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Editorial

# Intravascular Ultrasound and Infrapopliteal Arterial Interventions: Helping the Blind Squirrel Find a Nut?

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When intravascular ultrasound (IVUS) was introduced over 3 decades ago, it revolutionized catheter-based endovascular interventions by providing real-time 3-dimensional intraluminal imaging, and with it, procedural guidance.[1] By generating detailed cross-sectional images, IVUS provides accurate evaluation of vessel dimensions, characterization of plaque morphology, and feedback regarding procedural results. IVUS has the added advantage of minimizing radiation exposure and reducing iodinated contrast use.[2]

In the coronary arteries, randomized trials have demonstrated that adjunctive IVUS imaging reduces major adverse cardiovascular events, cardiac death, stent thrombosis, target-lesion revascularization, and target-vessel revascularization.[3] The evidence base supporting IVUS for peripheral vascular intervention (PVI) is less robust but has expanded significantly in recent years. In observational studies, IVUS has been associated with improved stent expansion and patency as well as with reduced reintervention rates following femoropopliteal PVI. Randomized data have demonstrated that IVUS reduces 12-month binary restenosis rates following femoropopliteal PVI.[4] Nevertheless, significant gaps in our knowledge remain regarding the utility of IVUS to facilitate infrapopliteal (IP) PVI, a critical component in the management of patients with chronic limb-threatening ischemia.

It is well established that angiography underestimates IP vessel diameters when compared with IVUS.[5] Not surprisingly, adjunctive IVUS results in use of larger balloon diameters during IP artery angioplasty procedures.[6] IVUS also detects the presence and severity of dissections following IP PVI.[5] It is plausible that use of IVUS would improve clinical outcomes following IP PVI, yet randomized data are lacking. In observational studies, IVUS has been associated with a greater propensity toward limb salvage without reintervention, and earlier wound healing.[6] Likewise, national claims data suggest that IVUS, when used during PVI, is associated with lower rates of major adverse limb events at intermediate-term follow-up.[4]

Based on much of the above-cited data, IVUS use was deemed appropriate during the preintervention, intraprocedural, and postintervention optimization phases of tibial artery interventions in a consensus document on the use of IVUS during arterial and venous lower extremity interventions.[7] Although IVUS use in PVI has become more frequent in recent years, significant variability across clinical settings and physician specialties remains.[2] IVUS is underutilized during PVI in general, and this is particularly notable during IP PVI.

In this issue of *JSCAI*, Snyder et al[8] evaluate IVUS to facilitate IP PVI in a retrospective cohort study of 100 patients and 142 IP lesions (23% treated using IVUS guidance). After multivariable adjustment, their analyses revealed a significant reduction in 1-year binary restenosis in the IVUS- compared with the angiography-guided group. Target-lesion revascularization rates were numerically but not significantly lower in the IVUS-guided group. Other outcomes, including amputation, major adverse limb events, and all-cause mortality, were not significantly different between groups.

The authors are to be congratulated on making an important contribution to the sparse body of evidence relating IVUS to outcomes following IP PVI. When considered alongside other data in this space, these results underscore the potential for IVUS to optimize procedural outcomes in the IP arterial bed and further highlight the need for long-term prospective randomized controlled trials to validate these observations and inform a more standardized approach to IP PVI.

Notwithstanding the importance of these findings, there are noteworthy limitations. First, despite multivariable adjustment, selection and other biases, such as operator imaging preference, may have influenced the decision to employ IVUS. Second, baseline differences in unmeasured confounders may have influenced the study outcomes (eg, missing data about calcification severity—an important predictor of restenosis—precluded full model adjustment). Third, the study was conducted at a single, highly experienced center where IVUS is frequently performed and expertly interpreted; these findings may not be fully generalizable to other centers where IVUS is employed less often or with less expertise. Fourth, although IVUS-guided procedures may offer long-term cost savings compared with angiography-guided approaches, the present study did not address the cost effectiveness of IVUS following IP PVI, and this issue will be critical if there is to be widespread real-

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world adoption of IVUS to support PVI. Finally, while the observed reduction in binary restenosis is important, larger randomized studies with longer-term follow-up will be needed to evaluate its impact on patient-centered outcomes such as need for reintervention, limb salvage, and mortality. Despite these limitations, the study by Snyder and colleagues adds to the evidence base supporting IVUS for IP PVI and highlights areas critical for further exploration.

What does the future hold with respect to IVUS during PVI? First and foremost, greater focus on operator training and proficiency is needed. Training for peripheral IVUS, unlike for coronary IVUS, remains unstandardized. Development of comprehensive educational modules encompassing all aspects of IVUS use and interpretation is imperative, and interdisciplinary collaboration between interventional cardiologists and other vascular specialists will be an essential step toward establishing standardized training frameworks, leveraging existing structured coronary IVUS programs as a model.[2] Artificial intelligence holds promise for addressing educational and procedural gaps and has the potential to enhance interpretation of IVUS images, support clinical decision making, and improve outcomes. More standardized translation of IVUS-derived data into clinical practice will be needed as well. As outlined in the SCAI/AVF/AVLS/SIR/SVM/SVS Multidisciplinary Expert Opinion on Intravascular Ultrasound Use in Peripheral Arterial and Deep Venous Interventions,[2] consensus is lacking on IVUS-guided device sizing, leading to variability in clinical practice. Similarly, while IVUS is more sensitive than angiography at detecting procedural complications such as vessel dissection, agreement on when to treat versus defer treatment for IVUS-detected dissections is lacking.[9] Finally, optical coherence tomography provides even greater resolution than IVUS, yielding better visualization of the vessel wall and plaque components; additional studies comparing IVUS with optical coherence tomography in IP arteries are needed.[10]

No doubt, vascular interventional cardiologists still have much to learn about the performance, interpretation, and application of IVUS during PVI, especially when performed below the knee. For now, we must settle for outcomes that are more often associated with angiography- than IVUS-guided procedures. Rest assured, even a blind squirrel finds a nut.

## Declaration of competing interest

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