Imaging and Physiology to Guide Venous Graft Interventions Without Contrast Administration in Advanced Renal Failure

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Patients with previous coronary artery bypass grafting and advanced chronic kidney disease (CKD) are considered high risk for revascularization. In addition to native coronary artery angiography, additional contrast is required to visualize the bypass conduits, increasing the risk of contrast-induced nephropathy (CIN) and need for renal replacement therapy. As a result, despite the need for revascularization, these patients are frequently under-treated.[1] There is evidence in the literature that intravascular ultrasound (IVUS)-guided interventions reduce the amount of contrast and its associated risk of CIN.[2] We recently described intravascular imaging and physiology-guided percutaneous coronary intervention (PCI) without contrast administration in advanced CKD.[3] Here we describe step-by-step "zero-contrast" saphenous vein bypass graft (SVG) intervention using a modified technique.

- Ultra-low contrast angiography, defined as contrast volume/estimated glomerular filtration rate <1, is performed.
- The left ventricular end-diastolic pressure is used to guide hydration.
- Imaging- and physiology-guided PCI is performed 1 week after angiography.
- Guide-catheter engagement is confirmed by the entry of a workhorse guidewire into the SVG.
- A pressure wire capable of measuring pressure and flow is used to record the baseline fractional flow reserve (FFR) and coronary flow reserve (CFR).
- Near-infrared spectroscopy (NIRS)/IVUS (Infraredx) is used for assessment of reference vessel sizing, stent landing zones, and plaque composition with stent length based on the distance between the two reference areas, ensuring complete lesion coverage.
- The NIRS/IVUS catheter is re-advanced, manually marking the landing zones by "dry" cine angiograms for co-registration.
- An embolic protection device is considered for high lipid-core burden index (LCBI).[4,5] $LCBI_{4mm}$ is a quantitative summary metric of the total lipid-core plaques detected over any 4 mm segment of vessel relative to total length of the pullback.
- Following stent deployment, NIRS/IVUS identifies areas of under-expansion and postdilation is performed to optimize PCI results.
- Final FFR confirms resolution of ischemia and CFR the absence of slow flow with improved absolute flow.

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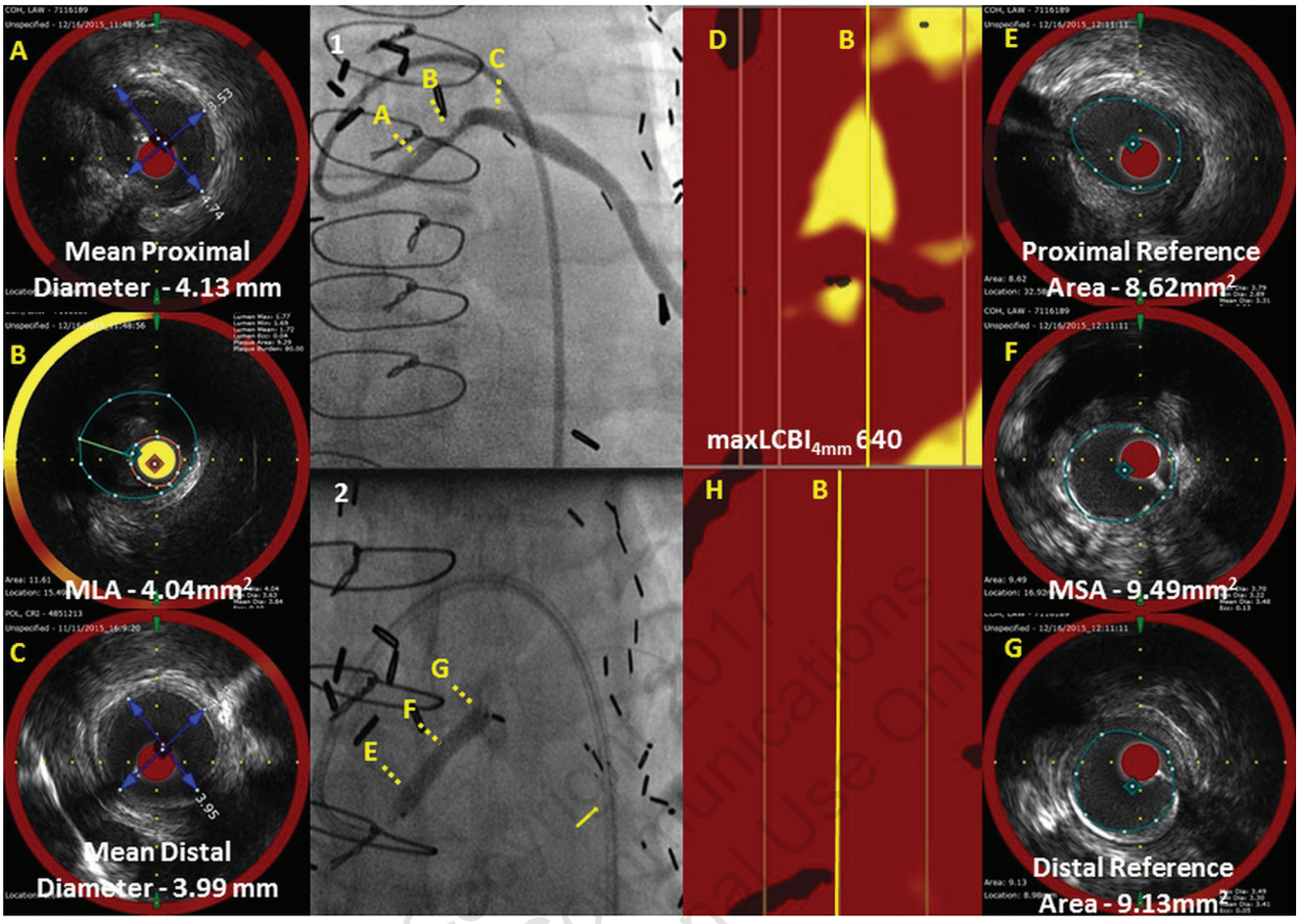

FIGURE 1. (1) Ultra-low contrast angiography identified a lesion in the proximal saphenous vein graft (SVG) to first obtuse marginal artery (fractional flow reserve 0.74; coronary flow reserve 1.8) in a patient with chronic kidney disease (CKD) stage V. Intravascular ultrasound (IVUS) marked the (A) proximal reference, (B) minimal luminal area, and (C) distal reference. (D) The block chemogram identified a large lipid core with max lipid core burden index ($LCBI_{4mm}$ 640), (2) based on which embolic protection device (EPD; yellow arrow) was deployed followed by stenting with a 3.50 x 20 mm drug-eluting stent (DES). Postdilation was performed with a non-compliant 3.75 x 15 mm balloon at 20 atm to areas of underexpansion identified by IVUS. Following PCI optimization, the (E) proximal reference area was found to be smaller than the (F) minimal stent area and (G) distal reference area confirming optimal stent expansion. (H) The block chemogram showed a significant reduction in the lipid burden (max $LCBI_{4mm}$ 120) and absence of yellow at the site of previous max LCBI consistent with lipid embolization, captured in the EPD (B). Improved fractional flow reserve (0.91) and coronary flow reserve (3.1) confirmed physiological improvement. *(continued)*

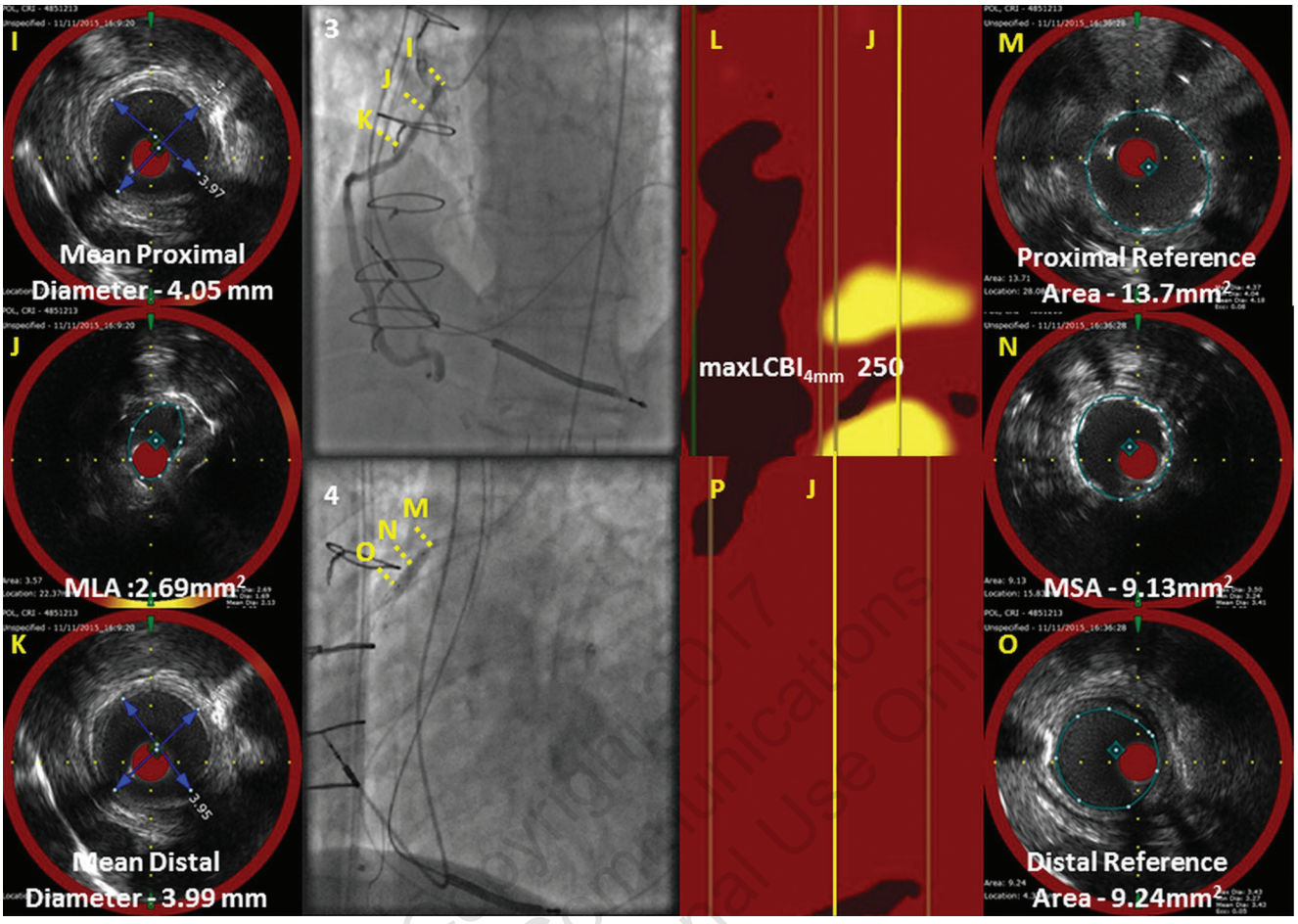

FIGURE 1 ***(continued).*** (3) Ultra-low contrast angiography identified a lesion in the proximal SVG to posterior descending artery (fractional flow reserve 0.70; coronary flow reserve 1.1) in a patient with CKD stage V. IVUS marked the (I) proximal reference, (J) minimal luminal area, and (K) distal reference. (L) The block chemogram identified a lipid core with max $LCBI_{4mm}$ 250 corresponding with the minimal luminal area (J) and thus, no EPD was used. (4) Following stenting with a 3.5 x 15 mm DES, postdilation was performed with a non-compliant 3.75 x 12 mm balloon at 22 atm to areas of underexpansion identified by IVUS. Following PCI optimization, the (M) proximal reference area was larger than the (N) minimal stent area (9.13 mm^2), as was the (O) distal reference area, confirming optimal stent expansion. (P) The block chemogram no longer identified significant lipid burden (max $LCBI_{4mm}$ 90). Improved fractional flow reserve (0.89) and coronary flow reserve (2.0) confirmed physiological improvement.

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