ESC European Society of Cardiology

European Heart Journal - Case Reports (2023) **7**, 1–7
https://doi.org/10.1093/ehjcr/ytad415

CASE REPORT
Coronary intervention

Follow-up optical coherence tomography to evaluate circumflex ostium after fenestration of left main Papyrus covered stent: a case report

Annette Maznyczka *, Sacchin Arockiam, Heerajnarain Bulluck, and Abdul Mozid

Yorkshire Heart Centre, Leeds General Infirmary, Leeds Teaching Hospitals NHS Trust, Great George Street, Leeds LS1 3EX, UK

Received 15 February 2023; revised 3 August 2023; accepted 16 August 2023; online publish-ahead-of-print 18 August 2023

Background Left main (LM) perforations necessitating a covered stent risk sacrificing the side branch. The lost side branch can be promptly recovered by fenestration of the covered stent, using a stiff wire. However, it is unclear whether subsequent balloon angioplasty of the recovered side branch ostium is sufficient to preserve side branch patency. We report the longer-term patency of the circumflex (LCx) ostium after LM covered stenting.

Case summary A 78-year-old lady, with stable angina, presented for elective angiography. Percutaneous coronary intervention of the left anterior descending (LAD) artery to LM was complicated by a distal LM perforation. A covered stent across the LM sealed the perforation but resulted in acute occlusion of the LCx. The LCx was rescued by fenestration of the covered stent with a stiff wire, followed by balloon angioplasty to the LCx ostium. At follow-up, the angina had resolved. However, follow-up angiography demonstrated a new severe stenosis at the LCx ostium, with remnants of the polyurethane membrane seen protruding into the LCx ostium on optical coherence tomography. Therefore, the LCx ostium was stented, using the reverse Culotte technique.

Conclusion This case demonstrates that stenting the LCx ostium should be considered after covered stent implantation from LM to LAD, because balloon angioplasty of the LCx ostium may not provide a durable result in this scenario.

Keywords Perforation • Covered stent • Bifurcation • Optical coherence tomography • Case report

ESC curriculum 3.1 Coronary artery disease • 3.4 Coronary angiography • 7.4 Percutaneous cardiovascular post-procedure

Learning points

- Coronary artery perforations necessitating a covered stent and resulting in significant side branch loss can be promptly treated by fenestration of the covered stent using a stiff wire and an angled microcatheter.
- Stenting the LCx ostium should be considered after covered stent implantation in the LM to LAD, because balloon angioplasty of the LCx ostium may not provide a durable result in this scenario.

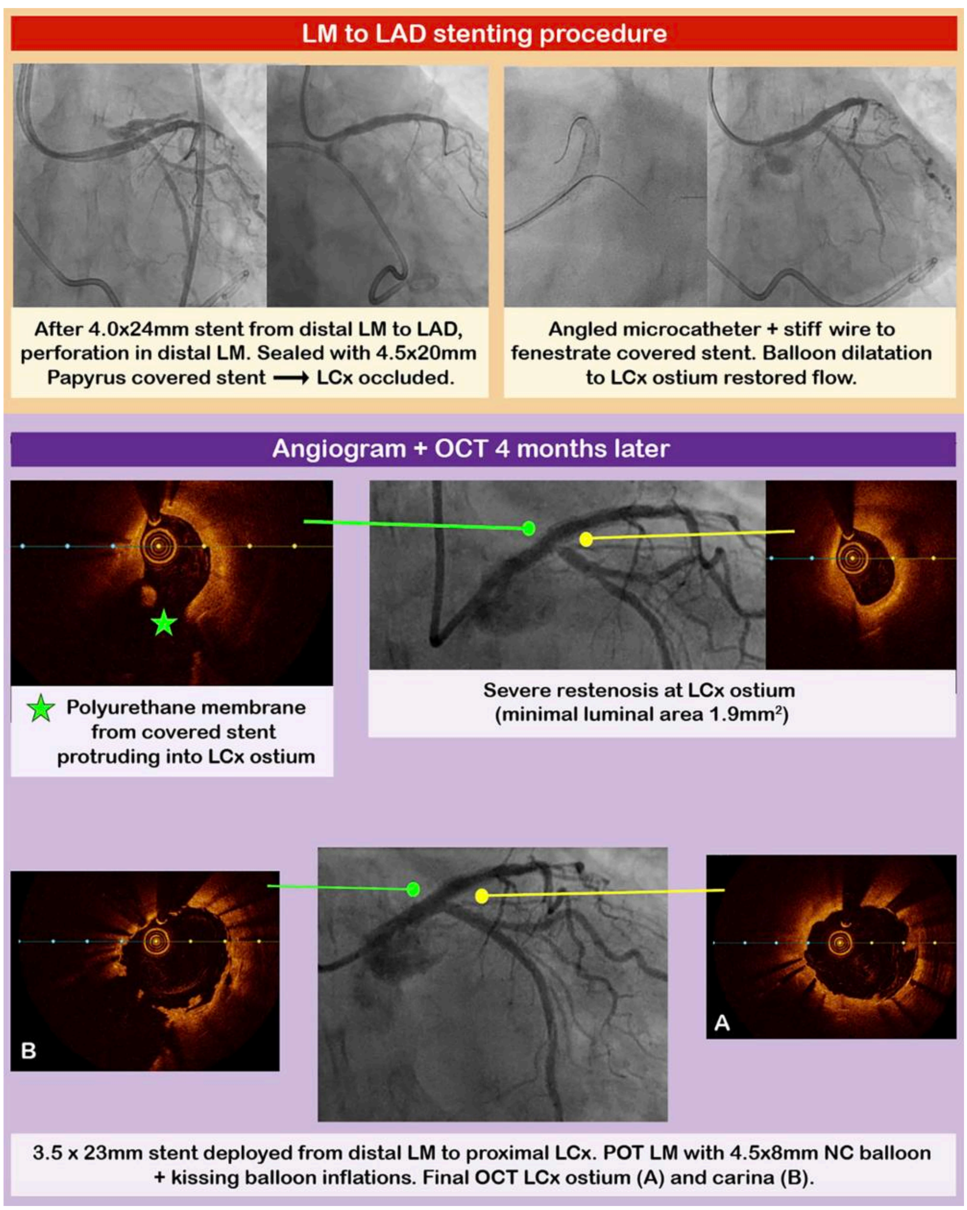
* Corresponding author. Tel: +44 0113 2432799, Email: amaznyczka@nhs.net

Handling Editor: Francesco Moroni
Peer-reviewers: Ippei Kosedo; Sharath Reddy; Antonios Karanasos
Compliance Editor: Sara Monosilio

Introduction

Left main (LM) coronary perforation is a serious, but rare, complication of percutaneous coronary intervention (PCI).[1] Covered stents in this setting risk sacrificing the side branch. Herein, we describe a case where the circumflex artery (LCx) was rescued after LM covered stenting, using a stiff wire and angled microcatheter. We then describe the longer-term patency of the LCx ostium after LM covered stenting and whether LCx ostial stenting should be recommended in this setting.

Summary figure



Case presentation

A 78-year-old lady, with angina, presented for elective angiography. She had hypertension but was not diabetic. On examination, heart sounds were normal. Her blood pressure was 132 systolic and 74 diastolic. Her electrocardiogram at rest showed normal sinus rhythm. Prior stress echocardiography showed widespread inducible ischaemia, and she had mild left ventricular systolic dysfunction. Renal function and haemoglobin were normal. Angiography showed mild LM atheroma, a critically severe calcified stenosis in the proximal left anterior descending (LAD) artery with further severe disease in the mid LAD, and a moderate stenosis in the proximal LCx (*Figure 1*). There was also a critically severe

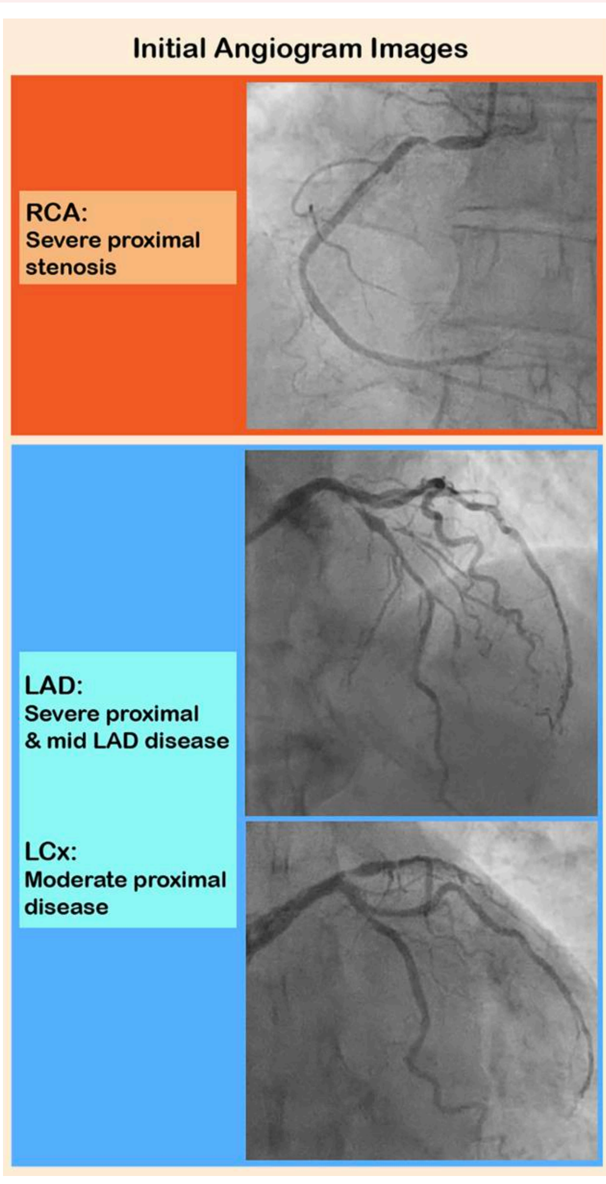


Figure 1 Baseline angiographic images before percutaneous coronary intervention. Abbreviations: LAD, left anterior descending artery; LCx, circumflex artery; RCA, right coronary artery.

lesion in the proximal right coronary artery (RCA), with collaterals from the left system. She was discussed in the heart team meeting and both PCI and coronary artery bypass graft (CABG) surgery were considered reasonable. She was turned down for surgery, due to the lack of graft conduits. Therefore, she returned to the catheterization laboratory for PCI. The plan was to treat the RCA lesion first and then stent from the LM to LAD.

A right radial artery 7 French sheath was used. Stenting the RCA was uneventful. For LM to LAD PCI, a Voda VL3.5 (Boston Scientific, USA) 7 French guide catheter was used. A Sion Blue wire (ASAHI INTECC USA) was advanced into the LAD, and a second Sion Blue wire was put in the diagonal branch. The proximal LAD was pre-dilated with a 2.5 × 15 mm semi-compliant balloon, to allow the intravascular ultrasound (IVUS) catheter to pass. IVUS confirmed severe disease from proximal to mid LAD, with concentric calcification in the proximal LAD (*Figure 2*). Notably, there was negative remodelling in the proximal LAD; however, the measurements to guide stent sizing were performed on the more distal reference area where the luminal diameter was 4.25 mm (*Figure 2*).

Further lesion preparation to the proximal LAD was with 2.5 and 3.0 mm Scoreflex balloons (OrbusNeich Medical Company Limited) and a 3.0 × 12 mm intravascular lithotripsy Shockwave balloon. The IVUS appearance pre- and post-vessel preparation with intravascular lithotripsy is shown in *Figure 2*. A 2.75 × 38 mm Synergy stent (Boston Scientific, USA) was then deployed in the mid LAD. This was overlapped with a 4.0 × 24 mm Synergy stent, from proximal LAD back to LM. Immediately after this, she became haemodynamically unstable, with chest pain. An Ellis type 3 perforation (frank perforation into pericardium) was detected, which was initially presumed to originate from the ostial LAD (*Figure 3*). The stent balloon was inflated proximal to the site of perforation to occlude flow. Prolonged balloon inflations failed to seal the perforation but allowed time for an echocardiogram and pericardial drain insertion. Femoral venous and arterial access was obtained. A second Voda VL3.5 7 French guide catheter was advanced femorally, to enable rapid delivery of equipment, between balloon inflations, using the ping-pong technique.[2] She had two units of blood transfused. The on-call cardiac surgeon arrived, but the bleeding site was thought to be inaccessible for surgical packing, and CABG surgery was not possible due to the lack of graft conduits.

We thought a covered stent would be required, but landing the covered stent across the distal LM into the LAD would occlude the LCx. A 4.0 × 15 mm Papyrus covered stent (BIOTRONIK, Germany) was deployed, aiming to nail the LAD ostium, followed by proximal optimization with a 4.5 mm non-compliant (NC) balloon. However, after this, the leak persisted (*Figure 3*). At this point, we felt the only remaining option was to deploy a further covered stent from LM to LAD to seal the bleed point. First, a Sion Blue wire was passed into the LCx, so that this could be used as a target for re-entering the LCx. Next, a 4.5 × 20 mm Papyrus covered stent was deployed from LM to LAD, overlapping with the first covered stent, with deliberate occlusion of the LCx to ensure sealing of the perforation. Proximal optimization technique (POT) was performed with a 5.0 mm NC balloon. A SuperCross 120 microcatheter (Teleflex, Pennsylvania, USA), which has an angled tip, was used to advance an Astato 20 stiff wire (ASAHI INTECC USA), to fenestrate the covered stent into the LCx. The angled tip microcatheter was advanced into the LCx, and the Astato stiff wire was exchanged for a Sion Blue wire. The fenestration in the covered stent was then dilated using 2.5 × 15 mm and 3.0 × 15 mm NC balloons, to restore LCx flow. At the end of the procedure, there was thrombolysis in myocardial infarction (TIMI) 3 flow in the LAD and LCx and a fully sealed perforation (*Figure 3*). An alternative to an angled microcatheter, to support a stiff wire with fenestration of the covered stent, could be a dual lumen microcatheter.

Of note, she had two layers of covered stents at the LAD ostium, which might increase restenosis risk. Furthermore, we were concerned that despite ballooning into the LCx ostium, there could be protrusions from the polyurethane membrane of the covered stent into the LCx ostium, which might increase the likelihood of restenosis. Therefore, she was discharged on long-term dual antiplatelet therapy.

Four months later, she had no angina recurrence. However, a repeat angiogram was arranged to evaluate whether further optimization was required, given the concerns regarding restenosis risk. A left radial artery 6 French sheath and Voda VL3.0 6 French guide catheter were used. The LM and LAD stents were patent; however, there was severe stenosis at the LCx ostium (*Figure 4*). Therefore, we performed reverse Culotte LM bifurcation PCI, to stent the LCx ostium, using optical coherence tomography (OCT) guidance (*Figure 5*).

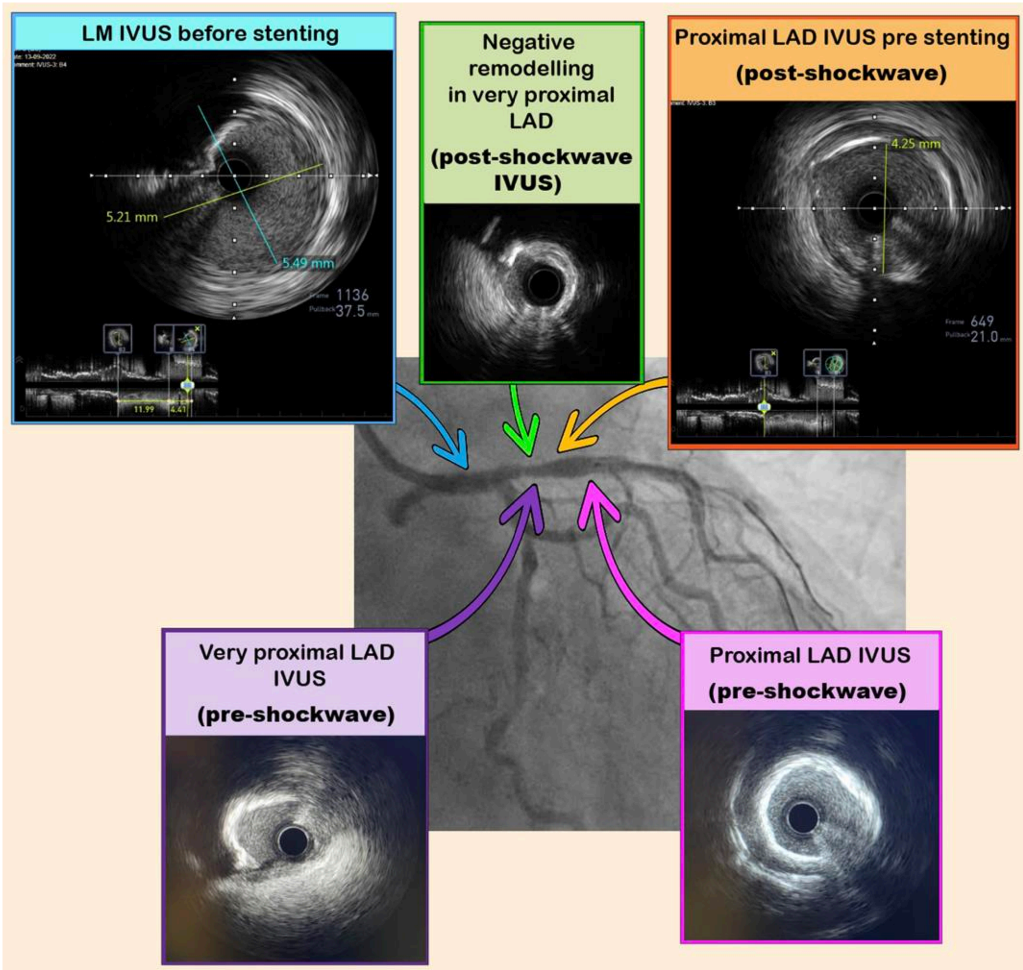


Figure 2 Intravascular ultrasound (IVUS) measurements in left main and proximal left anterior descending (LAD) before stent implantation, demonstrating negative remodelling in the very proximal LAD. IVUS images before and after shockwave intravascular lithotripsy are shown.

Sion Blue wires were advanced into the LAD and LCx arteries. Optical coherence tomography of the LCx confirmed a tight stenosis at the LCx ostium (minimum luminal area 1.9 mm^2) and also showed possible polyurethane membrane from the covered stent protruding into the LCx ostium (*Figure 4* and Supplementary material online, *Video S1*). The LCx ostium was dilated with a 3.0 × 15 mm semi-compliant balloon, before deploying a Xience 3.5 × 23 mm stent (Abbott, USA) from the distal LM into the proximal LCx. POT was performed in the LM with a 4.5 × 8 mm NC balloon. Kissing balloon inflations were performed using a 4.0 × 15 mm NC balloon in the LAD and a 3.0 × 15 mm NC balloon in the LCx. Final OCT of the LCx confirmed excellent stent expansion (*Figure 4* and Supplementary material online, *Video S2*).

Discussion

Risk factors for coronary perforation include rotablation, orbital atherectomy, high-pressure balloon inflations, calcified arteries, older patients, female sex, hypertension, chronic kidney disease, acute coronary syndromes, and previous CABG.[1,3,4] In our case, the contributory mechanisms leading to perforation were concentric calcification in the proximal LAD with negative remodelling in that segment. The likely reason for perforation was oversized stent in this area of negative remodelling.

The implantation of the LM covered stent in our case resulted in acute LCx occlusion. This scenario has been described in four previous publications.[5–8] In one case, a BeGraft covered stent (Bentley InnoMed, Germany) was implanted.[8] The other case reports used the Papyrus covered stent, which has a polyurethane membrane that can be penetrated by a stiff wire. However, among these case reports, there is variability in the technique used to recovery the side branch. Two previous cases[7,8] describe recovery of the LCx using a dual lumen catheter over the LAD wire and then advancing a stiff wire from the side port to penetrate the covered stent membrane into the LCx. In one of those cases, the LCx ostium was subsequently stented during the same procedure,[6] whereas in the other case, the LCx ostium was treated with balloon angioplasty after LM covered stent implantation without further LCx stent implantation.[7] One previous case described rescuing the LCx using an angled microcatheter and stiff wire; however, in contrast to our example, the LCx was stented immediately after LM covered stent implantation using the T and protrusion technique.[5] In the

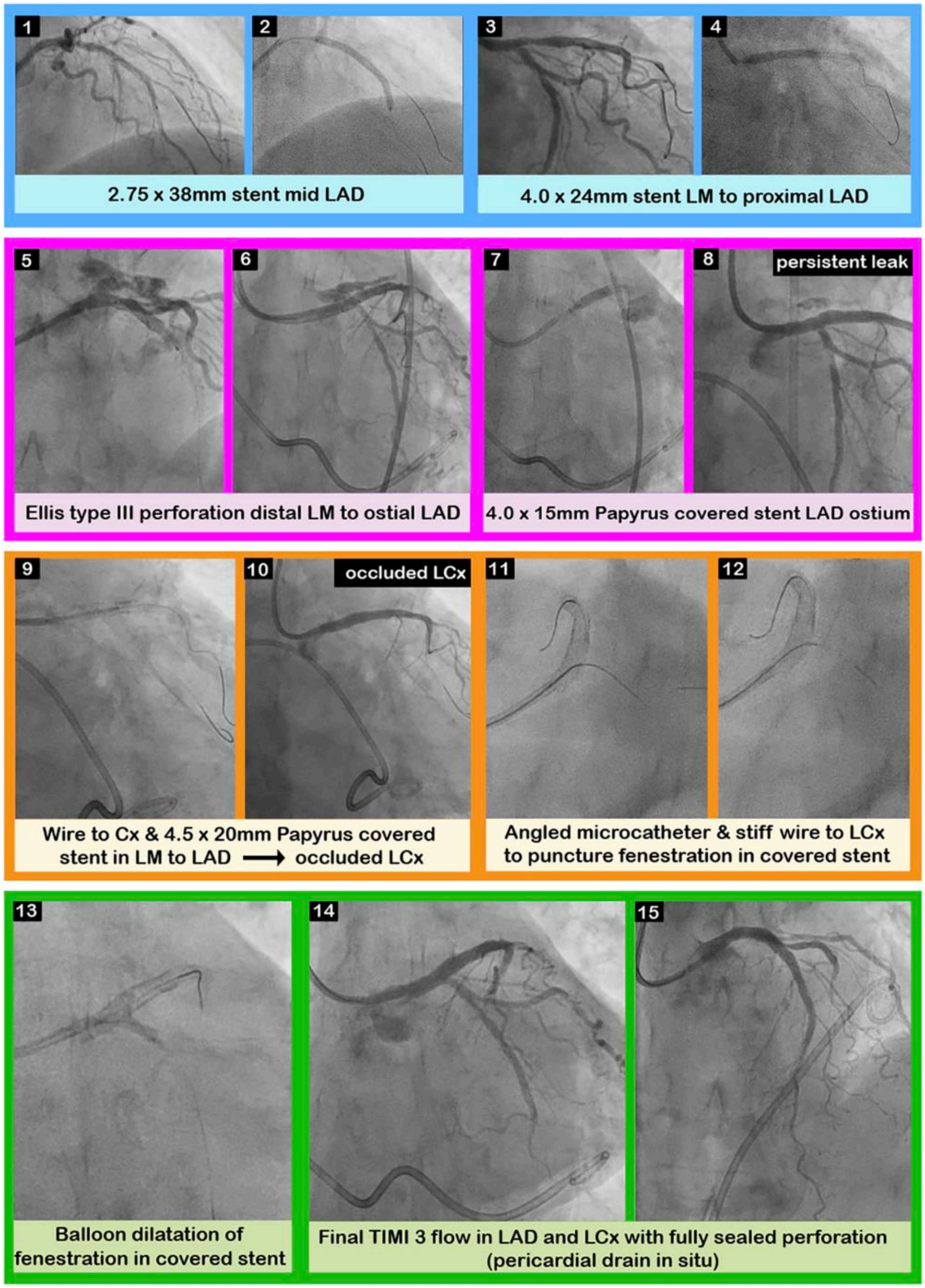


Figure 3 Summary of LM to LAD stenting procedure and management of the perforation with Papyrus covered stents. Abbreviations: LAD, left anterior descending artery; LCx, circumflex; LM, left main.

case that used the BeGraft covered stent,[8] it was not possible to cross the LM covered stent fenestration to access the LCx, despite using a SuperCross microcatheter and Hornet 14 wire (Boston Scientific, USA). In that case, retrograde puncture of the covered stent was performed, via a septal collateral from the LAD to the LCx, but the LCx ostium was not subsequently stented.[8]

Notably, none of the previous published cases[5–8] performed follow-up angiography with OCT to assess for early restenosis and LCx ostium patency. In our case, repeat angiography demonstrated severe stenosis of the LCx ostium, with remnants of the polyurethane membrane seen protruding into the LCx ostium on OCT.

Conclusion

In conclusion, stenting the LCx ostium should be considered after covered stent implantation from LM to LAD, because balloon angioplasty of the LCx ostium may not provide a durable result in this scenario.

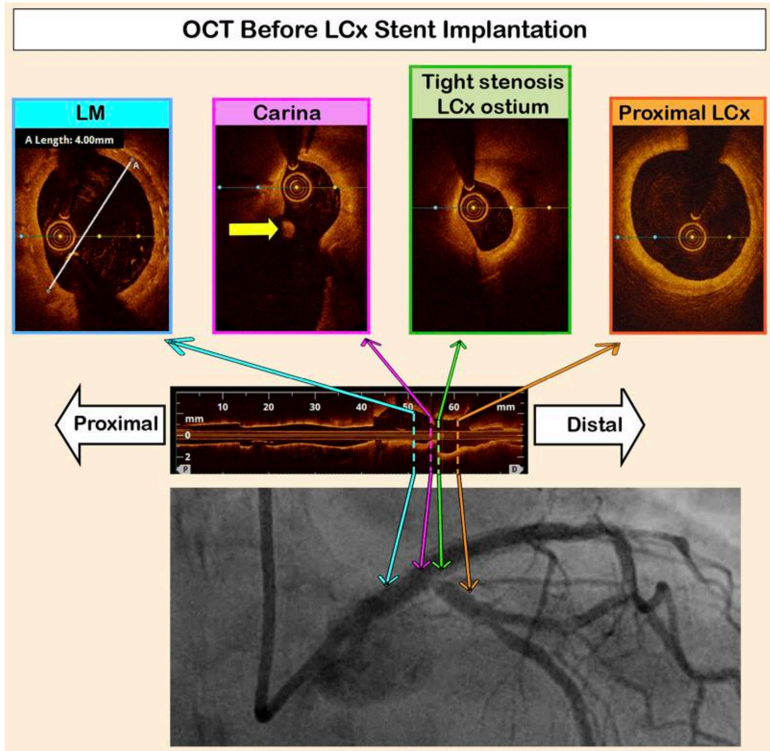


Figure 4 Optical coherence tomography before circumflex artery stent implantation. The yellow arrow in the OCT image second from the left points to a possible protrusion from the polyurethane membrane of the covered stent into the LCx ostium, at the carina.

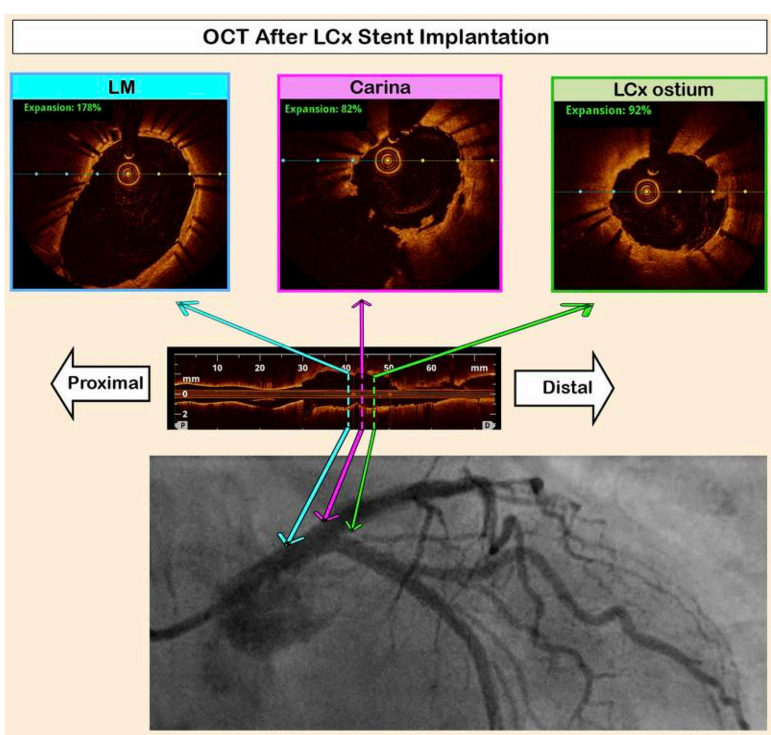


Figure 5 Optical coherence tomography after circumflex artery stent implantation.

Lead author biography

Dr Annette Maznyczka completed her cardiology training in the UK, with complex PCI training in Portsmouth and Leeds. She has been awarded an EAPCI fellowship to train in valve intervention at Bern University Hospital, Switzerland, from 2023 to 2024. Annette is passionate about clinical research and was awarded her PhD in 2020 from the University of Glasgow, on invasive coronary physiology and no-reflow in STEMI.

Supplementary material

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

Acknowledgements

The authors would like to acknowledge the assistance from Dr Stephen Wheatcroft in the preparation of this manuscript.

Consent: Written consent for submission and publication of this case report has been obtained from the patient in line with the Committee on Publication Ethics (COPE) guidance.

Conflict of interest: None declared.

Funding: None declared.

Data availability

All available data relevant to this case are presented within the manuscript.

References

1. Mikhail P, Howden N, Monjur M, Jeyaprakash P, Said C, Bland A, *et al.* Coronary perforation incidence, outcomes and temporal trends (COPIT): a systemic review and meta-analysis. *Open Heart* 2022;**9**:e002076.
2. Silver KH, Bauman WB, Berkovitz KE. Dual-catheter covered stenting: a novel approach to the treatment of coronary artery perforations. *J Invasive Cardiol* 2003;**15**:348–350.
3. Klein LW. Coronary artery perforation during interventional procedures. *Catheter Cardiovasc Interv* 2006;**69**:713–717.
4. Al-Lamee R, Lelasi A, Latib A, Godino C, Ferraro M, Mussardo M, *et al.* Incidence, predictors, management, immediate and long-term outcomes following grade III coronary perforation. *JACC Cardiovasc Interv* 2011;**4**:87–95.
5. Cilia LA, Stefanescu Schmidt AC, Sakhuja R, Jaffer FA. Circumflex rescue after left main covered stenting using a stiff wire, angled microcatheter, and stent target. *JSCAI* 2022;**1**:100407
6. Werner GS, Ahmed WH. Fenestration of a Papyrus PK covered stent to recover the occluded left main bifurcation after sealing a left main perforation during a CTO procedure. *Cardiovasc Revasc Med* 2017;**18**:41–44.
7. Adusumalli S, Gaikwad N, Raffel C, Dautov R. Treatment of rotablation-induced ostial left circumflex perforation by papyrus covered stent and its fenestration to recover the left anterior descending artery during CHIP procedure. *Catheter Cardiovasc Interv* 2019;**93**:E331–E336.
8. Colangelo S, Sardone A, Colombo F, Boccuzzi G, Innaccone M. Retrograde fenestration of covered stent after left main—left anterior descending perforation. *JACC Cardiovasc Interv* 2022;**15**:e227–e229.