Role of intravascular ultrasound imaging during endovascular interventions of failing hemodialysis access grafts

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ABSTRACT

Background: Arteriovenous (AV) access graft complications represent a serious complication in patients undergoing hemodialysis. Angiography is one method of visualizing them. However, angiography is not always an effective means of detecting lesions that occur in this context. Intravascular ultrasound (IVUS) is an adjunct modality used to identify stenoses responsible for failing access by identifying multiple stenoses, including those that are most severe. The purpose of this study was to define the value of IVUS in patients with failing AV access grafts by comparing digital subtraction angiography (DSA) alone with DSA followed by IVUS.

Methods: This was a single-center randomized study comparing IVUS with DSA in patients with failing hemodialysis access grafts. It consisted of 100 randomized hemodialysis patients presenting with failing AV access who were being considered for endovascular intervention. Interventions in the control group were guided by DSA alone, whereas interventions in the test group were guided by DSA followed by IVUS. Patients were observed for 6 months after intervention. The primary end point was the time in days to AV access graft failure after the index intervention, expressed as median and interquartile range. Secondary analyses included influence of DSA and IVUS on index procedure decision-making and percentage of patients with AV access graft reinterventions or discontinuation through 3 and 6 months.

Results: Median time to first AV graft reintervention or discontinuation was 61 days in the test group and 30 days in the control group ($P = .16$), with analysis limited to patients who experienced reintervention or discontinuation ($n = 59$). IVUS resulted in a change in treatment plan in 76% (44/58) of patients, with no treatment change after IVUS in 24% (14/58) of patients. At 6 months, approximately 35% of patients in both the control and test groups remained free from reinterventions ($P = .88$). At 6 months, approximately 75% of patients in the control group and 80% of patients in the test group remained free from AV graft discontinuation or abandonment ($P = .45$).

Conclusions: This pilot study suggests that addition of IVUS to standard angiography during endovascular interventions of failing hemodialysis access grafts holds potential to extend the time to the first reintervention. The data support the design and execution of an adequately powered randomized trial with longer follow-up to reliably discern the clinical benefit of IVUS as an addition to standard angiography in the setting of failing AV access grafts. (J Vasc Surg 2016;■:1-7.)

Arteriovenous (AV) access graft complications are responsible for a large proportion of morbid events in the hemodialysis population. The rate of complications rises considerably once AV access fails, justifying surveillance for failing accesses and correction of stenotic lesions before thrombosis occurs. In this regard, the Kidney Disease Outcomes Quality Initiative Work Group recommended serial access flow, venous dialysis pressure measurements, or duplex ultrasound imaging as the preferred monitoring techniques for monitoring of AV access. Unmasked abnormalities should trigger the performance of angiography to identify and to correct culprit lesions.

Angiography, however, is neither sensitive nor specific for the detection of coronary lesions. In this regard, intravascular ultrasound (IVUS) has been studied as an adjunctive modality that can be used in addition to angiography.[1-4] Despite the potential of IVUS to improve diagnostic accuracy, comparative data regarding its use remain limited. The current study was a prospective, randomized trial to define the value of IVUS in patients with failing AV access grafts, comparing digital subtraction angiography (DSA) alone with DSA followed by IVUS in this setting.

METHODS

This pilot study of IVUS imaging during endovascular interventions of failing hemodialysis access grafts was a prospective, randomized, nonblinded, single-center study comparing IVUS with traditional DSA in patients

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This work was funded by Volcano Corporation (San Diego, Calif).

Author conflict of interest: K.O. and A.J.P. are employees of Syntactx, which receives research support from Volcano. K.O. is also an equity holder of Syntactx. D.L.F. has been paid a consulting fee by Volcano Corporation.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

http://dx.doi.org/10.1016/j.jvs.2016.10.115

with failing hemodialysis access grafts. It was conducted at the Dialysis Access Institute at the Regional Medical Center (Orangeburg, SC). The study randomized 100 hemodialysis patients presenting with failing AV access and considered for endovascular intervention (Fig 1). Patients were randomized on the day of intervention, also referred to as day zero. Randomization was conducted through use of numbered envelopes opened by the site on enrollment. The numbered envelope informed the site as to whether a given patient would receive IVUS. Patients who received IVUS were enrolled in the test group, and those who did not enrolled in the control group. This pilot study did not involve formal hypothesis testing; as such, the sample size was not calculated in a statistically driven manner. This pilot study was descriptive in nature, and no formal hypothesis testing or powered sample size calculations were performed.[5-7]

Eligibility criteria included patients with slow flow for a failing AV access graft that previously provided access for at least one successful hemodialysis session, aged 18 to 85 years, with eligibility for endovascular intervention. Patients scheduled for kidney transplantation or planned switch to peritoneal dialysis within the next 6 months were ineligible for inclusion, as were pregnant or lactating patients and those with a life expectancy of <6 months. The determination of slow flow through the access was site reported and represented a situation in which flow was insufficient to support hemodialysis.

The primary study end point was the time to AV access graft failure after the index intervention, assessed through 6 months after the index procedure. All patients had AV grafts, with none of the patients having AV fistulas. This allowed investigators to focus on the ability of IVUS to detect failing AV access grafts. Interventions in the control group were guided by DSA alone, whereas interventions in the test group were guided by DSA followed by IVUS. IVUS was performed using the Eagle Eye Platinum Catheter (Volcano Corporation, San Diego, Calif). ChromaFlo (Volcano Corporation) was also part of the workflow for all index procedure interrogations using IVUS. Secondary analyses included the influence of DSA or DSA and IVUS on index procedure decision-making, percentage of patients with AV access graft reinterventions or discontinuation at 3 months, and percentage of patients with AV access graft reinterventions or discontinuation at 6 months. It was possible for more than one adjustment to patient management to be selected per lesion. The operator's discretion was used to determine the timing and nature of potential reintervention. Operators decided whether to reintervene on the basis of a number of factors, including degree of stenosis and the patient's clinical profile, among others.

Data analysis was conducted using descriptive statistics. In light of the non-normal distribution of outcome data, standard and nonparametric metrics were measured, including mean, median, minimum, maximum, standard deviation, and interquartile range (IQR). Stratification of results across subgroups was considered as part of the analysis and as a basis for informing inclusion and exclusion criteria for future studies. Normality was assessed with the Shapiro-Wilks test. Data from the groups were compared with the Student *t*-test when the data were normally distributed and with the Mann-Whitney test when not. The probability of graft failure as a function of time was analyzed using Kaplan-Meier curves. Groups were compared with the Student *t*-test. Differences were considered statistically significant when the two-tailed *P* value was $< .05$.

This study was conducted in a manner that was compliant with the principles outlined in the Declaration of Helsinki. The protocol and informed consent were approved by an Institutional Review Board, and all subjects provided informed consent to participate in the study before the index procedure.

ARTICLE HIGHLIGHTS

- **Significance:** This study was designed to determine if adding intravascular ultrasound (IVUS) to angiography is beneficial in patients with failing arteriovenous (AV) access.
- **Type of Research:** Prospective randomized single-center trial
- **Take Home Message:** In failing AV grafts, the addition of IVUS has potential to identify lesions not fully appreciated with standard angiography.
- **Recommendation:** The authors suggest that a trial adequately powered and with longer follow-up be conducted to discern if IVUS in addition to angiography has clinical benefit in evaluating failing AV grafts.
- **Strength of Recommendation:** 2. Weak
- **Level of Evidence:** C. Low to very low

RESULTS

Baseline demographic data of the patients can be found in Table I. The differences between groups were not significant with respect to baseline demographic and comorbidity data. To further ensure that the groups were matched, they were also compared in terms of baseline AV graft characteristics and characteristics of index procedure performed. Differences between groups were not significant with respect to any of the metrics related to baseline AV graft characteristics or the nature of the index procedure performed. Baseline AV graft characteristics can be found in Table II. Of the 100 patients, 93 patients were studied, as 7 (3 from the control group and 4 from the test group) were considered unevaluable. There were two operators; one operator performed approximately 90% of the procedures, and the other operator performed approximately 10% of the