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Short Communication

Zero contrast optical coherence tomography–guided percutaneous coronary intervention for in-stent restenosis of the saphenous vein graft using a non-contrast flush medium

Nandhakumar Vasu*, Vijayakumar Subban, S. Ajit Mullasari

Institute of Cardio-Vascular Diseases, The Madras Medical Mission Hospital, Chennai, Tamilnadu, India

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ABSTRACT

Percutaneous coronary intervention (PCI) is often denied for individuals with coronary artery disease who are prone to develop contrast-induced acute kidney injury. We report a 73-year-old, stage 3 chronic kidney disease patient (CKD), who underwent coronary artery bypass surgery and saphenous vein graft (SVG) stenting in the past, presented with in-stent restenosis (ISR) of SVG stent. Zero contrast optical coherence tomography (OCT) guided–PCI was successfully performed using low molecular weight dextran-40 (LMWD-40) as the flush medium. Our report suggests the safety and feasibility of LMWD-40 –based OCT-guided zero contrast PCI in ISR of SVG in a CKD patient, although further prospective studies are needed to evaluate this technique.

1. Introduction

Chronic kidney disease (CKD) individuals are particularly prone to develop contrast-induced acute kidney injury (CI-AKI) and frequently need renal replacement therapy after percutaneous coronary intervention (PCI). Safety and feasibility of intravascular ultrasound (IVUS)–guided zero contrast PCI has been studied in a small number of patients.[1,2] Optical coherence tomography (OCT) guidance for PCI requires iodinated contrast as the flush medium to clear the blood in order to obtain optimal images. We describe the technique of zero contrast PCI with OCT guidance using low molecular weight dextran-40 (LMWD-40) as the flush medium in a patient with in-stent restenosis (ISR) in the saphenous vein graft (SVG).

2. Technique

Twenty years ago, a 73-year-old stage 3 CKD patient with estimated glomerular filtration rate (eGFR) of 39 ml/min/1.73 m^2 underwent coronary artery bypass surgery twenty years ago with four grafts. PCI was performed eight years prior for the ostial SVG to the obtuse marginal (OM) graft with a 4.0 × 18-mm bare-metal stent. Coronary angiogram (CAG) was taken using 25 ml of iodixanol contrast in the present hospitalisation for exertional angina, which showed patent left internal mammary artery (LIMA) to left anterior descending artery (LAD) and 78% distal edge ISR of SVG to OM graft (Fig. 1A) with thrombolysis in myocardial infarction (TIMI)-3 flow (Video 1). Distal right coronary artery (RCA) was filling through collaterals from OM (Fig. 1B). SVG grafts to the ramus intermedius and posterior descending artery were occluded. Echocardiogram showed left ventricular ejection fraction (LVEF) of 52%, and there was no pericardial effusion.

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PCI was performed 24 h later. Previous angiogram images were uploaded on the monitor. The standard anticoagulation protocol of 100 IU/Kg (7500 units) of unfractionated heparin was given intravenously. Right common femoral artery access was obtained. SVG to OM graft was engaged in the right anterior oblique-30° and caudal-20° view with 6 F multipurpose-1 guide catheter using the prior ostial stent as a marker (Fig. 1C). The working view was selected as the left anterior oblique-30° and cranial-24° from the angiographic images and transferred to the reference monitor as the road map. A 0.014″ × 190 cm balance middleweight universal

* *Corresponding author.*Institute of cardio-vascular Diseases, The Madras Medical Mission Hospital, 4-A, Dr.J.Jayalalitha.Nagar, Mogappair, Chennai, Tamilnadu, 600037, India.
E-mail addresses: nandhacard2013@gmail.com, nandhapaed1982@gmail.com (N. Vasu).

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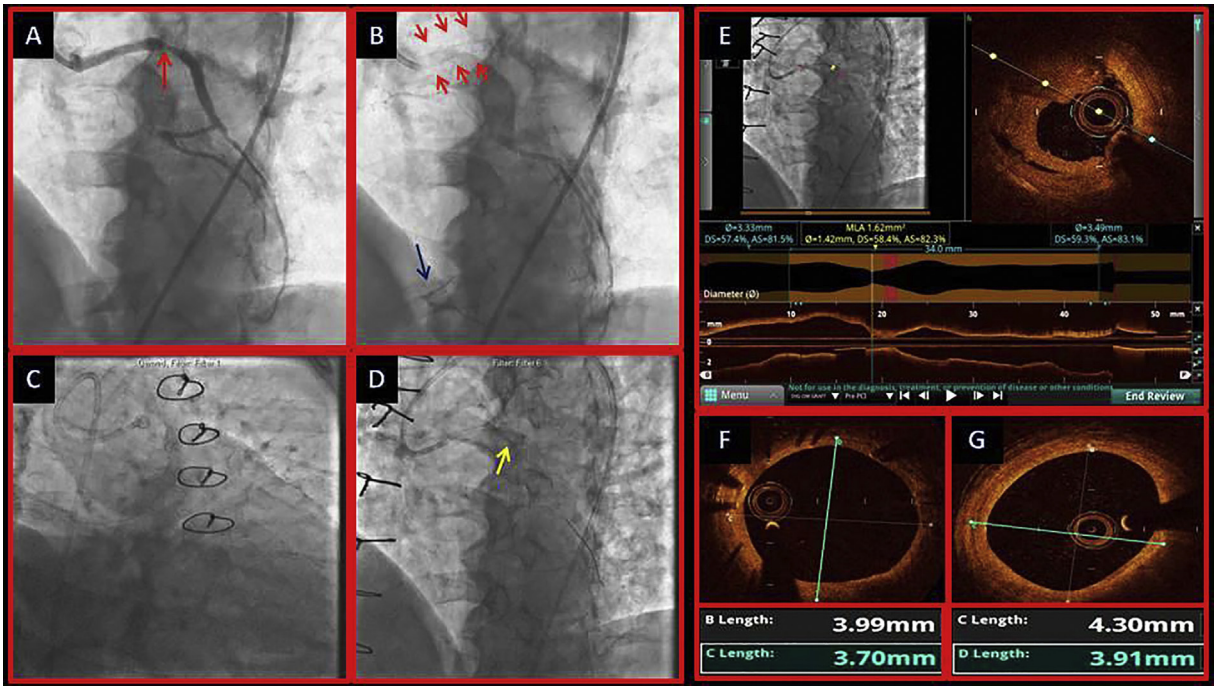

Fig. 1. A) 6 F Judkins right diagnostic catheter engaged the SVG to OM graft in LAO 30° cranial 20° (working view) and angiogram showing discrete distal edge ISR (red arrow) of the previous 4 × 18 mm bare-metal stent. (B) Long fluoroscopic recording of the angiogram shows the previous stent without contrast (between red arrows) and retrograde filling of RCA through collaterals (blue arrow). (C) 6 F multipurpose-1 guide engaged the OM graft in RAO 30° caudal 20° view using the previous ostial OM graft stent as a marker. (D) Predilatation using a 2.5 × 12-mm non-compliant balloon over 0.014″ x 190-cm BMW wire at the lesion site (yellow arrow). (E) OCT pullback with angiographic coregistration using the LMWD-40 flush medium; lesion length: 34 mm. (F) Proximal reference (EEM to EEM): (3.99 + 3.7)/2 = 3.84 mm. (G) Distal reference (EEM to EEM) (4.3 + 3.91)/2 = 4.1 mm. OM, obtuse marginal artery; SVG, saphenous vein graft; ISR, in-stent restenosis; OCT, optical coherence tomography; LMWD-40, low molecular weight dextran-40; LAO, left anterior oblique; RAO, right anterior oblique; BMW, balance middle weight; EEM, external elastic membrane.

(Abbott Vascular, Santa Clara, CA, USA) wire was placed across the lesion into the distal OM. Predilatation of the lesion was performed with a 2.5 × 12 mm non-compliant balloon at 16 atm in the working view with the distal edge of the stent as the marker (Fig. 1D). OCT with angiographic coregistration (Fig. 1E, Video 2) was performed (Dragonfly™ Duo; St. Jude Medical, MA) with undiluted LMWD-40 through a power injector for blood clearance (flow rate: 5.0 ml/s, duration: 4.0sec, total volume: 20 ml, pressure: 400psi, rise time: 0.0sec). The length of the lesion, proximal reference and distal reference diameters were measured as 34 mm, 3.86 mm and 4.11 mm respectively. The reference diameters were undersized to the nearest available diameter (within 0.5 mm) from the measured average external elastic membrane (EEM) diameters as 3.5 mm proximal reference diameter and 4.0 mm distal reference diameter (Fig. 1E–G). A 3.5 × 34 mm zotarolimus-eluting stent was accurately positioned with the guidance of angiographic coregistration and deployed at 12 atm (Fig. 2A–B). Poststent dilatation was performed using the same stent balloon at 18 atm. Post-PCI OCT run with LWMD-40 (Video 3) showed a well-expanded stent with no malapposition, edge dissection, geographic miss and <10% residual diameter stenosis (Fig. 2C–H). The periprocedural electrocardiogram (ECG) and haemodynamics were normal. Echocardiography was performed to rule out wire-related perforation. The total procedure time and cumulative fluoroscopy time were 26 min and 7.35 min, respectively. The total dose area product was 60.7 Gy cm^2, and air kerma was 0.67Gy. The eGFR after 48 h and one month of PCI were 53.68 ml/min/1.73 m^2 and 52.48 ml/min/1.73 m^2, respectively.

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3. Discussion

The principles of doing PCI without contrast using intracoronary imaging (ICI) guidance are as follows: (1) creating a metallic silhouette with coronary wires in the nearby branches or using the previous stent as a marker in case of prior PCI in the same vessel, (2) ICI to decide about lesion preparation and stent sizing, (3) ICI after deployment of stent to decide about post dilatation, (4) final ICI to look for edge dissection, tissue prolapse, malapposition, under expansion or geographic miss, (5) post-PCI echocardiogram for new onset pericardial effusion (to rule out pericardial coronary perforations). Zero contrast PCI using IVUS and coronary physiology guidance was studied in 31 subjects by Ali et al.[1] Fractional flow reserve (FFR) and coronary flow reserve (CFR) were used in their study as the coronary physiology parameters. FFR shows the stenosis severity, and CFR shows the combined stenosis significance and microvascular resistance. Hence, slow flow or no flow in the vessel may be assessed by the combination of FFR and CFR. OCT may serve as a better alternative to IVUS during zero contrast PCI as the resolution is better, coregistration is possible, quick pull-back time, accurate automated measurements and metallic stent optimization (MSO) software. Flushing the blood with colloid rather than iodinated contrast was successfully used in previous studies. Before this study, two case reports of zero contrast, OCT-guided PCI have been published. Galougahi et al[3] performed zero contrast PCI to LAD with OCT and coronary physiology (FFR and CFR) guidance. They used a mixture of saline and colloid infusate for blood clearance, but reproducibility of this technique is difficult. Azzalini et al[4] performed zero contrast PCI under OCT guidance without coronary physiology or angiographic coregistration. We tried to describe the steps in detail for better

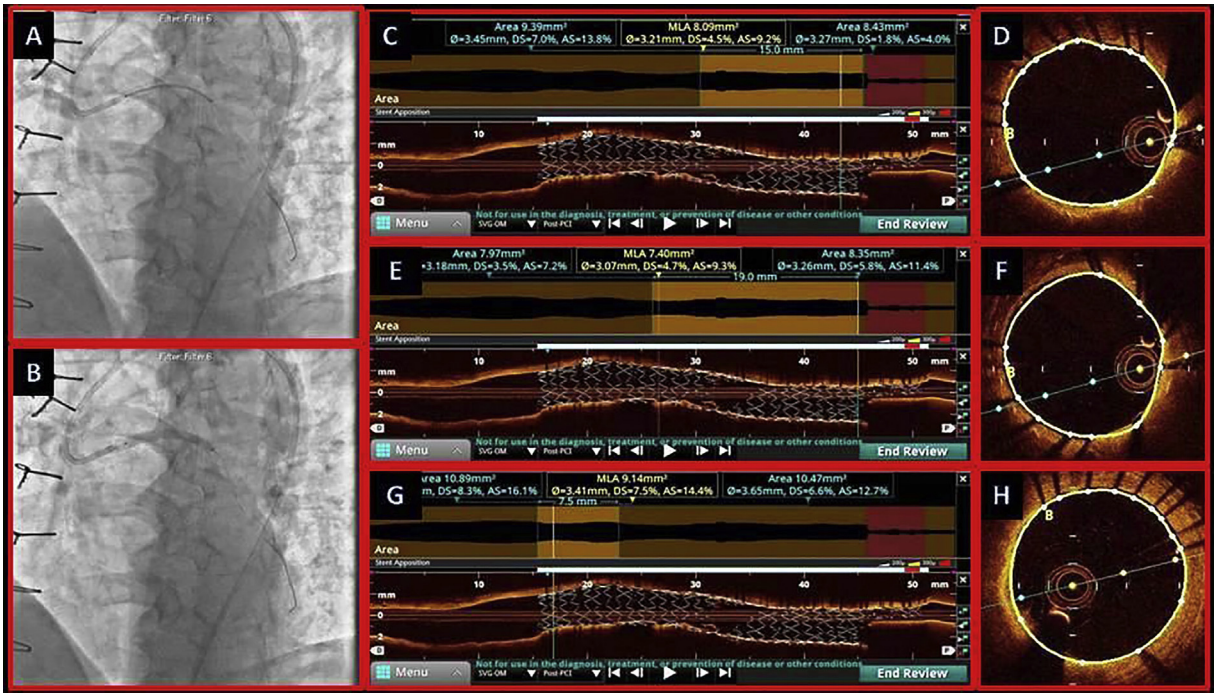

Fig. 2. A) 3.5 × 34 mm zotarolimus-eluting stent was placed in position. (B) Stent deployed at 12 atm. (C) Poststent OCT with LMWD-40 flush medium: long view with MSO showed 1.8% residual diameter stenosis of proximal half of stent without malapposition. (D) Cross-sectional view at proximal edge of stent. (E) Long view with MSO showed 5.8% residual diameter stenosis at lesion site. (F) Cross-sectional view at ISR site showed well-expanded stent. (G) Long view with MSO showed 8.3% residual diameter stenosis of distal half of stent without malapposition. (H) Cross-sectional view of proximal edge of stent. OCT, optical coherence tomography; ISR, in-stent restenosis; LMWD-40, low molecular weight dextran-40; MSO, metallic stent optimization .

Table 1
Comparison of zero contrast OCT-guided PCI technique with the previous reports.

Variable	Ali et al[1]	Azzalini et al[4]	Present report
Flush medium	Mixture of saline and colloid infusate	Dextran 40	Dextran 40
Pressure	NA	400 psi	400 psi
Flow rate	NA	4.0 ml/s	5.0 ml/s
Total volume	NA	14 ml	20 ml
Duration	NA	NA (calc = 3.5 s)	4 s
Rise time	NA	0.0 s	0.0 s
Angiographic coregistration (technique)	Yes (not mentioned)	No	Yes (mentioned)
Coronary physiology	FFR and CFR	No	No
Vessel	LAD	LAD	SVG-OM graft
Lesion	denovo	denovo	ISR
Procedural time	NA	45 min	26 min
Fluoroscopy time	NA	NA	7.35 min
Dose area product	NA	NA	60.7 Gy cm^2
Air kerma	NA	NA	0.67 Gy

OCT, optical coherence tomography; PCI, percutaneous coronary intervention; Calc, calculated; CFR, coronary flow reserve; FFR, fractional flow reserve; ISR, in-stent restenosis; LAD, left anterior descending artery; NA, not available; OM, obtuse marginal artery; SVG, saphenous vein graft.

reproducibility (Table 1). Angiographic coregistration without iodinated contrast needs the following protocol: (a) fluoroscopy dose to be maximized, (b) frame rate to be increased to 30 frames per second, (c) more number of tracker dots to be assigned in close proximity from distal marker of the OCT catheter to guide the catheter tip. In this study, we used 400 psi and 5 ml/s flow rate instead of the standard 300 psi and 4 ml/s, as the imaging needed to be carried out in a larger and longer SVG graft than the native coronary artery. Although two case reports are available in the literature, this report is novel as this technique was used the first time in a SVG with ISR. Focal edge ISR is ideal for zero contrast PCI as the stent serves as the metallic silhouette. Although in a SVG, metallic silhouette with coronary wires cannot be created because of the absence of branches; in this study, guide engagement, predilatation and stent positioning were carried out under the fluoroscopic guidance of the ostial SVG stent. Bailout coronary angiogram should be used as a backup in case of complications. Previous studies showed that the image quality and measurements during OCT image acquisition were similar for LMWD-40 and iodinated contrast.[5] Ozaki et al found that the volume of LMWD-40 during OCT-guided PCI was safe in renal insufficiency patients. The viscosity of LMWD-40 is 3.67 mm^2/s which is one third of iodixanol contrast and its osmolality ratio to saline is 1.0 (iodixanol to saline ratio is 3.0). Frick et al[6] analysed the correlation of measurements between iso-osmolar contrast OCT and LMWD-40 OCT using the correction factor of 1.117 for area measurements and 1.057 for length measurements as the LMWD-40 has different refractive properties. They found out that without the refractive index correction, the measurements were slightly smaller with LMWD-40 OCT, and with correction, the measurements were slightly larger than contrast. But excellent correlation was observed either with or

without refractive index correction. Seeliger et al[7] demonstrated that LMWD-40 itself is not nephrotoxic, and it is not filtered by the kidney. As LMWD-40 might influence the renal tubular reabsorption in the presence of hypovolaemia, it is prudent to monitor and correct the hypovolemic status when LMWD-40 is used during OCT. The improvement of eGFR from 39 ml/min/1.73 m^2 to 53.68 ml/min/1.73 m^2 after PCI could be due to two reasons. The baseline value might be taken during the dehydrated period, and the generous periprocedural hydration could improve the eGFR. In the past, LMWD-40 was used in addition to heparin during PCI to reduce the acute thrombosis events. LMWD-40 is a polysaccharide, which has antithrombotic properties by inhibiting factor VIII and to some extent factor V and II. It also has a direct antiplatelet effect.[8] The incidence of anaphylactoid reaction to LMWD-40 is 0.6% and severe life-threatening reaction occurs in 0.2% of patients, which is lesser than the incidence of iodinated contrast allergy.[9]

4. Limitations

Primary PCI in a ST segment elevation myocardial infarction is an absolute contraindication for zero contrast PCI. During the learning curve, it is better to avoid type B2 or C lesions, lesions requiring rotational atherectomy or chronic total occlusions as it may be technically difficult to perform. In the scenario of poor LVEF, it is better to avoid colloids, and pretreatment with diuretics is mandatory.

5. Conclusion

What is already known: OCT-guided, with or without coronary physiology–guided zero contrast PCI using LMWD-40 is feasible in native coronary artery stenosis.

What is new: OCT-guided zero contrast PCI using the LMWD-40 flush medium is safe and feasible in ISR and in SVG.

Conflict of interest

None of the authors have conflict of interest.

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