ESC European Society of Cardiology

European Heart Journal - Case Reports (2022) **6**(2), 1–3
https://doi.org/10.1093/ehjcr/ytac037

EDITORIAL

Mechanical circulatory support for percutaneous coronary intervention in high-risk patients undergoing transcatheter aortic valve replacement

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Received 10 November 2021; first decision 7 December 2021; accepted 20 January 2022; online publish-ahead-of-print 28 January 2022

This editorial refers to 'Mechanical circulatory-support and intravascular lithotripsy in high-risk patients undergoing percutaneous coronary intervention and transcatheter aortic valve replacement: a case series' by A. Marchese *et al.* https://doi.org/10.1093/ehjcr/ytab498

There has been a global expansion in the use of transcatheter aortic valve replacement (TAVR) to treat severe aortic stenosis, especially in intermediate- and low-risk patients. This has resulted in a need to improve patient safety and efficacy outcomes, including how to manage those with concomitant significant coronary artery disease (CAD). Recently, the ACTIVATION trial comparing percutaneous coronary intervention (PCI) to no PCI prior to TAVR (with the postulation that improved coronary perfusion may protect against some of the ischaemic procedural complications of TAVR) demonstrated no difference in death or rehospitalization at 1 year, and increased risk of bleeding in the PCI cohort.[1] However, the trial was terminated prematurely and patients with unprotected left main disease, acute coronary syndromes, or significant angina were excluded. The Italian CoreValve registry observed that in patients with critical ostial CAD, those who were not revascularized prior to TAVR had higher rates of myocardial infarction at 12 months.[2] Afterwards, several other studies demonstrated that PCI before TAVR is associated with better clinical outcomes compared to no PCI.[3,4]

Patients undergoing TAVR frequently exhibit complex coronary lesions and multivessel disease. Marchese *et al.*[5] report a case series of two patients with severe aortic stenosis, critical calcified ostial multivessel CAD, and poor left ventricular systolic function, successfully treated with upfront PCI facilitated by mechanical circulatory support (MCS), followed by TAVR. This report illustrates the challenges of managing complex CAD in patients with severe aortic stenosis and severe pump dysfunction. Both patients were deemed ineligible for surgical intervention due to prohibitive comorbidities. The heart team decided a staged procedure for the first patient and a combined procedure for the second patient, as the first patient needed dobutamine stress echocardiography after PCI to secure the diagnosis of true low-flow low-gradient severe aortic stenosis. Of note, the European guidelines for the management of valvular heart diseases state that PCI and TAVR may be undertaken as combined or staged procedures according to individualized heart team discussion based on the patient's clinical presentation, pattern of CAD, and extent of myocardium at risk.[6] The current state of techniques and/or abilities to perform peri-TAVR PCI is somehow challenging, especially after valve implant, due to issues with coronary access. However, the optimal timing for PCI remains unclear due to the lack of evidence.

The choice of calcium modifying intravascular lithotripsy (IVL) in this report is interesting. Of note, atherectomy, including rotational, orbital, or laser, may precipitate arterial and myocardial injury by generation of heat and microembolization of atherosclerotic material, with the potential clinical manifestation of slow- or no-reflow phenomenon. Cutting or scoring balloons may avoid these complications; however, they failed to show additional clinical benefits with an increased procedural risk compared to standard balloons.[7] Intravascular lithotripsy has a high yield in calcified vessels and avoids these complications,[8] which may be less tolerated in patients with severe aortic stenosis and severe left ventricular systolic dysfunction. One of the IVL drawbacks is that myocardial ischaemia might result

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Handling Editor: Amardeep Ghosh Dastidar

Table 1 Characteristics and limitations of commonly utilized mechanical circulatory support devices

	IABP	Impella devices (Impella 2.5, Impella CP, and Impella 5.0)	VA-ECMO	TandemHeart
Cardiac output support	0.3–0.5 L/min	2.5–5 L/min	Up to 6 L/min	2.5–5 L/min
Bedside insertion	Yes	No	Yes (peripheral)	No
Access sheath size	7 Fr	Impella 2.5 12 Fr Impella CP 14 Fr Impella 5.0 21 Fr	Up to 21 Fr	Up to 21 Fr
Need for cardiac synchrony	Yes	No	No	No
Transseptal puncture	No	No	No	Yes
Maximum implant duration	Weeks	Days	Weeks	Weeks
LVED pressure	↓	↓↓	↔	↓↓
Cardiac afterload	↓	↓	↑↑	↑
Right ventricular support	No	Impella RP System can be used	Yes	Yes
Major limitations	• Lower haemodynamic support compared to other devices • Unreliable in arrhythmia or tachycardia	• Relatively short duration of support • Higher risk of lower extremity ischaemia compared to other devices	• Increases afterload • Higher risk of lower extremity ischaemia compared to other devices	• Limited availability • Requires transseptal puncture

IABP, intra-aortic balloon pump; LVED, left ventricular end diastolic; VA-ECMO, veno-arterial extracorporeal membrane oxygenation.

from prolonged vessel occlusion during energy delivery. In the first case, the operators overcame this risk by applying shorter balloon inflations (5 pulses each instead of the usual 10 pulses).

The risk of haemodynamic compromise in patients with severe aortic stenosis and depressed left ventricular systolic function undergoing complex or unprotected left main PCI is extremely high. MCS devices may help to mitigate this risk but will also increase the procedural complications and hospitalization costs. There are generally four devices used in clinical practice: intra-aortic balloon pump (IABP), Impella device (Abiomed, Danvers, MA, USA), extracorporeal membrane oxygenation (ECMO), and TandemHeart (*Table 1*). In the two cases reported, veno-arterial ECMO (VA-ECMO) was chosen to support PCI. Additionally, IABP was used as an adjunctive device in Case 2. The use of Impella was discarded. Of note, the utility of these devices in patients with severe aortic stenosis and severe left ventricular dysfunction undergoing complex PCI and/or TAVR has been demonstrated.[9,10] However, no comparative data on their efficacy or safety have been established. Intra-aortic balloon pump provides only minimal cardiac output support (up to 0.5 L/min) and requires a stable or synchronous cardiac rhythm. Veno-arterial ECMO provides heart and lung support but often requires adjunctive devices to unload the left ventricular. The Impella device provides higher cardiac output support (2.5–5 L/min) compared to IABP and its insertion across stenotic aortic valves is feasible but may occasionally require upfront predilatation. The use of TandemHeart has been limited in clinical practice due to the complexity of its implantation compared to other devices.

More trials are warranted to better define the most efficient and safe PCI and MCS techniques for high-risk patients undergoing TAVR. Until more data are available, the revascularization strategies of these patients need to be individualized, taking into consideration the patients and procedural characteristics as well as the centres/operators expertise. A pragmatic approach is to treat only critical unprotected left main or proximal left anterior descending lesions. Some centres (including Freeman and Imperial, UK) have now stopped performing routine invasive coronary angiography prior to TAVR, and treat the coronaries alone if these prognostic lesions are complex, or proceed to PCI then TAVR if the lesions are straightforward.

Lead author biography

Dr Mohamed Farag is an interventional and structural cardiologist with a strong academic interest at the Newcastle Freeman hospital in UK.

Conflict of interest: None declared.

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