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A Novel Angiographic Quantification of Aortic Regurgitation After TAVR Provides an Accurate Estimation of Regurgitation Fraction Derived From Cardiac Magnetic Resonance Imaging

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ABSTRACT

OBJECTIVES The study sought to compare a new quantitative angiographic technique to cardiac magnetic resonance-derived regurgitation fraction (CMR-RF) for the quantification of prosthetic valve regurgitation (PVR) after transcatheter aortic valve replacement (TAVR).

BACKGROUND PVR after TAVR is challenging to quantify, especially during the procedure.

METHODS Post-replacement aortograms in 135 TAVR recipients were analyzed offline by videodensitometry to measure the ratio of the time-resolved contrast density in the left ventricular outflow tract to that in the aortic root (videodensitometric aortic regurgitation [VD-AR]). CMR was performed within an interval of ≤30 days (11 ± 6 days) after the procedure.

RESULTS The average CMR-RF was 6.7 ± 7.0% whereas the average VD-AR was 7.0 ± 7.0%. The correlation between VD-AR and CMR-RF was substantial ($r = 0.78$, $p < 0.001$). On receiver-operating characteristic curves, a VD-AR ≥10% corresponded to >mild PVR as defined by CMR-RF (area under the curve: 0.94; $p < 0.001$; sensitivity 100%, specificity 83%), whereas a VD-AR ≥25% corresponded to moderate-to-severe PVR (area under the curve: 0.99; $p = 0.004$; sensitivity 100%, specificity 98%). Intraobserver reproducibility was excellent for both techniques (for CMR-RF, intraclass correlation coefficient: 0.91, $p < 0.001$; for VD-AR intraclass correlation coefficient: 0.93, $p < 0.001$). The difference on rerating was -0.04 ± 7.9% for CMR-RF and -0.40 ± 6.8% for VD-AR.

CONCLUSIONS The angiographic VD-AR provides a surrogate assessment of PVR severity after TAVR that correlates well with the CMR-RF. (J Am Coll Cardiol Intv 2018;■:■-■) © 2018 by the American College of Cardiology Foundation.

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ABBREVIATIONS AND ACRONYMS

AR = aortic regurgitation

AUC = area under the curve

CI = confidence interval

CMR = cardiac magnetic resonance

LV = left ventricle/ventricular

PVR = prosthetic valve regurgitation

RF = regurgitation fraction

TAVR = transcatheter aortic valve replacement

VD-AR = videodensitometric aortic regurgitation

Since the introduction of transcatheter aortic valve replacement (TAVR) as a minimally invasive alternative to surgery (1), significant improvements have been introduced to this technology. Currently, TAVR outperforms surgery in many aspects (2), but prosthetic valve regurgitation (PVR) still occurs at a higher rate than after surgery and portends worse prognosis (3). The quantification of PVR is challenging (4). Although long-term surveillance is typically based on echocardiography, recent data support a more reliable prognostic value of cardiac magnetic resonance-derived regurgitation fraction (CMR-RF) (5,6). This superior prognostication is added to some other well-known advantages of CMR over echocardiography, including more reproducible and quantitative assessment (4). CMR can, therefore, be considered as an ideal tool to quantify PVR but is limited by a number of logistic constraints. The high cost, limited availability, technical demand, and incompatibility with some implanted cardiac rhythm devices all make CMR a less practical tool for routine PVR assessment compared with echocardiography (4).

Recently, the minimalist TAVR approach is increasingly adopted by large TAVR centers. In this approach, general anesthesia is replaced by sedation and transesophageal echocardiography is seldom an option. In this setting, angiographic assessment, which currently serves as the first screening tool in most laboratories, is becoming even more crucial in determining the severity of PVR during the procedure. Angiographic assessment using the classic visual (Sellers') method (7) bears many limitations, including subjectivity and lack of precise quantification (4). Quantitative videodensitometric aortic regurgitation (VD-AR) assessment was recently reported to overcome the limitations of the Sellers' method (4,8,9). In this study, we sought to compare 2 quantitative modalities for PVR assessment; a well-established modality that cannot be used in the cath lab (CMR-RF) and a novel one which has the potential to be applied in the cath lab for PVR quantification and decision-making guidance (VD-AR). The primary objective was to estimate the correlation between these 2 modalities, whereas the secondary objective was to compare their reproducibility.

METHODS

STUDY POPULATION. All patients who were treated with TAVR and had a CMR study performed after the procedure at the Heart Center, Segeberger Kliniken GmbH (Bad Segeberg, Germany), were screened for inclusion in this study. The flow chart of the study is displayed in Online Figure 1. The main reason for exclusion was VD-AR nonanalyzability (principally due to overlap of the regions of interest by the contrast-filled descending aorta [83%] or breathing motions [9%]). A total of 135 consecutive patients treated with TAVR who had quantitative angiographic and CMR assessments of PVR performed within an interval of ≤30 days constituted the study population. Data collection was approved by the institutional review board, and all patients signed a written informed consent.

QUANTITATIVE AORTIC ROOT ANGIOGRAPHY USING VIDEODENSITOMETRY. Aortic root angiography was performed after valve replacement using a nonionic contrast (25 to 30 ml) injected through a pigtail catheter positioned above the prosthetic valve (in case of a balloon- or mechanically-expandable device) or within the distal third of the prosthetic valve (in case of a self-expanding device). A dedicated software (CAAS A-Valve 2.0.2, Pie Medical Imaging, Maastricht, the Netherlands) was used for offline analysis of the angiograms. The details of this technique have been described elsewhere (9,10). Briefly, the aortic root and the subaortic (basal) one-third of the left ventricle (LV) are manually traced, and the aortic valve annular plane is indicated to define the distal end of the LV region of interest. Contrast time-density curves are generated for both the region of interest (in the LV) and the reference region (the aortic root) from at least 3 cardiac cycles after contrast injection. From these time-density curves, the area under the curve (AUC) is automatically calculated to represent the time-density integral. VD-AR corresponds to the relative AUC, which is automatically calculated by dividing the AUC of the LV region of interest by the AUC of the aortic root (**Figure 1**). VD-AR was analyzed by an independent core laboratory (Cardialysis Clinical Trials Management and Core Laboratories, Rotterdam, the Netherlands) and observers were blinded to all baseline, procedural, and CMR data. Rerating by the same observer was performed in 75 cases to test the intrinsic variability of the method.

CMR IMAGING PROTOCOL AND DATA ANALYSIS. All patients were investigated by electrocardiogram-gated CMR in the supine position with a 5-element cardiac phased-array coil using a 1.5-T whole-body scanner (Magnetom Espree, Siemens AG, Erlangen, Germany). The flow signal at the level of the stent of the prosthetic valve could be safely interrogated by CMR as previously described (11,12).