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Determinants and Outcomes of Acute Transcatheter Valve-in-Valve Therapy or Embolization

A Study of Multiple Valve Implants in the U.S. PARTNER Trial (Placement of AoRTic TraNscathetER Valve Trial Edwards SAPIEN Transcatheter Heart Valve)

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Objectives This study investigated the determinants and outcomes of acute insertion of a second transcatheter prosthetic valve (TV) within the first (TV-in-TV) or transcatheter valve embolization (TVE) after transcatheter aortic valve replacement (TAVR).

Background TAVR failure can occur with both TV-in-TV and TVE as a consequence of TAVR malpositioning. Only case reports and limited series pertaining to these complications have been reported to date.

Methods Patients undergoing TAVR in the PARTNER (Placement of AoRTic TraNscathetER Valve Trial Edwards SAPIEN Transcatheter Heart Valve) randomized trial (cohorts A and B) and accompanying registries were studied. Data were dichotomized for those with and without TV-in-TV or TVE, respectively.

Results From a total of 2,554 consecutive patients, 63 (2.47%) underwent TV-in-TV and 26 (1.01%) TVE. The indication for TV-in-TV was significant aortic regurgitation in most patients, often due not only to malpositioning but also to leaflet dysfunction. Despite similar aortic valve function on follow-up echoes, TV-in-TV was an independent predictor of 1-year cardiovascular mortality (hazard ratio [HR]: 1.86, 95% confidence interval [CI]: 1.03 to 3.38, $p = 0.041$), with a nonsignificant trend toward greater all-cause mortality (HR: 1.43, 95% CI: 0.88 to 2.33, $p = 0.15$). Technical and anatomical reasons accounted for most cases of TVE. A multivariable analysis found TVE to be an independent predictor of 1-year mortality (HR: 2.68, 95% CI: 1.34 to 5.36, $p = 0.0055$) but not cardiovascular mortality (HR: 1.30, 95% CI: 0.48 to 3.52, $p = 0.60$).

Conclusions Acute TV-in-TV and TVE are serious sequelae of TAVR, often resulting in multiple valve implants. They carry an excess of mortality and are caused by anatomic and technical factors, which may be avoidable with judicious procedural planning. (THE PARTNER TRIAL: Placement of AoRTic TraNscathetER Valve Trial; NCT00530894) (J Am Coll Cardiol 2013;62:418–30) © 2013 by the American College of Cardiology Foundation

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Transcatheter aortic valve replacement (TAVR) has shown both safety and efficacy (1) beyond 2 years (2,3). Malpositioning can result in transcatheter valve embolization (TVE) or valve failure. The latter can be treated conservatively, but poor clinical outcomes have been consistently observed with this approach (3,4). Transcatheter valve-in-valve (TV-in-TV) is an established technique to treat acute failure of TAVR (5,6) (it also has an important potential role in treating late TAVR failures, likely an issue in the future). Limited data exist for both TVE and TV-in-TV predictors and sequelae, with a notable absence of adjudicated and core laboratory assessments of clinical and hemodynamic outcome. Using core laboratory adjudicated data, this study sought to investigate the nature, determinants, and outcomes of 2 clinical scenarios in which multiple transcatheter valves may be implanted: TAVR failure with TV-in-TV and TVE.

Methods

Study design and procedure. In an as-treated (AT) analysis, patients undergoing TAVR in the PARTNER (Placement of AoRTic TraNscathetER Valve) Trial, including patients randomized in cohort A (those with high surgical risk), and B (those with inoperable conditions), and accompanying nonrandomized registries were studied. All patients underwent TAVR with the Edwards Sapien heart valve system (Edwards Lifesciences, LLC, Irvine, California). This valve was available in 2 sizes, 23 mm and 26 mm. The procedure was performed with guidance by transesophageal echocardiography (TEE) and fluoroscopy, as previously described (1).

Data were dichotomized for those with and without device embolization. Device embolization was defined as occurring when the "valve prosthesis moves during or after deployment such that it loses contact with the aortic annulus," as proposed by updated Valve Academic Research Consortium guidelines (7). In addition, TV-in-TV cases were compared to those that received a single TAVR in the annular position. A second valve was implanted at the discretion of the operator in a similar fashion to and within the first valve. The valve size used was the same as the first one in all cases.

Baseline demographic and core laboratory interpreted echocardiographic characteristics and clinical outcomes at 1 year were studied. Nonrandomized patients had the same data collection and core laboratory analysis as randomized patients. Additional information on indication, timing, severity, and mechanism of each respective complication and immediate outcomes was studied primarily by using a detailed review of procedure reports, with review of supplemental information from the intraprocedural TEE and angiograms for clarification, if required. A minority of patients had baseline cardiac computed tomography (CT) scans available that were systematically analyzed (8).

Outcomes. Clinical outcomes studied included acute procedural and 30-day outcomes and late outcomes up to 1 year. The principal end points compared were all-cause mortality, cardiovascular mortality, rehospitalization, stroke, and New York Heart Association (NYHA) functional class. Core laboratory echocardiographic data included valve areas, transvalvular gradients, left ventricular (LV) size and function, and valvular and paravalvular aortic regurgitation (AR), evaluated with baseline and follow-up transthoracic echocardiograms (TTEs).

Statistical analysis. Categorical variables were compared with the Fisher exact test. The Kolmogorov-Smirnov test was performed to test the normality for continuous variables and data expressed as mean ± SD or medians (interquartile range [IQR], compared by Student *t*-test or Wilcoxon rank sum test). Survival curves for time-to-event variables were

Abbreviations and Acronyms

AR = aortic regurgitation
AT = as-treated
BSA = body surface area
CABG = coronary artery bypass
CT = computed tomography
LV = left ventricular
TAVI = transcatheter aortic valve implantation
TAVR = transcatheter aortic valve replacement
TEE = transesophageal echocardiograms
THV = transcatheter heart valve
TIA = transient ischemic attack
TV = transcatheter prosthetic valve
TVE = transcatheter valve embolization
TV-in-TV = transcatheter prosthetic valve within a transcatheter prosthetic valve
V-in-V = transcatheter valve-in-surgical valve

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