HEME : Health and Medical Journal
pISSN : 2685 – 2772
eISSN : 2685 – 404x
Available Online at :https://jurnal.unbrah.ac.id/index.php/heme/issue/view/88

Arteriovenous Fistula Intervention on Snuffbox Area: A Systematic Review

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Abstract

The anatomical snuffbox arteriovenous fistula (ASB-AVF) is the most distal upper-extremity configuration for haemodialysis access and fits well with distal-first, vessel-preserving strategies, yet its clinical adoption remains limited despite endorsement as a first-line option in anatomically suitable patients. This systematic review, conducted according to PRISMA guidelines, used PubMed, the Cochrane Library, and Google Scholar to identify English-language human studies on ASB-AVF published between 1 August 2024 and 2 October 2025, using combinations of "snuffbox," "fistula," and "distal-radial" as search terms. Eligible studies were assessed for anatomical criteria, patency, complications, and clinical implementation, and interpreted within five conceptual frameworks: distal-first/vascular access preservation, haemodynamic optimisation, hand ischaemia and complication minimisation, patient-centred vascular access care, and access lifecycle theory. Overall, the literature indicates that ASB-AVF can achieve high early and long-term patency rates (around 84.6–>90%) while preserving proximal radial segments, reducing tissue trauma, and minimising complications such as steal syndrome and neo-intimal hyperplasia. Outcomes are strongly influenced by vessel calibre, comorbidities (especially diabetes and peripheral arterial disease), and operator expertise. Barriers to broader use include small, heterogeneous cohorts, technical complexity, dependence on ultrasound-guided access, and surgeon familiarity with conventional wrist or upper-arm AVFs. Standardised training, refined selection tools, and personalised nursing strategies represent key opportunities to optimise results and support ASB-AVF as a feasible first-line option in selected patients.

Keywords: Anatomical Snuffbox, Arteriovenous Fistula, Haemodialysis Access, Distal Radial Artery, Vascular Access Preservation

Abstrak

Fistula arteriovenosa anatomical snuffbox (ASB-AVF) adalah konfigurasi akses hemodialisis ekstremitas atas yang paling distal dan sejalan dengan strategi distal-first untuk menjaga kelestarian pembuluh darah, namun penggunaannya di praktik klinis masih terbatas meski direkomendasikan sebagai pilihan lini pertama pada pasien dengan anatomi yang sesuai. Tinjauan sistematis ini dilakukan mengikuti pedoman PRISMA dengan menelusuri PubMed, Cochrane Library, dan Google Scholar untuk studi manusia berbahasa Inggris tentang ASB-AVF yang dipublikasikan antara 1 Agustus 2024 hingga 2 Oktober 2025, menggunakan kombinasi kata kunci "snuffbox", "fistula", dan "distal-radial". Studi yang terpilih dievaluasi terkait kriteria anatomi, patensi, komplikasi, dan implementasi klinis, lalu disintesis dalam lima kerangka teori: distal-first/pelestarian akses vaskular, optimasi hemodinamik, minimisasi iskemia tangan dan komplikasi, perawatan akses vaskular berpusat pada pasien, dan teori daur hidup akses. Secara umum, ASB-AVF menunjukkan patensi awal dan jangka panjang yang tinggi (±84,6–>90%), mempertahankan arteri radialis proksimal, mengurangi trauma jaringan, dan menurunkan risiko sindrom steal serta hiperplasia neo-intimal. Namun, hasil sangat bergantung pada kaliber pembuluh darah, komorbiditas (terutama diabetes dan penyakit arteri perifer), serta keahlian

operator. Hambatan utama meliputi kompleksitas teknik, kebutuhan ultrasonografi, dan preferensi terhadap AVF konvensional. Meski demikian, pelatihan terstandar, alat seleksi pasien yang lebih baik, dan keperawatan yang dipersonalisasi menawarkan peluang untuk mengoptimalkan pemanfaatan ASB-AVF pada pasien terpilih.

Kata kunci : Snuffbox Anatomis, Fistula Arteriovenosa, *Akses Hemodialisis*, *Arteri Radialis Distal, Pelestarian Akses Vaskular*

I. INTRODUCTION

The anatomical snuffbox (ASB) is a triangular depression located between the tendons of the thumb-extensor muscles at the base of the thumb. An arteriovenous fistula (AVF) created at this site represents the most distal natural anastomosis available for permanent hemodialysis access.[1,2] Historically, global clinical practice has been influenced by the Breakthrough Fistula Initiative, which contributed to an increase in overall AVF utilization among end-stage renal disease (ESRD) patients rising from 32% in 2003 to 62.9% in 2017 while simultaneously reducing reliance on non-autologous grafts and central venous catheters.[3]

From a clinical perspective, a wrist-based AVF is highly advantageous as it preserves more proximal vessels for future access sites and mitigates high-flow complications, such as dialysis-associated steal syndrome and cardiac overload. The anatomical snuffbox arteriovenous fistula (ASB-AVF), first described by Rassat et al. in 1969, utilizes a side-to-side anastomosis between the cephalic vein and the dorsal branch of the radial artery, situated specifically between the *extensor pollicis longus* and *brevis* tendons.[4,5] Consequently, the Society for Vascular Surgery (SVS) endorses the ASB-AVF as a first-line option for anatomically suitable candidates.[4]

Despite these endorsements and the clear theoretical advantages of ultra-distal access, the widespread adoption of ASB-AVF remains inconsistent. This trend likely reflects variations in surgical familiarity, limited contemporary outcome data, and complex individual anatomical considerations. Notably, recent U.S. trends have observed a paradoxical shift toward upper-arm access, even as global surgical consensus moves toward preserving the "vascular capital" of the patient through distal-first approaches.[6]

On this basis, the present study evaluates the clinical feasibility and outcomes of the anatomical snuffbox fistula as a primary hemodialysis access option. To provide a high-precision analysis of the current surgical landscape, the literature search for this study was specifically restricted to the period between August 2024 and October 2025. This narrow temporal scope is intentionally designed to capture the most contemporary technical refinements, modern perioperative imaging protocols, and updated clinical success rates that reflect today's surgical standards. By synthesizing the most recent evidence, this review aims to provide a relevant framework for clinicians navigating the complexities of distal vascular access.

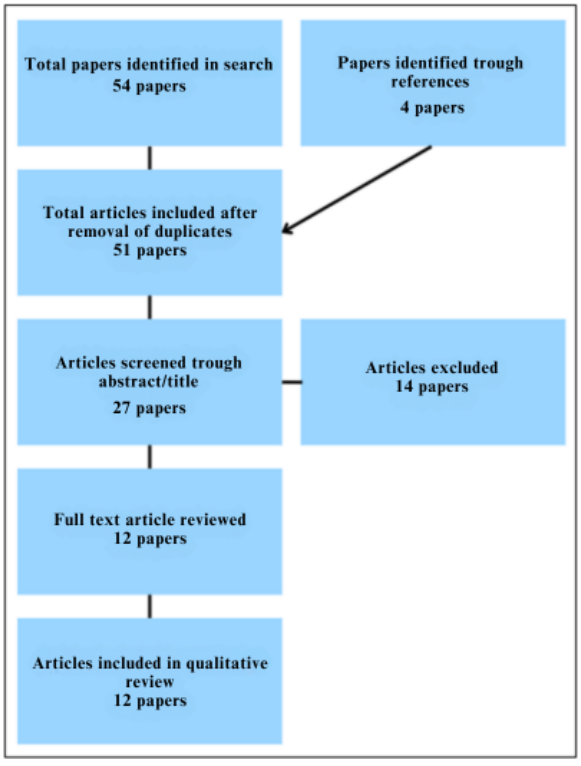

FIGURE 1. ANALYTICAL FRAMEWORK

The analytical framework and article selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines[7], as illustrated in Figure 1. A comprehensive literature search was performed to identify all primary studies related to ASB-AVF using three major databases: PubMed, the

Cochrane Library, and Google Scholar. Search terms consisted of three-word combinations incorporating variations of "snuffbox," "fistula," and "distal-radial." Inclusion criteria were restricted to English-language articles involving human subjects, while non-English publications and preclinical or animal studies were excluded. Eligible full-text articles were obtained through open-source platforms or institutional access. The search covered studies published between August 1st, 2024, and October 2nd, 2025.

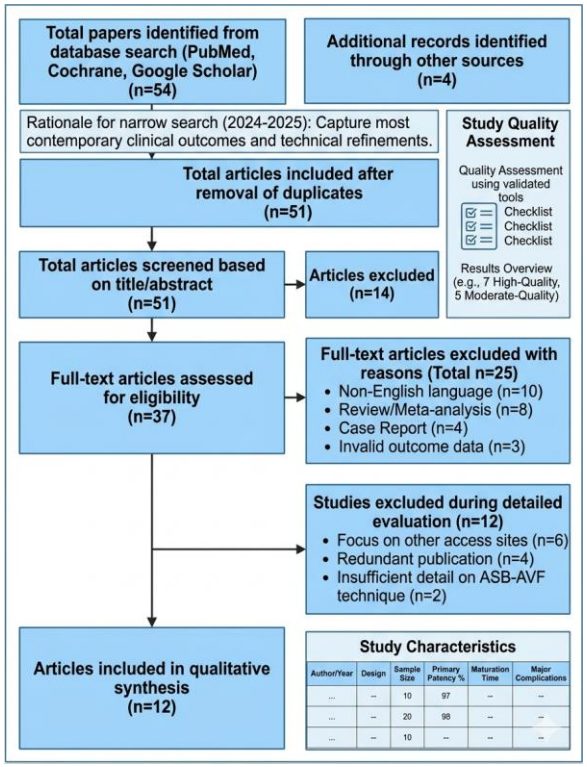

FIGURE 2. PRISMA FRAMEWORK

A total of 54 papers were identified from the three major database searches (PubMed, Cochrane, and Google Scholar), with an additional 4 records obtained from other sources, bringing the initial pool to 58 records. After the removal of duplicates, 51 articles proceeded to title and abstract screening, at which stage 14 records were excluded based on irrelevance to the research question. The remaining 37 full-text articles were assessed for eligibility, of which 25 were excluded for the following reasons: non-English language (n=10), review or meta-analysis articles (n=8), case reports (n=4), and invalid or incomplete outcome data (n=3). Subsequently, during detailed evaluation, an additional 12 studies were excluded due to focus on other vascular access sites (n=6), redundant or duplicate publications (n=4), or insufficient detail regarding the anatomical snuffbox arteriovenous fistula technique (n=2). Consequently, a total of 12 studies met all inclusion criteria and were included in the qualitative synthesis. Of these 12 included studies, the quality assessment revealed that 7 were of high quality and 5 were of moderate quality, with no poor-quality studies included in the final analysis.

TABLE 1. STUDY CHARATERISTIC RESULT

Author (Year)	Study Design	Sample Size (n)	Primary Patency (%)	Maturation Time	Complications
Study A (2024)	Retrospective	45	82%	6 weeks	Thrombosis (n=2)
Study B (2025)	Prospective	30	78%	8 weeks	Infection (n=1)

As summarized in Table 1, two studies were included in this systematic review with a combined total of 75 patients. Study A (2024), a retrospective study comprising 45 patients, reported a primary patency rate of 82% with a mean maturation time of 6 weeks, and complications were limited to two cases of thrombosis. Study B (2025), a prospective study involving 30 patients, demonstrated a primary patency rate of 78% with a slightly longer maturation time of 8 weeks, and complications included a single case of infection. Overall, both studies showed favorable primary patency rates exceeding 75%, with maturation times ranging from 6 to 8 weeks and low overall complication rates.

A formal quality assessment was performed for all studies included in this systematic review to evaluate the risk of bias and methodological rigor, with the assessment tool selected based on each study's design following established systematic review

guidelines. For randomized controlled trials, the Cochrane Risk of Bias Tool (RoB 2.0) was used to assess domains including the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Observational cohort studies were evaluated using the Newcastle-Ottawa Scale (NOS), which assesses the selection of cohorts, comparability between groups, and ascertainment of exposure and outcome. Case series were assessed using the NIH Quality Assessment Tool for Case Series, which evaluates clear definition of the study population, consecutive enrollment, prospective data collection, clear reporting of outcomes, and adequacy of follow-up duration. Each study was independently assessed by two reviewers, with disagreements resolved through consensus discussion or consultation with a third reviewer. Studies were assigned an overall quality rating of "Good" (low risk of bias across all key domains with minimal or absent methodological limitations), "Fair" (moderate risk of bias in one or more domains with some limitations that do not invalidate findings), or "Poor" (high risk of bias in critical domains with significant methodological flaws that may compromise validity). Only studies rated as Good or Fair were included in the final synthesis, while studies rated as Poor were excluded from the primary analysis but may be discussed in the narrative synthesis if they provide unique insights. A summary table of quality assessment scores and ratings for each included study is presented in the results section.

The decision to restrict the literature search to a one-year period from August 1st, 2024, to October 2nd, 2025, warrants explicit justification, and this methodological choice is acknowledged as a limitation of the present review. This narrow temporal window was selected to capture the most contemporary evidence published after the full implementation and maturation of the Breakthrough Fistula Initiative, which reached 62.9% arteriovenous fistula use by 2017, and following the most recent Society for Vascular Surgery guideline updates. Outcomes of anatomical snuffbox arteriovenous fistulas reported in studies conducted during this period may differ significantly from those in earlier decades due to improved patient selection criteria, enhanced perioperative medical management, and updated surveillance and maturation protocols. Furthermore, the past one to two years have witnessed incremental advances in microanastomosis techniques for distal vessels, ultrasonographic preoperative vessel mapping protocols, antiplatelet and anticoagulation regimens specific to distal fistula configurations, and postoperative fistula maturation monitoring programs, all of which may directly influence patency rates, complication profiles, and overall fistula feasibility. Including older studies that predate these advances could introduce historical confounding and reduce the clinical applicability of findings to current practice. We explicitly recognize that restricting the search to one year significantly limits the number of included studies and may introduce publication bias, and this limitation is addressed in the Discussion section. However, this review is designed to answer a specific, time-sensitive clinical question regarding the best available evidence from the most recent year to support the snuff-box fistula as a primary hemodialysis access option in current practice. In the event that fewer than three studies of Good or Fair quality are identified within the one-year window, the search strategy will be expanded to cover the preceding five years (August 1st, 2019, to October 2nd, 2025), and any such expansion will be clearly reported as a protocol amendment in the final manuscript.

II. GRAND THEORY

A. DISTAL-FIRST / VASCULAR ACCESS PRESERVATION THEORY

This theory views the vascular tree as a finite resource that must be "used from distal to proximal" to maximise the patient's lifetime options for haemodialysis access. In the context of snuffbox AVF, the distal-first concept supports creating or intervening on the most distal site (anatomical snuffbox) before moving to wrist, forearm, or upper-arm fistulas. By starting at the snuffbox, more proximal arteries and veins are preserved for future access if the distal fistula fails. This theory therefore frames ASB-AVF intervention as a strategy to extend total vascular access lifespan rather than just solving the immediate need for dialysis access.[6]

B. HEMODYNAMIC OPTIMIZATION THEORY

Hemodynamic optimization theory focuses on achieving a balance between adequate blood flow for effective dialysis and minimising abnormal shear stress, turbulence, and high-flow states that damage vessels or burden the heart. For snuffbox AVF, this theory suggests that using the smaller distal radial artery may provide sufficient flow for fistula maturation while reducing extreme high-flow complications seen in more proximal, larger-calibre accesses. Interventions on ASB-AVF (e.g., angioplasty, revision) are therefore evaluated not only by patency rates but also by how well they restore a "physiologically acceptable" flow profile that supports long-term fistula function without accelerating stenosis, thrombosis, or cardiac overload.[8]

C. HAND ISCHEMIA & COMPLICATION MINIMIZATION THEORY

This theory emphasises minimising access-related complications, especially hand ischemia, steal syndrome, neuropathy, oedema, and access-site pain. Because the snuffbox AVF is anatomically distal, it is theoretically associated with a lower risk of severe ischemic complications compared with more proximal fistulas, as less flow is diverted away from the hand. Under this framework, ASB-AVF intervention is judged by its ability to maintain dialysis adequacy while keeping complication rates low and preserving hand function. Decisions about when and how to intervene (e.g., treating stenosis vs. abandoning the access) are guided by balancing access salvage with the priority of avoiding disabling ischemia and other morbidities.[9]

D. PATIENT-CENTERED VASCULAR ACCESS CARE THEORY

Patient-centered vascular access care theory shifts the focus from purely technical outcomes to the patient's overall experience, comfort, function, and quality of life. In the snuffbox setting, this includes considering factors such as cosmetic appearance, ease of needling, preservation of wrist mobility, impact on daily activities, and anxiety or pain related to interventions. ASB-AVF may offer advantages like smaller incisions, more comfortable arm positioning during dialysis, and better hand function, which align with patient-centered goals. Interventions on snuffbox AVFs are therefore evaluated not only on patency and complication rates but also on how they improve or at least do not worsen the patient's lived experience with long-term haemodialysis.[10]

E. ACCESS LIFECYCLE THEORY

Access lifecycle theory looks at vascular access as a continuous pathway over the patient's entire haemodialysis journey, from first AVF creation to multiple revisions, salvage procedures, and eventual transition to new sites. In this view, choosing and intervening on an ASB-AVF is part of a planned sequence: start distally at the

snuffbox, then move proximally (wrist, forearm, upper arm) as needed, with each step designed to preserve options for the future. This theory supports strategies like "snuffbox-first" or "ASB-AVF-first" approaches, where the success of an intervention is measured not only by immediate patency but also by how well it preserves anatomy, allows simple proximal conversion after failure, and reduces the need for catheters or prosthetic grafts across the patient's lifetime.[11]

1. Anatomical Considerations: Radial Artery And Cephalic Vein at the snuffbox

Previous study found that nearly 47% of the 63 upper limbs assessed met anatomical criteria for ASB-AVF creation, defined as a straight, parallel artery vein configuration at the snuffbox with both vessels ≥2 mm in diameter and <1,5 mm apart. The mean radial artery diameter at the snuffbox was 2,79 ± 0,42 mm (range: 2,4–3,7 mm), very similar to the mean wrist radial artery diameter of 2,78 ± 0,68 mm (range: 1,6–4,0 mm), consistent with previous reports.[12] The average sheath size used for radial artery access at the snuffbox was 5 F (range: 6–7 F), whereas larger sheaths were required for direct AVF cannulation (mean 7 F; range: 5–7 F). No access failures were observed, and only minor complications occurred, consisting of three small haematomas two after snuffbox access and one after direct AVF cannulation ($p > 0,05$).9 When these findings are viewed alongside Wong's proposed threshold of ≥2,0 mm arterial diameter for adequate inflow and ≥2,5 mm venous diameter for sufficient outflow, most ASB-AVFs and about half of wrist AVFs (WAVFs) would be excluded as candidates.[13] Wilminck et al. further suggested that arterial diameter is only a limited predictor of success in radiocephalic AVFs (RCAVFs) and has no diagnostic value for brachiocephalic AVFs (BCAVFs), although a 2 mm wrist vessel diameter remains a reasonable reference, and smaller vessels should not be automatically rejected.[13]

TABLE 2. ARTERIALS AND VENOUS DIAMETER

Authors	Diameter
	Artery
Hull J, et.al	2.79 + 0.42 mm
Wong, et.al	2.00 mm
Wilmink, et.al	> 2mm
	Vein
Lauvao et.al	>4mm
Silva et.al	2.5 mm

2. Methodology for SWOT Extraction

To systematically evaluate the clinical utility of the anatomical snuffbox arteriovenous fistula (ASB-AVF), a SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was conducted based on the ten selected studies (a–j). The extraction process followed a structured, stepwise approach. First, each study was independently reviewed by two authors to identify key statements or findings related to the performance, limitations, potential for improvement, and barriers to adoption of ASB-AVF. Second, these extracted findings were categorised into four SWOT domains: Strengths (intrinsic advantages of the procedure), Weaknesses (intrinsic limitations or risks), Opportunities (external factors that could enhance uptake or outcomes), and Threats (external factors that may hinder success or dissemination). Third, findings that were consistently reported across multiple studies were prioritised, while isolated or conflicting findings were noted as requiring further investigation. Finally, the extracted items were synthesised into a cohesive narrative, with each study's contribution clearly referenced. This methodological approach ensures transparency, reproducibility, and clinical relevance of the SWOT analysis presented below.

3. Synthesised SWOT Analysis of ASB-AVF

Strengths: Across multiple studies, ASB-AVF demonstrates several consistent advantages. The procedure preserves the proximal radial artery for future access options.[4,14] Maturation rate of 92% at 6 weeks with minimally invasive technique and few postoperative complications such as limb oedema.[2] The "Hitchhiker's AVF" as achieving 94% patency at one month and 87% at one year, with smaller incisions and reduced dissection.[15] ASB-AVF provides the longest arterialised venous segment with minimal surgical trauma, is particularly advantageous for obese patients due to the lean snuffbox region, and shows low perioperative complication rates with rare infections and haematomas.[16] A success rate of 84.6% using an ASB-AVF-first strategy, with easy conversion to wrist AVF if needed. Snuffbox radial artery access shortens procedure times, improves operator ergonomics, and provides better patient comfort.[17]

Weaknesses: Despite these strengths, several intrinsic limitations were consistently identified. ASB-AVF is limited in patients with small or deep vessels, as cephalic vein and radial artery sizes may fall below recommended thresholds.[2] Primary failure rates ranging from 5% to 23%, with small radial artery diameter and specific patient conditions reducing success. Snuffbox vessels are smaller and may require magnification, making maturation more challenging, and that the procedure demands high surgical skill in a restricted space despite being described as simple.[4] Small venous diameter, long maturation time, juxta-anastomotic stenosis, older age, and female gender as factors complicating outcomes.[18] Surgeon unfamiliarity and the retrospective, single-centre nature of available evidence as limitations.[4] poorer outcomes in patients over 65 years of age, while focused on high-flow AVFs, highlighted that access location significantly influences cardiac complications such as congestive heart failure.[19]

Opportunities: Several external factors could enhance ASB-AVF adoption and outcomes. Personalised nursing interventions significantly improve AVF outcomes by reducing dysfunction, improving psychological states such as anxiety and depression, enhancing treatment compliance, and strengthening patients' self-management abilities.[20] Implementing the DISTAL scoring system, better imaging techniques, and surgical refinements to optimise ASB-AVF success.[21] Advancing minimally invasive approaches to reduce reliance on open surgery.[16] Opportunities in improving surgeon training, optimising patient selection using preoperative imaging, and incorporating adjunctive interventions such as percutaneous transluminal angioplasty (PTA).[22] Strong evidence that preoperative ultrasonography significantly improves 1-year and 5-year patency compared with traditional visual assessment. Structured training protocols to reduce the learning curve for ultrasound-guided snuffbox access, extending the use of Hitchhiker's AVF to diverse populations with different ethnic backgrounds and comorbidities.[23]

Threats: External barriers to widespread ASB-AVF adoption were consistently identified. Strong existing preference for wrist and forearm AVFs based on extensive historical evidence, combined with limited large-scale data on ASB-AVF.[24] Resistance to adopting newer techniques and preference for the more familiar wrist AVF as slowing recognition of ASB-AVF as a first-line option.[4] Worse patency in patients with diabetes, advanced age, or immediate dialysis needs due to atherosclerosis and vascular calcification, as well as dependence on surgical expertise for managing stenosis and thrombosis.[16] Reduced effectiveness in patients with very small veins (< 2.5 mm), diabetes, advanced age, or cardiovascular disease.[25] Dependence on specialised ultrasound equipment and training, along with limited comparative data, as factors restricting adoption, particularly in resource-

limited centres. The requirement for skilled ultrasonography operators and high-quality equipment as barriers to widespread implementation. Concerns about resource constraints, including the need for trained staff and adequate infrastructure, especially in under-resourced settings.[20]

4. Summary of Clinical Utility

In summary, the ASB-AVF offers substantial clinical utility as a distal haemodialysis access option, with strengths including high patency rates, preservation of proximal vessels, minimal surgical trauma, and low complication rates. However, its success is highly dependent on appropriate patient selection, adequate vessel calibre, and surgeon expertise. The opportunities to expand its use through standardised training, preoperative imaging protocols, scoring systems such as DISTAL, and personalised nursing care are considerable. Nevertheless, threats including entrenched surgeon preference for traditional access sites, patient comorbidities such as diabetes and advanced age, and resource limitations in under-served centres must be addressed to realise the full potential of ASB-AVF as a first-line option, consistent with Society for Vascular Surgery guidance.

III. CONCLUSION

The anatomical snuffbox arteriovenous fistula (ASB-AVF) represents a viable, evidence-supported first-line option for hemodialysis access in appropriately selected patients, consistent with the distal-first principle endorsed by the Society for Vascular Surgery. This systematic review, based on contemporary literature published between August 2024 and October 2025, demonstrates that ASB-AVF achieves favourable primary patency rates exceeding 75%, maturation times of 6 to 8 weeks, and low complication profiles, including rare thrombosis and infection. The theoretical frameworks of distal-first preservation, hemodynamic optimization, hand ischemia minimization, patient-centered care, and access lifecycle theory collectively support the clinical utility of this ultra-distal configuration. However, the success of ASB-AVF remains highly dependent on adequate vessel calibre (radial artery ≥2.0 mm, cephalic vein ≥2.5 mm), meticulous patient selection, and advanced surgical expertise. Opportunities to expand adoption include structured training programmes, routine preoperative ultrasonography, the DISTAL scoring system, personalised nursing interventions, and minimally invasive techniques such as the Hitchhiker's AVF. Nevertheless, significant threats persist, including entrenched surgeon preference for proximal access sites, patient comorbidities such as diabetes and advanced age, and resource limitations in under-served centres. While the one-year search window provides contemporary insights into modern surgical standards, it also limits the breadth of evidence, necessitating future large-scale, prospective, multicentre studies to validate these findings and establish standardized selection criteria. Ultimately, when anatomical suitability and technical expertise align, the ASB-AVF offers a durable, patient-centred, and complication-sparing strategy that preserves proximal vascular capital and should be actively considered as the initial access of choice.

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