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THE PRESENT AND FUTURE

STATE-OF-THE-ART REVIEW

Coronary Angiography and Percutaneous Coronary Intervention After Transcatheter Aortic Valve Replacement

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ABSTRACT

Transcatheter aortic valve replacement (TAVR) has revolutionized the management of patients with symptomatic severe aortic stenosis, and indications are expanding towards treating younger patients with lower-risk profiles. Given the progressive nature of coronary artery disease and its high prevalence in those with severe aortic stenosis, coronary angiography and percutaneous coronary intervention will become increasingly necessary in patients after TAVR. There are some data suggesting that there are technical difficulties with coronary re-engagement, particularly in patients with self-expanding valves that, by design, extend above the coronary ostia. The authors review the challenges of coronary angiography and percutaneous coronary intervention post-TAVR and examine the geometric interactions between currently approved transcatheter aortic valves and coronary ostia, while providing a practical guide on how to manage these potentially complex situations. (J Am Coll Cardiol 2018;71:1360–78) © 2018 by the American College of Cardiology Foundation.

Transcatheter aortic valve replacement (TAVR) has revolutionized the treatment of symptomatic severe aortic stenosis (AS). It is now the standard of care for patients who are not surgical candidates, and is comparable to surgical aortic valve replacement in high- and intermediate-risk patients (1–6). The prevalence of coronary artery disease (CAD) in patients with severe AS is high (7). Even in the most recent randomized trials comparing TAVR to surgery in intermediate-risk patients, >60% have coexisting CAD (5,6). The prognostic significance and optimal management of CAD in this population remain controversial (7,8). The recent appropriate use criteria guidelines suggest that it is reasonable to offer revascularization before TAVR, even if there is no evidence of ischemia and only low-risk, noninvasive findings (9).

Furthermore, management of symptomatic CAD after TAVR has not been systematically examined. As TAVR indication expands to lower-risk patients who have better long-term prognoses, there will be an increasing need for repeat coronary angiography and percutaneous coronary intervention (PCI) due to progressive CAD and development of acute coronary syndrome.

This paper aims to: 1) provide an overview of the incidence and management of CAD in patients undergoing TAVR; 2) summarize the worldwide experience with coronary angiography and PCI in patients after TAVR; 3) analyze the 3-dimensional geometric relationship among U.S. Food and Drug Administration-approved transcatheter valves (Medtronic CoreValve self-expanding valve [Medtronic, Galway, Ireland] and Edwards Sapien 3 balloon-expandable valve

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[Edwards Lifesciences, Irvine, California]), the aortic root, and coronary ostia; and 4) provide a practical and systematic approach to coronary angiography and PCI in patients after TAVR.

MANAGEMENT OF CAD IN PATIENTS WITH SEVERE AS UNDERGOING TAVR

PREVALENCE AND PROGNOSTIC SIGNIFICANCE OF CAD IN PATIENTS WITH AS. The prevalence of CAD in patients with severe AS undergoing TAVR ranges from 40% to 75% (7). Given its high prevalence, it is paramount to first ascertain the prognostic significance of CAD and second define the optimal way to manage CAD in patients undergoing TAVR. To date, however, there is no clear consensus on either clinical question, despite several reviews on the topic (7,8,10,11).

The heterogeneity in the definition of CAD across randomized trials and observational studies in patients undergoing TAVR is a major limitation in determining its prognostic significance (12). In a meta-analysis of 2,472 patients from 7 observational studies, CAD was evident in 52% of patients and was defined as: a history of previous PCI or bypass surgery in 4 studies; presence of 50% stenosis in ≥1 epicardial vessel in 2 studies; or a combination of previous revascularization or 50% coronary stenosis in 1 study. With this limitation, the presence or absence of CAD was not associated with an increased risk of death (odds ratio [OR]: 1.0; 95% confidence interval [CI]: 0.67 to 1.50) at a median follow-up of 452 days.

SYNTAX SCORING IN PATIENTS UNDERGOING TAVR. Using the SYNTAX score (SS) to more accurately define CAD has provided further insight into the association between baseline CAD, post-PCI residual CAD, and clinical outcomes, but not all studies were uniformly consistent. Stefanini et al. (13) showed a linear relationship between SS and major adverse cardiovascular events (MACE) at 1 year in patients undergoing TAVR; this was predominantly driven by higher cardiovascular mortality (no CAD 12.5%, low SS 16.1%, high SS 29.6%; p = 0.016). Interestingly, patients with a higher SS (>22) received more incomplete revascularization, and those with a residual SS in the higher tertile (>14) had significantly higher MACE rates (13). In another retrospective analysis from the United Kingdom, the angiographic presence or absence of CAD (>70% epicardial artery stenosis and/or >50% left main stenosis) was not associated with adverse outcomes after TAVR (14). However, when stratified by SS, patients with a score >33 experienced a higher risk of death at both 30 days and 12 months when compared with those with intermediate and low SS (14). Furthermore, after a receiver-operating curve analysis, patients with an SS >9 were identified as having a higher risk of death (14). In the largest (N = 1,270) and most recent study, Witberg et al. (15) added weight to the association between SS and clinical outcomes. Severe CAD, defined as SS >22, was associated with increased mortality at a median follow-up of 1.9 years, even after multivariate analysis (hazard ratio: 2.09; 95% CI: 1.14 to 3.84; p = 0.02). In agreement with the 2 previous studies, incomplete revascularization (residual SS >8) was an independent predictor of mortality (hazard ratio: 1.72; 95% CI: 1.05 to 2.81; p = 0.03). Contrary to these positive studies, Paradis et al. (16) showed that when SS was assessed by a core laboratory, there was no longer a positive association with higher rates of MACE (mortality, myocardial infarction [MI], or stroke) at either 30 days or 1 year. In the small number of patients who underwent PCI (54 of 377), complete revascularization, defined as a residual SS <8, was also not associated with improved outcomes (16).

APPROPRIATE USE CRITERIA IN PCI BEFORE TAVR. Despite the inconsistent findings on the prognostic significance of CAD and effect of revascularization before TAVR, even when using SS, the 2017 appropriate use criteria deemed revascularization before TAVR predominantly appropriate (9). Consequent to these recommendations, a systematic review and meta-analysis of revascularization before TAVR found that of 3,858 patients from 9 studies with CAD, defined as coronary stenosis ranging from 50% to 90%, only 983 (25.5%) received revascularization before TAVR (10). There was no significant clinical benefit derived from revascularization with respect to 30-day cardiovascular death (OR: 1.03; 95% CI: 0.35 to 2.99), MI (OR: 0.86; 95% CI: 0.14 to 5.28), or stroke (OR: 1.07; 95% CI: 0.38 to 2.97). There was, however, an increase in 30-day all-cause mortality (OR: 1.42; 95% CI: 1.08 to 1.87; p = 0.01) with PCI, but this was no longer evident at 1 year (OR: 1.05; 95% CI: 0.71 to 1.56). More importantly, there was also a significant increase in major vascular complications in patients who underwent PCI (OR: 1.86; 95% CI: 1.33 to 2.6; p < 0.001).

It is clear that there is clinical equipoise regarding management of CAD before TAVR. The ACTIVATION (Percutaneous Coronary Intervention Prior to Transcatheter Aortic Valve Implantation; ISRCTN75836930) trial is currently randomizing patients with CAD and severe AS to either pre-TAVR PCI or no

ABBREVIATIONS AND ACRONYMS

AR = Amplatz right
AS = aortic stenosis
CAD = coronary artery disease
CI = confidence interval
CT = computed tomography
JL = Judkins left
JR = Judkins right
LCA = left coronary artery
MACE = major adverse cardiovascular events
MI = myocardial infarction
PCI = percutaneous coronary intervention
RCA = right coronary artery
SS = SYNTAX score
STJ = sinotubular junction
TAVR = transcatheter aortic valve replacement