POLISH HEART JOURNAL
Kardiologia Polska
The Official Peer-reviewed Journal of the Polish Cardiac Society since 1957
Online first
This is a provisional PDF only. Copyedited and fully formatted version will be made available soon
ISSN 0022–9032
e-ISSN 1897–4279

When to perform percutaneous coronary interventions in TAVI patients? Recent advances

Authors: Mattia Lunardi, Francesco Bianchini, Cristina Aurigemma, Enrico Romagnoli, Lazzaro Paraggio, Emiliano Bianchini, Andrea Zito, Carlo Trani, Francesco Burzotta

Article type: Review
Received: July 11, 2024
Accepted: July 30, 2024
Early publication date: July 31, 2024

When to perform percutaneous coronary interventions in TAVI patients? Recent advances

Mattia Lunardi[1], Francesco Bianchini[1], Cristina Aurigemma[1], Enrico Romagnoli[1], Lazzaro Paraggio[1], Emiliano Bianchini[2], Andrea Zito[2], Carlo Trani[1, 2], Francesco Burzotta[1, 2]

[1]Department of Cardiovascular Sciences, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy
[2]Department of Cardiovascular and Pulmonary Sciences, Università Cattolica del Sacro Cuore, Rome, Italy

Correspondence to:
Francesco Burzotta MD, PhD,
Department of Cardiovascular Sciences,
Fondazione Policlinico Universitario A. Gemelli IRCCS,
Università Cattolica del Sacro Cuore,
Largo A. Gemelli 1, 00168 Rome, Italy,
phone: +39 063 015 59 50,
e-mail: francesco.burzotta@unicatt.it

ABSTRACT

Coronary artery disease (CAD) is prevalent in approximately 50% of patients with severe aortic valve stenosis undergoing transcatheter aortic valve implantation (TAVI). The impact of CAD on TAVI outcomes and optimal management strategies remains unclear.

This manuscript reviews the latest evidence on assessing and determining the timing for treating CAD in TAVI patients to optimize clinical outcomes and resource utilization.

We discuss the current methods for CAD diagnosis, including invasive coronary angiography (ICA), coronary computed tomography angiography, and the role of functional assessment indices like fractional flow reserve and instantaneous wave-free ratio in guiding revascularization decisions. While ICA remains the standard for determining CAD severity in TAVI candidates, coronary computed tomography angiography has shown potential in reducing unnecessary ICA procedures. When indicated, fractional flow reserve seems more reliable than instantaneous wave-free ratio in aortic valve stenosis patients, particularly when

evaluated post-TAVI. Recent data suggest that percutaneous coronary intervention post-TAVI may be associated with improved outcomes compared to pre-TAVI interventions.
Concluding, the optimal management of CAD in TAVI patients is still under investigation. Current evidence supports a tailored approach, considering both pre- and post-TAVI percutaneous coronary intervention strategies based on individual patient characteristics and procedural complexities. Further randomized trials are needed to establish definitive guidelines.

Key words: aortic valve stenosis, coronary artery disease, coronary revascularization, fractional flow reserve, instantaneous wave-free ratio, transcatheter aortic valve implantation

INTRODUCTION

The prevalence of coronary artery disease (CAD) in patients with severe aortic valve stenosis (AVS) undergoing transcatheter aortic valve implantation (TAVI) is approximately 50% [1–4], with variations ranging from 15% to 80% in major clinical trials based on patients' age and risk profile [5–9]. Notably, CAD prevalence is lower in low-risk patients compared to those at intermediate and high risk. Among TAVI recipients with CAD, about half have multivessel disease, and there is often involvement of the left main (LM)/left anterior descending artery (LAD) [10, 11].

Early observational studies conducted shortly after the introduction of TAVI produced mixed results regarding the impact of coexisting CAD on patient outcomes. Some studies found no significant difference in survival between patients with and without significant coronary lesions [12, 13], or between those who underwent complete versus incomplete revascularization, while other studies reported the opposite findings [14]. Additionally, higher rates of procedural complications have been observed when percutaneous coronary intervention (PCI) is performed concurrently with TAVI, potentially leading to adverse outcomes in this vulnerable patient population [15]. However, it is important to note that most studies had a limited follow-up period of less than 2 years, and a longer duration may be necessary to accurately assess the impact of CAD on clinical outcomes post-TAVI.

Moreover, there is no consensus on how to evaluate the clinical relevance of identified stenoses in AVS patients with CAD, nor on the timing of eventual revascularization in this setting, with many operators relying solely on angiographic severity to guide PCI decisions.

Currently, these specific issues have not been definitively addressed by the scientific community, and the management of CAD is often left to the experience of individual operators or centres. This manuscript aims to review the latest evidence on the assessment and the potential timing strategies for the treatment of CAD in patients undergoing TAVI, with the goal to optimize patients' outcomes and healthcare resource utilization (Figure 1).

CAD SEVERITY ASSESSMENT IN PATIENTS WITH SEVERE AORTIC STENOSIS: INDICATION FOR PCI

Given the fragility of the population being examined, the primary goal is to achieve diagnosis while conserving resources, time, and minimizing the risk of complications. This approach will enhance patient comfort and optimize the use of medical resources. There are several potential methods to investigate the presence and significance of CAD: invasive coronary angiography (ICA), coronary computed tomography angiography (CCTA), or non-invasive ischemia tests. However, TAVI candidates are often not ideal for non-invasive ischemia tests due to their fragility, which prevents them from performing physical stress tests, and the frequent presence of left ventricular (LV) hypertrophy, which can confound results.

Given that TAVI patients necessarily require an ECG-gated computed tomography (CT) prior to TAVI, some authors have suggested using this imaging technique to select patients for ICA based on CT results. A dedicated study showed that this hybrid strategy is feasible and potentially clinically relevant, with CA performed in only a quarter of patients due to the detection of obstructive stenosis on CT, without affecting clinical outcomes when ICA was deferred [16]. As expected from experiences with non-AVS patients, compared to ICA, CCTA has excellent negative predictive value and sensitivity, but low specificity, which decreases further in the presence of previous stented segments or heavy calcifications [17]. Despite these limitations, a recent large meta-analysis also demonstrated that using CT as a gatekeeper for ICA in the TAVI work-up could reduce the number of coronary angiographies by 37%. With an increasing number of low-risk TAVI patients, this reduction is likely to grow, given the lower probability of CAD and calcified lesions in younger patients [18].

However, to date, ICA remains the standard examination for determining the presence and severity of CAD in TAVI candidates. The current European Society of Cardiology guidelines [19] state that myocardial revascularization using PCI should be considered in patients with a primary indication to undergo TAVI and presenting, based on angiography alone, with coronary artery diameter stenosis >70% in proximal segments, although this recommendation has a low level of evidence (C). In contrast, no recommendations are provided for non-proximal or less severe stenosis. Notably, American Guidelines indicate that investigation of intermediate CAD through invasive physiological assessment is safe even in the presence of AVS [20].

Although an angiographic stenosis >70% seems a reliable threshold for detecting critical stenosis in patients with aortic stenosis [21, 22], coronary physiology studies suggest that 20% of these cases have a normal fractional flow reserve (FFR), a percentage that increases dramatically (up to 65%) with 50%–70% stenosis [23]. While this is well-documented for non-AVS patients, similar conclusions cannot be drawn for AVS patients, where morphological and hemodynamic changes induced by the valve disease may affect functional indexes [24].

Theoretically, LV hypertrophy with interstitial fibrosis, commonly found in AVS, increases LV end-diastolic pressure and induces microvascular dysfunction, both potentially leading to blunted vasodilatory capacity and increased “back pressure” (Pd), resulting in altered FFR values. Although instantaneous wave-free ratio (iFR) does not require pharmacological vasodilation, it may also be affected by LV end-diastolic pressure. High left ventricular filling pressures impact coronary resting flow by increasing myocardial metabolic demand. It has been reported that increasing resting flow reduces the pressure drop along the target vessel, resulting in falsely higher iFR values [25].

Additionally, LV obstruction reduces systemic pressure and consequently the pressure upstream of the stenosis, causing a concomitant decrease in Pa. Based on this hypothesis, when using FFR or iFR, we might expect an increased Pd due to impaired vasodilatory response to adenosine or higher resting flow, which combined with lower Pa, could result in falsely higher values.

However, comparing FFR and iFR with myocardial perfusion imaging (stress single photon emission computed tomography [SPECT]) in AVS patients, it has been shown that these functional indexes perform relatively well. FFR, in particular, had the best agreement with SPECT (85%), with an area under the curve 0.91 and negative predictive value 95% for detecting ischemia. On the other hand, iFR produced a significant proportion of false positives (39% of negative SPECT) using the standard cut-off ≤0.89, while using a pre-specified 0.82 cut-off improved iFR agreement with SPECT to 73% [26].

This finding was further confirmed in another study, which showed that the conventional iFR cut-off had lower diagnostic agreement with FFR classification of coronary lesions in the presence of AVS, compared to non-AVS patients. According to the data, the best iFR cut-off for predicting FFR ≤0.8 was lower (0.83) than the standard one (0.89) [27, 28].

Further studies have investigated the variability of FFR and iFR after TAVI, once LV obstruction was removed, reflecting a more physiologic condition. Regarding FFR, only minor variations were observed after TAVI compared to baseline. Notably, the direction of these variations (improvement or worsening) depended on pre-TAVI FFR results: positive FFR values tended to worsen post-TAVI, while negative FFR values tended to improve post-TAVI [24]. TAVI, by inducing an immediate decrease in hyperaemic microvascular resistance and an increase in hyperaemic flow velocity, is associated with an immediate improvement in coronary microcirculation's vasodilator capacity. This pathophysiologic assumption may be one factor underlying FFR variations post-TAVI, although dedicated studies are needed [29].

Similar patterns were not observed for iFR, which showed wide individual variations after TAVI, with higher delta (iFR after TAVI — iFR before TAVI) associated with a greater drop in transaortic gradient after valve intervention [22].

Considering that TAVI patients will live without AVS, it is intuitive that the functional significance of intermediate coronary lesions should be evaluated in the absence of this condition, hence after valve implantation. Available literature supports FFR as a more reliable parameter than iFR, and even suggests measuring it post-TAVI for a more accurate assessment of the need for myocardial revascularization, especially for borderline FFR values that may decrease after AVS removal [24].

Moreover, the recent advent of image-based functional assessment techniques (e.g., quantitative flow ratio) is timely, considering TAVI candidates represent an ideal population for their application. The ability to examine the functional significance of coronary stenosis without wiring the vessel is appealing, particularly when post-TAVI measurement is desirable. Mejía-Rentería et al. [30] analyzed the diagnostic performance of quantitative flow ratio in AVS patients against FFR, reporting per-vessel sensitivity, specificity, area under the ROC curve, and accuracy of 84% (95% CI, 71%–92%), 80% (95% CI, 69%–88%), 0.88 (95% CI, 0.82–0.93), and 81%, respectively [30, 31].

Beyond these peculiarities, clinical outcomes after physio-guided revascularization of intermediate stenosis in TAVI patients support the validity of this strategy. An observational study including 216 patients compared FFR-guidance to angio-guidance for myocardial revascularizations in the TAVI context: patients evaluated with FFR had significantly better outcomes at 2 years compared to those guided by angiography alone (major adverse cardiac and cerebrovascular events free-survival 92.6% vs. 82.0%; $P = 0.035$), mainly due to a higher rate of periprocedural myocardial infarction in the angio-group. Most lesions assessed by FFR were negative (72%), and these patients, treated medically, performed better than those treated by angio-guided PCI [32]. In line with this, investigating the residual functional SYNTAX score (rFSS) after TAVI revealed that functional incomplete revascularization (rFSS >0) was associated with worse event-free survival at follow-up [33].

Despite the observational nature of these studies, the data reassure about the safety of PCI deferral based on negative FFR, while cautioning against the risks of angio-driven PCI. The upcoming results of randomized clinical trials (FAITAVI — NCT03360591, NOTION-3 — NCT03058627, TAVI-PET — NCT04882488) focused on this specific topic will further elucidate the role of invasive functional assessment in determining when to perform PCI in TAVI patients (Table 1).

PCI TIMING IN PATIENTS UNDERGOING TAVI

Once the indication for PCI is established, it is common practice to perform it upstream of TAVI, still in the presence of severe AVS, through a staged procedure or during TAVI before valve deployment, with initial studies supporting such a strategy [15, 19, 34–37]. This is also the recommendation provided in the present American Guidelines [20], while European guidelines do not specify timing for coronary revascularization, suggesting it should be based on clinical presentation and coronary anatomy complexity [19]. These studies have generally been interpreted as proof of the feasibility of a PCI pre-TAVI approach, rather than offering a comparison between different timings for PCI (pre- and post-TAVI).

However, operators choosing this strategy must contend with several drawbacks: an increased risk of acute kidney injury, dual antiplatelet therapy before TAVI which might increase bleeding and vascular complications during TAVI [38], and systemic hypoperfusion derived from aortic valve obstruction which might complicate some complex PCI procedures. On the other hand, performing PCI before TAVI is desirable in the presence of ongoing ischemia (i.e., acute coronary syndromes), it allows easier coronary access, and it might be preferred in case of ostial/proximal lesions to prevent large myocardial ischemia during LV pacing (Table 2).

An appealing alternative consists in alleviating LV overload by performing a balloon aortic valvuloplasty followed by PCI during the same procedure [39, 40]. This approach, when tolerated, reduces systemic hypoperfusion and potential secondary ischemic PCI complications, serving as a bridge to TAVI in patients with temporary TAVI contraindications.

Conversely, few studies have investigated the potential advantages of performing PCI after TAVI in the absence of AVS, hampered by the risk of ischemic and hemodynamic complications potentially inducible during the TAVI procedure due to the presence of a large ischemic territory [41–44].

Ochiai et al. [45], using balloon-expandable valves only, reported similar clinical outcomes between pre-TAVI (n = 143), concomitant (n = 77), or post-TAVI (n = 38) PCI groups at 2 years. However, the use of balloon-expandable valves only limits the generalization of such results to the real-world population, where self-expandable valves notably hinder coronary access.

Another study examined the feasibility, periprocedural complications, and 2-year outcomes of PCI pre- vs. post-TAVI in 144 patients, 73% (n = 105) of whom underwent PCI of LM, proximal LAD, or proximal dominant right coronary artery (RCA). Both self- and balloon-expandable valves were included [44]. While procedural success was achieved in all cases and overall periprocedural complications were similar, a higher incidence of in-hospital stroke was reported among the PCI pre-TAVI group. Additionally, at 2 years, the major adverse cardiac and cerebrovascular events free-survival was lower in patients who underwent PCI before TAVI.

These results have recently been corroborated by the REVASC-TAVI registry, a large multicentre international study. Based on data from 1603 patients, the study concluded that performing PCI after TAVI seems to be associated with improved 2-year clinical outcomes compared to other revascularization timing strategies, significantly reducing all-cause deaths, as well as the composite of all-cause death, stroke, MI, or unplanned rehospitalization for heart failure [46] (Table 3).

These findings offer interesting insights: firstly, PCI after TAVI appears safe and feasible, at least as a PCI-first approach. The similar rate of periprocedural complications suggests that even the presence of “high-risk” lesions (i.e., LM or proximal LAD stenosis), with a large ischemic burden, does not compromise the TAVI procedure when coronary lesions are treated after TAVI, regardless of the valve type.

Available data on the feasibility of coronary access after TAVI suggest greater difficulties with high frame, supra-annular prostheses compared to low frame, intra-annular valves [47, 48]. However, even considering only supra-annular high frame prostheses (e.g., Medtronic Evolut device), the inability to cannulate the coronaries ranges between 0 to 15%, with most studies reporting almost 100% success [43, 49–53].

While the type of prosthesis plays a key role in this setting, other risk factors for difficult coronary canulation include patients’ anatomical characteristics and procedural techniques.

Procedural factors are particularly relevant today, as there is increasing attention from prosthesis manufacturers and operators on developing enhanced devices to achieve commissural alignment and the ideal implant height during valve implantation. It has been demonstrated that orienting the Medtronic Evolut device with the flush port placed at 3 o'clock and keeping the Evolut hat marker at the outer curve of the thoracic aorta reduced the misalignment between device commissures and coronary ostia from 38 to 24% [54]. Similarly, the COMALIGN study showed that orienting the specific fluoroscopic markers of any prosthesis according to the cusp overlap angiographic view (left and right cusps) can achieve correct commissural alignment in up to 9 out of 10 patients [55].

The above-reported rates of successful coronary engagement after TAVI also referred to earlier TAVI periods when operators paid less attention to commissural alignment. Considering the current improved implantation techniques and devices, today we may expect a lower failure rate of coronary access after TAVI. These data can help operators either guide the decision to perform PCI before or after TAVI based on the prosthesis selected for a given patient, or choose a specific valve type (e.g., low frame, intra-annular) to facilitate post-TAVI PCI.

Additional advantages of a TAVI-first approach are worth mentioning, as they might be relevant in selected settings, such as complex PCI procedures, chronic kidney disease, high bleeding risk, and borderline stenosis severity (Table 2). The opportunity to remove LV obstruction and improve systemic perfusion before PCI is particularly relevant in the case of potential ischemic or mechanical complications related to complex PCI that could further impair cardiac output, even if only transiently, affecting organs with low ischemic thresholds such as kidneys and the brain that are already hypoperfused in patients with severe AVS. The immediate favourable hemodynamic effect of TAVI might explain the better kidney tolerance and the lower stroke rate observed [56].

At this regard, it has been demonstrated that TAVI has a protective effect on contrast induced-acute kidney injury incidence (odds ratio, 0.334; 95% CI, 0.193–0.579; *P* <0.001) [57], when compared to any other coronary procedures (either diagnostic angiograms or PCI).

This observation suggests the impact of contrast administration on kidney function in patients who had undergone TAVI may be better tolerated because of the hemodynamic changes following aortic valve replacement. This supports an eventual PCI post-TAVI strategy in patients at higher risk of contrast induced-acute kidney injury.

On the other side, explaining the lower incidence of strokes is less straightforward, considering such events might derive from either prolonged brain hypoperfusion in the context of a diffuse cerebral vascular disease, or thromboembolisms. The latter deserves particular attention, as there exist numerous cerebral protection devices [58], potentially helpful preventing that event. However considering the still limited — and not conclusive — evidence about their use during TAVI [19], the decision to use such devices should be taken on a case-by-case basis. In the setting of PCI and TAVI, the higher risk of strokes observed when PCI is performed firstly (hence while not intervening on the calcified aortic valve) suggests the former physiopathology the most likely. Hence, the eventual use of cerebral protection devices should be limited to cases considered at higher risk of strokes, on the sole basis of the aortic valve disease anatomy and the expected TAVI complexity, regardless to the subsequent PCI.

Considering CAD in AVS patients is often associated with a high burden of coronary calcification, complex procedures are sometimes needed, including debulking techniques (e.g., intravascular lithotripsy and rotational atherectomy [RA]), which could be better tolerated thanks to improve myocardial contractile reserve and global hemodynamics. When implemented before TAVI, RA required the use of balloon pumps and/or inotropic support in a considerable number of patients, testifying to the higher ischemic burden in the presence of AVS [59, 60]. Conversely, other observational data reported the feasibility and safety of RA after TAVI, either through a self-expandable or a balloon-expandable valve [61–63], without periprocedural major cardiovascular or cerebral adverse events.

Importantly, with regard to bleeding, performing TAVI after PCI, in most cases implies the use of dual anti-platelet therapy, or even triple antithrombotic therapy in case of patients requiring anticoagulation. Although TAVI can be deferred until tiple therapy is shifted to anticoagulant plus clopidogrel, this association has been demonstrated to increment the risk of bleeding and vascular complications (1.6-fold risk compared to anticoagulation alone) according to the recent POPULAR TAVI study [38]. This evidence strongly supports operators performing TAVI first in patients under anticoagulant medications (or at high bleeding risk), in order to secure vascular accesses healing before staring any additional antithrombotic agent.

Furthermore, the absence of AVS permits a more accurate diagnosis of the ischemic potential of a given angiographic intermediate stenosis by physiological assessment, as previously reported [22, 24, 64].

Lastly, one may suppose some conduction disturbances after TAVI might present a ischemic component (e.g., right coronary severe disease), prompting the need for revascularization before TAVI. Of note, the incidence of new-onset conduction disorders requiring permanent pacemaker implantation remains relatively high and represents a cause for concern [65, 66]. Currently, definitive evidence is lacking on the effect of functional assessment and/or PCI before or after TAVI and its association with post-TAVI conduction disturbances.

However, there are no available randomized clinical trials clearly defining the best timing approach for myocardial revascularization in AVS patients. An ongoing trial (Optimal Timing of Transcatheter Aortic Valve Implantation and Percutaneous Coronary Intervention — The TAVI PCI Trial, NCT04310046) comparing PCI pre- vs. post-TAVI (according to iFR ≤0.89 or angiographic stenosis >90%) will offer more solid evidence on this topic.

For the time being, the available literature suggests both approaches are feasible [67]. Regarding safety, they are mostly comparable, and as to clinical benefits, differences may be subtle and could emerge only after the analysis of a larger number of cases not yet available. Until definitive evidence becomes available, choosing a TAVI-first approach addresses the primary clinical problem, while concomitant stable CAD remains an occasional finding and, as such, the need for treatment is uncertain and can always be considered after a thorough clinical or instrumental evaluation.

CONCLUSIONS AND TAKE HOME MESSAGES (FIGURE)

The best management of CAD in TAVI candidates is still under investigation, and most of the available evidence is based on observational studies from high-volume centres (Tables 1 and 2). Therefore, definitive indications cannot yet be formulated. The following messages should be interpreted as reasonable advice arising from the above-discussed studies:

- **Streamline CAD Detection**: Operators should streamline CAD detection by utilizing CCTA to select patients with abnormal findings to undergo ICA.
- **Functional Evaluation for Intermediate Stenosis**: Once CAD is detected, functional evaluation is desirable in cases of intermediate stenosis (at least >50%) to guide revascularization and avoid worthless and potentially harmful interventions.
- **Timing of Functional Evaluation**: Functional evaluation should be carried out after valve deployment to avoid the hemodynamic influence generated by LV obstruction. Among functional indexes, FFR has shown the best correlation with myocardial nuclear imaging in detecting ischemia, providing more reliability when measured before and after TAVI.
- **Timing of PCI**: Ischemia-driven interventions are feasible and safe either pre- or post-TAVI. Potential advantages may arise from postponing the PCI until after valve replacement; however, as there is no one-size-fits-all approach, the best strategy should be tailored on a case-by-case basis.

Article information

Conflict of interest: ML received speaker fees from Medtronic. FBia received a research grant from Abbott Vascular. CA Aurigemma received speaker fees from Abbott Vascular, Abiomed, Medtronic, Terumo, and Daiichi Sankyo. ER received speaker fees from Abiomed, Abbott Vascular and Terumo. LP received speaker fees from Abiomed and Terumo. CT and FBur received speaker fees from Abbott Vascular, Abiomed, Medtronic, and Terumo. The other authors report no conflicts of interest to declare.

Funding: None.

REFERENCES

1. Goel SS, Ige M, Tuzcu EM, et al. Severe aortic stenosis and coronary artery disease-implications for management in the transcatheter aortic valve replacement era: A comprehensive review. J Am Coll Cardiol. 2013; 62(1): 1–10, doi: 10.1016/j.jacc.2013.01.096, indexed in Pubmed: 23644089.
2. Walther T, Hamm CW, Schuler G, et al. Perioperative results and complications in 15,964 transcatheter aortic valve replacements: Prospective data from the GARY registry. J Am Coll Cardiol. 2015; 65(20): 2173–2180, doi: 10.1016/j.jacc.2015.03.034, indexed in Pubmed: 25787198.
3. Bonow RO, Carabello BA, Chatterjee K, et al. 2008 Focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1998 Guidelines for the Management of Patients With Valvular Heart Disease): endorsed by the Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, and Society of Thoracic Surgeons. Circulation. 2008; 118(15): e523–e661, doi: 10.1161/CIRCULATIONAHA.108.190748, indexed in Pubmed: 18820172.

4. Danson E, Hansen P, Sen S, et al. Assessment, treatment, and prognostic implications of CAD in patients undergoing TAVI. Nat Rev Cardiol. 2016; 13(5): 276–285, doi: 10.1038/nrcardio.2016.9, indexed in Pubmed: 26864912.
5. Reardon MJ, van Mieghem NM, Popma JJ, et al. Surgical or transcatheter aortic-valve replacement in intermediate-risk patients. N Engl J Med. 2017; 376(14): 1321–1331, doi: 10.1056/nejmoa1700456, indexed in Pubmed: 28304219.
6. Leon MB, Smith CR, Mack MJ, et al. Transcatheter or surgical aortic-valve replacement in intermediate-risk patients. N Engl J Med. 2016; 374(17): 1609–1620, doi: 10.1056/nejmoa1514616, indexed in Pubmed: 27040324.
7. Mack MJ, Leon MB, Thourani VH, et al. Transcatheter aortic-valve replacement with a balloon-expandable valve in low-risk patients. N Engl J Med. 2019; 380(18): 1695–1705, doi: 10.1056/NEJMoa1814052, indexed in Pubmed: 30883058.
8. Popma JJ, Deeb GM, Yakubov SJ, et al. Transcatheter aortic-valve replacement with a self-expanding valve in low-risk patients. N Engl J Med. 2019; 380(18): 1706–1715, doi: 10.1056/NEJMoa1816885, indexed in Pubmed: 30883053.
9. Smith CR, Leon MB, Mack MJ, et al. Transcatheter versus surgical aortic-valve replacement in high-risk patients. N Engl J Med. 2011; 364(23): 2187–2198, doi: 10.1056/NEJMoa1103510, indexed in Pubmed: 21639811.
10. Kotronias RA, Teitelbaum M, Webb JG, et al. Transcatheter aortic valve implantation with or without percutaneous coronary artery revascularization strategy: a systematic review and meta-analysis. J Am Heart Assoc. 2017; 6(6): 1759–1771, doi: 10.1161/JAHA.117.005960, indexed in Pubmed: 28655733.
11. D'Ascenzo F, Verardi R, Visconti M, et al. Independent impact of extent of coronary artery disease and percutaneous revascularisation on 30-day and one-year mortality after TAVI: A meta-analysis of adjusted observational results. EuroIntervention. 2018; 14(11): e1169–e1177, doi: 10.4244/EIJ-D-18-00098, indexed in Pubmed: 30082258.
12. Gautier M, Pepin M, Himbert D, et al. Impact of coronary artery disease on indications for transcatheter aortic valve implantation and on procedural outcomes. EuroIntervention. 2011; 7(5): 549–555, doi: 10.4244/EIJV7I5A90, indexed in Pubmed: 21930458.
13. Snow TM, Ludman P, Banya W, et al. Management of concomitant coronary artery disease in patients undergoing transcatheter aortic valve implantation: the United Kingdom TAVI Registry. Int J Cardiol. 2015; 199: 253–260, doi: 10.1016/j.ijcard.2015.06.166, indexed in Pubmed: 26209948.

14. Sankaramangalam K, Banerjee K, Kandregula K, et al. Impact of coronary artery disease on 30-day and 1-year mortality in patients undergoing transcatheter aortic valve replacement: A meta-analysis. J Am Heart Assoc. 2017; 6(10), doi: 10.1161/JAHA.117.006092, indexed in Pubmed: 29021275.
15. Griese DP, Reents W, Tóth A, et al. Concomitant coronary intervention is associated with poorer early and late clinical outcomes in selected elderly patients receiving transcatheter aortic valve implantation. Eur J Cardiothorac Surg. 2014; 46(1): e1–e7, doi: 10.1093/ejcts/ezu187, indexed in Pubmed: 24819362.
16. Chieffo A, Giustino G, Spagnolo P, et al. Routine screening of coronary artery disease with computed tomographic coronary angiography in place of invasive coronary angiography in patients undergoing transcatheter aortic valve replacement. Circ Cardiovasc Interv. 2015; 8(7): e002025, doi: 10.1161/CIRCINTERVENTIONS.114.002025, indexed in Pubmed: 26160830.
17. Matsumoto S, Yamada Y, Hashimoto M, et al. CT imaging before transcatheter aortic valve implantation (TAVI) using variable helical pitch scanning and its diagnostic performance for coronary artery disease. Eur Radiol. 2017; 27(5): 1963–1970, doi: 10.1007/s00330-016-4547-4, indexed in Pubmed: 27562479.
18. van den Boogert TPW, Vendrik J, Claessen BE, et al. CTCA for detection of significant coronary artery disease in routine TAVI work-up : A systematic review and meta-analysis. Neth Heart J. 2018; 26(12): 591–599, doi: 10.1007/s12471-018-1149-6, indexed in Pubmed: 30178209.
19. Vahanian A, Beyersdorf F, Praz F, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J. 2022; 43(7): 561–632, doi: 10.1093/eurheartj/ehab395, indexed in Pubmed: 34453165.
20. Otto CM, Nishimura RA, Bonow RO, et al. 2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. J Am Coll Cardiol. 2021; 77(4): 450–500, doi: 10.1016/j.jacc.2020.11.035, indexed in Pubmed: 33342587.
21. Di Gioia G, Scarsini R, Strisciuglio T, et al. Correlation between angiographic and physiologic evaluation of coronary artery narrowings in patients with aortic valve stenosis. Am J Cardiol. 2017; 120(1): 106–110, doi: 10.1016/j.amjcard.2017.03.250, indexed in Pubmed: 28483203.

22. Scarsini R, Pesarini G, Zivelonghi C, et al. Physiologic evaluation of coronary lesions using instantaneous wave-free ratio (iFR) in patients with severe aortic stenosis undergoing transcatheter aortic valve implantation. EuroIntervention. 2018; 13(13): 1512–1519, doi: 10.4244/EIJ-D-17-00542, indexed in Pubmed: 28846545.
23. Pim AL, Tonino DCJK, Nico HJ. Invasive physiological assessment of coronary disease (FFR). Percutaneous interventional cardiovascular medicine – The PCR-EAPCI Textbook. 2023.
24. Pesarini G, Scarsini R, Zivelonghi C, et al. Functional assessment of coronary artery disease in patients undergoing transcatheter aortic valve implantation: Influence of pressure overload on the evaluation of lesions severity. Circ Cardiovasc Interv. 2016; 9(11): e004088, doi: 10.1161/CIRCINTERVENTIONS.116.004088, indexed in Pubmed: 27803040.
25. Arashi H, Yamaguchi J, Ri T, et al. The impact of tissue Doppler index E/e' ratio on instantaneous wave-free ratio. J Cardiol. 2018; 71(3): 237–243, doi: 10.1016/j.jjcc.2017.09.003, indexed in Pubmed: 29054592.
26. Scarsini R, Cantone R, Venturi G, et al. Correlation between intracoronary physiology and myocardial perfusion imaging in patients with severe aortic stenosis. Int J Cardiol. 2019; 292: 162–165, doi: 10.1016/j.ijcard.2019.04.050, indexed in Pubmed: 31029497.
27. Scarsini R, Pesarini G, Zivelonghi C, et al. Coronary physiology in patients with severe aortic stenosis: Comparison between fractional flow reserve and instantaneous wave-free ratio. Int J Cardiol. 2017; 243: 40–46, doi: 10.1016/j.ijcard.2017.05.117, indexed in Pubmed: 28610962.
28. Scarsini R, Pesarini G, Lunardi M, et al. Observations from a real-time, iFR-FFR "hybrid approach" in patients with severe aortic stenosis and coronary artery disease undergoing TAVI. Cardiovasc Revasc Med. 2018; 19(3 Pt B): 355–359, doi: 10.1016/j.carrev.2017.09.019, indexed in Pubmed: 29113864.
29. Wiegerinck EMA, van de Hoef TP, Rolandi MC, et al. Impact of aortic valve stenosis on coronary hemodynamics and the instantaneous effect of transcatheter aortic valve implantation. Circ Cardiovasc Interv. 2015; 8(8): e002443, doi: 10.1161/CIRCINTERVENTIONS.114.002443, indexed in Pubmed: 26245891.
30. Mejía-Rentería H, Nombela-Franco L, Paradis JM, et al. Angiography-based quantitative flow ratio versus fractional flow reserve in patients with coronary artery disease and severe aortic stenosis. EuroIntervention. 2020; 16(4): e285–e292, doi: 10.4244/EIJ-D-19-01001, indexed in Pubmed: 32207408.

31. Fezzi S, Ding D, Scarsini R, et al. Integrated assessment of computational coronary physiology from a single angiographic view in patients undergoing TAVI. Circ Cardiovasc Interv. 2023; 16(10): e013185, doi: 10.1161/CIRCINTERVENTIONS.123.013185, indexed in Pubmed: 37712285.
32. Lunardi M, Scarsini R, Venturi G, et al. Physiological versus angiographic guidance for myocardial revascularization in patients undergoing transcatheter aortic valve implantation. J Am Heart Assoc. 2019; 8(22): e012618, doi: 10.1161/JAHA.119.012618, indexed in Pubmed: 31718439.
33. Scarsini R, Venturi G, Pighi M, et al. Incomplete functional revascularization is associated with adverse clinical outcomes after transcatheter aortic valve implantation. Cardiovasc Revasc Med. 2022; 42: 47–52, doi: 10.1016/j.carrev.2022.02.024, indexed in Pubmed: 35272945.
34. Stortecky S, Buellesfeld L, Wenaweser P, et al. Impact of coronary artery disease and percutaneous coronary intervention on outcomes in patients with severe aortic stenosis undergoing transcatheter aortic valve implantation. EuroIntervention. 2011; 7(5): 541–548, doi: 10.4244/EIJV7I5A89, indexed in Pubmed: 21930453.
35. Conradi L, Seiffert M, Franzen O, et al. First experience with transcatheter aortic valve implantation and concomitant percutaneous coronary intervention. Clin Res Cardiol. 2011; 100(4): 311–316, doi: 10.1007/s00392-010-0243-6, indexed in Pubmed: 20959999.
36. van Rosendael PJ, van der Kley F, Kamperidis V, et al. Timing of staged percutaneous coronary intervention before transcatheter aortic valve implantation. Am J Cardiol. 2015; 115(12): 1726–1732, doi: 10.1016/j.amjcard.2015.03.019, indexed in Pubmed: 25890631.
37. Avvedimento M, Campelo-Parada F, Nombela-Franco L, et al. Procedural characteristics and late outcomes of percutaneous coronary intervention in the workup pre-TAVR. JACC Cardiovasc Interv. 2020; 13(22): 2601–2613, doi: 10.1016/j.jcin.2020.07.009, indexed in Pubmed: 33069647.
38. Nijenhuis VJ, Brouwer J, Delewi R, et al. Anticoagulation with or without clopidogrel after transcatheter aortic-valve implantation. N Engl J Med. 2020; 382(18): 1696–1707, doi: 10.1056/NEJMoa1915152, indexed in Pubmed: 32223116.
39. Ben-Dor I, Maluenda G, Looser PM, et al. Outcomes of concomitant percutaneous coronary intervention and balloon aortic valvuloplasty. Catheter Cardiovasc Interv. 2013; 82(7): E835–E841, doi: 10.1002/ccd.23193, indexed in Pubmed: 21735514.

40. Daniec M, Sorysz D, Dziewierz A, et al. In-hospital and long-term outcomes of percutaneous balloon aortic valvuloplasty with concomitant percutaneous coronary intervention in patients with severe aortic stenosis. J Interv Cardiol. 2018; 31(1): 60–67, doi: 10.1111/joic.12418, indexed in Pubmed: 28833508.
41. Pasic M, Dreysse S, Unbehaun A, et al. Combined elective percutaneous coronary intervention and transapical transcatheter aortic valve implantation. Interact Cardiovasc Thorac Surg. 2012; 14(4): 463–468, doi: 10.1093/icvts/ivr144, indexed in Pubmed: 22232234.
42. Blumenstein J, Kim WK, Liebetrau C, et al. Challenges of coronary angiography and intervention in patients previously treated by TAVI. Clin Res Cardiol. 2015; 104(8): 632–639, doi: 10.1007/s00392-015-0824-5, indexed in Pubmed: 25720330.
43. Allali A, El-Mawardy M, Schwarz B, et al. Incidence, feasibility and outcome of percutaneous coronary intervention after transcatheter aortic valve implantation with a self-expanding prosthesis. Results from a single center experience. Cardiovasc Revasc Med. 2016; 17(6): 391–398, doi: 10.1016/j.carrev.2016.05.010, indexed in Pubmed: 27396607.
44. Lunardi M, Venturi G, Del Sole PA, et al. Optimal timing for percutaneous coronary intervention in patients undergoing transcatheter aortic valve implantation. Int J Cardiol. 2022; 365: 114–122, doi: 10.1016/j.ijcard.2022.07.030, indexed in Pubmed: 35870638.
45. Ochiai T, Yoon SH, Flint N, et al. Timing and outcomes of percutaneous coronary intervention in patients who underwent transcatheter aortic valve implantation. Am J Cardiol. 2020; 125(9): 1361–1368, doi: 10.1016/j.amjcard.2020.01.043, indexed in Pubmed: 32106928.
46. Rheude T, Costa G, Ribichini FL, et al. Comparison of different percutaneous revascularisation timing strategies in patients undergoing transcatheter aortic valve implantation. EuroIntervention. 2023; 19(7): 589–599, doi: 10.4244/EIJ-D-23-00186, indexed in Pubmed: 37436190.
47. Barbanti M, Costa G, Picci A, et al. Coronary cannulation after transcatheter aortic valve replacement: the RE-ACCESS study. JACC Cardiovasc Interv. 2020; 13(21): 2542–2555, doi: 10.1016/j.jcin.2020.07.006, indexed in Pubmed: 33069648.
48. Yudi MB, Sharma SK, Tang GHL, et al. Coronary angiography and percutaneous coronary intervention after transcatheter aortic valve replacement. J Am

Coll Cardiol. 2018; 71(12): 1360–1378, doi: 10.1016/j.jacc.2018.01.057, indexed in Pubmed: 29566822.

49. Zivelonghi C, Pesarini G, Scarsini R, et al. Coronary catheterization and percutaneous interventions after transcatheter aortic valve implantation. Am J Cardiol. 2017; 120(4): 625–631, doi: 10.1016/j.amjcard.2016.10.046, indexed in Pubmed: 27964903.
50. Chetcuti S. Percutaneous coronary intervention after self-expanding transcatheter aortic valve replacement. J Am Coll Cardiol. 2016; 68(Suppl 18): B300–B301.
51. Htun WW, Grines C, Schreiber T. Feasibility of coronary angiography and percutaneous coronary intervention after transcatheter aortic valve replacement using a Medtronic™ self-expandable bioprosthetic valve. Catheter Cardiovasc Interv. 2018; 91(7): 1339–1344, doi: 10.1002/ccd.27346, indexed in Pubmed: 28988450.
52. Chakravarty T, Sharma R, Abramowitz Y, et al. Outcomes in patients with transcatheter aortic valve replacement and left main stenting: the TAVR-LM registry. J Am Coll Cardiol. 2016; 67(8): 951–960, doi: 10.1016/j.jacc.2015.10.103, indexed in Pubmed: 26916485.
53. Boukantar M, Gallet R, Mouillet G, et al. Coronary procedures after TAVI with the self-expanding aortic bioprosthesis Medtronic Corevalve™, not an easy matter. J Interv Cardiol. 2017; 30(1): 56–62, doi: 10.1111/joic.12363, indexed in Pubmed: 28078734.
54. Tagliari AP, Vicentini L, Zimmermann JM, et al. Transcatheter aortic valve neo-commissure alignment with the Portico system. EuroIntervention. 2021; 17(2): e152–e155, doi: 10.4244/EIJ-D-20-01095, indexed in Pubmed: 33342763.
55. Bieliauskas G, Wong I, Bajoras V, et al. Patient-specific implantation technique to obtain neo-commissural alignment with self-expanding transcatheter aortic valves. JACC Cardiovasc Interv. 2021; 14(19): 2097–2108, doi: 10.1016/j.jcin.2021.06.033, indexed in Pubmed: 34538602.
56. Venturi G, Pighi M, Lunardi M, et al. Contrast-induced nephropathy in patients undergoing staged versus concomitant transcatheter aortic valve implantation and coronary procedures. J Am Heart Assoc. 2021; 10(15): e020599, doi: 10.1161/JAHA.120.020599, indexed in Pubmed: 34310197.
57. Venturi G, Pighi M, Pesarini G, et al. Contrast-induced acute kidney injury in patients undergoing TAVI compared with coronary interventions. J Am Heart Assoc. 2020; 9(16): e017194, doi: 10.1161/JAHA.120.017194, indexed in Pubmed: 32787652.

58. Richter I, Abdel-Wahab M, Desch S, et al. Cerebral embolic protection in patients undergoing transcatheter aortic valve implantation: Recent advances. Kardiol Pol. 2022; 80(6): 644–650, doi: 10.33963/KP.a2022.0118, indexed in Pubmed: 35521720.
59. Naganuma T, Kawamoto H, Takagi K, et al. Can we perform rotational atherectomy in patients with severe aortic stenosis? Substudy from the OCEAN TAVI Registry. Cardiovasc Revasc Med. 2017; 18(5): 356–360, doi: 10.1016/j.carrev.2017.02.018, indexed in Pubmed: 28314673.
60. Lippmann M, Patel J, Kvapil J, et al. Safety and feasibility of rotational atherectomy in elderly patients with severe aortic stenosis. J Invasive Cardiol. 2017; 29(8): 271–275, indexed in Pubmed: 28756420.
61. Lunardi M, Pighi M, Venturi G, et al. Short-and-long-term outcomes after coronary rotational atherectomy in patients treated with trans-catheter aortic valve implantation. J Clin Med. 2020; 10(1): 112, doi: 10.3390/jcm10010112, indexed in Pubmed: 33396185.
62. Lunardi M, Pesarini G, Scarsini R, et al. Coronary rotational atherectomy in patients treated with transcatheter aortic valve implantation. Structural Heart. 2019; 3(6): 471–477, doi: 10.1080/24748706.2019.1646947.
63. Piccoli A, Lunardi M, Ariotti S, et al. Expanding TAVI options: Elective rotational atherectomy during trans-catheter aortic valve implantation. Cardiovasc Revasc Med. 2015; 16(1): 58–61, doi: 10.1016/j.carrev.2014.11.003, indexed in Pubmed: 25544677.
64. Amat-Santos IJ, Blasco-Turrión S, Ferrero V, et al. PCI of bystander coronary artery lesions should be performed before TAVI: Pros and cons. EuroIntervention. 2022; 18(10): 783–785, doi: 10.4244/EIJ-E-22-00038, indexed in Pubmed: 36412138.
65. Novelli L, Jamie G, Regazzoli D, et al. How to predict conduction disturbances after transcatheter aortic valve replacement. Kardiol Pol. 2023; 81(4): 330–337, doi: 10.33963/KP.a2023.0039, indexed in Pubmed: 36745533.
66. Bianchini F, Bianchini E, Romagnoli E, et al. Anatomical annulus predictors of new permanent pacemaker implantation risk after balloon-expandable transcatheter aortic valve implantation. Am J Cardiol. 2024; 224: 26–35, doi: 10.1016/j.amjcard.2024.05.034, indexed in Pubmed: 38844197.
67. Cangemi S, Aurigemma C, Romagnoli E, et al. Management of concomitant coronary artery disease and aortic valve stenosis in the era of transcatheter aortic valve treatment. Mini-invasive Surgery. 2022; 6(3), doi: 10.20517/2574-1225.2021.99.

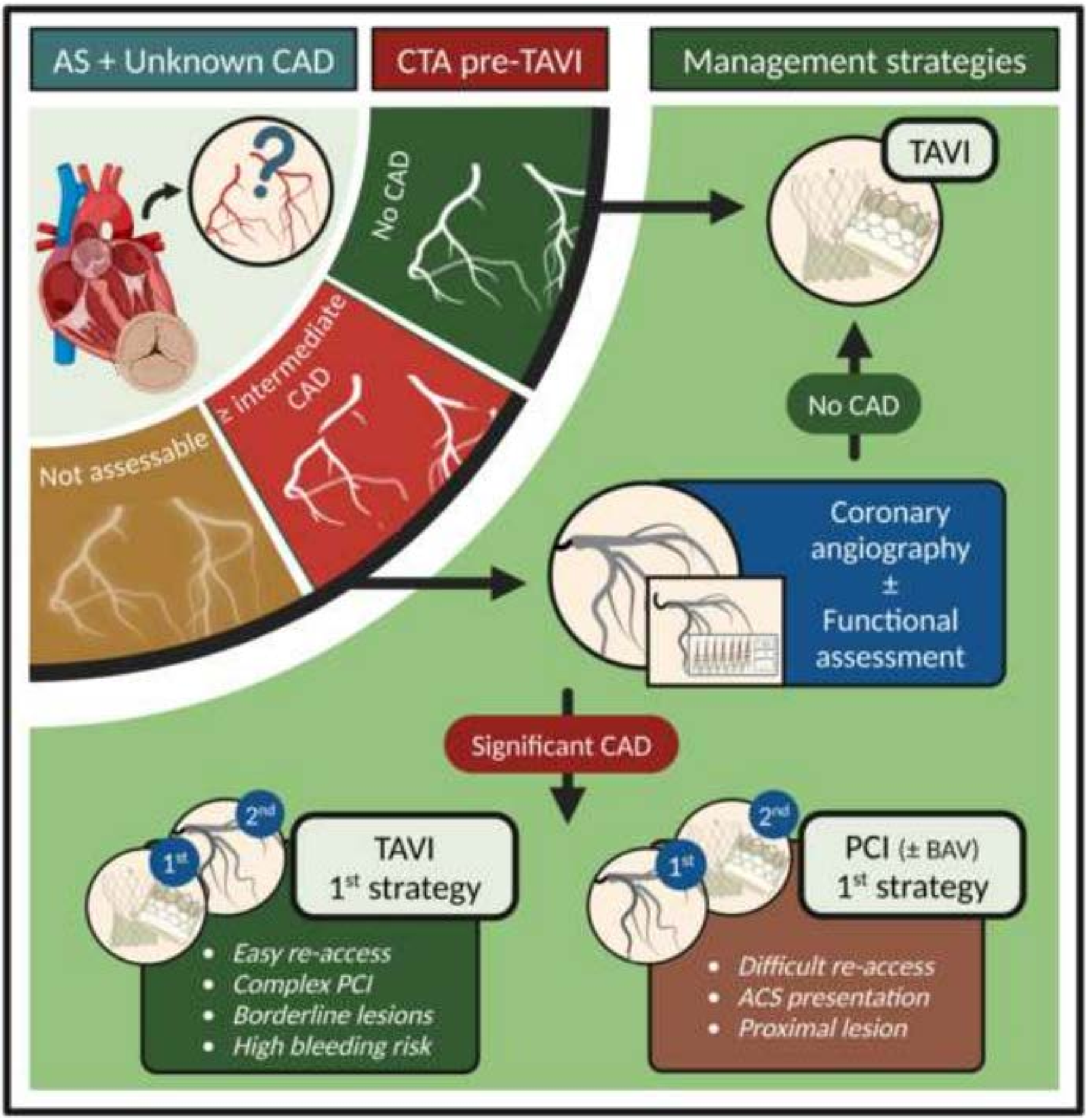

Figure 1. Proposed algorithm for CAD severity assessment and treatment in patients undergoing TAVI. CAD should be ruled out by CCTA, when available. If not, or if CCTA reveals abnormal findings, coronary angiography is required, before valve implantation. In case of detection of intermediate stenosis, a TAVI-first strategy is recommended when feasible, according to clinical presentation and patients' characteristics (expected easy coronary re-access, high bleeding risk, etc.). Once TAVI is performed, functional evaluation of intermediate stenosis should be performed with pressure wire or image-based functional assessment to guide eventual revascularization. If a PCI-first approach is desirable (large ischemic myocardium, acute settings, etc.), operators might consider to perform aortic ballon valvuloplasty before PCI as bridge to TAVI

Abbreviations: ACS, acute coronary syndrome; AS, aortic stenosis; BAV, balloon aortic valvuloplasty, CAD, coronary artery disease; CTA, coronary tomography angiography; PCI, percutaneous coronary intervention; TAVI, transcatheter aortic valve replacement

Table 1. Main studies on CAD severity assessment in patients with severe aortic stenosis

Study	**Objective**	**Design**	**Sample Size**	**Publication Year**	**Key findings**
Chieffo A	CCTA to rule out CAD	Observational retrospective	491	2015	Only 25% of patients underwent CA
van den Boogert TPW	Diagnostic accuracy of CCTA for CAD diagnosis	Meta-analysis	1275	2018	High NPV and sensitivity, but low specificity. CA spared in 37%
Scarsini R	Correlation between SPECT and FFR/iFR	Observational prospective	28	2019	FFR <0.80 — SPECT agreement 85%, iFR <0.82 — SPECT 73%
Scarsini R	Comparison FFR vs. iFR in AS	Observational retrospective	179	2017	Best iFR cut-off to predict FFR <0.80: 0.83
Pesarini G	FFR variations before vs. after TAVR	Observational prospective	133	2016	No significant variations after TAVR. 6% only changed indication to treat
Scarsini R	iFR variations before vs. after TAVR	Observational prospective	145	2018	Erratic individual variations. 15% changed indication to treat

Mejía-Rentería H	QFR diagnostic performance in AVS	Observational retrospective	138	2020	Accuracy in predicting FFR <0.80: 81%
Lunardi M	Angio- vs. functional-guidance for PCI	Observational retrospective	216	2021	Higher 2y MACCE-free survival in functional arm
FAITAVI trial	Angio- vs. functional-guidance for PCI	Randomized clinical trial	320	–	–
NOTION-3 trial	FFR-guided PCI or medical treatment	Randomized clinical trial	452	–	–
TAVI-PET trial	Correlation of FFR and iFR with cardiac PET perfusion	Observational prospective	20	–	–

Abbreviations: AS, aortic stenosis; AVS, aortic valve stenosis; CA, coronary angiography; CCTA, coronary computed tomography angiography; FFR, fractional flow reserve; iFR, instantaneous wave-free ratio; MACCE, major adverse cardiac and cerebrovascular events; NPV, negative predictive value; PET, positron emission tomography; QFR, quantitative flow ratio; SPECT, single photon emission computed tomography; TAVR, transcatheter aortic valve replacement; other — see Figure 1

Table 2. Examples of preferred PCI timing based on clinical scenarios

PCI timing	**Clinical scenarios**
Pre-TAVI	• Acute coronary syndromes (i.e., when ischemia is the acute issue)

	• Ostial/proximal right coronary artery or left main stenosis (possibly leading to large myocardial ischemia during left ventricular pacing implanting the valve) • Specific anatomies leading to unfavourable interactions between the selected valve and the coronary ostia, making coronary canulation after TAVI more challenging (e.g., low coronary ostia, ectopic ostia, narrow sinuses, valve-in-valve procedures, etc.) • Following balloon aortic valvuloplasty (bridge to TAVI) when tight severe aortic stenosis is present (particularly high aortic-ventricular gradients)
Post-TAVI	• Expected complex and long PCI procedures (e.g., requiring debulking techniques, etc), when the presence of aortic valve obstruction, thus the systemic hypoperfusion, might pose the PCI at higher risk of procedural complications • Presence of severe chronic kidney disease, and high risk of contrast-induced acute kidney injury (the normalization of the systemic perfusion after TAVI promotes better kidneys perfusion and reduces the risk of acute injury during additional contrast medium administrations) • Patients presenting with high bleeding risk or on anticoagulation, to avoid performing TAVI on double antithrombotic therapy. • Borderline coronary stenosis severity at coronary angiogram/physiology before TAVI, requiring functional re-evaluation after the aortic valve stenosis treatment

Abbreviations: see Figure 1

Table 3. Main studies on PCI timing in patients undergoing TAVR

Study	**Objective**	**Design**	**Sample Size**	**Publication Year**	**Key findings**

Venturi G	Concomitant vs. staged CA	Observational retrospective	339	2021	Staged CA increased risk of CI-AKI
Ochiai T	Comparison of different timing for PCI	Observational retrospective	258	2020	No 2 years differences in outcomes between pre-, concomitant, post-TAVR PCI
Lunardi M	Comparison of pre-TAVR vs. post-TAVR PCI	Observational retrospective	144	2022	Higher in hospital stroke rate, and 2 years MACCE in pre-TAVR arm
TAVI PCI trial	Comparison of pre-TAVR vs. post-TAVR PCI (iFR guided)	Randomized clinical trial	986	–	–
Lunardi M	Feasibility and 2 years outcomes of RA after TAVR	Observational retro/prospective	19	2020	15% inotropic support, 100% success, 100% 30d survival, 84% 2 years survival
Naganuma T.	Feasibility and 30 days outcomes of RA before TAVR	Observational retrospective	25	2017	40% inotropic support, 100% success, 100% 30 days survival
Lippmann M.	Feasibility and	Observational retrospective	29	2017	30% inotropic support, 100%

	immediate outcomes of RA before TAVR				success, 100% immediate survival
REVASC-TAVI registry	Comparison of pre-TAVR vs. concomitant vs. post-TAVR PCI	Observational retrospective	1603	2023	PCI performed before, after or concomitantly with TAVR in 65.6% (n = 1052), 9.8% (n = 157) or 24.6% (n = 394). 2-year all-cause death in post-TAVR, pre-TAVR, concomitant: 6.8% vs. 20.1% vs. 20.6%; *P* <0.001

Abbreviations: CI-AKI, contrast induced-acute kidney injury; RA, rotational atherectomy; TAVR, transcatheter aortic valve replacement; other — see Figure 1 and Table 1