Cath Lab Digest

A product, news & clinical update for the cardiac catheterization laboratory specialist

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EDUCATIONAL PROGRAMS

The Weber State University Cardiac Specialist Program

"The expertise our graduates provide is uncommon in cath labs yet vital for modern practice," says Christopher Steelman, MS, RT(R)(CI)(ARRT), RCIS, FACVP, AACC, Associate Professor of Radiologic Sciences at Weber State University and Founding Director of the Cardiac Specialist Program, Ogden, Utah.

Can you share an overview of your institution and program?

The Weber State University School of Radiologic Sciences began in 1966, celebrated its 50th anniversary in 2016, and is 59 years old in 2025. The Cardiac Specialist Program launched in fall 2020. Since then, it has continuously refined its curriculum and strengthened clinical partnerships to stay at the forefront of interventional cardiology. The program has attracted students with a broad range of experience from across the country and around the world.

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SIRP 2025

Q&A With Dr. Robert Foster: Shining a Light on Radiation Safety

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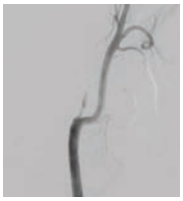
CASE STUDY

When the Guard Gets You With Friendly Fire: Filter Choking and De-Choking During High Plaque Burden Carotid Artery Stenting



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Roadmap Imaging in the Endovascular Treatment of Complex Peripheral Vascular Disease

Ivana Kumar; Anshita Kumari, MBBS; Kusum Lata, MD, FACC, FSCAI

Peripheral vascular disease (PVD), specifically in its more advanced forms such as chronic limb-threatening ischemia (CLTI), presents a great clinical challenge. Endovascular interventions have become the primary approach for revascularization, but these procedures heavily rely on advanced imaging techniques to ensure accuracy, and minimize patient and operator risk. Traditional methods like fluoroscopy, cine angiography, and digital subtraction angiography have long been standard, yet come with significant limitations in terms of radiation exposure, contrast use, and procedural efficiency. One of the most promising advancements in this field is roadmap imaging, a technique that integrates pre-acquired imaging with live fluoroscopy, enhancing precision while simultaneously minimizing the necessity of high-radiation modalities. Roadmap imaging capabilities are available on most advanced cardiac cath lab platforms from GE, Philips, and Siemens Healthineers.

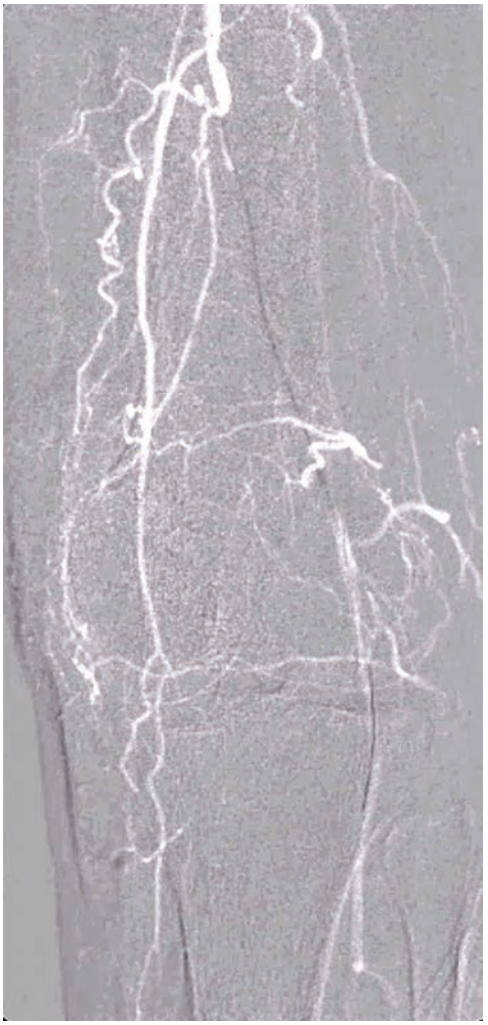

Figure 1 (Video 1 online). Roadmap imaging guiding the wire advancement to chronic total occlusion intervention of left superficial femoral artery intervention.

Imaging Modalities in Peripheral Vascular Interventions

Imaging is vital in the management of PVD, guiding catheter navigation, balloon angioplasty, and stent placement. Common imaging techniques include:

1. **Fluoroscopy:** Provides continuous real-time X-ray imaging with the lowest radiation dose, but lacks the detailed visualization required for complex anatomy, especially in small-caliber vessels or heavily calcified arteries.

2. **Cine Angiography:** Generates high-quality dynamic imaging over time, offering a more detailed view of arterial anatomy and hemodynamics, but at a cost of a significantly higher radiation dose (at least four to five times that of fluoroscopy[1]; when fluoro save is used, cine angiography dose can be 10–50 times higher[2,3]).

3. **Digital Subtraction Angiography (DSA):** The gold standard for angiographic imaging, particularly in the assessment of complex vascular anatomy. However, DSA requires multiple contrast injections, and exposes both patients and operators to substantial radiation, with about a 30-fold increase in radiation dose to the operating physician compared to low-dose fluoroscopy in some systems and procedures[4] (when fluoro save is used, dose can be up to 100 times higher[3]).

The development of roadmap imaging has further refined the guidance of endovascular interventions. By generating a real-time, detailed overlay of vascular anatomy aligned to live fluoroscopy, roadmap imaging enables more precise and accurate navigation during these procedures, thereby reducing the risk of complications as well as improving patient outcomes.

Roadmap Imaging: Mechanism and Benefits

Roadmap imaging represents a sophisticated blend of pre-acquired images (often from computed tomography [CT] angiography or DSA) with real-time fluoroscopy, providing a continuous overlay that allows for precise guidance throughout the procedure. The technology works by creating a "virtual road" overlaid onto live fluoroscopic images, facilitating catheter and device navigation.

Key Advantages

1. **Enhanced Precision in Complex Anatomy:** The ability to superimpose pre-acquired images over real-time fluoroscopy improves the visualization of vessel course, tortuosity, and calcifications, essential for navigating complex below-knee vessels.

2. **Reduced Radiation Exposure:** By minimizing the need for repeated contrast injections, cine, and DSA, roadmap imaging significantly reduces the radiation dose to both the patient and the operator. This is especially critical in long, intricate procedures where radiation burden can accumulate rapidly.

Figure 2 (Video 2 online). Roadmap imaging guiding the wire negotiation to high-grade right common iliac artery stenosis.

3. **Minimized Contrast Use:** In traditional imaging, repeated contrast injections are required to guide catheter, wire, and device movement, which not only increases the risk of contrast-induced nephropathy but also elevates radiation exposure. Roadmap imaging eliminates the need for continuous contrast injections, enhancing patient safety.

4. **Real-Time Guidance:** The fusion of live fluoroscopy with static images allows for immediate, real-time adjustments in catheter and wire placement, improving procedural outcomes and efficiency. This is particularly beneficial in below-knee interventions, where vessel access and navigation can be particularly challenging due to tortuosity, small vessel calibers, and collateral circulation.

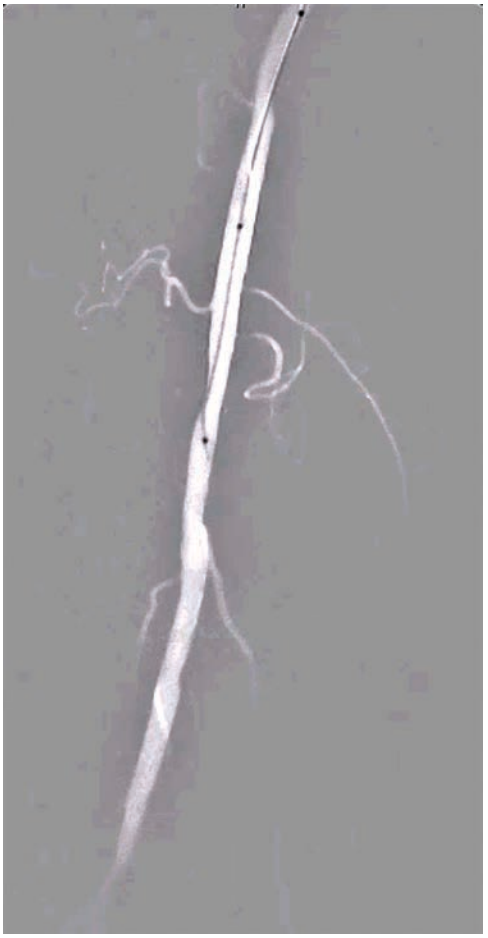

Figure 3 (Video 3 online). Roadmap imaging, superficial femoral artery with supporting catheter.

5. **Improved Procedural Efficiency:** With the ability to precisely navigate complex vascular paths, roadmap imaging reduces the time spent searching for and confirming the target vessels, thus decreasing overall procedure time and improving the likelihood of successful revascularization.

Clinical Impact in Below-Knee Interventions

Below-knee interventions are among the most challenging in endovascular procedures. The small vessel size, presence of extensive calcification, and complex collateral network make navigation difficult, especially in patients with chronic total occlusions (CTOs). Roadmap imaging provides several distinct benefits in the following situations:

Figure 4 (Video 4 online). Roadmap imaging, wiring from the popliteal to the anterior tibial arteries.

1. **Tortuosity and Calcifications:** Roadmap imaging allows for accurate identification and navigation around tortuous or calcified segments, which is crucial for reducing the risk of procedural failure or complications, such as arterial perforation or dissection.

2. **Subintimal Access:** In cases where intraluminal access is not possible, roadmap imaging can help guide operators into the subintimal space, increasing the chances of successful crossing in CTOs.

Figure 5 (Video 5 online). Roadmap imaging, wiring an iliac artery.

3. **Improved Limb Salvage Rates:** Successful revascularization of below-knee vessels, particularly in the setting of CLTI, is paramount for limb salvage. Roadmap imaging contributes to higher technical success rates by optimizing navigation, reducing radiation, and minimizing contrast use, improving clinical outcomes for these high-risk patients.

Challenges and Limitations

Despite its benefits, roadmap imaging entails certain limitations, including:

1. **Misregistration:** A potential drawback of roadmap imaging is the risk of misregistration, where the pre-acquired image does not align perfectly with the real-time fluoroscopic view. This misalignment can be caused by patient movement, arterial pulsations, or changes in the position of the catheter during the procedure. In below-knee interventions, where the vessels are distal and farther from the heart, such movements are generally less of a concern, but they can still affect image accuracy.

2. **Patient Sedation:** In complex procedures like those involving below-knee vessels, patients are often moderately sedated. This sedation helps to limit motion, but excessive movement or respiratory artifacts can still challenge the accuracy of roadmap imaging.

3. **Technology Availability and Cost:** While roadmap imaging is a powerful tool, its availability is restricted to certain advanced imaging platforms, and it can incur higher costs in both equipment and operator training. This may limit access to the technology in certain healthcare settings or regions.

4. **Learning Curve:** Properly utilizing roadmap imaging requires specialized training and experience. Misuse or lack of familiarity can lead to suboptimal results, making operator proficiency a critical factor in its success.

Conclusion

Roadmap imaging represents a groundbreaking advancement in endovascular interventions, particularly for complex cases of peripheral vascular disease. By providing real-time, high-precision navigation of vascular structures while minimizing radiation and contrast exposure, roadmap technology offers significant clinical benefits. Its ability to enhance procedural accuracy and efficiency is invaluable in challenging cases, especially in below-knee interventions for CTOs and CLTI.

While there are challenges related to misregistration, technology availability, and the need for specialized training, the advantages of roadmap imaging in improving patient safety, clinical outcomes, and procedural success make it an indispensable tool in modern vascular procedures. ■

By minimizing the need for repeated contrast injections, cine, and DSA, roadmap imaging significantly reduces the radiation dose to both the patient and the operator.

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