

CASE REPORT

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# Spontaneous avulsion of left internal mammary artery graft a complication of coronary artery bypass surgery: case report and review of the literature

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## Abstract

**Background** Coronary artery bypass grafting (CABG) surgery is a common procedure for managing multi-vessel coronary artery disease to revascularize the myocardium. Among the various conduits used, the left internal mammary artery (LIMA) is preferred due to its better long-term patency rate. However, CABG procedures involving LIMA may result in rare but serious complications, such as avulsion of the LIMA post-CABG, which leads to disruption of blood flow to the myocardium and the development of fatal cardiac tamponade.

**Case presentation** We hereby present a unique case of spontaneous avulsion of a LIMA graft to the left anterior descending artery (LAD) away from the site of anastomosis, twenty-four hours following CABG surgery in a 67-year-old male patient. Emergency re-exploration and repair of the LIMA with interposition vein graft were performed and resulted in successful stabilization of the patient's critical condition. However, this was followed by a complicated recovery period involving atrial fibrillation, acute kidney injury, and wound infection.

**Conclusion** Avulsion of LIMA graft following CABG is rare, yet a fatal complication that requires high clinical suspicion and prompt management. Avulsion has been reported a few times in literature following both minimal invasive and conventional CABG. Understanding the etiology, clinical presentation, and management of this complication is crucial to avoid catastrophic outcomes.

**Keywords** Left internal mammary artery, Avulsion, LIMA, CABG, Grafts

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## Background

Coronary artery bypass grafting (CABG) surgery is a well-known procedure for the management of multi-vessel coronary artery disease that is performed for revascularization of the myocardium.

Variable conduits can be used in CABG, but the left internal mammary artery (LIMA) takes advantage due to its proven long-term patency rates and improved patient's outcome in comparison with other grafts [1–3].

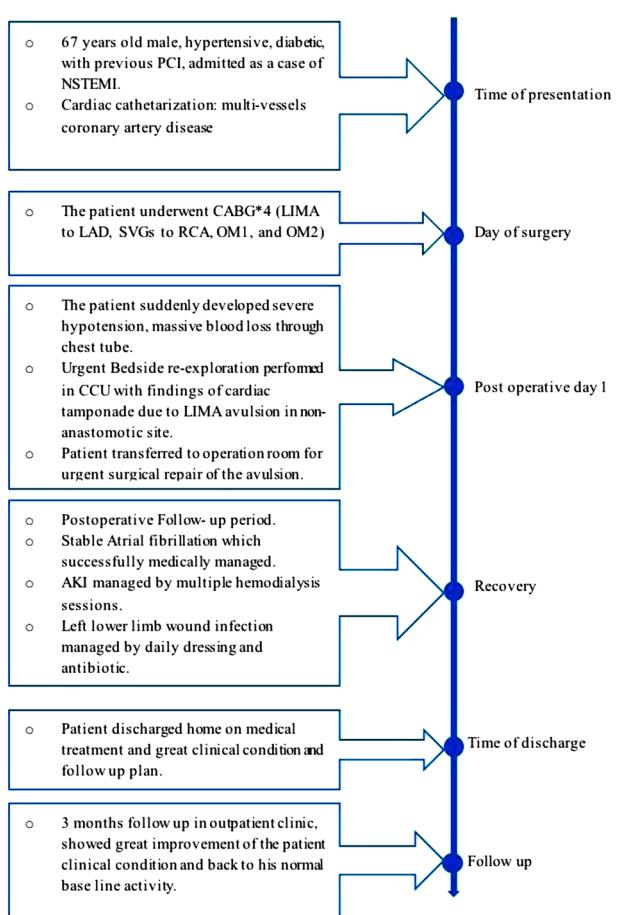
LIMA is commonly used as a conduit in CABG to bypass obstructed coronary arteries, especially the left anterior descending artery (LAD), due to its anatomical features such as its proximal location. CABG surgeries in which LIMA is used can be complicated by avulsion of the LIMA post-surgery, which is rare, but potentially catastrophic, rendering it a serious complication [4].

Post-CABG avulsion of the LIMA is described as sudden tearing or detachment of the LIMA graft from its anastomotic site or other sites, leading to the disruption of blood flow to the myocardium. This complication has severe consequences, such as hemodynamic instability, life-threatening ischemia, or cardiac tamponade [4]. Due to its potential deadly outcome, it is important to understand its etiology, clinical presentation, and immediate management strategies.

Multiple previous studies reported possible causes for this complication, including inadequate graft length, interaction with the pericardium, mediastinitis, abrupt and forceful shear of the conduit following trauma, or adhesion of the conduit to adjacent structures, thereby heightening the risk for traction. Avulsion can be triggered by factors including coughing, constipation, sneezing, blunt chest or abdominal trauma, and cardiopulmonary resuscitation (CPR) [4–6].

In this review, we aim to provide an overview of post-CABG avulsion of LIMA, focusing on its definition, clinical significance, management strategies, and outcomes, thus enhancing our understanding of this serious life-threatening complication.

## Timeline



## Case presentation

A 67-year-old male patient with a complicated cardiac history presented to the cardiology department complaining of worsening typical anginal chest pain of two months duration. Risk factors for coronary artery disease in this patient included morbid obesity, hypertension, and diabetes of twenty years duration.

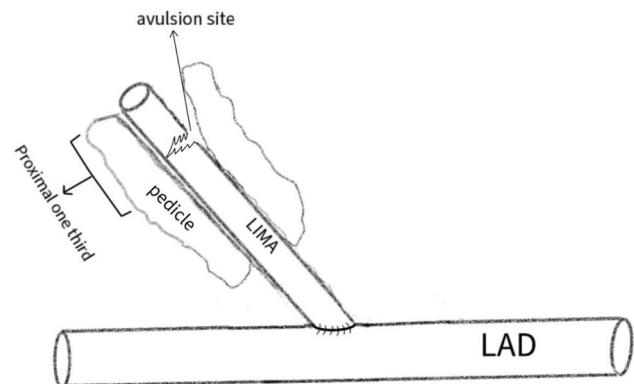
The patient's cardiac history started when he underwent cardiac catheterization twice, with stent placement in 2016, and without intervention in 2018. On Examination, he was hemodynamically stable, with no significant cardiac or respiratory findings. Laboratory investigations

at admission were within normal range except for positive troponin. Electrocardiography showed normal sinus rhythm. We referred him to urgent cardiac catheterization as a case of non-ST elevation myocardial infarction (NSTEMI). Cardiac catheterization showed significant multi-vessel coronary artery disease including the left main stem, and the decision was to go for CABG. Trans-thoracic echocardiography as a part of his pre-operative evaluation, showed a sclerotic aortic valve without regurgitation, diastolic dysfunction grade 1, otherwise normal chambers size and valves.

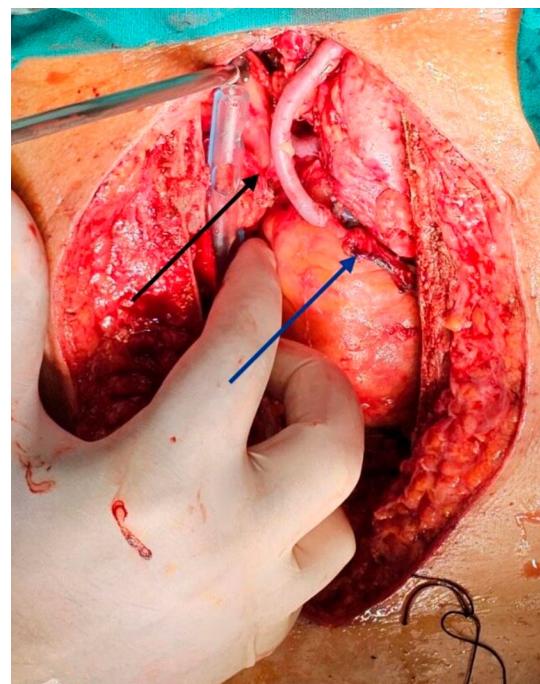
Within the next two days, the patient underwent an uncomplicated on-pump CABG for his coronary artery disease. A good quality LIMA graft was harvested from its origin as a pedicle, however there was an area of adhesion with the chest wall in the middle part of the LIMA, as a result we continued the harvesting as skeletonized LIMA. LIMA was anastomosed to the LAD as in situ graft, and separate venous grafts were anastomosed to both the obtuse marginal 1 and 2, and to the right coronary artery. Before closing the chest, we carefully examined the LIMA and its anastomosis to the LAD, no bleeding or tension were noted. At the end of the procedure, the patient was stable, heartbeat returned spontaneously with minimal inotropic support, and the surgery was completed without any complications. The patient was then transferred to the Cardiac care unit (CCU) for observation.

The patient was extubated smoothly on the same day of the surgery. On the first post operative day he was in excellent clinical condition, had minimal blood loss through the chest tubes, and was able to mobilize out of bed. However, while he was returning back to his room on postoperative day one, he suddenly developed severe hypotension, a decreased level of consciousness, and 400 ml of blood gushed through the chest tubes. Urgent bedside re-exploration was performed in the CCU, which revealed massive cardiac tamponade due to bleeding from the avulsion of the proximal one third of the LIMA graft away from the anastomotic site (Fig. 1). After primary control was achieved in the CCU, we transferred the patient to the operating room for definitive repair of the avulsion. Upon arrival to the operation room, we dissected the damaged segment of the LIMA. The flow of proximal LIMA was found to be good, and the lower segment was satisfactory with retrograde flow from the LAD to the LIMA. A new vein graft was harvested from the right lower limb and used as an interposition graft to repair the LIMA (Fig. 2). After the surgery the patient was transferred back to CCU for close observation.

The Early postoperative period was complicated by stable atrial fibrillation, acute kidney injury, and left lower limb wound infection. Due to these conditions, the patient underwent multiple hemodialysis sessions through a temporary dialysis catheter, with daily



**Fig. 1** Schematic representation of the intra-operative finding showing the avulsion site in the proximal one-third of LIMA away from the site of anastomosis



**Fig. 2** Intra-operative photo showing LIMA repair at the site of the avulsion using a vein as an interposition graft. The black arrow is pointing to the venous interposition graft, and the blue one to the distal part of the LIMA anastomosed to the left anterior descending artery

dressing, and antibiotics management. After the patient was clinically and hemodynamically better, he was discharged home one month after the surgery. After three months follow up, the patient's condition remained satisfactory, and he was able to return to his daily activities.

## Discussion and conclusion

Avulsion of LIMA following CABG surgery is considered a rare but life threatening complication with high mortality rate. Avulsion can complicate both minimal invasive and conventional CABG. According to a PubMed search this complication has been reported in the literature on eight

occasions: five cases following minimal invasive CABG and three cases post-conventional CABG.

The first case of LIMA avulsion following minimal invasive CABG was reported by McMahonet al. [7] in 1997 in a 58-year-old male patient on the fifth post-operative day while lifting a heavy object, and was successfully managed with re-exploration. Since then, avulsion of LIMA has been reported in additional three cases [5, 8–10].

Regarding conventional CABG, avulsion has been firstly reported by Morrittet al.<sup>11</sup> in 2004 in 65-year-old patient four hours following surgery. Re-exploration showed non-anastomotic avulsion of the LIMA graft two centimeters proximal to the anastomotic site at the site of the clipped side branch. Later, tow more case of LIMA avulsion post-conventional CABG were reported in which the avulsion occurred at the site of anastomosis of LIMA to LAD [4–6].

The etiology of the avulsion is usually multifactorial, however after reviewing all the reported cases in the literature it is well established that the most important factor for avulsion in both conventional and minimal invasive CABG is inadequate length of LIMA at the time of the harvest, making it vulnerable for avulsion with the development of any shear force [4]. Thus, ensuring adequate length of the conduit at the time of harvest and utilizing meticulous techniques are crucial in preventing such a fatal complication.

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 the chest wall, mediastinum, or lung, make it susceptible to excessive traction, and have been named as other possible causes for avulsion [6]. Cardiopulmonary resuscitation, hyperventilation, coughing, sneezing, blunt trauma, and weightlifting have also been considered as possible risk factors for avulsion in what may be assumed as a vulnerable conduit [4].

The avulsion most commonly occurs at the site of the anastomosis, however only two of the previously reported cases in literature, in addition to our case have described non-anastomotic avulsion of the conduit [9–11]. There are no suggested factors to predict the site of the avulsion, however inadequate length of the LIMA graft side by side, the tension force excreted by cough in the presence of chronic lung disease are the possible causative factors in our case. Caution must be exercised in patients with chronic lung disease by adding additional length to the LIMA in order to avoid tension. This could be achieved by increasing the length of skeletonization, creating fasciotomy to the LIMA, or even a fissure in the lung to allow passage of the graft [12].

Treatment options can include both surgical and catheter-based interventions. Urgent surgical exploration

for bleeding control and relief of cardiac tamponade if present, is more convenient in hemodynamically unstable patients as in our case.

Our case is one of a kind that will enrich the published literature on this deadly complication, and help broaden our understanding of the effective management that should be tailored to every specific case according to its specific presentation.

#### Abbreviations

CABG	Coronary Artery Bypass Graft
LIMA	Left Internal Mammary Artery
LAD	Left Anterior Descending Artery
RCA	Right Coronary Artery
SVG	Saphenous Vein Graft
OM	Obtuse Marginal Artery
NSTEMI	Non-ST Elevation Myocardial Infarction
CCU	Cardiac Care Unit
AKI	Acute Kidney Injury

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#### Author contributions

MN: Drafted the work, substantial contributions to the conception, interpretation of data, revision.- HA: Drafted the work, substantial contributions to the conception, interpretation of data.- AA: Drafted the work, interpretation of data, design of the work, revision.- IA: Interpretation of data, revision.- WO: Interpretation of data, revision.- NY: Interpretation of data, revision.

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#### Data availability

No datasets were generated or analysed during the current study.

#### Declarations

##### Ethics approval and consent to participate

Not applicable for our institution.

##### Consent for publication

Consent was obtained from the patient and ready to submit upon request.

##### Competing interests

The authors declare no competing interests.

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#### References

1. Loop FD, Lytle BW, Cosgrove DM, et al. Influence of the internal-mammary-artery graft on 10-year survival and other cardiac events. *N Engl J Med*. 1986;314(1):1–6. <https://doi.org/10.1056/NEJM198601023140101>.
2. Cameron AA, Green GE, Bogno DA, Thornton J. Internal thoracic artery grafts: 20-year clinical follow-up. *J Am Coll Cardiol*. 1995;25(1):188–92. [https://doi.org/10.1016/0735-1097\(94\)00332-k](https://doi.org/10.1016/0735-1097(94)00332-k).
3. Barner HB, Swartz MT, Mudd JG, Tyras DH. Late patency of the internal mammary artery as a coronary bypass conduit. *Ann Thorac Surg*. 1982;34(4):408–12. [https://doi.org/10.1016/s0003-4975\(10\)61402-6](https://doi.org/10.1016/s0003-4975(10)61402-6).
4. Tehrani S, Rathore S. Successful percutaneous treatment of a catastrophic left internal mammary artery graft avulsion occurring 4 weeks post-coronary artery bypass grafting surgery: a case report. *Eur Heart J Case Rep*. 2020;5(2):ytaa524. <https://doi.org/10.1093/ehjcr/ytaa524>. Published 2020 Dec 22.

5. Radermecker MA, Grenade T, Desirou Q, Limet R. Avulsion of the left internal mammary artery graft after minimally invasive coronary surgery. *Ann Thorac Surg.* 2001;71(4):1401–2. [https://doi.org/10.1016/s0003-4975\(00\)01897-x](https://doi.org/10.1016/s0003-4975(00)01897-x).
6. Kaleda VI, Belash SA, Barsuk AV, Barbuhati KO. Perioperative avulsion of a left internal mammary artery graft in a patient with syphilis. *Surg Res Pract.* 2014;2014:574346. <https://doi.org/10.1155/2014/574346>.
7. McMahon J, Bergsland J, Arani DT, Salerno TA. Avulsion of the left internal mammary artery after minimally invasive coronary bypass. *Ann Thorac Surg.* 1997;63(3):843–5. [https://doi.org/10.1016/s0003-4975\(96\)01265-9](https://doi.org/10.1016/s0003-4975(96)01265-9).
8. Ricci M, Karamanoukian HL, D'Ancona G, Jajkowski MR, Bergsland J, Salerno TA. Avulsion of an H graft during closed-chest cardiopulmonary resuscitation after minimally invasive coronary artery bypass graft surgery. *J Cardiothorac Vasc Anesth.* 2000;14(5):586–7. <https://doi.org/10.1053/jcan.2000.9440>.
9. Asherson AP, Vohra HA, Mason MJ, Gaer JA. 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. <https://doi.org/10.1510/icvts.2005.127381>.
10. Viel G, Balmaceda U, Sperhake JP. 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(1):60–4. <https://doi.org/10.1258/rsmmsl.49.1.60>.
11. Morritt DG, Shah SS, Morritt AN, 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(4):653–5. <https://doi.org/10.1016/j.icvts.2004.08.001>.
12. Rao PS, Natarajan KM, Morritt G. LIMA fissure for a tension-free IMA graft in emphysema. *Ann Thorac Surg.* 1997;63(2):561–2. [https://doi.org/10.1016/s0003-4975\(96\)01233-7](https://doi.org/10.1016/s0003-4975(96)01233-7).

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