Rescue aortic balloon valvuloplasty during procedural cardiac arrest while treating critical left main stem stenosis: a case report

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Background
Best timing for coronary revascularization in patients with severe aortic stenosis (AS) who was a candidate for transcatheter aortic valve implantation (TAVI) is still matter of debate.

Case summary
We here report the case of an 87-year-old man with severe AS presenting with non-ST-segment elevation myocardial infarction. Coronary angiography revealed a highly complex and calcific left main stem (LMS) lesion. Rotablation-assisted percutaneous coronary intervention (PCI) was attempted but was complicated by post-stenting rapidly evolving haemodynamic impairment. A rescue ‘pace-free’ balloon aortic valvuloplasty (BAV) was performed to rescue the patients, allowing prompt restoration of cardiac output and coronary perfusion.

Discussion
According to guidelines and preliminary evidence, decision should be performed case by case and based on the degree of severity and complexity of either AS or coronary disease. The strategy of treating coronary lesions first may limit the risk of potential ischaemic complications during TAVI. However, the downside of it is the risk of hemodynamic crash with potential catastrophic evolution in case of PCI complications in presence of severe AS. A ‘bailout BAV’ can be considered as a salvage-strategy in case of complex and complicated LMS-PCI in the context of severe AS and advanced status of haemodynamic impairment. This approach must be seen as very last resort, while appropriate pre-procedural planning is still highly recommended in order to prevent potentially fatal procedural complications in this fragile clinical setting.

Keywords
Aortic stenosis • Left main • Cardiac arrest • Percutaneous coronary intervention • Complication • Case report

Learning points
- The best management of left main coronary stenosis in patients with severe aortic stenosis (AS) scheduled to undergo transcatheter aortic valve implantation, and particularly the timing of percutaneous coronary intervention (PCI), remains unclear.
- Bailout ‘pace-free’ balloon aortic valvuloplasty may be a valuable option in case of dire haemodynamic impairment during complex PCI procedure in the setting of untreated AS.
**Introduction**

Transcatheter aortic valve implantation (TAVI) has transformed the management of patients with aortic stenosis (AS) at high surgical risk. However, it remains unclear how and when to manage coronary artery disease (CAD) in patients with severe AS who are candidates for TAVI.

We report the case of a highly complex left main stem (LMS) disease in the setting of severe AS requiring an unconventional approach to solve a potential catastrophic scenario; thereby highlighting the unmet need of a clear and agreed decision-algorithm to successfully manage this clinical setting.

**Timeline**

| Day   | Event                                                                                           |
|-------|-------------------------------------------------------------------------------------------------|
| Day 1 | An 87-year-old patient with severe aortic stenosis (AS) admitted with non-ST-segment elevation myocardial infarction |
| Day 2 | • Coronary angiography: complex calcific lesion in the left main stem (LMS) involving the trifurcation.  
       • MDT discussion: no surgical options due to prohibitive surgical risk. The agreed treatment strategy was percutaneous coronary intervention (PCI) to LMS and staged transcatheter aortic valve implantation. |
| Day 3 | PCI to LMS and emergent balloon aortic valvuloplasty                                             |
| Day 8 | Hospital discharge.                                                                             |
| Day 15| Outpatient clinic visit: the patient was asymptomatic for shortness of breath and chest pain at rest. There were no signs of congestive heart failure. New York Heart Association (NYHA) functional Class II. There was evidence of significant residual AS at transthoracic echocardiogram. The patient declined to undergo further interventions. |
| 1 year after | Outpatient clinic follow up visit: the patient was alive, in good general conditions. He reported a NYHA Class II. No adverse clinical events were reported. |

**Case presentation**

An 87-year-old male patient was admitted to our institution with a diagnosis of non-ST-segment elevation myocardial infarction.

His past medical history included treated hypertension and hypercholesterolaemia. His reported symptoms included worsening dyspnoea in the last few weeks and recurrent episodes of severe chest pain in the previous 48 h.

Physical examination on admission revealed moderate systolic hypertension (155/85 mmHg) with normal heart rate (74 b.p.m.). There were no signs of peripheral or pulmonary oedema. Cardiac examination revealed an absent second heart sound and a rough systolic murmur radiating to both the carotid arteries.

High-sensitivity troponin T (normal range: <14 ng/L for women and <22 ng/L for men) at admission was elevated (133 ng/L) and electrocardiogram showed antero-lateral T-wave inversion (Supplementary material online). On transthoracic echocardiogram mild left ventricular (LV) impairment was detected with an ejection fraction of 47% (normal values: 55–70%). Hypokinesia of the anterior, anterolateral wall, and the apex was noted. Severe AS [mean aortic gradient of 30 mmHg (normal value: <5 mmHg), maximum aortic gradient of 62 mmHg (normal value: <10 mmHg), maximum velocity 4 m/s (normal value: ≤2.5 cm²), and aortic valve area of 0.52 cm² (normal values: 2.5–4.5 cm²)] was detected (Figure 1A).

Coronary angiography showed highly calcific complex lesion of the LMS involving the trifurcation and with two large and in tandem aneurysmal segments of the shaft and distal LMS (Figure 18–D; Supplementary material online, Video S1).

The procedure was stopped to allow multidisciplinary team discussion. The option for surgical management was excluded because of the prohibitive surgical risk (EuroSCORE II = 14.05%) and it was agreed to offer a percutaneous treatment option for both LMS and AS. Because of the complexity and apparent acuity of LMS, percutaneous coronary intervention (PCI) was planned first with AS treatment [either with TAVI or balloon aortic valvuloplasty (BAV)] as a subsequent staged procedure.

Percutaneous coronary intervention was performed via the right radial access using a sheathless guiding catheter (PB3.5 7.5 Fr) with a plan for elective rotational atherectomy to left anterior descending coronary artery (LAD) and left circumflex coronary artery (LCx). However, after multiple failed attempts to wire the LCx, rotational atherectomy was performed only on the LAD with a 1.75-mm burr (RotaLink, Boston Scientific) (Figure 2A). Even after LAD rotational atherectomy, wiring of the LCx was still not possible. Consequently, the LMS was then predilated with a 3.0 × 20 mm semicompliant balloon and stented towards the LAD with a 3.5 × 22 mm zotarolimus eluting stent (Figure 2B).

Unfortunately, stent deployment was followed by loss of flow in both the intermediate branch and in the LCx (Figure 2C). Prompt wiring of the intermediate branch or LCx was attempted but failed so proximal optimization technique of the LMS stent with a 4.5 × 8 mm non-compliant balloon, was performed.

At this stage, the patient became very hypotensive (blood pressure= 50/30 mmHg) and bradycardic (heart rate= 25 b.p.m.), with a critically ischaemic electrocardiogram showing a 10-mm ST-segment depression in leads V4–V6, and lost cardiac output. Cardiopulmonary resuscitation was promptly started followed by inotropic support and ventilation via a laryngeal mask.

Because of the severe low-output status and severe bradycardia in the setting of an untreated AS, a ‘bail-out’ rescue BAV with a 22-mm balloon (VACS II Osypka) was performed via right femoral access (10 Fr). The absence of cardiac output meant there was no requirement for temporary wire insertion for fast ventricular pacing (Figure 2D). Immediately after aortic valve dilation haemodynamic recovery (blood pressure = 100/60 mmHg and heart rate = 100 b.p.m.) was promptly achieved.

At this stage, the intermediate branch was wired with a hydrophilic coated wire (Pilot 200 guide wire (Abbott)) but wiring of the LCx was still unsuccessful. The intermediate branch was predilated with a 2.0 × 12 mm semicompliant balloon and then stented with a 2.75 × 16 mm zotarolimus eluting stent (T-stenting and small protrusion...
technique) (Figure 2E and F). An intra-aortic balloon pump was inserted and the patient was then transferred to coronary care unit for monitoring (Supplementary material online, Videos S2 and S3). The patient made a full recovery and discharged on the fifth day (Supplementary material online, Video S4), with an initial plan for TAVI in a month. When reassessed in clinic, significant AS was still evident on echocardiogram, with no signs of aortic regurgitation, but, in the absence of symptoms, the patient declined to undergo further intervention. No significant clinical events were documented at follow-up 1 year later. Written consent of the patient for this case report was specifically requested and obtained.

Discussion

The impact of CAD on the natural history of AS has been previously reported in the literature, with up to a 10-fold increased risk of 30-day mortality in CAD patients undergoing TAVI. Although the presence of CAD is accepted as a marker of poor prognosis in patients with severe AS undergoing TAVI, the role and the best timing for revascularization is unclear. Because of absence of evidence, the current guidelines are relatively vague on the topic, suggesting a tailored treatment consistent with the degree of severity of either coronary or aortic valve disease and based on the final opinion of the Heart Team.

Overall, prior PCI is generally agreed to be a safe option and potentially better as it reduces the risks associated with the TAVI procedure itself. However, PCI to the LMS prior to TAVI is a different and potentially underreported scenario, with two main procedural and decisional challenges to face: (i) the potential interaction between the LMS stent and the prosthesis and (ii) the higher risk of severe haemodynamic deterioration during LMS-PCI in the context of an untreated severe AS.

In our case, we have reported a clinical scenario where the operators initially had to make a difficult choice between PCI on an
unusually complex LMS disease vs. BAV/TAVI. The large calcific burden, the involvement of the trifurcation and the presence of a large aneurysmal dilation were all elements pointing towards a potential superior complexity in treating LMS disease than AS. For this reason, dealing with LMS first was felt to be the most appropriate initial choice. Notably, in this case, pre-procedure preparation for BAV allowed this to be done with minimum delay.

The case provides a further element of discussion when considering the dramatic and rapid haemodynamic deterioration following a procedural complication during PCI such as the occlusion of a side branch, requiring a prompt rescue strategy.

In this case, given the advanced haemodynamic compromise, BAV was performed without the need for rapid pacing which is normally required to lower the cardiac output during the aortic balloon inflation. Balloon aortic valvuloplasty resulted in an immediate improvement of myocardial reperfusion, reverting the dramatic downward spiral initially triggered by the simultaneous LCx and intermediate branch occlusion post-stenting. It has been recognized that relief of AS results in improved coronary flow, although this has not been described in a peri-arrest condition. Interestingly, in this case, BAV and PCI to LMS-LAD and intermediate branch resulted in a considerable improvement in LV function (See Supplementary material online, Video S4) despite significant residual disease with impaired flow in the LCx territory.

Figure 2 (A) Rotational atherectomy of the left anterior descending coronary artery. (B) Stenting of the left main stem towards the left anterior descending coronary artery. (C) Sudden post-stenting loss of flow both on intermediate branch and left circumflex coronary artery. (D) ‘Pacing-free’ rescue balloon aortic valvuloplasty. (E and F) Stenting of intermediate branch and final result.

Balloon aortic valvuloplasty can be considered as a potential bailout strategy in cases of PCI-related haemodynamic instability in the context of severe AS. Importantly, appropriate pre-procedural planning is essential to allow rapid balloon deployment. Further studies on the best sequence of treatments for this complex patient group and the potential role of mechanical haemodynamic support assisted PCI in patients with AS are warranted.

Lead author biography

Professor Adrian Banning is the Professor of Interventional Cardiology at Oxford University. He has had a prominent role in a number of pivotal trials in Interventional Cardiology including Taxus, Syntax, and Excel. He has a particular expertise in treatment of the left main coronary artery with stents. His research interests include minimizing revascularization injury and optimizing myocardial revascularization in ST-segment elevation myocardial infarction.
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: none declared.

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