Successful percutaneous treatment of a catastrophic left internal mammary artery graft avulsion occurring 4 weeks post-coronary artery bypass grafting surgery: a case report

Shana Tehrani and Sudhir Rathore

Department of Cardiology, Frimley Health NHS Foundation Trust, Portsmouth Rd, Camberley GU16 7UJ, UK

Background
Avulsion of the left internal mammary artery (LIMA) graft near the anastomosis to the left anterior descending artery (LAD) artery post-coronary artery bypass grafting (CABG) is a rare but potentially catastrophic complication which can result in sudden ischaemia, haemodynamic compromise and life-threatening bleeding into the pericardium.

Case summary
We report a case of a spontaneous LIMA graft avulsion at the site of the anastomosis to the LAD artery, which occurred 4 weeks post-conventional CABG surgery and resulted in anterior myocardial infarction (MI), cardiac tamponade and cardiogenic shock. This life-threatening event was treated by deploying a covered stent in the LAD artery and by coiling the dehisced LIMA graft.

Discussion
To our knowledge, this is the first report of late LIMA graft avulsion that has been uniquely and successfully treated by percutaneous coronary intervention.

Keywords
LIMA graft avulsion • STEMI • Covered stent • Coil embolization • Case report

Learning points
- Left internal mammary artery (LIMA) graft avulsion is a rare but serious complication of coronary artery bypass grafting (CABG) and minimally invasive direct coronary artery bypass (MIDCAB) surgery.
- It can result in life-threatening ischaemia and tamponade.
- Mobilizing of the LIMA and adequate conduit length is prerequisite to optimal routing of the graft in both MIDCAB and conventional bypass surgery.
- Early recognition of this complication in patients with previous CABG who present with anterior MI is crucial.
- Prompt percutaneous treatment can be life-saving.
- Interventionist should be familiar with techniques that may stop the bleeding caused by the graft avulsion.
Introduction

Avulsion of the left internal mammary artery (LIMA) graft is a rare but serious complication of coronary artery bypass grafting (CABG) surgery which can result in myocardial infarction (MI) and cardiac tamponade. The pathogenesis of LIMA graft avulsion is multifactorial but inadequate length of the LIMA and subsequent tension on the graft is probably the main contributing factor.1

The previously reported cases in the literature have all been treated surgically. We report a unique percutaneous treatment of a catastrophic LIMA graft avulsion occurring 4 weeks post-conventional CABG surgery.

Timeline

Case presentation

A 58-year-old male patient was directly admitted to our cardiac catheterization laboratory with sudden onset chest pain of 2 h duration. The electrocardiography performed by the ambulance crew demonstrated anterior ST-segment elevation. The chest pain had started when he was straining to have a bowel movement. Upon arrival in the department, he was in cardiogenic shock. He had undergone off-pump CABG surgery 4 weeks earlier with LIMA graft to the left anterior descending (LAD) artery and saphenous vein grafts (SVGs) to the right coronary artery (RCA) and to the circumflex (LCx) artery. His other cardiac history included previous percutaneous coronary intervention (PCI) to the LAD and LCx arteries 10 years before. His pre-operative echocardiogram was reported as normal. He was a recent ex-smoker and was on treatment for hypertension and dyslipidaemia.

Emergency diagnostic coronary angiography was performed via the right radial access route and showed severe proximal stenosis in the LAD artery. Extravasation of the contrast media from the LAD artery into the pericardium was noted (Figure 1). There was no flow in the distal LAD artery; hence dehiscence of the LIMA graft was suspected. Injection of the contrast media to the LIMA graft demonstrated the flow of the contrast media to the mid-segment only with no further flow of the contrast after the mid-vessel (Figure 2). The SVGs to the RCA and LCx were patent.

Following diagnostic coronary angiography, patient developed pulseless electrical activity cardiac arrest. Return of the spontaneous circulation was achieved with one cycle of cardiopulmonary resuscitation (CPR). Intra-aortic balloon pump was inserted. Urgent echocardiography showed a large global pericardial effusion with right atrial and right ventricular collapse. Emergency pericardiocentesis was performed via sub-xiphoid approach and seldinger technique using an 8.3 Fr/50 cm straight drainage catheter of PerVac™.

Angiography showed dehisced LIMA graft, bleeding into the pericardium, causing Tamponade

Covered Stent to LAD. Coil embolisation to LIMA. Bleeding discontinued. Patient stabilised. Unable to drain residual organised pericardial fluid

Transfer to cardiothoracic surgical centre for surgical relief of Tamponade. Good recovery, no neurological sequelae

Figure 1 Extravasation of contrast media from the left anterior descending artery.
Pericardiocentesis Kit (Boston Scientific, Marlborough, MA, USA) and echocardiography guidance. Seven hundred millilitres of haemorrhagic fluid was aspirated with slow drainage. Further aspiration of the pericardial fluid was not possible, indicative of the presence of an organized thrombus. Due to on-going haemodynamic compromise and non-availability of cardiac surgery on site, decision was made to treat the LAD artery stenosis with PCI. Using a 6 Fr EBU 3.5 guidewire-catheter (Medtronic, Minneapolis, MN, USA) a Sion Blue guidewire (ASAHI Intecc, Aichi, Japan) was used to cross the vessel. The lesion was pre-dilated with a 2.5 mm × 20 mm semi-compliant balloon (Emerge, Boston Scientific, Marlborough, MA, USA) and then stented with a 2.5 mm × 20 mm PK Papyrus covered stent (Biotronik AG, Bülach, Switzerland). Subsequent to PCI, thrombolysis in myocardial infarction (TIMI) 3 flow was achieved. No further extravasation was seen at the dehiscence site and ST-segment elevation resolved (Figure 3). Further assessment of the LIMA graft showed a sluggish flow with extravasation of the contrast media into the pericardium; therefore, embolization of the LIMA graft was performed with four coils (Tornado Embolisation Microcoils. Cook Medical, Bloomington, IN, USA) and the flow was subsequently stopped (Figure 4).

The patient’s haemodynamic condition stabilized at this stage. The echocardiogram post PCI demonstrated residual blood clots in the pericardial space that were difficult to extract percutaneously. The patient was then transferred to the local cardiac surgery unit and underwent emergency re-sternotomy and evacuation of the blood clots. His haemoglobin level post CABG (4 weeks prior to this admission) was measured at 100 g/L and dropped to 79 g/L following LIMA avulsion. He received 2 units of blood transfusion. The patient made a good recovery with no neurological sequelae and was discharged home after a few days. Outpatient review at 3 months confirmed an excellent recovery without report of cardiovascular symptoms. Control coronary angiography was performed at 5 months and the patient underwent successful PCI to mid and proximal LAD into the left main (LM) artery with LCx ostium optimization (Figure 5).
Discussion

Avulsion of the LIMA graft close to the site of the anastomosis to the LAD artery is a rare but very serious complication that may lead to ischaemia, bleeding into the pericardium and cardiac tamponade. Since the introduction of conventional CABG and minimally invasive direct coronary artery bypass (MIDCAB) surgery, this potentially life-threatening complication has been described in the literature on seven occasions; five cases were reported post-MIDCAB surgery and two cases post-conventional CABG surgery.

The first report of a LIMA graft avulsion was by McMahon et al.¹ in 1997 in a patient who had lifted a heavy item on Day 5 post-MIDCAB surgery. Since then this complication has been reported in a few more MIDCAB cases.²⁻⁵

In conventional CABG setting, a complete transection of the LIMA to LAD graft was first reported by Morritt et al.⁶ in 2004 in a patient who deteriorated after 3 h post-operation at the time of weaning from ventilation. Emergency re-sternotomy showed complete transection of the LIMA graft 2 cm proximal to the anastomosis at the origin of a side branch which had been ligaclipped.

Ten years later in 2014 Kaleda et al.⁷ reported peri-operative avulsion of the LIMA to LAD at 1.5 h post-conventional CABG surgery and again 9 h after emergency re-insertion of the ruptured LIMA to the LAD artery. Following rupture of the LIMA graft for the second time, the LAD was bypassed with a vein graft. This patient was later on diagnosed with mediastinitis caused by syphilis.

As mentioned above, the reported time interval between the conventional CABG operation and the graft avulsion has been very short; 1.5 h⁶ and 3 h post-surgery.² In MIDCAB setting however the time interval has been variable; as short as 6 h post-operation following closed-chest CPR,³ 13 days post-operation following vigorous stretching exercise,² 18 days post-operation,⁵ and up to 3 months post-operation.⁴

The mechanism for avulsion of the LIMA graft is not entirely understood. It is probably multifactorial, but it has been widely accepted by the experts that inadequate length of the LIMA graft and sudden shear forces on a vulnerable conduit tethered to the chest wall can cause acute vessel transection.⁴ Therefore, meticulous surgical technique is of crucial importance. Mobilizing of the LIMA and adequate conduit length is prerequisite to optimal routing of the graft in both MIDCAB and conventional bypass surgery.²

Several other technical aspects have also been hypothesized to contribute to LIMA graft avulsion. Interaction of the artery with the edge of the pericardium, inadequate side branch clipping, and adhesion of the conduit to the surrounding anatomical structures such as chest wall, mediastinum, or lung makes LIMA susceptible to excessive traction.⁷ Adequate mobilization of the conduit will enable it to adapt with slight variations of chest wall amplitude, lungs, or diaphragm excursion.⁵ Rupture of the LIMA graft can occur during weaning from the ventilator when sudden forceful lung expansion happens and results in contact of the lung edge with the graft with a considerable force.⁶ Cardiopulmonary resuscitation, hyperventilation, coughing, sneezing, blunt trauma, and weightlifting have also been named as possible causes.⁷⁸ In patients with chronic lung disease, LIMA should be harvested long enough by making a fasciotomy to the LIMA or by extending the length of skeletonization.⁶ Graft tension can be reduced in these patients by creating a fissure in the lung to allow passage of the graft.⁹

LIMA graft avulsion post-conventional CABG surgery has been reported twice in the literature.⁶⁷ In these reported cases, transection of the LIMA graft had occured within the first few hours of the operation. On the contrary, in our case, this complication happened late after the surgery. Sub-optimal surgical technique and possible short length of the LIMA graft alongside the undue tension of straining with constipation are the probable culprits. This case re-emphasizes the importance of meticulous surgical technique specifically in patients with chronic lung disease.

Post-CABG, due to presence of adhesions, accumulation of pericardial fluid can be slow and localized. This could be one of the reasons for survival of our patient to hospital admission. Prompt recognition and timely treatment of the catastrophic bleeding resulted in a favourable outcome.

Conclusion

This case demonstrates a rare complication of LIMA graft avulsion late after CABG surgery, uniquely and successfully treated with covered stent to the LAD and coil embolization of the LIMA graft. Avulsion of the LIMA graft from the LAD is a life-threatening condition and should be recognised as a differential in presentation of anterior MI post-CABG surgery. Prompt percutaneous treatment can be life-saving.
Lead author biography

Shana Tehrani, MRCP, MD
Interventional Cardiology Fellow.
Frimley Health NHS Foundation Trust, UK.

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 guidelines.

Conflict of interest: none declared.

Funding: None declared.

References

1. John M, Jacob B, Arani Djavad T, Salerno Tomas A. Avulsion of the left internal mammary artery after minimally invasive coronary bypass. Ann Thorac Surg 1997; 63(3):843–4. doi: 10.1016/S0003-4975(96)01265-9.
2. Marc R, Thierry G, Quentin D, Raymond L. Avulsion of the left internal mammary artery graft after minimally invasive coronary surgery. Ann Thorac Surg 2001; 71:1401–1402.
3. Marco, R Karamanoukian HL, Giuseppe D, Jakowski, MR, Jacob B, Salerno TA. Salerno Tomas A. Avulsion of an H graft during closed-chest cardiopulmonary resuscitation after minimally invasive coronary artery bypass graft surgery. J Cardiosor Ann Thorac 2000; 14(5):586–7. doi: 10.1053/jctcan.2000.9440.
4. Asherson Andrew P, Vohra Hunaid A, Mason Mark A, Gaer Julien A. Non-anastomotic avulsion of a left internal mammary artery graft - a rare complication of minimally invasive direct coronary artery bypass surgery. Interact Cardiovasc Thorac Surg 2006; 5(4):454–5. doi: 10.1510/icvts.2005.127381.
5. Viel G, Balmaceda U, Sperhake JP, Sperhake Jan P. Avulsion of the left internal mammary artery graft after minimally invasive coronary surgery: fatal complication or medical error? A case report. Med Sci Law 2009; 49:60–64.
6. Morriss D, Shah S, Morriss A, Kaul P. Acute transection of the left internal mammary artery remote from the anastomosis following coronary artery bypass surgery. Interact Cardiovasc Thorac Surg 2004; 3:653–655.
7. Kaleda VI, Belash SA, Barsuk AV, Barbakhuti KO. Perioperative avulsion of a left internal mammary artery graft in a patient with syphilis. Surg Res Pract 2014; 2014:1–3.
8. Smith Douglas C, Senac MO, Bailey Leonard L. Embolotherapy of a ruptured inter nal mammary artery secondary to blunt chest trauma. J Trauma - Inj Infect Crit Care 1982; 22(4):333–5. doi: 10.1097/00005373-198204000-00014.
9. Rao Podila Sita Rama N, Krishna M, Graham M. “LIMA fissure” for a tension-free IMA graft in emphysema. Ann Thorac Surg 1997; 63(2):561–2. doi: 10.1016/S0003-4975(96)01233-7.