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Back to Basics: Types and Anatomic Variants in Vascular Access

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Vascular access for hemodialysis remains the cornerstone of long-term renal replacement therapy, and its success critically depends on a thorough understanding of vascular anatomy and its variations. This review revisits the fundamental types of arteriovenous access and highlights key anatomic variants that influence access selection, creation, and outcomes. Arteriovenous fistulas (AVFs), particularly radiocephalic and brachiocephalic configurations, are the first-line choice due to their superior patency and lower complication rates. The transposed basilic AVF serves as an important secondary option, particularly when superficial veins are unsuitable. Each AVF type presents a characteristic risk profile, with juxta-anastomotic stenosis being a common maturation failure point in distal AVFs, while cephalic arch stenosis and high-flow access are more prevalent in upper arm fistulas. When native AVFs are not feasible, arteriovenous grafts (AVGs) offer viable alternatives. Configurations such as brachio-basilic, brachio-cephalic, and brachio-brachial looped AVGs provide flexibility in complex anatomies. However, AVGs are inherently more prone to venous outflow stenosis, thrombosis, infection, and pseudoaneurysm formation, particularly in cases with limited cannulation zones. Straight or curved upper arm grafts, often reserved as last-resort options in common practice, further underscore the importance of detailed preoperative planning. Outflow venous anatomy, including the central venous pathway, also plays a crucial role. Anomalies such as bifid cephalic arch, and early convergence of brachial and basilic veins may complicate access creation or increase complication risk. Underlying venous thoracic outlet stenosis or external compression of the left brachiocephalic vein can also become problematic following arteriovenous access creation. High bifurcation of the brachial artery, found in up to 12.3% of patients, can alter inflow dynamics and surgical strategy. Preoperative ultrasound vein mapping, knowledge of functional segments (inflow, anastomosis, cannulation segment, outflow, and central vein), and vigilant recognition of clinical indicators—such as arm swelling, prolonged hemostasis, and abnormal thrill or bruit—are indispensable in optimizing VA outcomes. These

principles guide both surgical planning and endovascular management, including percutaneous angioplasty and thrombectomy, which must be tailored to the individual's vascular anatomy and type of access. In summary, understanding the spectrum of vascular access types and anatomical variants is essential for nephrologists, surgeons, and interventionalists. A back-to-basics approach reinforces the anatomical knowledge required to tailor access strategies to individual patients, thereby improving access longevity and dialysis efficacy.

Keywords: Hemodialysis, Arteriovenous fistula, Anatomy, Ultrasound, Angioplasty