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CASE REPORT
Coronary heart disease

Fate of a coronary artery intramural haematoma complicating aortic root surgery: a case report

Giulio Folino [1]*, Raffaele Scaffa[2], Andrea Salica[3], and Ruggero De Paulis [3]

[1]Department of Cardiac Surgery, University of Padua, Via Giustiniani, 2, 35128 Padova, Italy; [2]Department of Cardiac Surgery, San Giovanni di Dio e Ruggi d'Aragona, Largo Città di Ippocrate, 84131 Salerno, Italy; and [3]Department of Cardiac Surgery, European Hospital, Via Portuense 700, 00181 Rome, Italy

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Background Coronary intramural haematoma (CIH) is an uncommon but potentially life-threatening complication during aortic root surgery (such as Bentall procedure). Depending on its extension it can lead to cardiogenic shock. Documented reports of this complication are lacking in literature.

Case summary In the report we present a case of CIH and its management and we show a stepwise imaging of the healing process that gives an insight of the fate of CIHs.

Discussion This case raises awareness of CIH as differential diagnosis for myocardial ischaemia during aortic root surgery. It underlines the effectiveness of immediate surgical revascularization, highlights the potential temporary role of coronary artery bypass graft that can stabilize the acute coronary syndrome and may give time to the CIH to reabsorb and native coronary circulation to re-establish.

Keywords Coronary intramural haematoma • Aortic root replacement • Bentall procedure • Myocardial ischaemia • Percutaneous coronary intervention • Case report

Learning points

- Coronary intramural haematoma (CIH) can develop during aortic root surgery with coronary reimplantation and can acutely lead to cardiogenic shock.
- Coronary artery bypass can promptly solve the cardiogenic shock and may play a role in sustaining the coronary circulation until the haematoma reabsorbs.
- This case documents the fate of a CIH: the haematoma may progressively reabsorb and re-establish the native circulation, while the competitive flow perhaps promotes graft thrombosis.

* Corresponding author. Tel: +39 3333357653, Email: folinogiulio@gmail.com
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Introduction

Coronary intramural haematoma (CIH) is an uncommon but possible complication during aortic root surgery requiring reimplantation of coronary buttons. Documented reports of this complication are lacking in literature. Depending on its extension, the haematoma may lead to an acute coronary syndrome with cardiogenic shock. Immediate coronary artery bypass grafting (CABG) can effectively solve the cardiogenic shock and temporarily sustain the coronary circulation, as evidenced by previous studies.[1] The CIH can gradually re-absorb and re-establish normal native coronary circulation. Close coronary angiographic follow-up is required.

Timeline

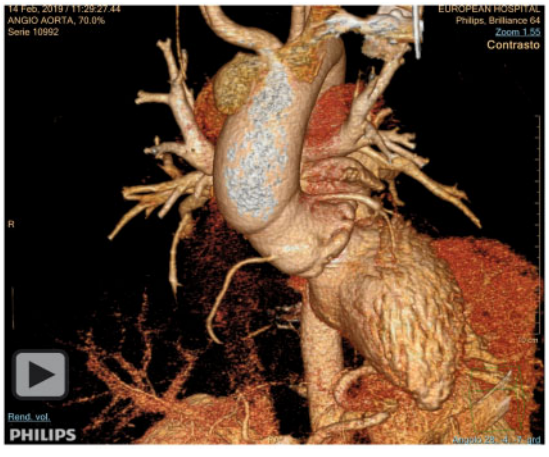
At time of admission	Clinical status: dyspnoea, New York Heart Association Class III
	Echo: peri-prosthetic leak, severe aortic insufficiency. Preserved left ventricle ejection fraction (LVEF)
	Computed tomography scan: partial detachment of the prosthesis and pseudoaneurysm
	Coronary angiography (CA): normal coronary arteries
At time of surgery	Surgical procedure: aortic root replacement and coronary buttons reimplantation (modified-Bentall procedure)
	Complication: cardiogenic shock at time of cardiopulmonary bypass (CPB) weaning with sign of anterolateral ischaemia
	Management: immediate revascularization (saphenous vein graft to mid-left anterior descending artery). Successful CPB weaning and intensive care unit admission
48 h after surgery	CA: significant stenosis of the left main stem due to a coronary intramural haematoma (CIH). Good flow downstream the lesion supported by the vein graft
	Heart-team discussion: no percutaneous intervention. Medical therapy and control CA at 6 months
At discharge	Clinical status: good recovery, no recurrent angina, chest pain nor dyspnoea
	Echo: mildly reduced LVEF, good functioning prosthesis
6 months after surgery	Clinical status: good recovery, no limitation in daily life
	Echo: normal LVEF, good functioning prosthesis
	CA: absorption of the CIH. Recovered native coronary tree. Occlusion of the venous graft

Case presentation

A 36-year-old man (weight 81 kg, height 180 cm) symptomatic for fatigue and dyspnoea on mild exertion (New York Heart Association Class III) with past medical history of two aortic valve replacements (AVR) was referred to our institution because of a relapse of *Staphylococcus warneri* prosthetic valve endocarditis (PVE). He underwent the first AVR 2 years earlier for a steno-insufficient bicuspid aortic valve. After 8 months a redo AVR with annular reconstruction was needed due to PVE; *S. warneri* was isolated from the explanted valve. At time of referral the patient had completed the antibiotic therapy, the blood cultures were negative and the laboratory findings were within normal ranges. No risk factors for recurrent infections were identified. On physical examination, the main finding was a holodiastolic murmur over the aortic valve area. The transthoracic echocardiogram showed a peri-prosthetic leak that determined a severe aortic insufficiency, good left ventricle's (LV) contractility, and ejection fraction (EF = 60%). The transoesophageal echocardiography (TOE) and electrocardiogram (ECG)-gated computed tomography scan demonstrated a pseudoaneurysm at the level of the LV outflow tract (LVOT) extending towards the mitro-aortic intervalvular fibrosa (Video 1). Pre-operative coronary angiography (CA) showed normal coronary arteries (*Figure 1*).

A modified-Bentall technique with a composite mechanical valve conduit (St. Jude Medical Masters HP valved graft with Gelweave Valsalva conduit) was carried out. After transecting the ascending aorta, two buttons of aortic wall including the coronary ostia were isolated and mobilized. By implanting the valved conduit, the pseudoaneurysm was excluded and the LVOT was reconstructed. Then, the ostia were sutured to two corresponding openings in the Dacron graft with a continuous suture of 6-0 Prolene[2] without using any foreign material and without the addition of glue. By using the Valsalva graft, tension-free anastomoses of the buttons were expected.[3] No macroscopic technical problems were encountered.

At the time of weaning off cardiopulmonary bypass (CPB) the LV showed signs of failure. Intraoperative TOE evaluation in the transgastric short-axis view revealed a marked hypokinesis of the entire anterolateral wall and septum from the basal segments to the apex. Transoesophageal echocardiography findings in addition to the concomitant anterolateral ST-segment elevation on the 12-lead ECG suggested an acute impairment in blood supply thorough the proximal left coronary system. The origin of both coronary arteries was



Video 1 The videoclip summarises the case report showing the preoperative imaging, the surgical procedure and the progressive healing of the coronary intramural haematoma.

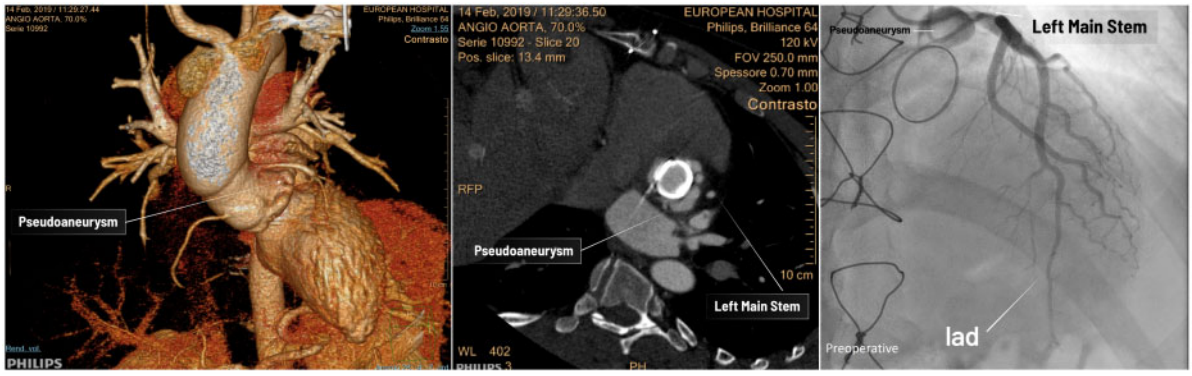


Figure 1 A 36-year-old male with history of previous cardiac surgeries was referred to our institution for a relapse of prosthetic valve endocarditis with a dehiscent aortic prosthesis and a pseudoaneurysm at the mitro-aortic intervalvular fibrosa. Volume-rendered reconstruction and electrocardiogram-gated computed tomography scan images of the pseudoaneurysm (left and central figure, respectively). Pre-operative coronary angiography showed normal coronary arteries (figure to the right).

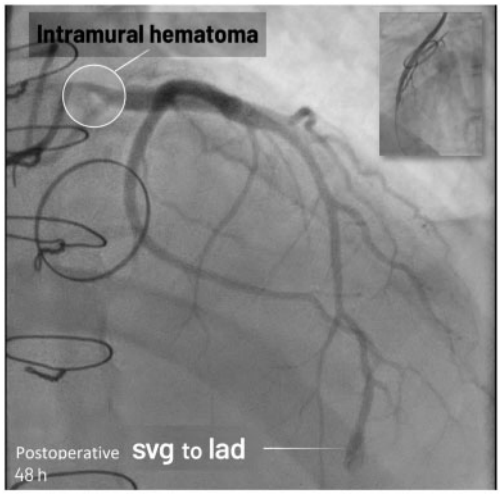


Figure 2 Coronary angiography performed 48 h after the operation. The angiogram showed significant stenosis of left main stem. The lesion is consistent with a coronary intramural haematoma, Type 3 pattern according to Saw classification of spontaneous coronary artery dissection.[12] The saphenous vein graft to the mid-left anterior descending artery was patent and effectively supported the flow downstream the lesion (inset at the upper right angle). No percutaneous coronary interventions were performed for the lesion.

identified on TOE; kinking was excluded and Doppler evaluation showed the presence of blood flow through the ostia. The haemodynamic instability and difficulty in CPB weaning prompted an early strategy to re-establish coronary perfusion to the left coronary system. Surgical revascularization was performed with a saphenous vein graft anastomosed to the mid-left anterior descending (LAD) artery and reimplanted on the aortic Dacron conduit. The second attempt of weaning from CPB was successful with normal ECG tracing and good whole myocardial contractility. The patient was admitted to the intensive care unit with stable haemodynamic. A control CA was performed after 48 h. The angiography showed a significant stenosis of the left main stem (LMS) due to a recently developed lesion consistent with haematoma of the coronary wall. The saphenous vein graft to mid-LAD anastomosis was patent and effectively supported the coronary flow downstream the lesion (*Figure 2*). No percutaneous coronary interventions (PCI) were performed for the lesion. Hospital monitoring, medical treatment (aspirin 100 mg/day and warfarin with a target international normalized ratio range 2.0–3.0 due to the mechanical aortic valve), and angiographic follow-up were planned.

The post-operative course was further complicated by hospital-acquired pneumonia successfully treated with IV antibiotics. The patient presented neither symptoms nor signs of angina and was discharged home on Day 28. At discharge the echocardiogram showed a good functioning prosthesis, mildly decreased LVEF (56%). The control CA was repeated after 6 months. It clearly revealed the resolution of the haematoma, a recovered LMS and LAD artery, while the vein graft was occluded (*Figure 3*). The patient has been followed at outpatient clinic uneventfully for 1 year.

Discussion

Coronary intramural haematoma is an accumulation of blood within the tunica media of the arterial wall that may displace the internal elastic membrane inward and the external elastic membrane outward.[4] Coronary intramural haematoma may manifest with a broad spectrum of clinical presentation, from acute coronary syndromes to cardiogenic shock or even sudden cardiac death.

Coronary intramural haematoma and dissection can occur as a consequence of a penetrating ulcer or plaque rupture secondary to atherosclerotic vascular disease, primary aortic dissection, rarely can arise spontaneously (spontaneous coronary artery dissection, SCAD), or from coronary instrumentation. Iatrogenic coronary dissections and haematomas have been reported as possible complications during CA or PCI.[5] Reviewing the current literature, no cases of CIH acutely developed after aortic root surgery were found and a

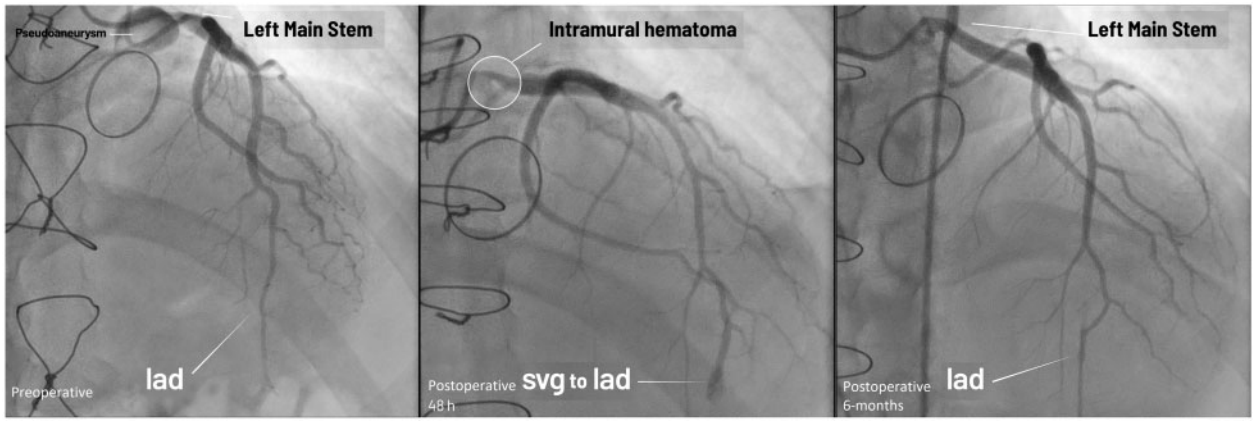


Figure 3 Three frames of different coronary angiographies performed pre-operatively, at 48 h and at 6 months from the operation. The images document the formation and progressive healing of the coronary intramural haematoma. The progressive healing may determine the gradual thrombosis of the vein graft possibly due to the competitive flow through the native coronary tree.

documented stepwise imaging of the haematoma and subsequent healing process has not been reported yet.

Overall, acute and sub-acute myocardial ischaemia after aortic valve and aortic root procedures[6–8] has a low incidence. A recent systematic review of Bentall procedures reports an early post-operative mortality of 5.6%, of which only 6% is caused by myocardial infarction.[9] Common complications leading to myocardial ischaemia or infarction are related to coronary buttons reimplantation. Several mechanisms are recognized: tilting and twisting, tension of the anastomoses, intimal damage during delivery of the cardioplegia or coronary instrumentation,[8] surgical glue at the anastomosis site directly compressing the coronary lumen or leading to abnormal inflammatory response.[10] Direct lesions of the coronary wall or damage during button mobilization might be encountered particularly in redo operation, due to pericardial adhesions.

As described in the report, all surgical strategies to prevent coronary problems were adopted: the coronary buttons were reimplanted respecting their natural position with limited mobilization and tension-free anastomosis thanks to the shape of the Valsalva graft.[11] This, in turn, avoids twisting, kinking, and potential later pseudoaneurysm. Foreign material and haemostatic glue were not used. Cardioplegia was delivered retrogradely through the coronary sinus avoiding potential intimal injuries related to selective antegrade delivery. Neither calcifications nor vegetation were present on the valve, which ruled out the possibility of solid emboli in the coronaries. However, unexpected acute coronary events leading to acute pump failure may occur. After excluding, intraoperatively, the most common complications related to coronary buttons reimplantation, CIH formation with impaired coronary flow remains a possible diagnostic alternative.

The 48 h post-operative CA showed a CIH developed at the level of the LMS. The angiographic features of the CIH are consistent with the Type 3 pattern according to the classification of SCAD proposed by Saw.[12] Despite Type 3 is defined as angiographically indistinguishable from a focal atherosclerotic stenosis, the pre-operative CA clearly excluded the presence of focal stenosis of the LMS. As for the majority of CIHs, in this case CA alone was sufficient for the diagnosis.[13] Additional intracoronary imaging, i.e. intravascular ultrasound or optical coherence tomography (OCT), might be helpful to support the diagnosis and eventually to guide coronary intervention.[13] However, in this clinical scenario further vessel wall assessment did not appear essential as the revascularization had already been effectively achieved and additional management strategy did not include stent placement. Moreover, intracoronary imaging with OCT carries a potential risk of extension of the false lumen. Computed tomography angiography to rule out external compression was also considered redundant since CA was judged clear enough for diagnosis and we wanted to avoid any unnecessary use of contrast material. The control CA performed 6 months later, showed a recovered native coronary circulation. This finding indirectly confirmed the diagnosis of CIH.

The treatment and optimal management of CIH should be based on the clinical scenario. Published studies consistently show poor success rates with PCI, with increased risk of coronary complications and possibly malpositioned coronary stents after reabsorption of the CIH.[13] In our case, the clinical circumstances imposed an immediate surgical revascularization. The control CAs (at 48 h and at 6 months) documented the following: first, the early effectiveness of the CABG in sustaining the coronary circulation downstream the lesion and second, the progressive healing of the haematoma which perhaps led to the gradual thrombosis of the vein graft possibly due to the competitive flow through the native coronary tree. Therefore, in this specific case, CABG was useful as temporary strategy to stabilize the acute coronary syndrome involving the LMS, and overcome the cadiogenic shock.

Conclusion

The natural history of CIHs is variable: several studies reported gradual resolution[14] but progression has also been documented.[15] Further evidences are needed to better understand the determinants of CIHs behaviour. Considering the unpredictable outcomes and lack

of randomized trials, treatment of CIHs should be considered on a case-by-case basis.

The present case documents a CIH as a possible complication during aortic root procedure and describes three different time points: (i) myocardial ischaemia with cardiogenic shock, (ii) surgical revascularization as a bail out option in the operating room scenario, and (iii) the fate of a CIH with gradual absorption and resolution.

Lead author biography

Giulio Folino, MD, is currently training as Cardiac Surgeon at the University Hospital of Padua.

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 author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: R.D.P. is the inventor of the Valsalva Graft and has received royalties from Vascutek Terumo in the past. All other authors declared no conflict of interest.

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