

From the Society for Vascular Surgery

## Preoperative point-of-care ultrasound and its impact on arteriovenous fistula maturation outcomes

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### ABSTRACT

**Objective:** Duplex ultrasound as a preoperative assessment tool in the clinic may help identify anatomic factors predictive of fistula maturation. Preoperative point-of-care ultrasound (POCUS) offers surgeons an alternative to routine formal vein mapping as it can be performed by the operator during the initial clinic visit. We sought to determine the impact of POCUS as an adjunct to physical examination on arteriovenous fistula maturation.

**Methods:** All consecutive patients undergoing first-time dialysis access creation from December 2007 to December 2014 were retrospectively reviewed. Surgeons who routinely use POCUS to assess preoperative maximal vein diameter and quality were compared with surgeons who relied only on physical examination. All access and patency definitions were in accordance with the Society for Vascular Surgery's reporting standards. The effects of POCUS on fistula maturation rate and fistula abandonment were analyzed using logistic regression, controlling for comorbidities of the patient, anticoagulant use, and location of fistula.

**Results:** A total of 316 patients were included in the study; 250 patients were assessed exclusively with physical examination, and 66 patients underwent preoperative ultrasound examination by the vascular surgeon in the clinic. The primary failure rate in the ultrasound group was 18% compared with 47% ( $P < .001$ ) in the group of patients who did not undergo ultrasound examination. In patients without preoperative ultrasound, there were higher rates of new access creation (31% vs 9%;  $P < .001$ ) and fistula abandonment (66% vs 39%;  $P < .001$ ). Multivariable analysis demonstrated that fistulas created without preoperative ultrasound were associated with a 3.56 greater risk of failure (95% confidence interval, 1.67-7.59;  $P = .001$ ) compared with fistulas in the POCUS group. Similarly, the rate of fistula abandonment was 2.63 times higher (95% confidence interval, 1.38-5.05;  $P = .003$ ) when ultrasound was not used preoperatively. Time to functional fistula maturation was better in the ultrasound group ( $P < .001$ ). At 1 year, 12% of fistulas in the ultrasound group and 32% in the clinical examination group had yet to be cannulated. Secondary patency at 1 year was better in the POCUS group at 73% compared with 59% in the group with no preoperative ultrasound ( $P = .01$ ).

**Conclusions:** POCUS as an adjunct to physical examination for dialysis access patients leads to decreased rates of primary failure, new access creation, and fistula abandonment compared with patients who undergo only physical examination. Ultrasound examination improved times to functional fistula maturation and secondary patency. Further studies are required to compare POCUS with formal preoperative vein mapping for arteriovenous fistula planning. (J Vasc Surg 2018;■:1-9.)

**Keywords:** Dialysis access; Fistula outcomes; Ultrasound use; Point-of-care ultrasound; Vein mapping; Surgical outcomes; Arteriovenous fistula

An autogenous arteriovenous fistula (AVF) is the preferred access choice for patients undergoing hemodialysis.<sup>1</sup> Failure of maturation, however, remains a considerable challenge, with primary failure rates between 30%

and 60%.<sup>2-8</sup> Preoperative duplex ultrasound (DUS) examination may result in improved AVF maturation, with several societies and guidelines, including the Society for Vascular Surgery (SVS), Kidney Disease Outcomes Quality Initiative guidelines, and European Best Practice Guidelines, promoting its use.<sup>1,9,10</sup> Our current practice in a Canadian center is limited by scarce resources, which does not allow us to perform routine vein mapping for all patients undergoing fistula creation. Our practice has been to perform selective vein mapping in patients, especially those with history of prior access creation and multiple ipsilateral line placements. A recent meta-analysis demonstrated that routine DUS vein mapping significantly reduced both the rate of immediate AVF failure and the rate of negative surgical exploration in patients compared with selective vein mapping.<sup>11</sup> We sought to evaluate preoperative point-of-care ultrasound (POCUS) as a cheap and rapid

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method of preoperative evaluation that offers operators an alternative in resource restricted-settings where formal vein mapping is not available for all patients.

Vein diameter on DUS has been consistently shown to be predictive of fistula maturation.<sup>12-17</sup> Moreover, venous ultrasound helps identify veins not evident on physical examination in obese patients and leads to improved rates of distal vascular access.<sup>18</sup> Vascular surgeons are adept at performing DUS and interpreting ultrasound imaging,<sup>19</sup> and this skill is being increasingly incorporated within the curriculum of new trainees with an emphasis on a hands-on and practical learning experience. In ultrasound examination, operators can gain tremendous real-time information on the patient's vasculature while performing the scan, as opposed to interpreting static images.

Accordingly, we hypothesized that routine vein assessment by vascular surgeons during the preoperative consultation with POCUS would improve fistula maturation compared with clinical examination alone.

## METHODS

We performed a retrospective cohort study from a prospectively gathered database to identify all patients who underwent first-time dialysis access creation from December 2007 to December 2014 at the London Health Sciences Center. Institutional Review Board approval was obtained, and the study was given authorization to waive consent of the patients, given its retrospective nature. All procedures were performed by vascular surgeons, who decided on the type of AVF based on the patient's history and physical examination findings. In accordance with Kidney Disease Outcomes Quality Initiative and SVS fistula creation guidelines, access establishment was attempted in the nondominant arm in the following order: radiocephalic, brachiocephalic, brachio basilic, and prosthetic fistula.<sup>19</sup> The majority of patients undergoing fistula creation underwent general anesthesia. Heparin was not consistently administered at the time of arterial clamping, and antiplatelet medications were continued perioperatively. Prolene sutures were used for arteriovenous anastomoses. Surgeons did not routinely repeat vein measurements with ultrasound in the operating room, although they did sometimes change the site of the planned fistula if exploration at a distal location revealed inadequate anatomy. Four vascular surgeons were involved in this study, two of whom routinely used ultrasound for vein diameter assessment and two who relied exclusively on physical examination. This allowed us to conduct a historical cohort comparison of the practice of routine preoperative vein assessment with ultrasound vs clinical examination alone. The typical follow-up regimen was similar between groups and consisted of one postoperative visit with the vascular surgeon and then subsequent follow-up with the patient's referring nephrologist. If there

## ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective comparative cohort study
- **Take Home Message:** Analysis of data of 316 patients undergoing first-time dialysis access creation found that preoperative point-of-care ultrasound (POCUS) in 66 patients decreased primary failure, new access creation, and fistula abandonment compared with 250 patients who underwent only physical examination. POCUS improved times to functional fistula maturation and secondary patency.
- **Recommendation:** The authors recommend POCUS in addition to physical examination before dialysis access is performed.

were maturation concerns or problems with achieving adequate flow, the patient would be referred back by the nephrologist or dialysis access coordinator for diagnostic investigations. Ultrasound was not used routinely for surveillance postoperatively but rather on a case-by-case basis after the nephrologist or vascular surgeon identified concerns.

**Patients.** Information relating to the patients' demographics, including comorbidities, secondary procedures, and postoperative complications, was collected from the patients' hospital and office charts. Time to cannulation and dialysis details were collected from a prospectively gathered vascular access database at our institution. Coronary artery disease was defined as previous myocardial infarction or coronary intervention. Oral anticoagulants consisted of any anticoagulation agents other than warfarin. Warfarin was reported individually to offer a point of comparison with studies in the literature.

Patients who were younger than 18 years, who were using the fistula for plasmapheresis, or who lacked a single clinic visit follow-up were excluded from the study. We identified consecutive patients who underwent first-time access creation at our institution during the defined period; 316 patients were found to meet the criteria for inclusion in this study. Causes for exclusion included loss of follow-up after surgery (7), creation of a loop graft fistula (33), fistula creation for plasmapheresis (3), and age <18 years (10).

Patients were separated into two groups for analysis. Group one underwent ultrasound assessment and physical examination in the clinic. Group two included patients whose vein diameter was assessed exclusively by physical examination.

**Terminology.** All terminology pertaining to access and patency was defined in accordance with the North American Vascular Access Consortium and the SVS reporting standards.<sup>20,21</sup> Freedom from failure of maturation and patency were determined by Kaplan-Meier

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