Rev Bras Cardiol Invasiva. 2015;**23(2)**:130-133

Original Article

Differences between systolic and diastolic dimensions of the aortic valve annulus in computed tomography angiography in patients undergoing percutaneous implantation of aortic valve prosthesis by catheter

Rafael Cavalcante Silva, José Mariani Jr., Breno de Alencar Araripe Falcão, Antonio Esteves Filho, Cesar Higa Nomura, Luiz Francisco Rodrigues de Ávila, José Rodrigues Parga, Pedro Alves Lemos Neto*

Instituto do Coração, Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, São Paulo, SP, Brazil

ARTICLE INFO

Article history:
Received 19 January 2015
Accepted 8 March 2015

Keywords:
Transcatheter aortic valve replacement
Tomography, X-ray computed
Aortic valve stenosis

ABSTRACT

Background: Accurate aortic valve annulus sizing has critical importance for the planning of percutaneous transcatheter aortic valve implantation (TAVI) in patients with severe aortic valve stenosis. Although there is a recommendation to perform the measurement during systole, little is known about the importance of the differences between systolic and diastolic dimensions of the annulus.
Methods: Consecutive patients referred for TAVI were evaluated with computed tomography for valve annulus sizing during systole and diastole. Area, circumference, minimum and maximum diameters, and their mean derived diameters were obtained in both phases of the cardiac cycle. Bland-Altman plots were constructed to evaluate the differences between the measures.
Results: The analysis included 41 patients with severe aortic stenosis. Mean area, circumference, and diameters were slightly greater in systole. However, in 35% of patients, diastolic dimensions were greater. These differences, although statistically significant, were small (the greatest difference of 0.6 mm in mean diameter). Bland-Altman plots showed good agreement between systolic and diastolic measurements on all parameters evaluated.
Conclusions: Small differences were observed in the systolic and diastolic dimensions of the aortic valve annulus with computed tomography scan, which, although statistically significant, probably do not impact the selection of prosthesis or the procedure outcome.

Diferenças entre as dimensões sistólica e diastólica do anel valvar aórtico na angiotomografia computadorizada em pacientes submetidos a implante percutâneo de prótese valvar aórtica por cateter

Palavras-chave:
Substituição da valva aórtica transcateter
Tomografia computadorizada por raios X
Estenose da valva aórtica

RESUMO

Introdução: A medida acurada do tamanho do anel valvar aórtico tem importância fundamental para o planejamento do implante percutâneo de prótese valvar aórtica transcateter (TAVI) em pacientes com estenose valvar aórtica grave. Embora haja recomendação de se realizar a medida na sístole, pouco se sabe sobre a importância das diferenças entre as dimensões sistólica e diastólica do anel.
Métodos: Pacientes consecutivos referidos para TAVI foram avaliados com tomografia computadorizada para medida do anel valvar na sístole e na diástole. Área, circunferência, diâmetros máximo e mínimo, e seus diâmetros médios derivados foram obtidos em ambas as fases do ciclo cardíaco. Gráficos de Bland-Altman foram construídos para se avaliarem as diferenças entre as medidas.
Resultados: Foram incluídos na análise 41 pacientes com estenose aórtica grave. As médias da área, circunferência e diâmetros médios foram discretamente maiores na sístole. No entanto, em 35% dos pacientes, as dimensões diastólicas foram maiores. Essas diferenças, embora estatisticamente significantes, foram pequenas (a maior diferença de 0,6 mm no diâmetro médio). Gráficos de Bland-Altman revelaram bons níveis de concordância entre as medidas sistólicas e diastólicas em todos os parâmetros avaliados.

DOI of original article: http://dx.doi.org/10.1016/j.rbci.2015.12.012
* Corresponding author: Avenida Dr. Enéas de Carvalho Aguiar, 44, bloco I, 3º andar, Hemodinâmica, Cerqueira César, CEP: 05403-000, São Paulo, SP, Brazil.
E-mail: pedro.lemos@incor.usp.br (P.A. Lemos Neto).
Peer Review under the responsability of Sociedade Brasileira de Hemodinâmica e Cardiologia Intervencionista.

Conclusões: Observamos pequenas diferenças nas dimensões sistólicas e diastólicas no anel valvar aórtico à tomografia computadorizada, as quais, embora estatisticamente significantes, provavelmente não impactam na seleção da prótese e nem no resultado do procedimento.

Introduction

Computed tomography angiography (CTA) is an important tool for anatomical assessment of patients with aortic valve stenosis who are candidates for percutaneous transcatheter aortic valve implantation (TAVI).[1] In many centers, CTA is considered the most important diagnostic method for planning intervention strategies for these patients. CTA has a particularly important role in valve annulus sizing, to guide the choice of the type and size of the prosthesis to be implanted.

Previous studies have demonstrated that aortic root dimensions may vary during the cardiac cycle.[2,3] These dimensional differences in systole and diastole are seemingly unpredictable, with systolic dimensions tending to be greater. However, the opposite can also occur.[2]

In daily clinical practice, CTA images are commonly acquired in a single phase of the cardiac cycle, often at the end of diastole, although an international expert consensus recommends that measures should be performed during systole.[1]

Although some studies have shown significant differences in systolic and diastolic measures, other groups suggest that these differences are minor, with little chance to change the decision making process.[2,4] However, there are few data in the literature to support recommendations with respect to the importance of these dynamic variations in the size of the aortic valve annulus to assess candidates for TAVI.

This study aimed to evaluate the differences in valve annulus size in systole and in diastole with CTA, and its potential effect on the planning of TAVI procedures.

Methods

Consecutive patients from two centers (Instituto do Coração, Hospital das Clínicas, University of São Paulo Medical School; and Hospital Sírio-Libanês) in the state of São Paulo (SP), with severe aortic valve stenosis (aortic valve area < 1 cm^2) considered inoperable or at high surgical risk, submitted to TAVI, and with CTA baseline images acquired both at the end of systole and of diastole were included in this analysis. All TAVI procedures were performed via transfemoral access with an Edwards Sapien XT balloon-expandable prosthesis (Edwards Lifesciences, Irvine, USA) or a Medtronic CoreValve auto-expandable prosthesis (Medtronic, Minneapolis, USA).

All scans were performed before (within 2 months) TAVI. Aquilion tomographs with 64- or 256-detector columns (Toshiba Medical Systems, Tokyo, Japan) were used, and the acquisition protocols were applied as previously described.[1] CTA image analysis was performed with the use of a dedicated workstation, as previously described, and by a single experienced analyst.[1] Briefly, the aortic valve plane was identified and the following valve annulus measurements were obtained in both systole and diastole: maximum (D_{max}) and minimum (D_{min}) diameter of the oval aortic valve annulus; mean diameter of the oval aortic valve annulus (MD = $[(D_{max} + D_{min})/2]$); planimetered area of the valve annulus (A); area-derived mean diameter, under the assumption of full roundness ($D_A = 2\sqrt{A}/\pi$); perimeter or circumference of the annulus (C); circle-derived mean diameter, under the assumption of full roundness ($D_C = C/\pi$).

Statistical analysis

Categorical variables were presented as absolute numbers and proportions. Continuous variables were presented as mean ± standard deviation and compared using the Student's paired t-test. Pearson correlation coefficients were used to correlate systolic and diastolic measures. The method proposed by Bland and Altman was used to assess differences in measurements of the aortic valve annulus in systole vs. diastole with CTA. In the Bland-Altman analysis, the difference between the two measures is plotted against their mean, with limits of 95% calculated to evaluate the correlation between these measures.[5,6]

Results

Study population

Between November 2012 and November 2014, 41 patients who underwent TAVI at 2 centers had a basal CTA with images at the end of systole and of diastole. The population characteristics are summarized in Table 1. In total, 48.8% of patients were female and were aged 83.5 ± 6.9 years. The mean logistic EuroSCORE was 13.7 ± 11.8%, and the mean Society of Thoracic Surgeons (STS) score was 19.2 ± 14.9%, reflecting a population at high surgical risk. Most (85.3%) were in functional class III or IV of the New York Heart Association (NYHA). At the baseline echocardiogram, the mean transvalvular gradient was 51.5 ± 17.4 mmHg and the mean aortic valve area was 0.7 ± 0.2 cm^2.

Table 1
Baseline characteristics.

	n = 41
Age, years	83.5 ± 6.9
Female, n (%)	20 (48.8)
STS score	19.2 ± 14.9
Logistic EuroSCORE	13.7 ± 11.8
Coronary artery disease, n (%)	22 (53.7)
NYHA functional class, n (%)	
I	1 (2.4)
II	5 (12.2)
III	24 (58.5)
IV	11 (26.8)
Previous AMI, n (%)	9 (22.0)
Previous coronary artery bypass graft surgery, n (%)	10 (24.4)
Previous PCI, n (%)	7 (17.1)
Previous aortic balloon valvuloplasty, n (%)	3 (7.3)
Cerebrovascular disease, n (%)	5 (12.2)
Peripheral arterial disease, n (%)	7 (17.1)
Creatinine > 2 mg/dL, n (%)	4 (9.8)
Severe COPD, n (%)	2 (4.9)
Hepatic cirrhosis (Child A or B), n (%)	1 (2.4)
Fragility, n (%)	6 (14.6)
Porcelain aorta, n (%)	1 (2.4)
Previous permanent pacemaker, n (%)	1 (2.4)
LV ejection fraction, %	57.3 ± 12.4
Mean aortic transvalvular gradient, mmHg	51.5 ± 17.4
Aortic valve area, cm^2	0.7 ± 0.2

STS: Society of Thoracic Surgeons; NYHA: New York Heart Association; AMI: acute myocardial infarction; PCI: percutaneous coronary intervention; COPD: chronic obstructive pulmonary disease; LV: left ventricle.