Vascular Suitability for an Endovascular Arteriovenous Fistula: Getting Beyond the Velvet Rope

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Two endovascular arteriovenous fistula (endoAVF) devices are available, and both are designed to utilize vascular anatomy in the proximal forearm, making it necessary to assess the upper extremity vasculature preoperatively using ultrasound in order to determine patient suitability. The WaveLinQ and Ellipsys devices create the arteriovenous anastomosis by different techniques and at slightly different locations (1,2). Yet, in order for a patient to be considered a suitable candidate for endoAVF creation, specific anatomic criteria must be met. Both approved devices require that the deep communicating vein (perforator vein) in the proximal forearm, which serves as the “bridge” between the deep and upper-arm superficial target veins, be patent and have a minimum diameter.

The WaveLinQ endoAVF device is a dual magnet-lined catheter system that uses radiofrequency energy to create an anastomosis between the ulnar artery and adjacent ulnar vein, or the radial artery and adjacent radial vein. The brachial vein and brachial artery are each cannulated (or the radial artery and radial vein are accessed), and under fluoroscopic guidance, the magnetic catheters in each vessel are aligned, attracting one another, and a radiofrequency electrode is released, creating a side-to-side anastomosis. After creation of the anastomosis, the brachial vein is coil embolized to direct flow to the upper-arm superficial veins (2).

The Ellipsys endoAVF device is a single-catheter system that uses thermal energy to create an anastomosis between the proximal radial artery and the perforator vein in the proximal forearm. Under ultrasound guidance, a single, retrograde venous puncture is made in the median basilic or median cephalic vein and traverses through the perforator vein and the adjacent proximal radial artery, where a guidewire and sheath are placed. The Ellipsys catheter is then inserted, and the device is advanced and positioned to capture the perforator vein and radial artery together, followed by activation of the device to create a side-to-side anastomosis. Balloon angioplasty is then performed at the anastomosis and within the perforator vein (1).

In this issue of *Kidney360*, Al-Balas *et al.* focus on an initial step of determining endoAVF patient selection: vascular suitability. The authors selected a cohort of ESKD and CKD patients who met pre-established vascular eligibility for a surgical AVF and, among this cohort, determined the proportion of those patients who also had vascular suitability for a WaveLinQ endoAVF creation while examining patient characteristics associated with suitability. Vascular suitability was determined by measuring inflow artery diameter of $\geq 2$ mm, a target vein diameter of $\geq 2.5$ mm, and absence of stenosis or thrombosis of the artery or draining vein with duplex ultrasound vessel mapping. The eventual type of AV access selected, complications, AV access usability, and the number of assisted maturation procedures were not ascertained.

This retrospective single-center study examined data collected between March 2019 and March 2021, and the authors found that 51% of patients had suitable vasculature for a surgical AVF in the upper or lower arm. Among these, 63% also had suitable anatomy for a WaveLinQ endoAVF (32% of all patients). The most common factor limiting WaveLinQ device suitability was inability to identify the perforator vein. The authors also found that younger, non-Black patients had vasculature more likely to be suitable for a WaveLinQ endoAVF, and that more patients <60 years of age had suitable perforator veins compared with those >60 years old.

Notably, the average age of those qualifying for a WaveLinQ endoAVF was 55 years—substantially lower than the average age of incident dialysis patients in the United States. Similarly, the average patient age was 51 years among patients in the FLEX study, which evaluated the safety and efficacy of the initial version of the WaveLinQ device (3), suggesting that patient age may play an important role in patient selection and outcomes. It is also interesting to note that 49% of all patients undergoing vessel mapping in this study were not suitable for any type of AVF, demonstrating that approximately one-third of patients undergoing vessel mapping may qualify for a WaveLinQ endoAVF on the basis of anatomic criteria, and that 60% of patients with vasculature suitable for a surgical AVF are also potential WaveLinQ endoAVF candidates. Understanding that 30 of 100 patients may
be eligible for an endoAVF may be useful to guide centers as they determine whether to initiate an endoAVF program.

Yet, several additional elements are important for both successful device use and future endoAVF usability. While the perforator vein and target vein and artery may meet diametric eligibility, the access sites from which the devices are passed may not be suitable, in the case of the Wave-LinQ device, or the course of the perforator for ultrasound-guided endoAVF may not be suitable (i.e., tortuous), in the case of the Ellipsys device. In addition, the diameter and flow of the upper-arm deep brachial veins must be considered because flow alterations can occur after endoAVF creation, resulting in disproportionately more drainage to the deep venous system rather than the superficial system, which may necessitate additional procedures to redirect flow to the superficial veins.

In terms of physiologic AVF maturation, several previous studies suggest that endoAVF successfully mature, typically with repeated angioplasty of the endo-anastomosis, and that when compared with surgical AVFs, are comparable with regard to technical success, access volume flow, and time to maturation (5). Moreover, creation of an endoAVF does not necessarily preclude the later creation of a surgical AVF (6)—an important consideration when evaluating long-term vascular access options and developing the ESKD life plan.

Another important consideration is the accessibility of the endoAVF cannulation segment. Given the variability of patient body mass index in the United States, the depth of the superficial cephalic and basilic veins may necessitate secondary surgical procedures such as superficialization or lipectomy to allow for successful cannulation. Further, competing outflow veins may require additional procedures, such as coiling, banding, or ligation, that redirect flow to the superficial veins and require a skilled interventionalist and/or dedicated dialysis access surgeon.

In areas where dialysis access surgeons are limited, an endoAVF approach by the nephrologist could be an excellent first step during the pre-ESKD period. However, the need for surgical procedures to make the access useable is not infrequent, and nonsurgical providers engaging in endoAVF creation need to practice in a network where surgical procedures can be scheduled in a collaborative fashion.

Of all of the considerations, cannulation is the most challenging aspect of endoAVF use. Many endoAVFs have dual outflow rather than the single-vessel flow of a surgical AVF, so, they appear different and are less pressurized, making palpation more challenging. The cannulation zone is frequently no longer in the distal arm or upper arm but at the antecubital cephalic and basilic veins, necessitating proper education of dialysis unit personnel regarding tourniquet use, needle angle, arm positioning, and delineation of the designated target vessels. It is recommended that a “cannulation map” be made in advance of cannulation, detailing the cannulation sites, blood-flow direction, and vessel depth, which can be made available to the dialysis unit staff and placed in the patient's medical record (7). Before cannulation, ultrasound should be used to mark the cannulation target sites in order to guide the expert cannulator for the first few cannulations. Ultimately, the adoption of endoAVF is dependent on successful cannulation.

Overall, where do endoAVFs fall in the access algorithm if a patient is a candidate for both a surgical and endoAVF as evidenced by this study? Should 32% of all hemodialysis patients receive an endoAVF? Standard practice has been to use an access algorithm strategy on the basis of physical and ultrasound examinations to determine the appropriate anatomy, while conserving forearm sites whenever possible, starting distally. The appropriate place of the endoAVF in this algorithm has yet to be determined, and some have suggested that they are a reasonable second choice in the succession algorithm, with a distal forearm AVF still preferred as first choice (8). However, top of mind is individualizing AV access according to the patient’s ESKD life plan.

Several questions remain. To date, the predictive value of the established vascular criteria is not known. Even when minimal vessel diameter criteria have been established for ultrasonography and used to select patients for AVF creation, these have limitations, as evidenced by the poor AVF maturation rates reported in the DAC study (9). The dialysis community will certainly benefit from results of ongoing post-market studies of both Food and Drug Administration-approved devices, which will inform us about necessary maintenance interventions, time to cannulation, and cannulator experience.

Overall, endoAVFs represent an exciting new innovation, and we look forward to study results that assist us all in determining their proper place.

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Author Contributions

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References


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