Aortic annulus and ascending aorta: comparison of preoperative and periooperative measurement in patients with aortic stenosis

Introduction

Precise determination of the aortic annulus size constitutes an integral part of the preoperative evaluation prior to aortic valve replacement. It enables the estimation of the size of prosthesis to be implanted. Knowledge of the size of the ascending aorta is required in the preoperative analysis and monitoring of its dilation enables the precise timing of the operation. Our goal was to compare the precision of measurement of the aortic annulus and ascending aorta using magnetic resonance (MR), multidetector-row computed tomography (MDCT), transthoracic echocardiography (TTE), and transoesophageal echocardiography (TEE) in patients with degenerative aortic stenosis.

Materials and Methods

15 patients (9 males and 6 females, mean age 68.8 $\pm$ 7,1 years,) indicated for aortic valve replacement due to degenerative aortic stenosis were enrolled into this prospective study. The study followed the principles established in the Declaration of Helsinki. The protocol was accepted by the local ethical board and informed consent was obtained from each patient. The study was performed in a tertiary medical centre. Preoperatively, TTE was performed in all patients, while TEE was performed in 10 patients, MDCT in 14 patients and MRI in 11 patients. The results of measurements using the respective techniques were compared with perioperative values as a reference. All echocardiography findings were evaluated by one experienced echocardiographist, while MDCT and MR findings were evaluated by one experienced radiologist. Measurements were performed during the diastole (according to ECG) between the insertions of the right and non-coronary leaflets to the aortic annulus and the mean value from three consecutive measurements was used. The ascending aorta diameter was measured from previous projections at a distance of 35 mm from the aortic annulus. Perioperative measurement of the aortic annulus and ascending aorta was performed by the main surgeon in all patients. Aortic annulus was measured using a standard gauge in the arrested heart during the diastole; we measured the distance between the insertion of the right and non-coronary leaflets. The ascending aorta was measured at the distance of 35 mm from the annulus using a standard gauge. The precision of measurements was evaluated using correlation coefficient between the perioperative measurements and the respective methods of preoperative measurements. The predictive value of the aortic annulus and ascending aorta was calculated according to the regression equation.

Results

A total of 15 patients underwent aortic valve replacement due to degenerative aortic stenosis. The average mean gradient on the aortic valve was 50±17.3 mmHg, while the average left ventricular ejection fraction was 62.6±10.6%. Results of the correlation coefficient and regression equation for the respective techniques are shown in summary tables 1 and 2. MR was found to be the most precise technique for the measurement of the aortic annulus, followed by CT, TTE and TEE. The difference ranges between the aortic annulus measured preoperatively by particular method and perioperative measurements were as follows: -0,45/+0,11 cm for TTE; -0,55/+0,20 cm for TEE; -0,15/+0,35 cm for CT; -0,07/+0,42 cm for MR. For the measurement of the ascending aorta, MR again was found to be the most precise technique, followed by CT, TEE and TTE. Since MR was found to be the most precise technique in both cases, values of measurement obtained by MR were compared to the predicted values of the aortic annulus and ascending aorta as calculated from the regression equation. The results are shown in summary table 3.

Table 1: Correlation between the aortic annulus size as measured by the respective techniques and perioperatively.

Method (number of measurements)	Correlation coef.	P	Regression equation y=a+b*x	
			a	b
TTE (15)	0.651	0.009	0.963	0.593
TEE (10)	0.606	NS	1.152	0.530
CT (14)	0.770	0.001	0.602	0.717
MR (11)	0.825	0.002	0.575	0.722

TTE – transthoracic echocardiography, TEE – transoesophageal echocardiography, CT – computerized tomography, MR – magnetic resonance, P – statistical significance, regression equation – regression of the perioperative size to the size obtained by the respective techniques, a, b – regression coefficients, y – predicted value, x – actual value measured by the respective technique, NS – non-significant.

Table 2: Correlation between the sizes of ascending aorta, as measured by the respective techniques and perioperatively.

Method (number of measurements)	Correlation coef.	P	Regression equation y=a+b*x a	b
TTE (15)	0.747	0.001	0.246	0.933
TEE (10)	0.828	0.003	0.218	0.936
CT (14)	0.853	0.000	-0.127	1.044
MR (11)	0.955	0.000	-0.740	1.212

TTE – transthoracic echocardiography, TEE – transoesophageal echocardiography, CT – computerized tomography, MR – magnetic resonance, P – statistical significance, regression equation – regression of the perioperative size to the size obtained by the respective techniques, a, b – regression coefficients, y – predicted value, x – actual value measured by the respective technique, NS – non-significant.

Table 3: Comparison between the sizes of aortic valve annulus and ascending aorta, as measured by magnetic resonance, predicted size values measured according to regression equation and actual sizes measured perioperatively in the respective patients.

Patient	*ANMR*	*AN periop.*	*AN estim.*	*ASCMR*	*ASC periop.*	*ASC estim.*
1.	2.59	2.50	2.44	4.60	5.30	4.84
2.	2.14	2.10	2.12	3.60	3.80	3.62
3.	2.10	2.10	2.09	3.60	3.50	3.62
4.	2.17	2.10	2.14	2.80	2.80	2.65
5.	2.72	2.30	2.54	5.70	6.20	6.17
6.	2.30	2.20	2.24	3.80	3.60	3.87
7.	2.10	2.10	2.09	2.80	2.80	2.65
8.	2.43	2.50	2.33	3.50	3.60	3.50
9.	2.46	2.30	2.35	3.85	3.70	3.93
10.	2.69	2.70	2.52	3.40	3.60	3.38
11.	2.45	2.30	2.34	3.80	3.20	3.87

AN MR – size of aortic valve annulus measured by magnetic resonance, AN periop. – size of aortic valve annulus measured perioperatively, AN estim. – predicted size of the aortic valve annulus, ASC MR – size of ascending aorta measured by magnetic resonance, ASC periop. – size of ascending aorta measured perioperatively, ASC estim. – predicted size of ascending aorta.

Discussion

In our work, MR was found to provide the highest precision of measurements in both cases (followed by CT). The precision of ascending aorta measurement was found to be higher than aortic annulus measurement for all techniques (but in particular echocardiography). This is most likely due to the fact that only patients with degenerative aortic stenosis were enrolled in the study, in whom the calcification of the aortic annulus frequently makes precise measurement impossible, especially when using an ultrasound technique. This is also supported by the fact that both echocardiographic techniques were more precise for the measurement of the ascending aorta than of the aortic annulus. We can only speculate that the precision of echocardiographic measurements would be higher in non-degenerative disorders of the aortic valve. In our study surgically measured size of the aortic annulus corresponded in all cases to the implanted prosthesis size and MR has the smallest variation in absolute values as compared to other methods used. The measurement precision between the different techniques was tighter when measuring the ascending aorta, but also here MR was found to be the most precise technique, although both echocardiographic techniques showed higher measurement precision than in case of the aortic annulus; better results of TEE (comparable to those of CT) were probably due to the partially worse transthoracic examination capacity of patients. On the other hand TTE as the least invasive (and cheapest technique) is irreplaceable as a basic technique for evaluation of cardiac patients and patients waiting for cardiac surgery and for the selection of more precise techniques.

Conclusion

According to our results, MR is the most precise technique for the evaluation of the size of the aortic annulus and ascending aorta in patients with severe degenerative aortic stenosis nearly followed by multidetector-row

CT. Ultrasound techniques in patients with degenerative aortic stenosis are more precise for the measurement of ascending aorta than aortic annulus.

Development of Corrected and Non-Corrected Mild to Moderate Functional Tricuspid Regurgitation

Introduction

Unoperated severe tricuspid regurgitation (TR) leads to the right ventricle (RV) failure. We wanted to determine if there was near-term post-operative progression of non-corrected mild to moderate functional TR in patients who underwent mitral valve surgery for chronic significant mitral regurgitation (MR), and if RV size and function was effected.

Patients and Methods

We performed a retrospective analysis of 45 patients (TVA+ group) who underwent repair or replacement of the mitral valve due to significant chronic mitral regurgitation of ischemic or degenerative etiology. Simultaneously, tricuspid valve annuloplasty was performed with an annuloplastic ring if the patient had an annulus dilatation greater than 40 mm and at least trace TR was present. This group of patients was compared with 22 patients (TVA− group) who underwent only repair or replacement of the mitral valve. While these patients' also had an annulus dilated more than 40 mm and had at least trace TR, TVA was not performed. A transthoracic echocardiographic examination was performed on both groups of patients before the operative procedure and again 3 months following the procedure. The Student's t-test and Mann-Whitney U test were used for statistical evaluation.

Results

The NYHA class improved for both groups. The TVA+ group showed a statistically significant decrease in right ventricle diameter but a non-significant increase in right and left ventricle ejection fractions. The decrease in the average grade of TR was statistically significant. None of the patients in the TVA+ group experienced progression in TR by more than one grade. Like the TVA+ group, the TVA− group showed a statistically significant NYHA class improvement as well as a TR grade decrease and a non-significant increase in the ejection fraction of both ventricles. However, the TVA− group showed a statistically significant dilatation of the right ventricle (Table 1). Seven patients (32%), from the TVA− group had post-operative TR progression by more than one grade with clinically significant right ventricular dilatation and decreases in ejection fraction (Table 2).

Table 1

Comparison of pre-operative and 3-month-post-operative values in patients with TVA -

Parameter	Pre-operative	Post-operative	p
NYHA	2,5±0,8	1,5±0,5	<0,001
LV EF (%)	41,1±16	41,3±14,9	ns
RV EF (%)	45,7±8,2	47,1±5,7	ns
RV diameter (mm)	28,8±6,0	32,3±3,9	<0,05
TR grade	1,7±0,7	1,1±1,2	<0,05