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CASE REPORT
*Coronary intervention*

# Intravascular ultrasound–guided tip-detection antegrade dissection and re-entry as a bailout strategy for calcification-induced side-branch occlusion during complex percutaneous coronary intervention: a case report

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**Background** Percutaneous coronary intervention (PCI) for heavily calcified bifurcation lesions presents unique challenges, side-branch occlusion representing a serious complication. Tip-detection antegrade dissection and re-entry (TD-ADR), originally developed for chronic total occlusion, enables true lumen re-entry when guidewires advance subintimally. We report its novel application as an effective bailout technique for calcification-induced side-branch occlusion.

**Case summary** A 67-year-old man with prior inferior myocardial infarction underwent PCI of a heavily calcified mid-left anterior descending (LAD) artery stenosis with ostial narrowing of diagonal branches D1 and D2. Rotational atherectomy and modified balloon dilation fragmented the calcific plaque, abruptly displacing fragments that occluded the D2 ostium. Conventional re-crossing attempts with multiple wires resulted in subintimal tracking. Intravascular ultrasound (IVUS) confirmed the guidewire entered the false lumen at D2 origin. Using a double-guide catheter setup and IVUS guidance, TD-ADR with a Conquest Pro 12 ST guidewire targeted the true lumen point, achieving precise re-entry and restoring TIMI 3 flow to D2. Culotte stenting of LAD and D2 was subsequently performed.

**Discussion** In calcified bifurcation interventions, plaque fracture during lesion preparation can directly obstruct side-branch ostia and render conventional guidewire re-crossing techniques ineffective. When guidewires enter the subintimal space and angiography-guided re-entry fails, IVUS-guided TD-ADR can pinpoint and penetrate the true lumen vertically, minimizing subintimal tracking, preserving side-branch perfusion, and providing a reliable bailout. This case demonstrates the utility of IVUS-guided TD-ADR as a targeted bailout strategy for achieving true lumen access in difficult side-branch occlusions during complex bifurcation PCI.

**Keywords** Case report • Complex percutaneous coronary intervention • Bifurcation • Side-branch occlusion • Tip-detection antegrade dissection and re-entry • Guidewire re-entry

**ESC curriculum** 3.1 Coronary artery disease • 3.3 Chronic coronary syndrome • 3.4 Coronary angiography

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## Learning points

- Calcific fragment displacement after lesion preparation can abruptly occlude a side branch and predispose to subintimal wire tracking in severely calcified bifurcations.
- Intravascular ultrasound–guided tip-detection antegrade dissection and re-entry enables precise, vertical puncture into the true lumen and is an effective bailout when angiographic re-wiring fails.
- High-penetration wires used during TD-ADR carry a tangible risk of distal perforation; operators should maintain vigilance and be prepared to perform prompt coil embolization.

# Introduction

Bifurcation percutaneous coronary intervention (PCI) involving moderate-to-severe calcification predisposes to target lesion failure and abrupt side-branch (SB) compromise.[1,2]

When an unprotected SB occludes during preparation or after stent deployment, standard manoeuvres (e.g. small-balloon inflation over a jailed wire) may be inadequate,[3] and subintimal guidewire passage hampers true lumen re-crossing.

The tip-detection antegrade dissection and re-entry (TD-ADR) leverages intravascular ultrasound (IVUS) to localize the puncture site and trajectory for controlled vertical re-entry from the subintimal space, and experimental data suggest faster crossing than IVUS-guided wiring alone.[4]

However, reports of successful branch re-entry during complex bifurcation PCI remain limited. We report IVUS-guided TD-ADR rescuing a SB occlusion caused by calcific fragment shift during mid-left anterior descending (LAD) bifurcation PCI.

# Summary figure

| Date | Event |
|---|---|
| 5 months ago | Onset of acute inferior myocardial infarction |
| | Coronary angiography revealed thrombotic occlusion at mid-RCA, 90% stenotic lesion at mid LAD and left circumflex (LCx) |
| | Primary PCI to RCA was performed |
| 4 months ago | Staged PCI for mid-LCx |
| Day 1 | Admission for PCI to the LAD |
| Day 2 | PCI to mid LAD |
| Day 3 | Discharged in a favourable clinical course |
| 3 months later | Follow-up revealed complete resolution of symptoms |
| 6 months later | No major adverse cardiac events were reported |

# Case report

A 67-year-old man underwent PCI of a severely stenotic mid-LAD lesion. He had prior inferior myocardial infarction (culprit: right coronary artery) and staged mid-LCx PCI. Comorbidities included hypertension, dyslipidaemia, and diabetes (HbA1c 6.1%); he was a former smoker. He was clinically stable on guideline-directed medical therapy.

Percutaneous coronary intervention was performed via a 6-Fr transradial approach using a Heartrail BL 3.75 M guide catheter (TERUMO, Tokyo, Japan). Angiography demonstrated a 90% calcified mid-LAD stenosis with ostial narrowing of diagonal branches D1 and D2 (*Figure 1A* and *B*, Supplementary material online, *Video S4*). Pre-procedural IVUS confirmed 270° circumferential calcification with eccentric calcium opposite the diagonal ostia (*Figure 1C*, Supplementary material online, *Video S1*). Given the calcium arc and guidewire bias, rotational atherectomy (RA) was selected.

Rotational atherectomy was performed with a ROTAPRO 1.5 mm burr (Boston Scientific, Natick, MA). Post-atherectomy IVUS showed calcium modification and lumen enlargement. Pre-dilatation used a $3.0 \times 13$ mm Aperta non-slip element (NSE) scoring balloon (NIPRO, Osaka, Japan). D1 was protected by a wire; D2 was unprotected. Immediately thereafter, angiography showed abrupt D2 occlusion (*Figure 2A*, Supplementary material online, *Video S5*) with chest discomfort and transient ST-segment elevations in leads I and aVL. Intravascular ultrasound indicated balloon-induced fragmentation displacing calcific pieces into the D2 ostium via a plaque-shift mechanism (*Figure 2B* and *C*).

Re-entry with a dual-lumen SASUKE catheter (Asahi Intecc, Aichi, Japan) and a Sion Black wire (Asahi Intecc) resulted in subintimal tracking. A parallel-wire attempt with an Abbys IM wire (NIPRO, Osaka, Japan) also failed (*Figure 3A* and *B*, Supplementary material online, *Video S6*). Angiography-guided re-wiring was abandoned in favour of IVUS-guided TD-ADR.

A double-guide catheter setup enabled simultaneous IVUS imaging and re-wiring. An AnteOwl IVUS catheter (TERUMO) was advanced into the subintimal space (*Figure 4A*, Supplementary material online, *Video S7*). Using the tip-detection method, the Conquest Pro ST-12(Asahi Intecc) tip was oriented towards the true lumen, and a short, orthogonal puncture from the subintimal plane into the distal D2 true lumen was achieved (*Figure 4B–D*, Supplementary material online, *Video S3*). Post–re-entry IVUS confirmed the distal true lumen course (*Figure 4E*, Supplementary material online, *Video S2*), while the proximal D2 segment of the wire remained subintimal.

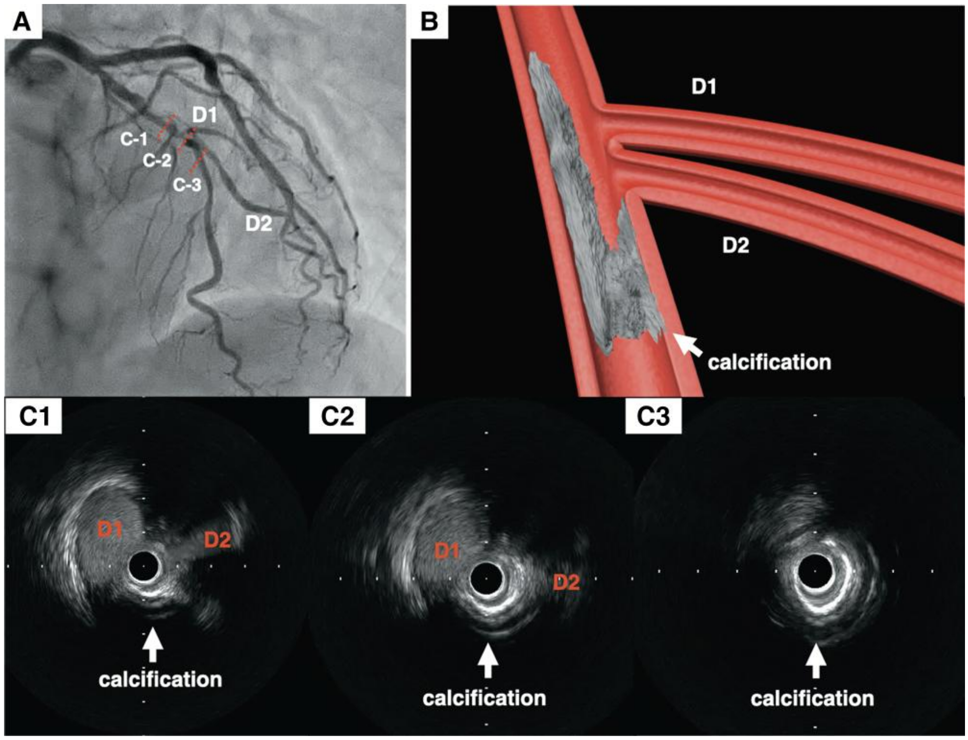


**Figure 1** Baseline angiography and initial intravascular ultrasound findings. (*A*) Control angiogram in left anterior oblique cranial projection. (*B*) Control angiogram in right anterior oblique cranial projection. (*C*) Intravascular ultrasound images acquired from the left anterior descending artery. (C-1) Proximal D1–D2 bifurcation: white arrows denote a calcified plaque, with the intravascular ultrasound catheter abutting the calcified segment. (C-2) Distal D1−D2 bifurcation: the calcified plaque on the wall opposite the diagonal branch ostium lies adjacent to D2. (C-3) Immediately distal to the diagonal branch take-off, the lesion exhibits severe circumferential calcification with an arc of approximately 270°, with calcium thickness likely exceeding 1.0 mm.

With D2 distal true lumen access, culotte stenting of D2 and LAD was completed. After stent deployment, contrast extravasation from distal D2—consistent with Ellis grade III—was observed (*Figure 5A*, Supplementary material online, *Video S8*). This was attributed to guidewire injury from initial subintimal tracking with a polymer-jacketed wire (Sion Black) and subsequent high-penetration wire use during TD-ADR. Haemostasis was achieved with two 15-mm C-STOPPER coils (PIOLAX, Kanagawa, Japan), resulting in complete occlusion. Dual antiplatelet therapy was continued; serial transthoracic echocardiography showed no pericardial effusion. Final angiography demonstrated TIMI 3 flow in both LAD and D2 (*Figure 5B*, Supplementary material online, *Video S9*).

At 3 months, the patient was asymptomatic, and repeat coronary angiography showed widely patent stented segments without restenosis. Over 6 months, no major adverse cardiac events occurred.

## Discussion

Calcified bifurcation lesions carry a high risk of SB compromise and adverse clinical outcomes.[1] Similarly, Fujino *et al.*[2] used optical coherence tomography to demonstrate that calcified bifurcation increase SB compromise by altering plaque geometry and impeding guidewire passage.

When a guidewire migrates into the SB subintimal space, IVUS permits early recognition of dissection planes and localization of the compressed true lumen, enabling accurate guidewire re-entry and optimal stent placement.[4]

Building on these advantages, IVUS-guided TD-ADR has emerged as a valuable strategy for chronic total occlusion (CTO) PCI. Real-time IVUS localizes the guidewire tip within the subintimal space and visualizes the compressed true lumen, enabling precise vertical puncture. Okamura *et al.*[5,6] reported that IVUS-guided TD-ADR achieved high first-pass re-entry rates with minimal subintimal injury, facilitating successful recanalization in complex CTO lesions.

In this case, calcific fragment shift acutely occluded D2 ostium in a manner analogous to plaque shift, occluding the branch and preventing guidewire passage into the true lumen. The wire repeatedly migrated into the subintimal space, and fluoroscopy could not reliably identify a true lumen target. Recognizing the high risk of peri-procedural myocardial infarction associated with SB occlusion, we employed IVUS-guided TD-ADR via a dual-guiding catheter system.[7] An additional 8 Fr Judkins Left (JL) 4.0 with a Y-connector established a double-guiding setup for concurrent wiring and IVUS; when access is limited, it can be performed with a 6 Fr. The AnteOwl WR IVUS catheter (AO-IVUS) was advanced subintimally distal to the LAD–D2 carina to obtain long- and short-axis views of the D2 ostium. Under IVUS guidance, the puncture trajectory was planned orthogonal to the true lumen wall and aligned with the D2 centreline, enabling a short, controlled vertical re-entry. Recent device innovations—AO-IVUS and novel high-penetration guidewires—have improved TD-ADR by enabling deep subintimal imaging and more precise puncture.[8] For puncture, we used Conquest Pro 12 ST (CP12-ST) for its high tip load, tapered stiff

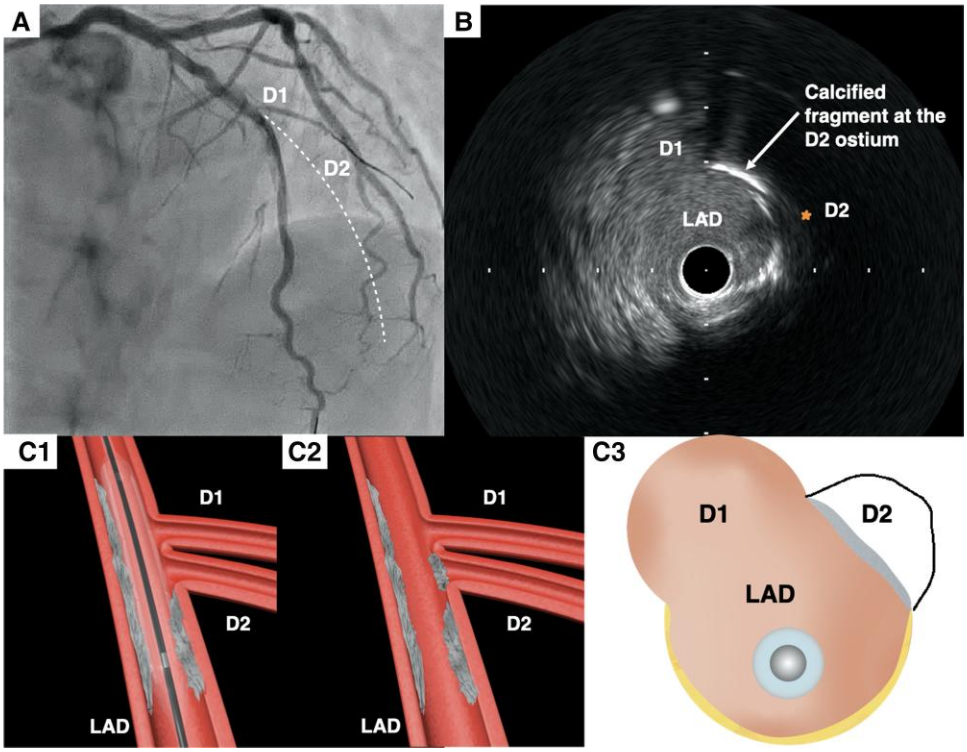


**Figure 2** Coronary angiography and intravascular ultrasound findings following rotational atherectomy and non-slip element balloon angioplasty of the left anterior descending artery. (*A*) Post-procedural angiogram demonstrating loss of antegrade flow in the second diagonal branch (D2). (*B*) Intravascular ultrasound image from the left anterior descending artery showing displacement of the calcified lesion at the bifurcation, resulting in occlusion of the D2 ostium. (*C*) Schematic image of an intravascular ultrasound image from the left anterior descending artery: arrowheads = calcification; asterisk = D2 true lumen.

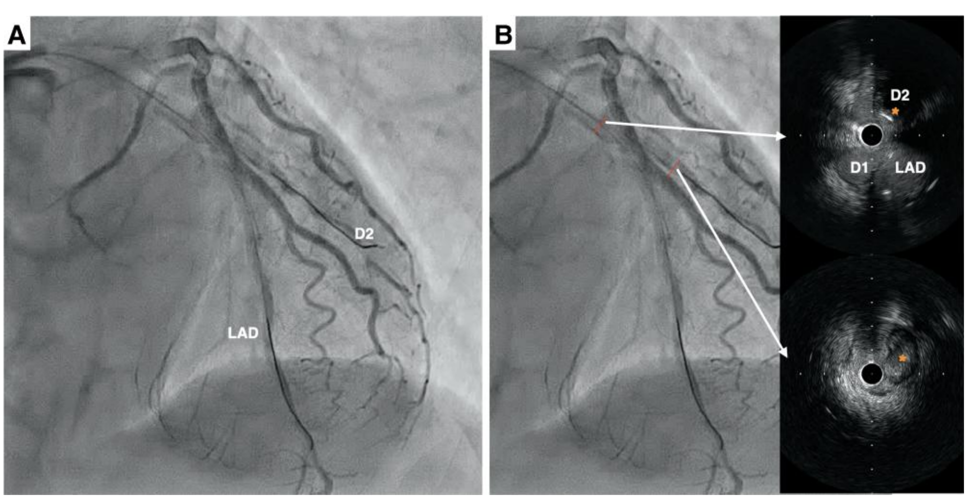


**Figure 3** Coronary angiography and intravascular ultrasound findings after re-crossing the guidewire following occlusion of the second diagonal branch (D2). (*A*) Post-crossing angiogram demonstrating that the guidewire has deviated outside the lumen of the imaged vessel. (*B*) Intravascular ultrasound image from the D2 branch showing the guidewire traversing the subintimal space immediately distal to the ostium. Asterisk (*) denotes the D2 true lumen.

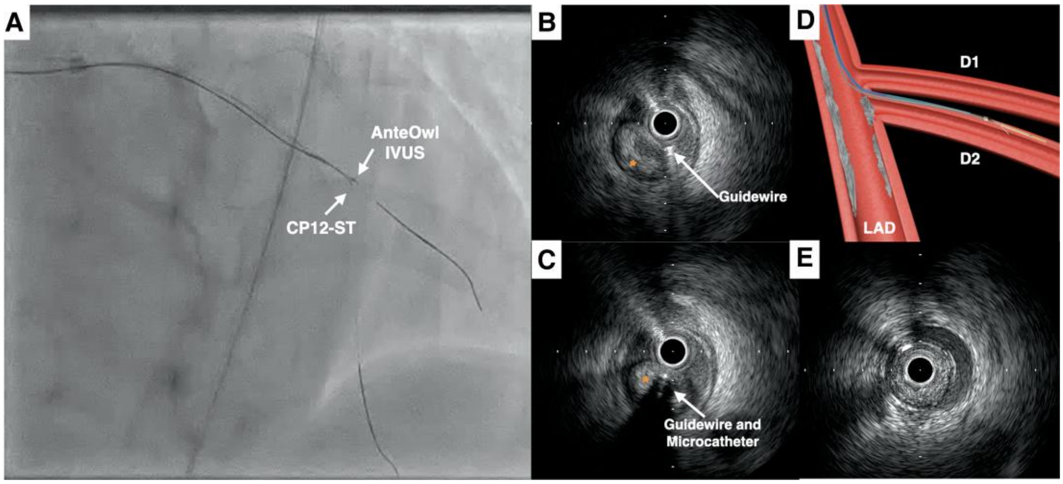


**Figure 4** Establishment of a double-guide catheter system and successful true lumen re-entry of the second diagonal branch (D2) using the tip-detection antegrade dissection and re-entry technique. (*A*) Using AnteOwl intravascular ultrasound, true lumen access of D2 was achieved with a Conquest Pro ST-12 guidewire. (*B*) Intravascular ultrasound image depicting the guidewire shaft. (*C*) Intravascular ultrasound images from D2 showing the tip of the Conquest Pro ST-12 guidewire directed towards and penetrating the true lumen. (*D*) Schematic left anterior oblique cranial view demonstrating fragmented calcification occluding the D2 ostium, with the guidewire positioned in the subintimal space; application of the tip-detection antegrade dissection and re-entry technique successfully secured true lumen access to D2. (*E*) Post–guidewire passage intravascular ultrasound image demonstrating that the guidewire is seated within the true lumen of the distal D2 segment. Asterisk (*) denotes the D2 true lumen.

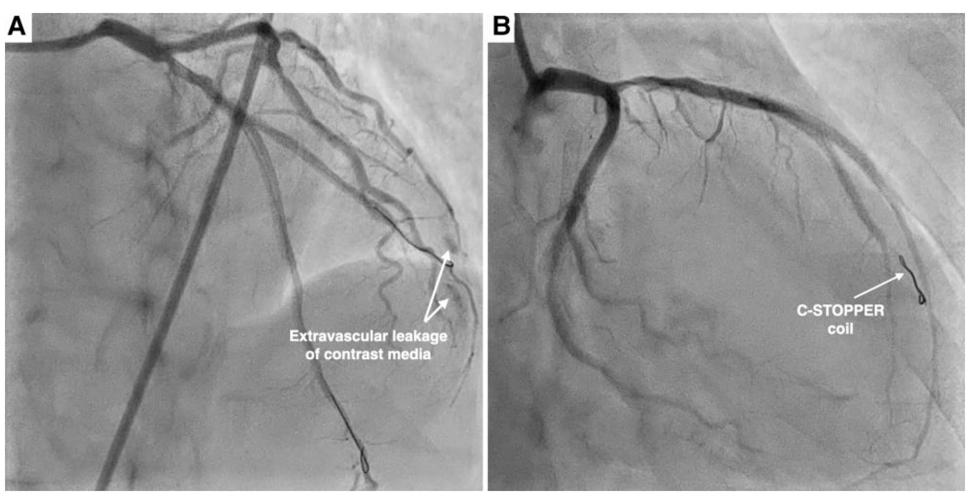


**Figure 5** Coil embolization of guidewire-induced perforation in the distal second diagonal branch (D2) and final angiographic outcome. (*A*) Brisk contrast jet from distal D2 consistent with Ellis grade III. Under angiographic guidance, coil embolization was performed to seal the guidewire-induced perforation in the distal D2 branch. (*B*) Final angiogram demonstrating successful haemostasis with no residual contrast extravasation and restoration of antegrade flow.

tip, and torque response, allowing short, controlled penetration under IVUS tip detection.[5,6,8,9] After microcatheter entry into the SB true lumen, we de-escalated to a workhorse wire (e.g. Sion) to reduce perforation risk; escalation (e.g. alternative high-penetration wire or a new re-entry site) was reserved if vertical puncture failed. Success cues were IVUS visualization of the wire at the D2 intimal surface, smooth microcatheter tracking without haematoma, and confirmation of distal intraluminal position. If re-entry remained limited by proximal calcification, we relocated the puncture to avoid dense calcium or performed incremental IVUS-guided plaque modification with a scoring balloon (e.g. Aperta NSE) before re-attempting, to improve deliverability and limit uncontrolled plaque shift.[10]

For transparency, the contrast 232 mL, fluoroscopy 67 min, and dose–area product 113 Gy • $cm^2$ are reported.

In CTO-PCI, IVUS-guided TD-ADR is an established re-entry option when conventional wiring or Stingray-based ADR fails.[8] Prior reports describe IVUS-guided vertical puncture into a compressed true lumen within CTO algorithms, but largely for planned main-vessel re-entry rather than emergent SB rescue.[6,9,11]

This case demonstrates IVUS-guided TD-ADR to rescue an acutely occluded SB during bifurcation PCI: balloon expansion fragmented eccentric calcium, shifting plaque into the D2 ostium, and precluding angiographic wiring; a dual-guide setup with IVUS tip detection enabled pinpoint vertical puncture into the branch true lumen, and two-stent optimization (culotte, final kissing) restored TIMI 3 flow (*Figures 3* and *4*). This extends TD-ADR from main-vessel CTO applications to time-critical bifurcation complications.

Despite its efficacy, TD-ADR requires expertise in IVUS interpretation and wire control; case selection should reflect operator experience, institutional IVUS volume, and resource availability.

Finally, these procedures were performed at a tertiary PCI centre (∼300 PCIs/year; five interventional cardiologists; senior operators ∼12 years' experience) with on-site surgical standby, supporting safe implementation.

# Conclusion

Intravascular ultrasound–guided TD-ADR provides an effective bailout for true lumen re-entry in calcified bifurcation PCI. Advanced IVUS visualization enables precise guidewire puncture, while preserving SB flow.

# Lead author biography

Dr Kei Kawai is an interventional cardiologist at Seirei Yokohama Hospital, Japan. He is a Board Certified Member of the Japanese Association of Cardiovascular Intervention and Therapeutics (CVIT). His primary clinical and research interests focus on complex coronary and peripheral vascular interventions, as well as the management of heart failure.

# Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports* online.

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**Consent:** The authors confirm that written consent for submission and publication of this case report, including images and associated text, has been obtained from the patient, in line with the COPE guidance.

*Conflict of interest.* None declared.

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None declared.

## Data availability

The data underlying this article are available within the article and its supplementary material (including IVUS and angiographic video files). Additional de-identified procedural data are available from the corresponding author on reasonable request.

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