

Successful percutaneous coronary intervention to the left anterior descending artery in-stent chronic total occlusion via the left internal mammary artery graft: a case report

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Background

Percutaneous coronary intervention (PCI) via left internal mammary artery (LIMA) graft is technically challenging, requires special consideration due to association with potential complications and therefore, infrequently performed. Data on in-stent chronic total occlusion (CTO) PCI via the LIMA graft is even rarer.

Case summary

A 59-year-old male with a background history of coronary artery bypass graft surgery and previous PCI, presented with progressive chest pain on mild exertion, in the setting of a chronic coronary syndrome. Transradial coronary angiography revealed significant native three-vessel disease with CTO of right coronary, left anterior descending (LAD) and left circumflex arteries. Left internal mammary artery-LAD was widely patent. The previous LIMA-LAD stent at the anastomosis had a CTO with severe in-stent restenosis (ISR) at the distal end of the stent in the native LAD. The distal LAD was filled from bridging collaterals. Following discussion at the heart team meeting, he underwent successful complex PCI of LAD CTO via the LIMA graft at the site of ISR of previous LIMA-LAD anastomosis stent, which was finally treated with drug-coated balloon (DCB) angioplasty.

Discussion

Recurrent angina post-coronary revascularization can be very challenging to manage by medical therapy alone. Percutaneous intervention of complex coronary lesions in these patients requires experience and skill, especially when approaching lesions using the LIMA as a conduit. The use of DCB for ISR management is a well-known strategy; however, adequate lesion preparation is the key to satisfactory outcome.

Keywords

Case report • Percutaneous coronary intervention • In-stent restenosis • Chronic total occlusion • Drug-coated balloon • Left internal mammary artery graft • Coronary artery bypass graft

ESC Curriculum

2.3 Cardiac magnetic resonance • 3.1 Coronary artery disease • 3.4 Coronary angiography

Learning points

- Percutaneous coronary intervention of the left internal mammary artery (LIMA)—left anterior descending artery anastomosis using the LIMA as a conduit makes the procedure high risk, but can be successful with the necessary equipment, knowledge and skills.
- The use of drug-coated balloon angioplasty for in-stent restenosis management is a well-known strategy; however, adequate lesion preparation is the key to satisfactory outcome.

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Introduction

Percutaneous coronary intervention (PCI) via left internal mammary artery (LIMA) graft is technically challenging, requires special consideration due to association with potential complications and therefore, infrequently performed. A large multicentre retrograde chronic total occlusion (CTO) PCI registry showed that the LIMA was used as a conduit in only 2% cases, with a procedural success rate of 70%. This was limited by a 20% procedural complication rate.^{1,2}

In this report, we describe the first documented case of PCI of a LIMA to left anterior descending artery (LAD) anastomosis in-stent CTO with a drug-coated balloon (DCB).

Timeline

2005	Ischaemic heart disease with coronary artery bypass graft surgery ×2 grafts i.e. left internal mammary artery (LIMA) graft to left anterior descending artery (LAD) and saphenous vein graft to right coronary artery, in Syria
2017	Percutaneous coronary intervention (PCI) to left main stem—left circumflex artery done in Egypt for chronic stable angina
2018	PCI to LIMA graft—LAD distal anastomosis done in Egypt for chronic stable angina
November 2019	Cardiology outpatient clinic review at our centre presenting with progressive chest pain on mild exertion
January 2020	Diagnostic coronary angiography and graft study
February 2020	Complex PCI to LIMA graft—LAD anastomosis in-stent chronic total occlusion via the LIMA graft

Case presentation

A 59-year-old male presented with a 6-month history of progressive chest pain on mild exertion, in the setting of a chronic coronary syndrome. He had a history of hypertension, hypercholesterolaemia, and ischaemic heart disease with coronary artery bypass graft surgery (CABG) 15 years ago in Syria. He also had PCI of native left circumflex (LCx) artery to left main stem (LMS) 2 years and PCI of LIMA-LAD anastomosis 1 year prior to his current presentation, in Egypt.

He was haemodynamically stable. Electrocardiography showed sinus rhythm with inverted T-waves inferolaterally (see [Figure 1](#)).

Despite optimization of anti-ischaemic medications i.e. Bisoprolol 2.5 mg once a day (OD), Isosorbide mononitrate 75 mg OD, and Ranolazine 750 mg twice a day, to maximum tolerated doses, the patient complained of persistent Canadian Cardiovascular Society (CCS) class three angina and thus scheduled for invasive angiography.

Coronary angiography revealed a dominant right coronary artery (RCA) with ostial CTO and the mid to distal vessel filling from epicardial collaterals originating from the conus branch. The saphenous

vein graft to the RCA was occluded. The previous LMS stent was widely patent. This stented segment extended to the distal LCx jailing the obtuse marginal system. There was a CTO of the proximal to mid LCx stent with bridging collaterals filling the distal artery. The LAD was occluded at its ostium. Left internal mammary artery-LAD was widely patent (see [Figure 2A](#)). The previous LIMA-LAD anastomosis stent had a CTO with severe in-stent restenosis (ISR; see [Figure 2B](#)). The distal LAD was filled from bridging collaterals.

The overall impression was severe three-vessel coronary artery disease with occluded LAD beyond the LIMA insertion. The patient was admitted for further investigations.

Transthoracic echocardiogram (TTE) demonstrated moderate-severe impairment of left ventricle (LV) function with extensive regional wall motion abnormalities (RWMAs; see [Video 1](#)).

Cardiac magnetic resonance imaging was in keeping with ischaemic cardiomyopathy. It confirmed a mildly dilated LV with moderate impairment, ejection fraction (EF) of 36%, and RWMAs with areas of dyskinesis and wall thinning (see [Video 2](#)). The RCA territory was considered non-viable with 75% late gadolinium enhancement (LGE) of the basal and mid-inferior, inferoseptal and inferolateral segments. The basal anterior and anteroseptal segments supplied by the LAD were fully viable whereas the mid-anteroseptum and apical septum had 50% LGE with only partial viability. The basal and mid-antrolateral walls had 25% LGE with potential viability of the LCx territory (see [Figure 3](#)).

The consensus at the heart team meeting was to perform PCI of the LIMA-LAD in-stent CTO. Japanese-CTO score was 2. The procedure strategy involved targeting the lesion via the LIMA graft, for which a left radial artery approach, using a 6-Fr sheath was adopted. The LIMA graft was cannulated with a Williams guide catheter with additional support from a GuideLiner (Teleflex). The lesion was initially approached using a Fielder XT-A (Asahi) wire with assistance of a Caravel (Asahi) microcatheter. The wire was then exchanged for a Confianza Pro 12 (Asahi) to puncture the proximal cap. We then switched over to a Turnpike LP (Teleflex) that was brought right up to the proximal cap and exchanged the Confianza Pro for a Pilot 150 wire (Abbott Vascular). This facilitated distal cap penetration and advancement of the Turnpike LP to the distal LAD. The Pilot 150 was switched to a balanced middle-weight wire (Abbott Vascular). Predilatation of the lesion was performed using a 1.2 Mini Trek (Abbott Vascular) coronary dilatation catheter, followed by a 2.0 Mini Trek (Abbott Vascular), 2.5 NC Euphora (Medtronic) and finally 3.0 NC Euphora (Medtronic). At this stage, we opted for DCB angioplasty and used a 3.0 × 30 mm SeQuent Please (B Braun) that was inflated for 1 min. The angiographic result was very pleasing with thrombolysis in myocardial infarction (TIMI)-3 flow in the distal LAD (see [Figure 2C](#)).

The final pictures showed a proximal dissection of the LIMA likely from GuideLiner induced trauma but with evidence of TIMI-3 flow (see [Figure 2D](#)). The patient remained haemodynamically stable throughout the procedure. He was discharged home the following day on dual antiplatelet therapy i.e. Aspirin and Clopidogrel for 6 months.

No angina was reported on follow-up review at 3 months. However, repeat TTE at that stage did not show any improvement in

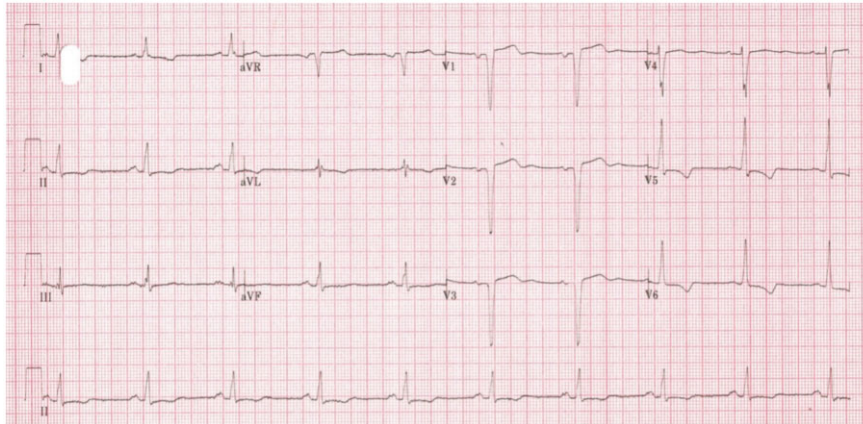


Figure 1 Electrocardiogram of the patient showing inverted T-waves inferolaterally.

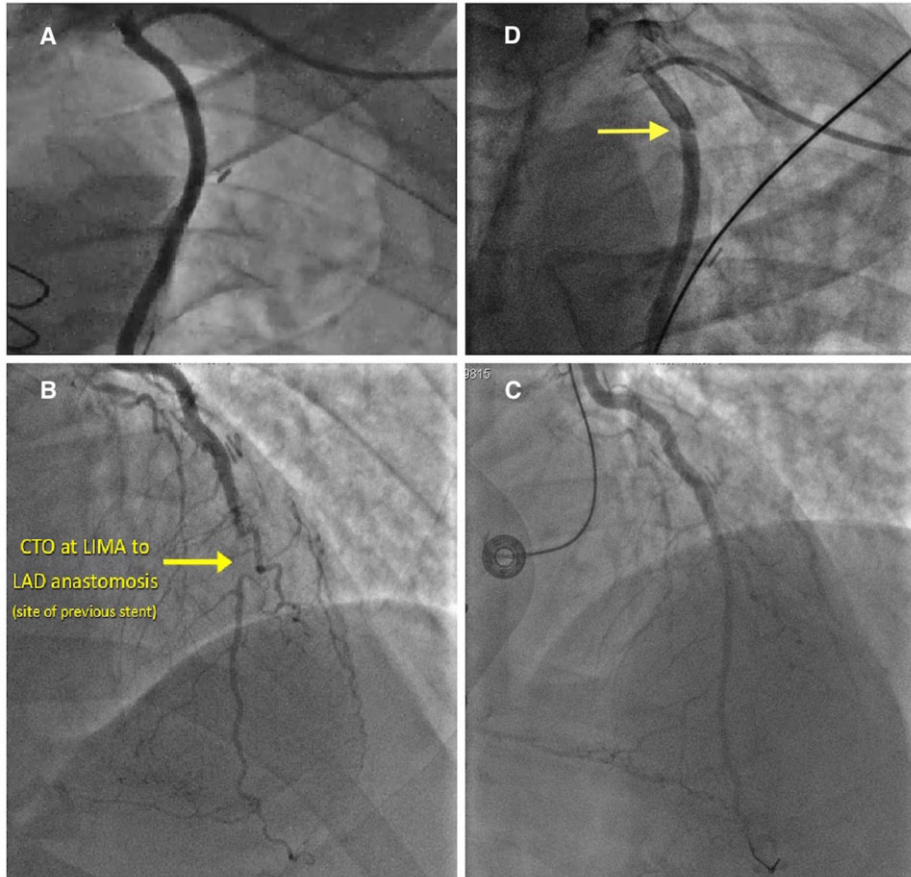
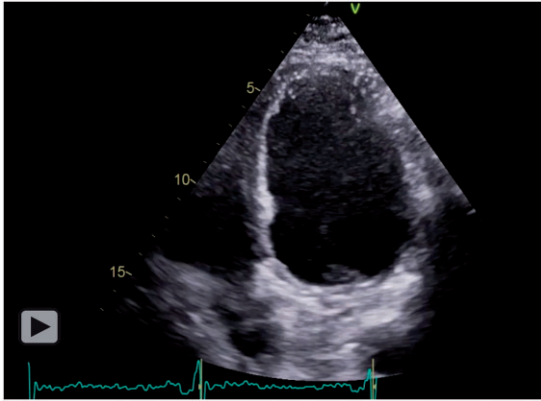
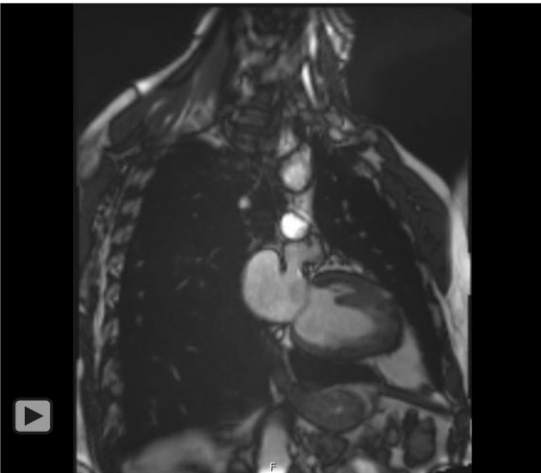


Figure 2 (A) Angiographic image of proximal left internal mammary artery-left anterior descending artery prior to percutaneous coronary intervention showing it was widely patent. (B) Angiographic image of the left internal mammary artery-left anterior descending artery anastomosis prior to percutaneous coronary intervention. There is a previous stent with a chronic total occlusion with severe in-stent restenosis at the distal end of the stent within the native left anterior descending artery (arrow). The distal left anterior descending artery is filled from bridging collaterals. (C) Final angiographic result following percutaneous coronary intervention of left internal mammary artery-left anterior descending artery in-stent chronic total occlusion with thrombolysis in myocardial infarction-3 flow to the distal vessel. (D) Final image of the left internal mammary artery following percutaneous coronary intervention showing a limited proximal dissection, likely due to GuideLiner[®] induced trauma, but with evidence of thrombolysis in myocardial infarction-3 flow down the graft.



Video 1 Transthoracic echocardiography demonstrating moderate-severe impairment of left ventricular function with extensive regional wall motion abnormalities.



Video 2 Cardiac magnetic resonance imaging showing features in keeping with ischemic cardiomyopathy with moderate impairment of left ventricular function and areas of dyskinesia and wall thinning.

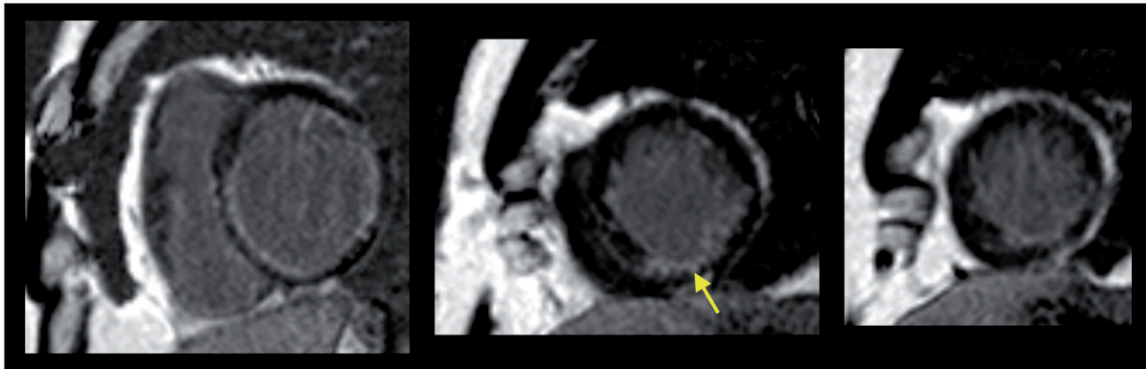


Figure 3 Short-axis late gadolinium enhancement-cardiac magnetic resonance images showing transmural infarction in the inferior wall of left ventricle (yellow arrow) and sub-endocardial infarction in the anterior and lateral walls.

the LVEF. A check angiogram of the LIMA graft at 6 months showed good run-off and the dissection had healed.

Discussion

Recurrent angina post-coronary revascularization, either percutaneous or surgical, is a known clinical problem.^{3,4} Early and late graft failures are the major causes of recurrent angina after CABG. Management of persistent angina in this patient subgroup is particularly challenging.

There is a dearth of data on percutaneous revascularization of internal mammary artery (IMA) grafts. A study including 174 patients undergoing percutaneous IMA intervention showed that two-thirds of the lesions were at the level of the anastomosis. Furthermore, balloon angioplasty alone had a more favourable outcome at 1-year follow-up when compared with bare-metal stents.^{5,6}

Moreover, IMA intervention is not risk free and comes with several technical challenges and potential complications like guide catheter induced dissection of internal mammary or subclavian artery, perforation, slow flow or no-reflow due to accordion effect, and challenging device delivery due to extreme tortuosity and long vessel length. These risks are minimized by considering a left radial approach, a long sheath, and appropriate guide catheter for good support.^{7,8}

Our case was particularly challenging not only due to the potential complications linked to IMA intervention but also considering the associated dilemma of the CTO. However, due to the growing experience, advances in equipment specific for this subgroup of intervention, the procedural success rate for CTO-revascularization has significantly increased within the last few years to within 90%.^{9,10} But in spite of these developments, the lesion subset of in-stent CTO, as in our case, has always been linked with lower procedural success rate (63–71%). Encouragingly, recent data have demonstrated that successful PCI of CTOs results in improved left ventricular function, reduced angina, and increased exercise tolerance.^{11,12} Intervention in this patient was undertaken to give symptomatic relief and hopefully improve LV function.

The complexity of an LIMA-LAD in-stent CTO lesion in our patient prompted us to treat it with a DCB, which based on studies, is

an established treatment option with low rates of target lesion revascularization and major adverse cardiovascular events (MACE).^{13,14}

Conclusion

There have been no other cases documented in the literature of successful PCI of in-stent CTO of the LIMA-LAD anastomosis treated with DCB. Approaching these lesions using the LIMA as a conduit makes the procedure high risk but can be successful with the necessary equipment, knowledge and skills. The use of DCB for ISR management is a well-known strategy; however, adequate lesion preparation is the key to satisfactory outcome.

Lead author biography



Dr Usman Azhar Khan is a specialty trainee registrar (StR) in Cardiology in Northern Ireland, UK. He is a member of the Royal College of Physicians of the UK (MRCPUK) and Royal College of Physicians of Ireland (MRCPi). He has a Master of Science degree in cardiology from Trinity College Dublin, Ireland. He has a special interest in interventional cardiology and has represented the Northern Ireland deanery in a number of national and international cardiovascular meetings.

Supplementary material

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

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

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 COPE guidance.

Conflict of interest: None declared.

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