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Multidetector computed tomography sizing of aortic annulus prior to transcatheter aortic valve replacement (TAVR): Variability and impact of observer experience

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KEYWORDS
Multidetector computed tomography (CT);
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Observer variation

Abstract
Purpose: To evaluate intra- and inter-observer variability of multidetector computed tomography (MDCT) sizing of the aortic annulus before transcatheter aortic valve replacement (TAVR) and the effect of observer experience, aortic valve calcification and image quality.
Methods: MDCT examinations of 52 consecutive patients with tricuspid aortic valve (30 women, 22 men) with a mean age of 83 ± 7 (SD) years (range: 64—93 years) were evaluated retrospectively. The maximum and minimum diameters, area and circumference of the aortic annulus were measured twice at diastole and systole with a standardized approach by three independent observers with different levels of experience (expert [observer 1]; resident with intensive 6 months practice [observer 2]; trained resident with starting experience [observer 3]). Observers were requested to recommend the valve prosthesis size. Calcification volume of the aortic valve and signal to noise ratio were evaluated.

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Results: Intra- and inter-observer reproducibility was excellent for all aortic annulus dimensions, with an intraclass correlation coefficient ranging respectively from 0.84 to 0.98 and from 0.82 to 0.97. Agreement for selection of prosthesis size was almost perfect between the two most experienced observers ($k = 0.82$) and substantial with the inexperienced observer ($k = 0.67$). Aortic valve calcification did not influence intra-observer reproducibility. Image quality influenced reproducibility of the inexperienced observer.
Conclusion: Intra- and inter-observer variability of aortic annulus sizing by MDCT is low. Nevertheless, the less experienced observer showed lower reliability suggesting a learning curve.

Aortic valve stenosis is a common disease with increasing prevalence, especially in elderly patients. For a long time, surgical aortic valve replacement has been the only standard of curative treatment. However, up to one third of patients are declined for surgery due to multiple comorbidities [1,2]. Percutaneous transcatheter aortic valve replacement (TAVR) has become the treatment of choice in patients with contraindications to surgery or high surgical risk [3—6]. Indication was even extended to intermediate risk patients [7—9].

As opposed to surgical valve replacement, sizing aortic valve under direct visualization is not possible during TAVR procedure. Accurate evaluation of the aortic root is critical before the procedure and strongly depends on multimodality imaging [10]. Valve undersizing may lead to paravalvular aortic regurgitation, a condition associated with poor clinical outcome [5,11,12], or valve embolization. On the contrary, valve oversizing may lead to obstruction of coronary ostia, atrioventricular block or rupture of the aortic root [12,13].

The virtual ring formed by joining basal attachments of aortic valve leaflets defines the aortic annulus [14]. Many studies have demonstrated the oval (non circular) shape of the annulus [15,16]. Two-dimensional echocardiography provides the shorter diameter of the annulus and it can underestimate the true annular dimensions by considering the annulus as circular [17—19]. Multidetector computed tomography (MDCT) plays a growing role in the assessment of various cardiac diseases [20—22]. In the context of aortic stenosis, MDCT allows a three-dimensional assessment of the aortic annulus and thus improves the accuracy of aortic annulus sizing [23—25]. However image processing is complex, seems to depend on the operator and few data are available regarding intra- and inter-observer variability of this technique. Furthermore, the variability associated with the level of training of the observer has never been evaluated.

The purpose of this study was to evaluate intra- and inter-observer variability of aortic annulus sizing with MDCT, as well as the effect of observer experience, aortic valve calcification and image quality on variability.

Materials and methods

Patients

This was a single center retrospective study carried out between July 2013 and April 2014. All patients having undergone both CT and TAVR in our institution were selected from the local TAVR register. We excluded patients with congenital bicuspid aortic valve and valve-in-valve procedure. Fifty-two consecutive patients were included. The institutional review board approved this retrospective study, and informed consent was waived.

MDCT image acquisition

MDCT examinations were performed on a 64-section Discovery 750-HD® scanner (GE Healthcare, Milwaukee, WI, USA) with the same acquisition protocol according to the recommendation issued by the Society of Cardiovascular Computed Tomography (SCCT) [10]. Tube voltage was set depending on the patient body mass index (BMI): 100 kVp in patients with a BMI less than 25 $kg.m^{-2}$; 120 kVp in others. Sixty milliliters of 350 mgI/mL contrast agent (Iobitridol, Xenetix®, Guerbet, Aulnay-sous-Bois, France) were injected at a flow rate of 4—5 mL/s with a timing bolus tracker pulsed by 20 mL of saline serum. Imaging was performed in deep inspiration in a cranio-caudal direction encompassing the heart and aortic arch using a retrospectively ECG-gated spiral acquisition mode. Diastolic (75% R-R) and systolic phase images (25—45% R-R every 5%) were reconstructed. Slice thickness was 0.6 mm. ECG-gated dose modulation of the mA was used. ECG data were drawn from CT scans metadata. All patients underwent CT angiography of the abdominal aorta and iliofemoral vessels during the same CT session but this part of the examination was not included in the present study.

Aortic annulus measurement

Native axial slices were transferred to a workstation (ADW® 4.6, GE Healthcare) and processed with dedicated

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