ESC European Society of Cardiology

European Heart Journal - Case Reports (2023) **7**, 1–7
https://doi.org/10.1093/ehjcr/ytad014

CASE REPORT
Coronary intervention

Drug-coated balloon angioplasty, intraoperatively through left anterior descending arteriotomy access, a novel hybrid revascularization strategy: a case report

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Received 8 February 2022; first decision 21 April 2022; accepted 9 January 2023; online publish-ahead-of-print 11 January 2023

Background Patients undergoing coronary artery bypass graft (CABG) sometimes have critical proximal lesion in left anterior descending (LAD) artery or chronic total occlusion followed by either skip lesions or diffuse disease of late mid-to-distal LAD artery. Such lesions require endarterectomy or atheroma bridging via long venous or arterial patch (patch-plasty), for which clinical outcomes are conflicting in studies due to a more thrombogenic milieu created by patch-plasty as well as incomplete endarterectomy. We present a hybrid approach with drug-coated balloon (DCB) angioplasty of mid-to-distal LAD through LAD arteriotomy followed by left internal mammary artery (LIMA) insertion to LAD.

Case summary A 35-year-old man who was thrombolyzed for anterior wall myocardial infarction in another city, reported to our hospital four weeks later with persistent angina. Coronary angiography showed severe multivessel coronary artery disease. There was diffuse disease in LAD distal to potential site of LIMA insertion and needed patch-plasty. We carried out a hybrid procedure by performing DCB angioplasty of mid-to-distal LAD through the LAD arteriotomy site during CABG followed by LIMA insertion to the LAD. The patient remained asymptomatic post procedure with a 6-month follow-up computerized tomography scan showing patent LIMA and mid-to-distal LAD.

Discussion This case shows a novel technique, first in the world, of performing angioplasty during CABG through arteriotomy followed by graft insertion.

Keywords Case report • Percutaneous coronary intervention (PCI) • Coronary artery bypass graft (CABG) surgery • Drug-coated balloon (DCB) • Patch-plasty • Hybrid revascularization • LAD arteriotomy

ESC Curriculum 3.1 Coronary artery disease • 7.5 Cardiac surgery • 3.4 Coronary angiography

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Handling Editor: Michel Corban
Peer-reviewers: Michel Pompeu Sá; Melissa Yen Moey; Laszlo Gobolos
Compliance Editor: Gal Tsaban
Supplementary Material Editor: Nikesh Jathanna
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Learning points

- This is first in the world, novel technique of performing percutaneous coronary intervention (PCI) through LAD arteriotomy during CABG.
- This hybrid strategy will be especially useful in patients with critical disease or chronic total occlusion (CTO) in proximal-to-mid LAD followed by diffuse mid-to-distal LAD disease who are candidates for CABG with LIMA implantation needing additional coronary end-arterectomy or patch-plasty.
- This approach may even be used retrogradely to treat proximal lesion if they are more than one so that septals can be better perfused.
- This innovative technique of introducing PCI hardware through arteriotomy site opens new avenue for hybrid coronary strategies.

Introduction

Diffuse left anterior descending (LAD) disease presents a therapeutic challenge, especially if optimal long-standing revascularization is desired. Coronary artery bypass graft (CABG) exposes them to a higher risk of mortality and complications due to the additional need for coronary endarterectomy during the procedure and clinical outcomes of coronary endarterectomy in most of the studies have not been encouraging.[1–6] Coronary angioplasty with stents in this segment has its own issues in terms of requirement of metal jackets or long stents occupying potential surgical graft sites thus making future CABG difficult. Long stents in any case have higher chances of in-stent restenosis.[7–11] In patients with diffuse mid-to-distal LAD disease, who are candidates for CABG with coronary endarterectomy or patch-plasty, a hybrid approach with left internal mammary artery (LIMA) to LAD and drug-coated balloon (DCB) in mid-to-distal LAD may offer an alternative approach to this difficult to treat group of patients. Data regarding DCB in this context are not available though.

Timeline

Time	Events
12 May 2021	Acute anterior myocardial infarction (streptokinase given) in another city
14 June 2021	Presented to our hospital with persistent angina but otherwise haemodynamically stable.
15 June 2021	Coronary angiography showed multivessel coronary artery disease.
17 June 2021	Heart Team meeting.
13 July 2021	Hybrid DCB CABG surgery.
13 July 2021	Immediate post-operative graft study done through femoral access in hybrid OR.
23 July 2021	Discharged from hospital.
06 August 2021	Outpatient department (OPD) clinic visit for follow-up. Patient had stable cardiovascular status and was asymptomatic.
03 September 2022	OPD clinic visit for follow-up. Patient had stable cardiovascular status and was asymptomatic.
11 November 2021	OPD clinic visit for follow-up. Patient had stable cardiovascular status and was asymptomatic.
20 January 2022	6 months after CABG, patient was asymptomatic and computerized tomography (CT) coronary angiogram with graft study showed patent grafts with patent mid-to-distal LAD which was treated with DCB.

Case presentation

A 35-year-old man of South Asian origin with a strong family history of ischaemic heart disease and history of smoking (15 pack-years) presented in another city with anterior wall myocardial infarction and was thrombolyzed with streptokinase. He did not have any other relevant personal medical history. Patient had low socioeconomic status and avoided leaving his work and travelling to another city for treatment. Four weeks later he presented to our hospital with persistent angina. On examination, patient was clinically stable and had a blood pressure of 155/90 mmHg with a heart rate of 97 beats per minute. His general physical and systemic examinations were unremarkable. Electrocardiogram showed Q waves in Leads V1–V6. Transthoracic echo revealed a left ventricular ejection fraction (LVEF) of 35% with hypokinetic anteroseptal and anterior, basal-to-apical segments but preserved wall thickness and normally functioning valves. His troponins were normal. Low-density lipoprotein was 165 mg/dL and HbA1c was 5.5%.

Coronary angiography showed multivessel coronary artery disease with critical disease in circumflex (LCx) and dominant right coronary artery (RCA). There was subtotal occlusion in mid LAD followed by diffuse disease in distal course needing endarterectomy/patch-plasty. Heart Team meeting decided for CABG with saphenous venous graft (SVG) to obtuse marginal (OM), SVG to RCA, and LIMA to LAD with hybrid DCB to distal LAD as an experimental treatment after patients consent. Endarterectomy/patch-plasty was planned as a bail out strategy. Hospital ethical board approval was obtained for this experimental treatment.

Operative technique

CABG was carried out through mid-line sternotomy as conventional on pump CABG with cardioplegia in our hybrid operation theatre with fluoroscopic facility. Cardioplegia dosage was repeated after every 60 min. Pedicled LIMA was harvested using electrocautery with the help of LIMA retractor. Meanwhile long saphenous veins were harvested from right and left legs. Cardiopulmonary bypass was established using aortic and two-stage venous cannula. Reverse SVG was anastomosed to distal RCA and OM using 7/0 Prolene suture with good distal run off. At the planned site for LIMA implantation, a 6 mm arteriotomy was made in the LAD and a reverse SVG was anastomosed to it temporarily with 7/0 Prolene suture using 6 stitches, while the proximal end of SVG was secured to 6 Fr radial sheath. This sheath remained in the SVG and was not advanced into the native LAD. This sheath SVG combination was then used for contrast injections and for taking wire and balloons into distal LAD (*Figure 1*). In order to prevent the contrast from crystallizing out in the coronaries, as the heart was not beating, the contrast was flushed continuously using saline and cardioplegia. These were directly given into the SVG sheath combination via the cardioplegia pump. Gentle contrast injections were taken through the SVG sheath (*Figure 2*) and then segment of LAD, distal to arteriotomy site, to be treated with angioplasty was marked by placing two metal clips on top of the heart surface. Road map was taken and BMW (Abbott vascular) 0.014 workhorse coronary wire was introduced into LAD through SVG sheath and parked in distal LAD. Mid-to-distal LAD disease was predilated between the 2 metal clips with 1.5 and 2 mm semi-

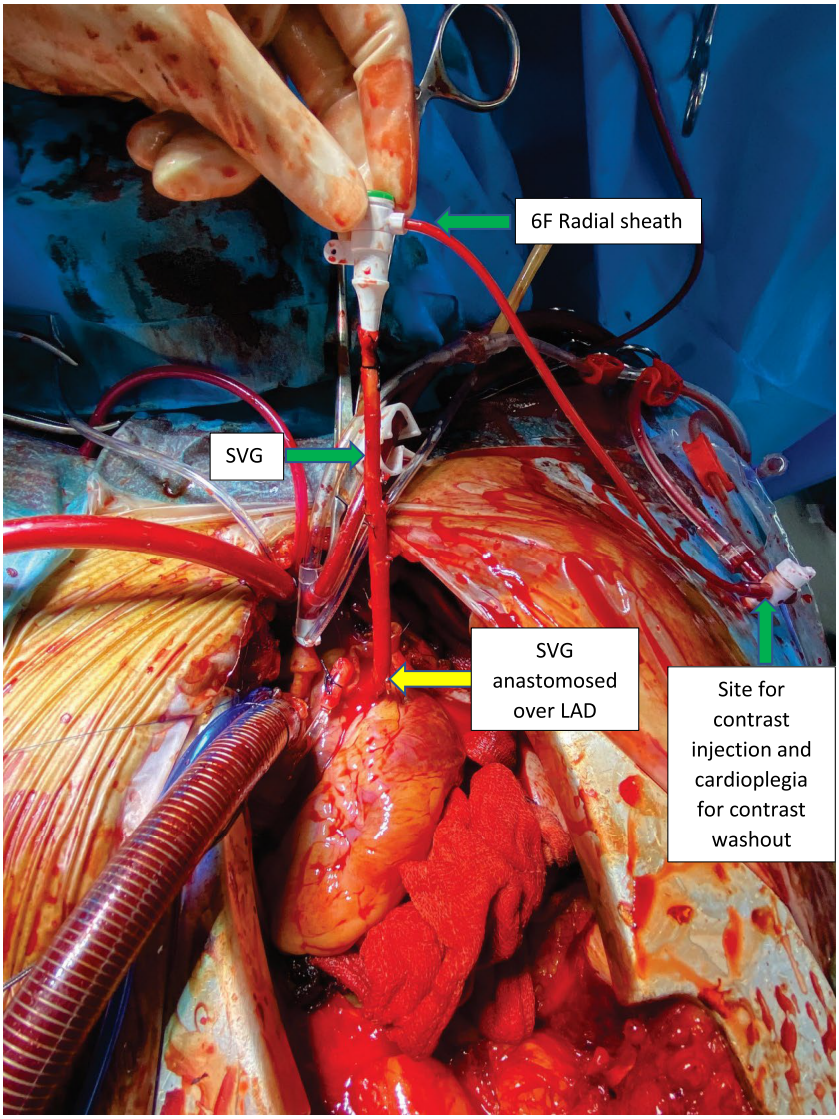

Figure 1 Operative image of on-pump coronary artery bypass graft surgery. Showing attachment of saphenous venous graft on left anterior descending artery and a 6 Fr radial sheath inserted and stitched in the saphenous venous graft. Sheath stops within the saphenous venous graft without entering the left anterior descending.

compliant, Sprinter (Medtronic) balloons (*Figure 3A*). Repeat contrast injection showed well-expanded LAD with no residual stenosis or significant dissection. Final treatment was done with 2 mm polymer-free paclitaxel DCB, Sequent Please Neo (B. Braun), extending 5 mm on both sides of predilated LAD segment (*Figure 3B*). Excellent angiographic result was obtained with no residual stenosis (*Figure 4A*). SVG radial sheath combination was then removed and LIMA was implanted on the proposed insertion site using 8/0 Prolene suture.

Anticoagulation during procedure was done with unfractionated heparin at a dose of 300 units/kg and then activated clotting time (ACT) maintained as per CABG protocol throughout the procedure. Patient was given 75 mg of Aspirin via N/G on induction of general anaesthesia.

After completing CABG, a final coronary angiogram was done through right femoral access. LIMA injection was done to confirm patency of LAD distal to LIMA insertion, that showed excellent results and CABG completed (*Figure 4B*). After CABG protamine was administered as 1.5 mg/kg aiming to achieve an ACT of 150–160 before shifting the patient to intensive care unit. In the ITC, patient was loaded with 75 mg of Aspirin and 300 mg Clopidogrel after 04 h of surgery after ensuring that chest tube drainage was less than 0.5 mL/kg/h for consecutive 3 h. Unfractionated Heparin was started as 1000 units/h after 04 h to maintain an ACT between 150 and 200 for 12 h followed by injection Clexane 0.5 mg/kg/day for 5 days. Twenty-four hours after CABG, patient was started on maintenance dose of 75 mg Clopidogrel, 75 mg Aspirin, and 40 mg Rosuvastatin daily.

Patient had an uneventful post-procedure recovery and remained asymptomatic during OPD visits. At 6-month follow-up, patient was asymptomatic with stable cardiovascular status. Transthoracic Echo revealed an LVEF of 45% with slightly hypokinetic anteroseptal and anterior, basal segments but preserved wall thickness and normally functioning valves. CT coronary angiography at 6 months revealed a patent LIMA to LAD with no significant stenosis in mid-to-distal LAD (*Figure 5*).

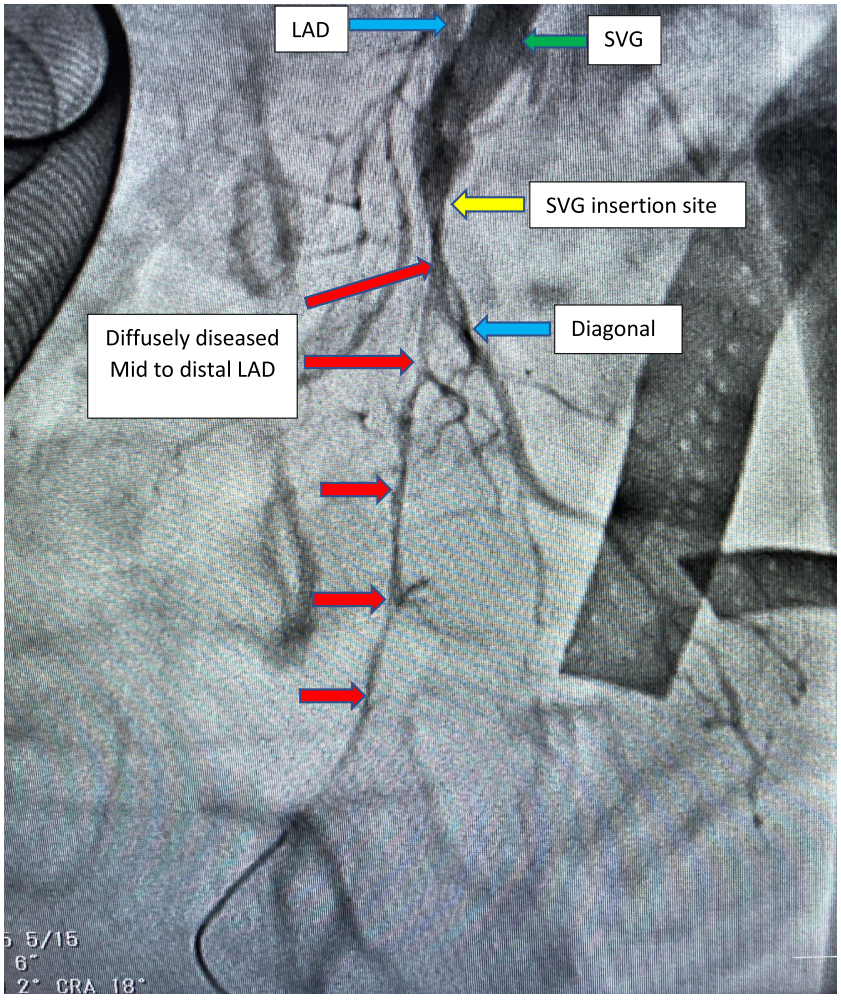

Figure 2 Coronary angiogram done in modified left anterior oblique cranial view. Contrast injection through radial sheath inserted in saphenous venous graft stitched over left anterior descending arteriotomy. Shows diffusely diseased mid-to-distal left anterior descending artery.

Discussion

Complete revascularization and in particular arterial grafting to the left coronary system has a significant impact on long-term survival of patients.[12] Diffuse mid-to-distal coronary artery disease has always been the Achilles heel for coronary intervention where cardiac surgeons need to plan reconstructive procedures using endarterectomy or patch-plasty[13,14] which not only increases surgical complexity and prolonged bypass time but also increases mortality and morbidity. With endarterectomy, there is a fear of early thrombosis, as endarterectomy removes intima from these vessels, and activates the coagulation cascade in early post-operative period.[4] 2018 ESC/EACTS guideline on myocardial revascularization has no reference to the clinical recommendation of coronary endarterectomy due to the absence of randomized controlled trials.[15] On the other hand, percutaneous coronary intervention (PCI) with coronary stents in these coronary segments leads to metal jackets with increased chances of stent failure and also makes future CABG challenging with stents occupying sites of graft insertion. DCB has provided a viable option for treating these diffusely diseased mid-to-distal segments without leaving any metal behind but the use of DCB still lacks long-term outcome data yet and moreover, it is not possible in cases where proximal-to-mid coronary segment has critical disease or a CTO. For such cases, we think that this hybrid DCB CABG procedure performed in a hybrid OR may provide a viable alternate solution.

Conventionally hybrid coronary revascularization terminology combines CABG with LIMA to LAD and PCI of LCx/RCA either during the same procedure or in a staged approach within 60 days.[16] Our hybrid procedure is slightly different to this widely accepted hybrid definition, as it also uses surgical arteriotomy site for introducing PCI equipment directly in the middle of the coronary during CABG for treating mid-to-distal coronary segment with DCB followed by LIMA insertion.

The hypothesis that we wanted to test was that is it possible to maintain the coronary endothelium distal to graft insertion, by treating the distal diffuse disease with DCB instead of endarterectomy and get good long-term patency rates by improving the graft outflow in a more physiological way and coating the diffuse disease with antiproliferative drug to prevent restenosis.

This patient was selected due to his diffuse mid-to-distal LAD disease with a prior critical lesion, the kind of disease that we wanted to treat with our new approach. He was an appropriate patient from safety point of view because he could get patch-plasty in case our technique

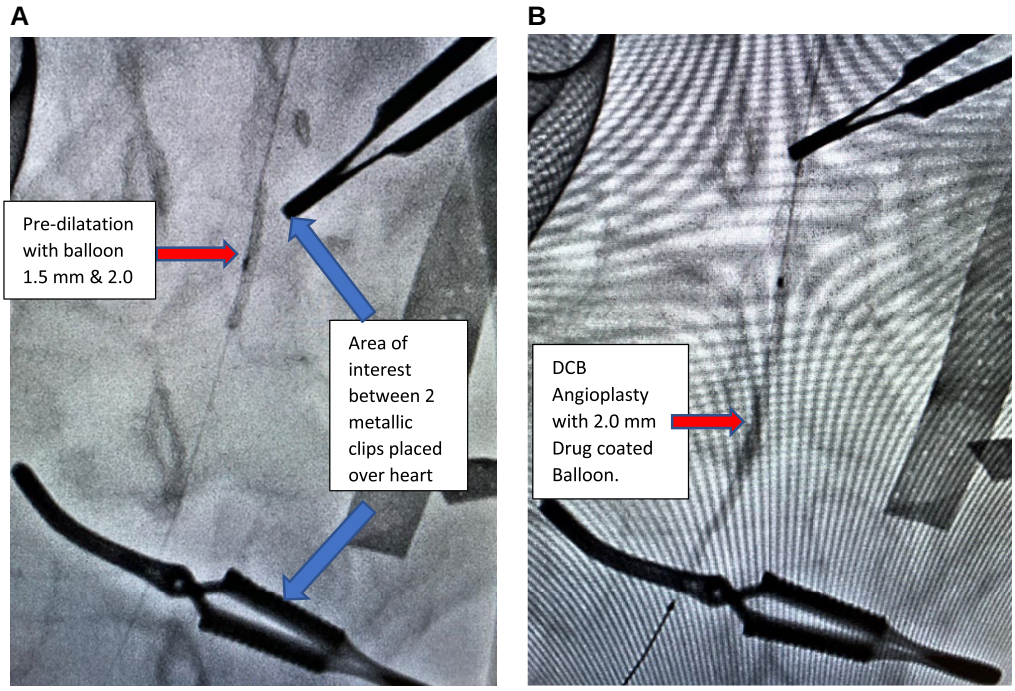

Figure 3 Balloon angioplasty. (*A*) Angiographic still image showing the area of interest marked with two metallic clips placed over the heart surface and predilatation with 1.5 and 2 mm balloons. (*B*) Angiographic still image showing balloon angioplasty with 2 mm drug-coated balloon inflation.

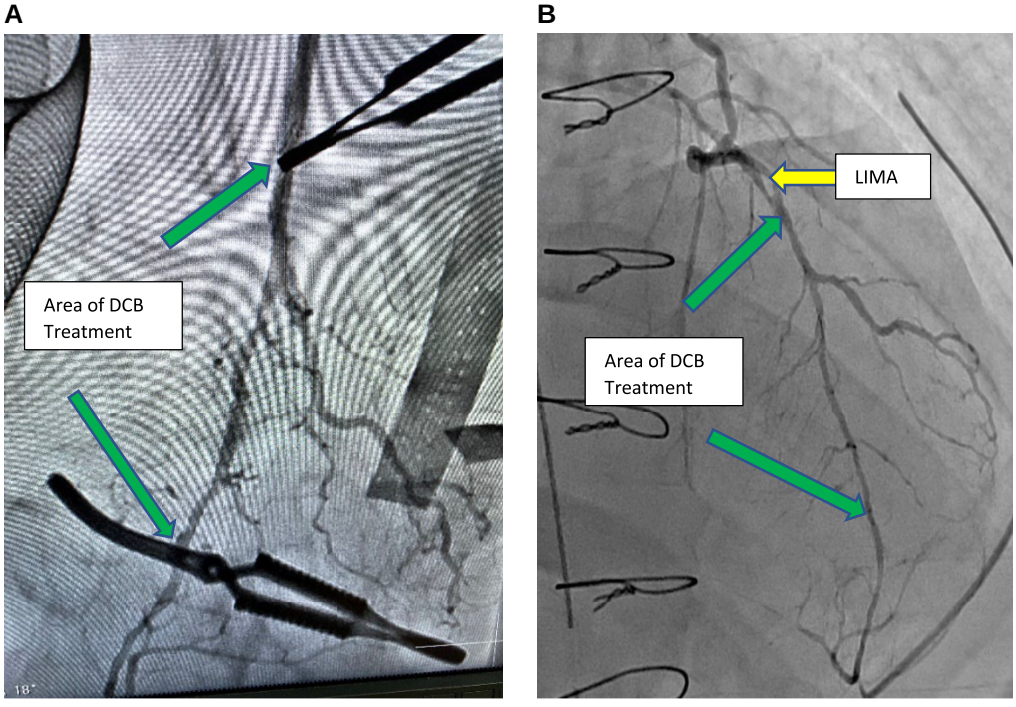

Figure 4 Post-procedure angiography. (*A*) Final result after drug-coated balloon angioplasty by contrast injection from radial sheath/saphenous vein graft through left anterior descending arteriotomy. (*B*) Angiographic still image of contrast injection through left internal mammary artery graft immediately post procedure via right femoral access.

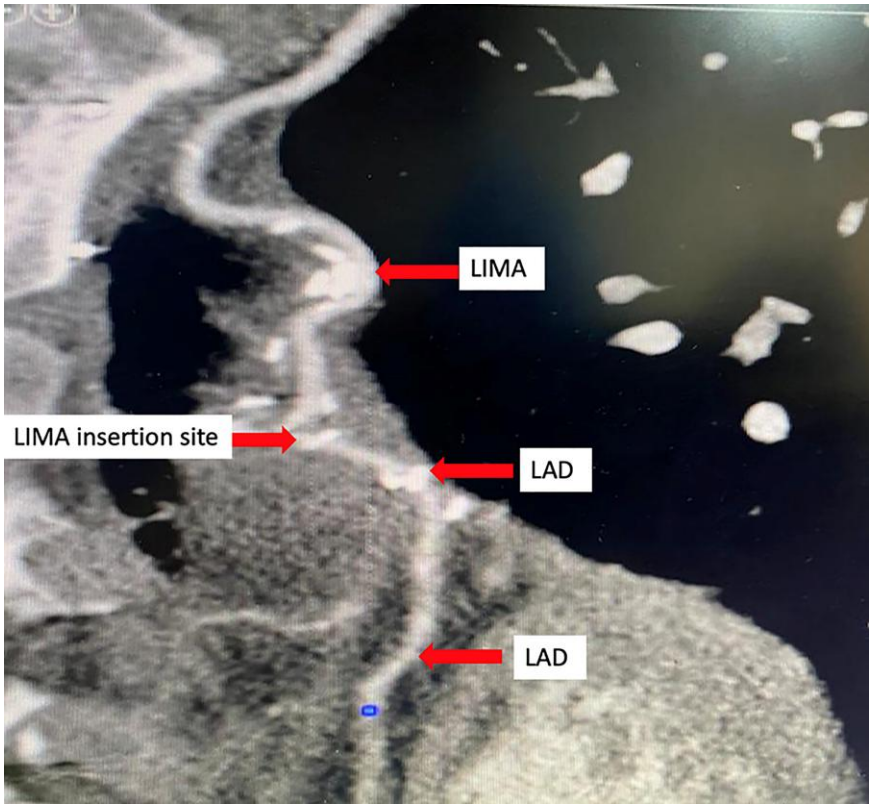

Figure 5 Six-month follow-up computerized tomography scan graft study showing patent mid-to-distal left anterior descending which was treated with drug-coated balloon, and a well-functioning left internal mammary artery graft.

failed. This experimental treatment approach was discussed in Multi-Disciplinary Team (MDT) and then hospital ethical board approval and patient's consent were obtained.

Our initial hurdle was to find a way of injecting contrast through coronary arteriotomy site without contrast leaking out of it. This is specially a problem when there is a CTO above the arteriotomy site and it is not possible to opacify the mid-to-distal coronary segment through native coronary injection. We did not want to enter any sheath or stiff material into LAD through arteriotomy site due to fear of damaging the native coronary. We solved this problem by using a piece of SVG, one end of which was temporarily stitched on the coronary arteriotomy site and the other end was stitched around a 6 Fr radial sheath. This way we were able to inject contrast without any leakage and also could safely take PCI hardware into this inaccessible coronary segment. Minimum contrast was used and metal clips were placed on top of the heart surface as markers for the disease segment to perform balloon angioplasty. In case of flow limiting dissection or coronary recoil with residual stenosis of 30% or more after predilatation, DCB would not have been used and the patient would have been treated with traditional endarterectomy or patch-plasty, followed by LIMA implantation. In this case, the result with 2 mm balloon predilatation was satisfactory with no significant recoil or flow limiting dissection. We used DCB in a 1:1 with predilatation balloon with good final result. Patient had an uneventful recovery and remained asymptomatic throughout follow-up period. Six months later CT graft study showed patent LIMA to LAD and fully patent mid-to-distal LAD segment without any significant stenosis thus showing viability of hybrid DCB CABG strategy as an alternative approach for these complex surgical disease patients. This strategy now needs to be tested in a larger cohort of patients for which we intend to start an RCT comparing this hybrid DCB CABG approach with CABG endarterectomy or patch-plasty in diffuse mid-to-distal coronary disease. This case report may open up new avenues for hybrid strategies and brings to attention an innovative method of introducing PCI hardware into coronaries through arteriotomy sites during CABG.

Lead author biography

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Supplementary material

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

Acknowledgements

The authors thank Professor Azhar Mahmood Kayani for acquiring hybrid cath lab for this institution and Dr Sanwal Mahmood for his help during CABG as perfusionist. They thank Dr Farqad Alamgir for his guidance and encouragement to publish. The authors also acknowledge Dr Hamza Azhar Ghauri for his hard work in final editing of the case report according to reviewer comments.

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

Consent: Case was first discussed in MDT and then hospital ethical board permission and patient's consent for this experimental treatment were obtained. Patient and his family were explained all aspects of this experimental treatment and also alternate option of conventional CABG with possible need for patch-plasty/endarterectomy. The authors confirm that written consent for submission and publication of this case report including the images and associated text have been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

Funding: The authors declare that no funds were borrowed for this study.

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