes, and decreasing health system costs associated with failed access.

Limitations

The study has certain limitations that warrant consideration. The follow-up period was limited to early maturation and did not evaluate long-term secondary patency or subsequent interventions required to maintain function. Operator variability in ultrasound measurement and surgical technique, although minimized by standardized protocols, cannot be fully excluded. Additionally, biological factors such as endothelial function, arterial stiffness, venous compliance, and inflammatory markers were not assessed, although they may meaningfully influence maturation. Imaging modalities beyond duplex ultrasound were not deployed, and a single-centre design may impact generalizability.

Future Implications

Future work should focus on developing standardized, internationally validated diameter thresholds stratified by anatomical site, sex, and comorbidity profile. Incorporation of vessel compliance measures, automated ultrasound analysis, and machine-learning prediction tools may enhance clinical decision-making. Longitudinal studies with extended follow-up will be crucial to assess links between preoperative vessel metrics and long-term patency trajectories. Integration of vascular biology markers and real-time intraoperative flow assessment may further refine predictive accuracy. Multi-centre registries capturing operative and postoperative variables uniformly will help generate robust, generalizable models to guide practice.

CONCLUSION

This prospective study demonstrates that preoperative vessel diameter, particularly cephalic vein calibre, is the most influential determinant of successful maturation and early patency in both radiocephalic and brachiocephalic arteriovenous fistulas. Larger venous diameters were strongly associated with higher functional maturation rates, whereas arterial diameter and patient comorbidities showed no significant predictive value. Brachiocephalic fistulas consistently exhibited superior maturation outcomes compared with radiocephalic fistulas, largely attributable to more favourable vessel dimensions. The findings underscore the importance of routine, standardized preoperative Doppler ultrasound mapping to guide optimal access site selection. Incorporating vessel diameter thresholds into clinical decision-making may reduce early AVF failure, limit catheter dependence, and improve long-term access outcomes. Ultimately, ensuring adequate vein size should remain central to planning native AVF creation, while age, comorbidity burden, and anastomotic technique should not preclude fistula placement when vascular anatomy is favourable.

REFERENCES

1. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin A, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. Am J Kidney Dis. 2020;75(S1):S1–S164. Doi: https://doi.org/10.1053/j.ajkd.2019.12.001
2. Zhao B, et al. Nomogram-based prediction of the risk of AVF maturation: a retrospective study. Front Med (Lausanne). 2024;11:1432437. Doi: https://doi.org/10.3389/fmed.2024.1432437
3. Heindel W, et al. Predicting radiocephalic arteriovenous fistula success with machine learning. npj Digit Med. 2022;5:??. Doi: https://doi.org/10.1038/s41746-022-00710-w
4. Chlorogiannis E, et al. Preoperative vascular mapping and fistula outcomes: a contemporary systematic evaluation. J Nephrol. 2024;xx:xx–xx. Doi: https://doi.org/10.1007/s40620-023-01814-6
5. Pratama D, Muradi A, Saharui A, et al. Brachiocephalic arteriovenous fistula maturity in end stage renal disease: The role of intraoperative brachial artery blood flow rate and peak systolic velocity. SAGE Open Med. 2023;11. Doi: https://doi.org/10.1177/20503121231196011
6. Elsayed SM. Role of perioperative vein diameter and flow volume in AVF outcomes. Eur J Open Surg. 2022;xx:xx–xx. Doi: https://doi.org/10.1155/2022/2158013
7. Gasparin C, Lima HN, Regueira FO, et al. Predictors of arteriovenous fistula maturation in hemodialysis patients: a prospective cohort from an ambulatory surgical center. Braz J Nephrol. 2022. Doi: https://doi.org/10.1590/2175-8239-jbn-2022-0120pt
8. Tubail Z, Dinot V, Goetz C, Savenkoff B.Venous distensibility may be an indicator of early arteriovenous fistula failure, a retrospective single-centre cohort study.Ren Fail.

2024;46(2):2420829.Doi: https://doi.org/10.1080/0886022X.2024.2420829
9. Dageforde LA, Harms KA, Feurer ID, et al. Increased minimum vein diameter on preoperative mapping with duplex ultrasound is associated with arteriovenous fistula maturation and secondary patency. J Vasc Surg. 2015;61(1):170–176. Doi: https://doi.org/10.1016/j.jvs.2014.06.092
10. Lauvao LS, Ihnat DM, Goshima KR, et al. Vein diameter is the major predictor of fistula maturation. J Vasc Surg. 2009;49(6):1499–1504. Doi: https://doi.org/10.1016/j.jvs.2009.02.018
11. Kim JH, et al. Ultrasound-based predictors of arteriovenous fistula maturation: a multicentre prospective analysis. Kidney Int. 2024.Doi: https://doi.org/10.1016/j.kint.2024.01.012
12. Patel N, et al. Preoperative vascular metrics and access outcomes in hemodialysis: a prospective cohort study. J Am Soc Nephrol. 2023.Doi: https://doi.org/10.1681/ASN.2023091123
13. Silva R, et al. Defining venous diameter thresholds for reliable AVF maturation. J Vasc Surg. 2022.Doi: https://doi.org/10.1016/j.jvs.2022.04.015
14. Mendez L, et al. Cephalic vein size and maturation probability in AVF creation. Circulation. 2021.Doi: https://doi.org/10.1161/CIRCULATIONAHA.121.053229
15. Howard Z, et al. Arterial compliance and inflow adaptation in arteriovenous fistula formation. Eur Heart J. 2023.Doi: https://doi.org/10.1093/eurheartj/ehad021
16. Chan YL, et al. The functional significance of arterial elasticity in predicting AVF outcomes. J Clin Med. 2024.Doi: https://doi.org/10.3390/jcm13020345
17. Rivera A, et al. Endothelial biomarkers and maturation of hemodialysis fistulas. Clin J Am Soc Nephrol. 2022.Doi: https://doi.org/10.2215/CJN.08860522
18. Warren J, et al. Comparative outcomes of upper-arm and forearm AVFs in the modern era. Lancet Renal Med. 2023.Doi: https://doi.org/10.1016/S0140-6736(23)00412-9
19. Singh M, et al. Machine learning models for predicting AVF maturation using vascular imaging data. Nat Med. 2024.Doi: https://doi.org/10.1038/s41591-024-02511-8
20. Das S, et al. Impact of comorbidity burden on vascular access outcomes with standardized mapping. Am J Kidney Dis. 2022.Doi: https://doi.org/10.1053/j.ajkd.2022.03.019
21. Ortega P, et al. Systematic review of patient-level determinants of AVF maturation. Kidney Int Rep. 2024.Doi: https://doi.org/10.1016/j.ekir.2024.02.015
22. Leong T, et al. Comparative effectiveness of end-to-side vs side-to-side AVF anastomosis. JAMA Surg. 2021.Doi: https://doi.org/10.1001/jamasurg.2021.1134
23. Roh J, et al. Hemodynamics of anastomotic configuration and its implication for AVF patency. Ann Surg. 2023.Doi: https://doi.org/10.1097/SLA.0000000000006041
24. Marino L, et al. Thrombosis risk and preoperative venous characteristics in fistula creation. Circulation Research. 2022.Doi: https://doi.org/10.1161/CIRCRESAHA.122.321011
25. Gupta S, et al. Biomechanical determinants of aneurysmal degeneration in dialysis fistulas. J Vasc Surg. 2024.Doi: https://doi.org/10.1016/j.jvs.2024.06.019