ESC European Society of Cardiology

European Heart Journal - Case Reports (2023) **7**, 1–5
https://doi.org/10.1093/ehjcr/ytad301

CASE REPORT
Coronary intervention

Rotational atherectomy of left main stem immediately after transcatheter aortic valve implantation in a patient with symptomatic severe aortic stenosis and an impaired left ventricular systolic function: a case report

Zahir Satti, Mohamed Farag, Mohaned Egred, and Mohammad Alkhalil *

Cardiothoracic Department, Freeman Hospital, Newcastle University, Freeman Rd, Newcastle upon Tyne, NE7 7DN, UK

Received 3 October 2022; first decision 9 April 2023; accepted 6 July 2023; online publish-ahead-of-print 8 July 2023

Background Severe aortic stenosis (AS) and coronary artery disease (CAD) often coexist since they both share the same risk factors and pathophysiology. Patients with severe AS with prohibitive surgical risk are often treated with transcatheter aortic valve implantation (TAVI) and percutaneous coronary intervention (PCI) as a staged or concurrent procedure. Significant calcified CAD and left ventricular (LV) systolic impairment in such patients would add more challenges to the management. A clear consensus on the timing of revascularization of such patients in relation to the TAVI procedure is lacking.

Case summary Herein, we present an 86-year-old male who presented to a local district hospital with non-ST-segment elevation myocardial infarction (N-STEMI) and decompensated heart failure. His transthoracic echocardiography showed moderate LV systolic impairment with low-flow severe AS. He was initially treated with dual anti-platelet and diuretic therapy and subsequently underwent coronary angiography that revealed severe calcified shelf-like left main stem (LMS) and moderate left anterior descending (LAD) disease. He was successfully treated with TAVI and rotational atherectomy (RA)-assisted PCI to LMS and LAD in the same setting.

Conclusion There is limited evidence on effective strategies to tackle high-risk angioplasty with concurrent TAVI in patients with impaired LV function. We performed TAVI and RA to LMS and LAD in the same setting using no mechanical circulatory support (MCS). Management strategies should be individualized to highly selected patients taking into account LMS involvement, calcium modulation strategies, haemodynamic instability, or cardiogenic shock and whether MCS is needed.

Keywords Left main stem • Percutaneous coronary intervention • Rotational atherectomy • Severe aortic stenosis • Transcatheter aortic valve implantation • Impaired left ventricular function • Case report

ESC Curriculum 3.1 Coronary artery disease • 3.2 Acute coronary syndrome • 3.4 Coronary angiography • 4.2 Aortic stenosis • 6.4 Acute heart failure

* Corresponding author. Tel: +44 191 233 6161, Email: mohammad.alkhalil@nhs.net
Handling Editor: Giulio Russo
Peer-reviewers: Sherif Mohammad Abd ElSamad; Marta Cvijic; Hesham Bahaa
Compliance Editor: Siddhartha Mohan
Supplementary Material Editor: Hikmet Kadioglu

Learning points

- Concurrent transcatheter aortic valve implantation (TAVI) and rotational atherectomy (RA)-assisted percutaneous coronary intervention (PCI) to left main stem in a relatively stable high-risk patient can be performed safely without mechanical circulatory support.
- Transcatheter aortic valve implantation prior to RA-assisted PCI can minimize the risk of haemodynamic compromise resulting from slow coronary flow.
- Coronary revascularization in patients undergoing TAVI needs to be individualized based on current available evidence.

Introduction

There is limited evidence to support rotational atherectomy (RA) of left main stem (LMS) disease during transcatheter aortic valve implantation (TAVI). Transcatheter aortic valve implantation has expanded as an effective treatment for patients who pose risk of mortality from conventional surgical aortic valve replacement (SAVR).[1] Patients with severe aortic stenosis (AS) frequently have coexistent coronary artery disease (CAD); the optimal management remains an area of ambiguity in the literature and warrants further research.[2, 3]

Timeline

Time	Events
25 December 2021	Admission with chest pain and shortness of breath. Echocardiogram 13 April 2021: moderate-to-severe AS. Coronary angiography: severe calcified LMS and LAD disease.
31 December 2021	Transferred to a tertiary centre.
4 January 2022	Heart Team (HT) decision: TAVI + percutaneous coronary intervention (PCI) to LMS/LAD. **Predicted mortality by EuroSCORE II:** 11.29%. **SYNTAX Score II:** **PCI** SYNTAX Score II: 42.3. PCI 4-year mortality: 17.9%. **CABG** SYNTAX Score II: 49.2. CABG 4-year mortality: 29.9%.
14 January 2022	12:38 TAVI performed. 12:45 RA of LMS and LAD. 15:04 Electrocardiograph (ECG): sinus rhythm (SR), left bundle branch block (LBBB), QRS duration 130 ms.
15 and 16 January 2022	ECG: SR, first degree heart block, LBBB, QRS Duration 128 ms. Discharged.

Case presentation

An 86-year-old male admitted to a district hospital with chest pain and shortness of breath. He was managed as acute coronary syndrome with decompensated heart failure. Coronary angiography demonstrated heavily calcified shelf-like 70–80% LMS stenosis, with 60–70% stenosis in mid-left anterior descending (LAD) (see Supplementary material online, *Videos S1–S3*). He was initially referred for consideration of SAVR plus surgical revascularization.

He has a history significant of asthma, hypertension, hypercholesterolemia, prostate cancer with previous radiotherapy, and chronic kidney disease (creatinine of 132 μmol/L with an estimated glomerular filtration rate of 42 mL/min/1.73 m^2). Clinical examination revealed haemodynamically stable patient with a heart rate of 82 b.p.m., blood pressure of 107/57 mmHg, respiratory rate of 18 breaths per minute, and oxygen saturation of 94%. He had a quiet second heart sound and estimated central venous pressure of 12–13 mmHg. There was reduced air entry on the right lung with evidence of bilateral peripheral oedema. Echocardiogram showed a calcified tri-leaflet aortic valve (AV) with restricted mobility, peak gradient of 50 mmHg, mean gradient of 31 mmHg, and AV area of 0.9 cm^2 with left ventricular (LV) ejection fraction of 40% (*Figure 1* and Supplementary material online, *Video S4*). The anterior wall was hypokinetic with normal left ventricle cavity size [diastolic LV internal diameter (LVIDD) of 4.57 cm] and moderately concentric LV hypertrophy (septum thickness of 1.44 cm and posterior wall of 1.39 cm). He had low stroke volume index (SVi) of 28.4 mL/m^2. Aortic valve calcium score was >3000 confirming severe AS. Computed tomography (CT) of the aorta confirmed suitability for transfemoral TAVI. The right coronary height was 19 mm, and the left coronary height was 15.6 mm.

The HT concluded that the severity of AS was secured without the need to perform dobutamine stress echocardiography (DSE) based on low indexed valve area of 0.47 cm^2/m^2 in the context of low flow alongside the degree of calcified AV leaflets on CT. The consensus was in favour of inpatient TAVI plus PCI to LMS as high surgical risk [The calculated Society of Thoracic Surgeons (STS) score of 8.44%] and patient's preference for a less invasive approach. Transcatheter aortic valve implantation was performed under conscious sedation using a 14 French (F) eSheath inserted into the right femoral artery. The LV was pre-conditioned by performing very short burst of incremental rapid pacing at 120, 140, 160, and 180 b.p.m. Following each pacing episode, we ensured both blood pressure and ECG changes return to baseline. A 26 mm Sapien 3 Ultra (Edwards Lifesciences Inc., Irvine, CA, USA) valve was successfully deployed under rapid pacing via the LV wire with no significant paravalvular leak (see Supplementary material online, *Video S5*).

Subsequently, the left coronary artery was selectively engaged using 7F EBU 4.0 guide catheter via the eSheath. A Fielder FC guidewire crossed the lesions and was exchanged to rota extra support guidewire using Turnpike LP microcatheter. A Rota Pro 1.5 burr was used to debulk coronary artery calcification (CAC) in LMS and mid LAD (see Supplementary material online, *Video S6*). A total of 3 runs per lesion

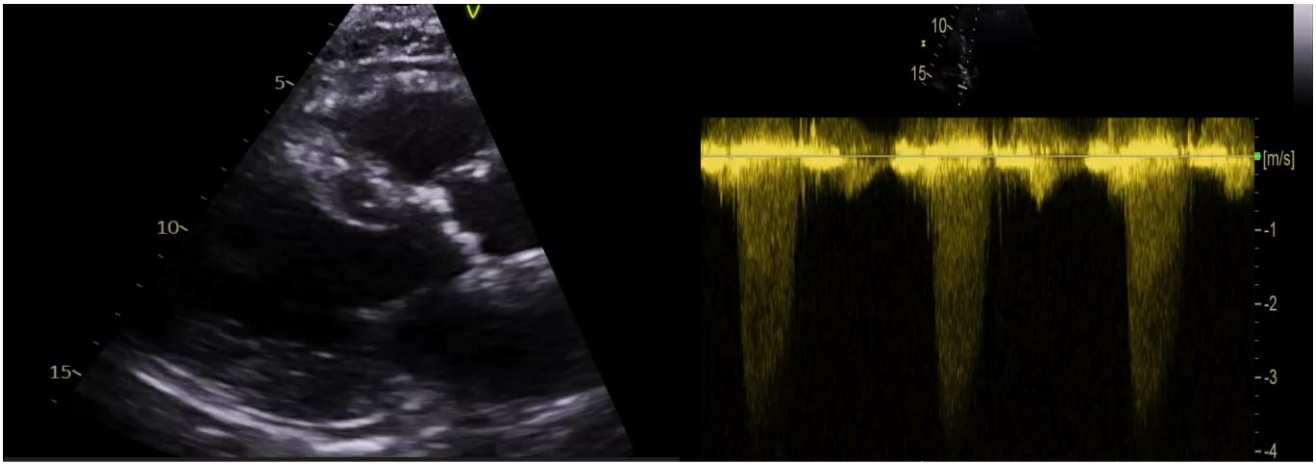

Figure 1 Long-axis transthoracic echocardiography image and continuous wave Doppler image highlighting severe aortic stenosis.

were used and each run lasting for less than 20 s at speed of no more than 170 *g*. The LAD and LMS lesions were pre-dilated using 3.0 × 12 mm Accuforce Non-Compliant Balloon (NCB) and 3.5 × 12 mm Quantum Apex NCB, respectively. A 3.0 × 18 mm Xience Sierra drug-eluting stent (DES) was deployed in mid-LAD and post-dilated with a 3.5 × 12 NCB. The LMS lesion was treated with a 4.0 × 15 mm Xience Sierra DES and optimized with a 5.0 × 8 mm NCB with excellent angiographic result (see Supplementary material online, *Videos S7* and *S8*). The procedure was performed with total contrast volume of 190 mL and activated clotting time (ACT) between 250 and 300 s. Patient developed LBBB with marked first-degree AV block and PR interval of >300 ms (*Figure 2*). He was discharged on aspirin and clopidogrel 2 days later. At 4-month follow-up, the patient reported no chest pain or shortness of breath and noted significant improvement in his exercise capacity. His peak and mean gradients across the valve were 19 and 12 mmHg, respectively, with effective orifice area of 1.78 cm^2. There was an improvement in his LV dysfunction from moderate to mild LV dysfunction with an estimated ejection fraction of 50%. His LVIDD was 4.4 cm with septum and posterior wall thickness of 1.4 and 1.36 cm, respectively.

Discussion

This case demonstrates that RA in patients with severely calcified LMS and concomitant severe AS and LV impairment maybe safe. Transcatheter aortic valve implantation could potentially act as a mechanical support device to facilitate high-risk coronary intervention. This is important since the prevalence of degenerative severe AS and CAD increases with age and both conditions coexist in 50% of patients aged ≥ 70 years old and in 65% in those aged ≥ 80 years old.[4] Previous studies have shown that 40–75% of patients undergoing TAVI also have significant CAD (defined as from >50% to 70% narrowing in an epicardial artery). Coronary artery disease and severe AS often share a similar pathophysiology and risk factors.[5] Severe AS is associated with abnormally diminished coronary flow reserve (CFR) that may be secondary to LV hypertrophy and higher resting flow. This phenomenon can contribute to the development of symptoms, LV systolic and diastolic dysfunction, and adverse outcomes. Adverse outcomes can be further exaggerated in the presence of CAC during angioplasty. There is lack of robust data and large randomized trials to guide optimal management and the impact of significant CAD in TAVI population.[6]

The TAVI-LM registry has shown that TAVI plus LMS PCI can be performed safely in patients with high surgical risk.[7] Abdel-Wahab *et al.*[8] demonstrated that PCI before TAVI using CoreValve (Medtronic, Minneapolis, MN, USA) was not associated with increased adverse events and was safe at 30 days and 6 months compared with TAVI alone. Several anatomical and procedural factors need to be considered when performing PCI in patients undergoing TAVI. Overhanging stents following revascularization of ostial coronary lesions can be crushed with expanded transcatheter heart valves. This needs to be considered when performing PCI prior to TAVI. The use of balloon valvuloplasty (BAV) prior to PCI may be associated with reduction in procedural risk. The risk of converting severe AS to aortic regurgitation has limited the use of this strategy. On the other hand, performing PCI after TAVI may add technical challenges, particularly when trying to engage guiding catheters.[9]

The presence of severe coronary calcification combined with impaired LV function has added further procedural risks. Both factors can synergistically increase the risk of no reflow and a require tailored approach to patients undergoing PCI and TAVI. It is well established that severe CAC is associated with worse procedural and long-term outcomes. This includes difficult stent delivery, stent under expansion, stent thrombosis, vessel dissection, coronary perforations, myocardial infarction, repeat vascularization, and even increased risk of death.[10] Therefore, RA was used in our case to adequately prepare the LMS lesion by debulking CAC and allowing for optimal stent expansion. Alternative calcium modifications strategies such as the use of intravascular lithotripsy (IVL) would have also been an option. The discrepancy in the size of the targeted arteries would have prompted the use of two shockwave balloons to manage the coronary lesions. Whilst IVL is less likely to cause no reflow compared with RA, the stable blood pressure post-TAVI and meticulous attention to the burr speed and duration enabled us to complete the PCI procedure without complications.

The ACTIVATION (PercutAneous Coronary inTervention prIor to transcatheter aortic VAlve implantaTION) trial concluded that death rates and re-hospitalization events were comparable among patients who underwent combined PCI and TAVI vs. TAVI-alone.[11] Nonetheless, the presence of unprotected LMS disease was an exclusion criterion from this study, and therefore its results cannot be applied to our case.

Although performing PCI prior to TAVI is a relatively common strategy to obviate the challenges associated with coronary access

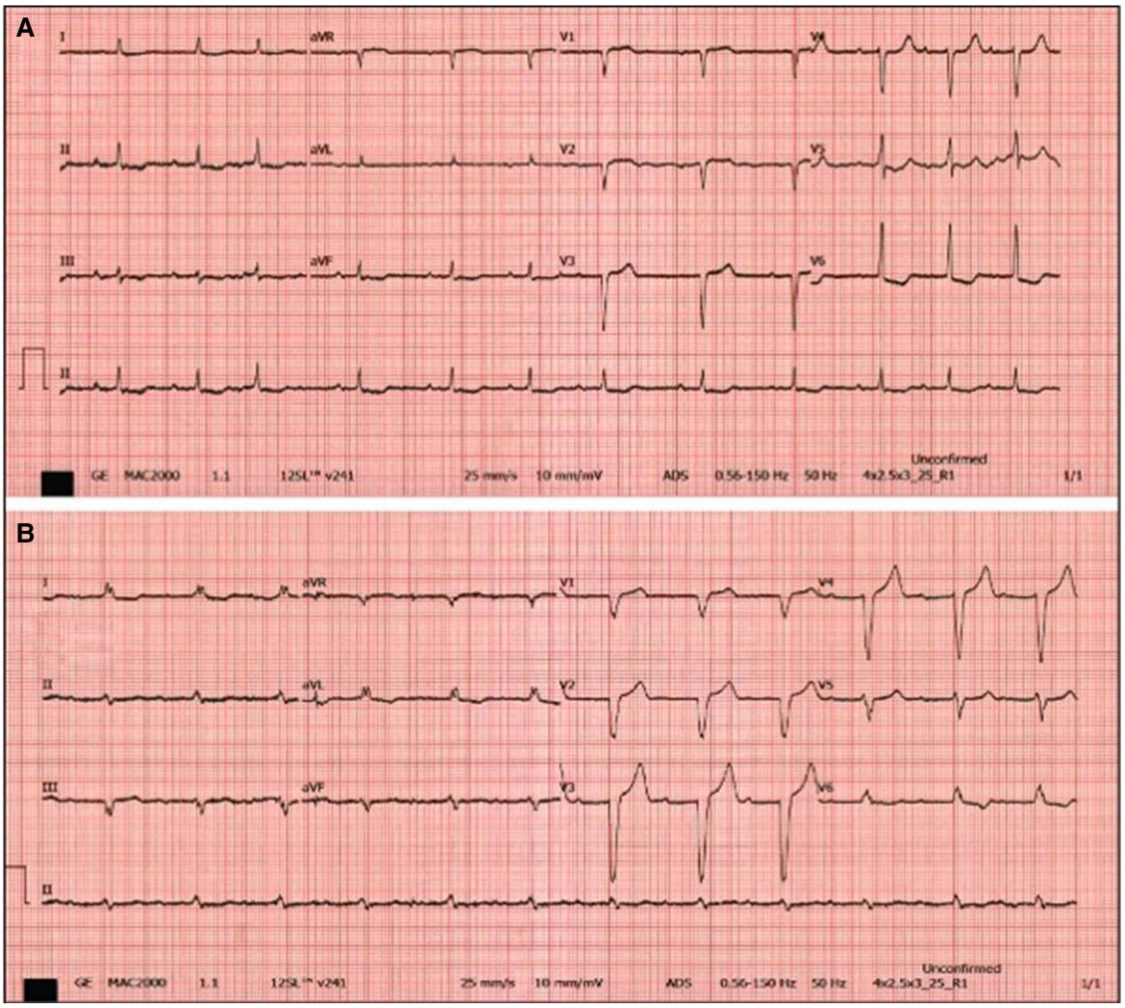

Figure 2 (*A*) Twelve-lead electrocardiograph on admission to our centre and prior to transcatheter aortic valve implantation and percutaneous coronary intervention to left main stem and left anterior descending. (B) Twelve-lead electrocardiograph post-transcatheter aortic valve implantation showing left bundle branch block.

post-TAVI, the combination of PCI and TAVI in a single setting is safe and cost-effective.[12] The use of same vascular access, reducing ischaemic burden during TAVI, possible decrease in the risk of contrast nephropathy, and reduction in radiation exposure to both patient and operators provide an advantage over performing PCI and TAVI in two different settings.[5]

The other challenge in this case was the presence of LV systolic impairment. High-risk angioplasty in this setting carries additional risk of intra-procedural haemodynamic instability.[13,14] The presence of untreated severe AS would inevitably exacerbate the risk. Therefore, we elected to perform TAVI to improve the haemodynamic status of the patient. Accessing the coronary ostia following TAVI may be challenging, particularly with a self-expanding valve. This may less be of an issue when using balloon expandable valve, particularly given the large top cell size that would allow easy access for future coronary intervention. By treating AS first, we obviate the need to use mechanical circulatory support (MCS) device. Overcoming pressure overload using TAVI prior to high-risk PCI would simplify the procedure and allow early discharge for patients.

In conclusion, high-risk LMS PCI using RA may be safe in patients undergoing TAVI with concomitant LV impairment. The decision to perform TAVI first would potentially avoid the need to use MCS in these settings.

Lead author biography

Dr Mohammad Alkhalil is Consultant Cardiologist and Structural Heart Interventionist at the Freeman Hospital. He graduated from Damascus University and completed his interventional cardiology training at the Royal Victoria Hospital in Belfast, UK and Toronto General Hospital in Canada. He obtained MSc in Cardiology at Trinity College Dublin, Ireland and DPhil degree in Cardiovascular Medicine at University of Oxford, UK. His research interests include atherosclerosis, myocardial infarction, transcatheter aortic valve implantation (TAVI), and cardiac magnetic resonance imaging.

Supplementary material

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

Slide set: A fully edited slide set detailing this case is available online as Supplementary data.

Consent: In accordance with COPE guidelines, patient-informed consent was obtained.

Conflict of interest: None declared.

Funding: None declared.

Data availability

The authors confirm that the data supporting the findings of this case report are available within the manuscript and its supplementary materials. Further details can be requested by contacting the corresponding author (M.A.).

References

1. Reardon MJ, Van Mieghem NM, Popma JJ, Kleiman NS, Søndergaard L, Mumtaz M, *et al.* Surgical or transcatheter aortic-valve replacement in intermediate-risk patients. *N Engl J Med* 2017;**376**:1321–1331.
2. Paradis JM, Fried J, Nazif T, Kirtane A, Harjai K, Khalique O, *et al.* Aortic stenosis and coronary artery disease: what do we know? What don't we know? A comprehensive review of the literature with proposed treatment algorithms. *Eur Heart J* 2014;**35**:2069–2082.
3. Alkhalil M, Jabri A, Puri R, Kalra A. Revascularization in the transcatheter aortic valve replacement population. *Interv Cardiol Clin* 2021;**10**:553–563.
4. Iung B. Interface between valve disease and ischaemic heart disease. *Heart* 2000;**84**:347–352.
5. Katta N, Abbott JD, Kalra A, Alenezi F, Goldsweig A, Aronow H, *et al.* Management of coronary artery disease in the setting of transcatheter aortic valve replacement. *Heart Int* 2020;**14**:24–28.
6. Madhavan MV, Tarigopula M, Mintz GS, Maehara A, Stone GW, Généreux P. Coronary artery calcification. *J Am Coll Cardiol* 2014;**63**:1703–1714.
7. Chakravarty T, Sharma R, Abramowitz Y, Kapadia S, Latib A, Jilaihawi H, *et al.* Outcomes in patients with transcatheter aortic valve replacement and left main stenting: the TAVR-LM registry. *J Am Coll Cardiol* 2016;**67**:951–960.
8. Abdel-Wahab M, Mostafa AE, Geist V, Stöcker B, Gordian K, Merten C, *et al.* Comparison of outcomes in patients having isolated transcatheter aortic valve implantation versus combined with preprocedural percutaneous coronary intervention. *Am J Cardiol* 2012;**109**:581–586.
9. Ramee S, Anwaruddin S, Kumar G, Piana RN, Babaliaros V, Rab T, *et al.* The rationale for performance of coronary angiography and stenting before transcatheter aortic valve replacement: from the interventional section leadership council of the American College of Cardiology. *JACC Cardiovasc Interv* 2016;**9**:2371–2375.
10. Lee MS, Gordin JS, Stone GW, Sharma SK, Saito S, Mahmud E, *et al.* Orbital and rotational atherectomy during percutaneous coronary intervention for coronary artery calcification. *Catheter Cardiovasc Interv* 2018;**92**:61–67.
11. Patterson T, Clayton T, Dodd M, Khawaja Z, Morice MC, Wilson K, *et al.* ACTIVATION (Percutaneous Coronary inTervention prIor to transcatheter aortic VAlve implantaTION): a randomized clinical trial. *JACC Cardiovasc Interv* 2021;**14**:1965–1974.
12. Yang Y, Huang FY, Huang BT, Xiong TY, Pu XB, Chen SJ, *et al.* The safety of concomitant transcatheter aortic valve replacement and percutaneous coronary intervention: a systematic review and meta-analysis. *Medicine (Baltimore)* 2017;**96**:e8919.
13. Al-Atta A, Zaidan M, Abdalwahab A, Asswad AG, Egred M, Zaman A, *et al.* Mechanical circulatory support in acute myocardial infarction complicated by cardiogenic shock. *Rev Cardiovasc Med* 2022;**23**:71.
14. Abdalwahab A, Al-Atta A, Egred M, Alkhalil M, Zaman A. Coronary revascularization in patients with left ventricle systolic dysfunction, current challenges and clinical outcomes. *Rev Cardiovasc Med* 2022;**23**:33.