Comparison of 64-Slice Computed Tomography Planimetry and Doppler Echocardiography in the Assessment of Aortic Valve Stenosis

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Background and aim of the study: **The study aim was to compare, prospectively, the planimetry of aortic stenosis on 64-slice computed tomography (CT), with the area calculated by Doppler transthoracic echocardiography (TTE) in symptomatic patients evaluated before potential aortic valve replacement.**

Methods: **Fifty-two consecutive patients (27 males, 25 females; mean age 74 ± 10 years) admitted to the authors' institution during 2005 were evaluated with 64-slice CT and Doppler TTE. The time interval between the two evaluations was 2 ± 1 weeks. Planimetry of the anatomic orifice area (AOA) drawn on 64-slice CT was compared to the effective area determined by Doppler TTE by Bland and Altman analysis, and the anatomic area threshold value corresponding to a significant effective aortic stenosis (≤0.75 cm²) was determined by receiver operating characteristic (ROC) analysis.**

Results: **The aortic orifice area measured by 64-slice CT correlated well with the effective area (r = 0.76; p <0.0001), but was significantly greater, with a systematic overestimation (0.132 cm²) and a variability of 0.239 cm². There was good agreement between planimetry determined by two independent radiologists (difference = 0.002, variability = 0.115 cm²). ROC analysis showed that a threshold value of 0.95 cm² as measured by 64-slice CT planimetry identifies significant aortic stenosis with sensitivity, specificity, accuracy, positive and negative predictive values of 82%, 77%, 81%, 91% and 59%, respectively.**

Conclusion: **64-slice CT is a reproducible and reliable non-invasive method to evaluate aortic valve stenosis compared to the reference method of Doppler TTE. Indeed, the CT approach could replace the latter evaluation when measurements used in the continuity equation are inadequate.**

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Aortic stenosis is the most frequent valvular disease among the elderly, with a high morbidity and mortality burden which can be alleviated by valve replacement (1). The evaluation of aortic stenosis carries important consequences for deciding on valve replacement in patients for whom the surgical risk is often high due to their age. Currently, aortic stenosis is evaluated routinely with Doppler transthoracic echocardiography (TTE). Initially, the planimetry of aortic stenosis was performed with transthoracic (2,3) and later transesophageal echocardiography (TEE) (4,5). Magnetic resonance imaging (MRI) was also found to be reliable for measurement of the aortic orifice area (6). Recent studies have also evaluated the accuracy of 16-slice computed tomography (CT) aortic valve planimetry to quantify aortic stenosis, although one study included 30 asymptomatic patients with aortic stenosis (seven of these patients (23%) had a valve area ≤0.75 cm²) (7), and the other study included 20 patients with aortic stenosis screened during multi-slice CT performed for coronary artery disease evaluation (8). Thus, the aim of the present study was to compare prospectively, in a routine clinical practice, the planimetry of aortic stenosis on 64-slice CT with the area calculated using the reference method (Doppler TTE) in symptomatic patients evaluated before potential aortic valve replacement.

Clinical material and methods

Patients

Fifty-two consecutive patients (27 males, 25 females;

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mean age 74 ± 10 years; range: 30 to 89 years) who were evaluated for symptomatic aortic valve stenosis over an entire year (2005) were enrolled into this prospective, single-center study. Among these patients, 42 were in sinus rhythm, six in atrial fibrillation (AF), and four had a pacemaker. Four patients had concomitant mitral stenosis. The time interval between TTE and 64-slice CT was 2 ± 1 weeks. No intercurrent event occurred between the two tests, or during 64-slice CT. The baseline characteristics of patients are listed in Table I.

Patients with an allergy to iodine, renal failure (serum creatinine >200 µmol/l), significant associated aortic regurgitation, with an aortic valve prosthesis and with a dynamic subaortic pressure gradient were excluded from the study.

Each patient provided their informed consent to participate in the study, the protocol of which was approved by the authors' institutional ethics committee.

Transthoracic echocardiography

Patients underwent Doppler TTE (Philips Sonos 7500) performed by a single, experienced operator. The left ventricular outflow tract (LVOT) diameter and flow velocity were measured, and the average diameter over five consecutive measurements was determined. In case of AF, flow velocity was also averaged over five cycles. The cross-sectional LVOT area, stroke volume, cardiac output and cardiac index were calculated from these measured data. The ejection fraction (EF) was determined using the Simpson biplane method. Continuous-wave Doppler was recorded from three different views (apical, suprasternal, right parasternal), and the greatest mean transaortic gradient was determined. The aortic valve resistance (dynes.s/cm^5) was calculated as [80 × mean aortic gradient (mmHg)/cardiac output (l/min)]. The effective aortic valve area was calculated using the continuity equation (9,10); significant effective aortic stenosis was defined as a valve area ≤0.75 cm^2.

Figure 1: Frontal view of the heart showing left ventricular outflow tract and ascending aorta on a systolic phase (here at 20% of the R-R interval). This phase was selected interactively, chosen at the maximal aperture of the valve as seen in both frontal and axial planes. A plane perpendicular to the outflow tract axis is created in order to generate an image in the exact plane of the aortic valve (see Fig. 2).

64-Slice computed tomography

All patients underwent planimetry of the anatomic aortic valve area with a Siemens 64-slice computed tomograph (Siemens AG, Erlangen, Germany). Concentrated iodinated contrast medium (95 ml) (Iopamidol 400; Bracco, Milan, Italy) was injected at a flow rate of 4 ml/s. Beta-blockers were not administered during this evaluation. The scanning protocol included both the heart and the ascending aorta; scan parameters for a 75-kg patient were: rotation time 330 ms, collimation 0.6 mm, 120 kV, tube current 600 mA, with individual adaptation of tube current and/or voltage. Radiation dose-modulation was not activated in order to obtain systolic images at full X-ray dosage; thus, the radiation dose was estimated as 20 mSv. Planimetries of the 20 first aortic valve areas were performed in consensus between two radiologists (with eight and three years' experience, respectively) in order to generate a common learning curve. The last 32 cases were performed independently by both radiologists. All 52 measurements were repeated by the senior radiologist one month after the first evaluation and compared to the previous measurements and to the effective valve area.

Analysis protocol

For each patient, 10 data sets were created for every 10% of the R-R interval. Cine images of the aortic valve were then visualized at these different phases in order to select the phase corresponding to the maximal systolic aperture of the aortic valve. When the data set had been chosen, the image showing the minimal valve area was selected for planimetry. Entire visualization of the leaflets was mandatory to select this final image. Planimetry of the aortic valve stenosis was manually traced on the final image (Figs. 1 and 2). Calcifications of the aortic valve were subjectively and independently quantified by the two radiologists on a two-point scale, with Ca1 as mild and Ca2 as heavy calcification.

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Figure 2: Planimetry of the inner contour of a mildly calcified stenotic aortic valve.

Figure 3: Planimetry of the inner contour of a heavily calcified stenotic aortic valve. Note that calcifications (in white) do not preclude tracing of the contour.

Planimetry of the LVOT area during the systolic phase was traced manually in a perpendicular section.

Statistical analysis

Data were presented as mean ± SD, unless otherwise stated. For other data, percentages were expressed with 95% confidence interval (CI). A linear regression model was used to assess the relationship between difference and average area values. Inter- and intra-observer 64-slice variabilities in CT planimetry, and agreement between the effective orifice area (EOA) and anatomic orifice area (AOA) were assessed using Bland and Altman analysis (11), since in each case the difference between the two measurements did not correlate significantly with the average value. Correlations were tested after transformation by using the z-value of Fischer to evaluate the probability of rejecting the null hypothesis (r = 0). Initially, the correlation coefficient (r) was reported, and the probability then assessed from the z transformation (*p*). Areas were also compared by ANOVA for repeated measurement with calcium score as factor, followed by Newman-Keuls post hoc subgroup testing. Inter-observer agreement for calcium scores was assessed using Cohen's Kappa test. The two groups (mildly and heavily calcified) were compared with a *t*-test. A ROC curve was used to determine an empirical threshold value for a significant aortic stenosis on 64-slice CT (versus a reference EOA stenosis ≤0.75 cm^2 on Doppler TTE). Based on that threshold value, sensitivity, specificity, accuracy, positive and negative predictive values of the aortic orifice area planimetry were assessed and compared to the effective area evaluation. All data were analyzed with Stat View™ 5.0 (SAS Institute). The Bland and Altman analysis, Cohen's Kappa test and ROC analysis were assessed with MS-Excel™. A p-value <0.05 was considered to be statistically significant.

Results

Transthoracic echocardiography

The mean stroke volume was 69 ± 20 ml, and cardiac output 4.9 ± 1.0 l/min (range: 3.2 to 7.9 l/min). In four patients the EF was <35%. The transaortic mean pressure gradient was 50 ± 20 mmHg, the aortic valve resistance 849 ± 358 dynes.s/cm^5, and the aortic effective area 0.71 ± 0.31 cm^2. Among the patients, 75% had a significant effective aortic stenosis (≤0.75 cm^2).

64-Slice computed tomography

All examinations were of good quality, allowing the evaluation of aortic stenosis in all cases. The heart rate during 64-slice CT scanning was 72 ± 14 beats/min. Planimetry of aortic stenosis was 0.84 ± 0.36 cm^2. Nineteen patients had a mildly calcified (Ca1) valve, and 33 a heavily calcified (Ca2) valve (Fig. 3). The LVOT was described as elliptical in all cases. A comparison of aortic valve calcification scores registered by the two radiologists showed excellent agreement (kappa = 0.88). An intra-observer comparison of the AOA showed a mean (± SEM) non-significant difference of -0.006 ± 0.015 cm² and a variability SD = 0.103 cm² (95% CI: -0.213 to 0.200). Inter-observer comparison showed a non-significant difference of 0.002 ± 0.019 cm² and a variability SD = 0.115 cm² (95% CI: -0.228 to 0.232).

Comparison between the two methods

Aortic valve areas assessed by the two methods were well correlated (r = 0.76; p <0.0001) (Fig. 4). 64-Slice CT significantly overestimated the aortic stenosis compared to the effective area, with a difference of 0.132 cm² (95% CI: 0.066 to 0.198) and a variability of 0.239 cm² (95% CI: -0.346 to 0.610) (Fig. 5). In a linear regression model, the discrepancy between the two evaluations of aortic valve area was not explained by cardiac output (r = 0.178, p = 0.25), mean aortic gradient (r = 0.110, p = 0.44), stroke volume (r = 0.230, p = 0.10), valvular resistance (r = 0.086, p = 0.58), LVOT planimetry on 64-slice CT (r = 0.119, p = 0.40), or calcium score (p = 0.61). Stroke volume and cardiac output did not differ when comparing mildly and heavily calcified valves (p = 0.11 and p = 0.40, respectively). The mean transaortic gradient and valve resistance were significantly higher in heavily calcified valves (p <0.0001 and p = 0.003, respectively). Aortic valve area determined by either method (TTE and 64-slice CT) was significantly less in heavily calcified valves (p <0.0001), and the difference between AOA and EOA was significant (p = 0.0002), independently of the calcium score (p = 0.61) (Fig. 6). Planimetry of the LVOT area by 64-slice CT was significantly greater than the assumed circular area computed from the TTE-measured LVOT diameter (p <0.0001).

Aortic stenosis planimetry that better corresponded to a significant effective area (≤0.75 cm²) was 0.95 cm² on ROC analysis. This cut-off value yielded a sensitivity of 32/39 (82%; 95% CI: 66 to 92), a specificity of 10/13 (77%; 95% CI: 46 to 95), an accuracy of 42/52 (81%; 95% CI: 67 to 90), a positive predictive value of 32/35 (91%; 95% CI: 77 to 98), and a negative predictive value of 10/17 (59%; 95% CI: 33 to 82). The area under the ROC curve was 0.815 (Fig. 7).

The diagnosis of significant aortic stenosis for the four patients with an EF <35%, and the four with concomitant mitral stenosis, was concordant by Doppler TTE and 64-slice CT with their respective threshold values. The difference between the AOA and EOA for each patient in AF was within 95% CI of the entire study population. Finally, 64-slice CT allowed the identification of four bicuspid aortic valves which were confirmed at surgery but not recognized at TTE. The comparison of aortic valve stenosis at 64-slice CT and at surgery is shown in Figure 8.

Discussion

Comparison between AOA and EOA

In the present study, comparison was made between planimetry of aortic stenosis on 64-slice CT and the EOA, as calculated with the continuity equation, in 52 patients. A good correlation was found between the two evaluations, with the EOA being significantly smaller, as expected by the convergent flow downstream from the stenosis (12). As shown previously, a good correlation (r = 0.79) was found when EOA evaluated by the continuity equation was compared with

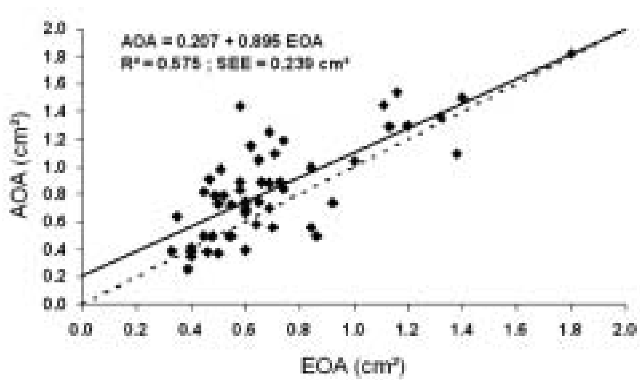

Figure 4: Comparison between the aortic orifice area measured by-64 slice CT planimetry and computed from Doppler TTE. The solid and dashed lines are the regression and identity lines, respectively, between the anatomic orifice area (AOA) and the effective orifice area (EOA). SEE: Standard error of estimate.

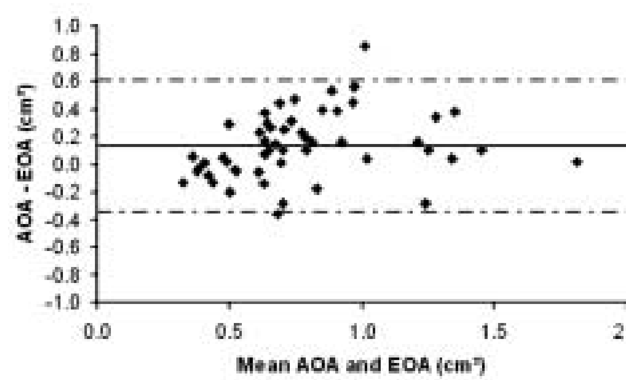

Figure 5: Comparison between the orifice area measured by 64-slice CT planimetry and computed from Doppler TTE. Bland and Altman plots of the difference between anatomic and effective area as a function of their mean value. The solid line is the difference and dashed-dotted lines are 95% limits of agreement. AOA: Anatomic orifice area; EOA: Effective orifice area.

that obtained at catheterization (5) if pressure recovery is negligible (13). A very good correlation (r = 0.96) was also found when anatomic area planimetries on TEE and MRI were compared (6). Comparison between the areas drawn on TEE and Doppler TTE was good in previous studies (r = 0.96 and 0.83) (4,5). However, MRI planimetry of the aortic stenosis was less well correlated with the EOA measured during cardiac catheterization (r = 0.64) (6). A recent study (7) which compared 16-slice CT planimetry with Doppler TTE-measured EOA in 30 patients with asymptomatic aortic stenosis did not include those presenting with arrhythmia or associated mitral stenosis, as in the present study. A larger volume (120 ml) of iodine contrast agent was injected, and beta-blocker used when the heart rate was >80 bpm. The correlation was better (r = 0.89) in this selected population. The present population is more representative of all symptomatic patients evaluated for aortic stenosis, and the study was conducted within a daily clinical routine.

Multi-slice CT and the continuity equation respectively measure the maximal and mean areas of the stenosis during systole. A previous report showed good correlation between these two measurements when planimetry of the aortic stenosis was performed on TTE or TEE (3). This better correlation than that obtained with the mean planimetry of the stenosis in systole may be explained by a shorter duration of flow through the stenotic valve compared to its opening, and a shorter maximal opening of stenotic compared to normal valves (3,14,15).

Calcification of the stenotic valve

Aortic valve calcification did not preclude valve planimetry in the present study. Planimetry on TEE is sometimes difficult due to the shadowing effect of calcifications on the lumen area, and this was the main reason for discrepancy between TEE and TTE evaluations (16). A recent study showed that calcification evaluated by electron beam CT correlated well with calcium weight obtained after digestion of the aortic valve tissue. The calcifications were well correlated with the area of aortic stenosis, and also predicted the events (17). The calcium score correlated with the effective and anatomic areas, with an overlap between mildly and heavily calcified valves. As reported previously by Messika-Zeitoun, the relationship between calcium score and effective area is depicted by a curvilinear relationship (17). As calcium scoring adds a prognostic factor which is independent of the effective aortic valve area (17), the information obtained with Doppler TTE and multi-slice CT appear complementary.

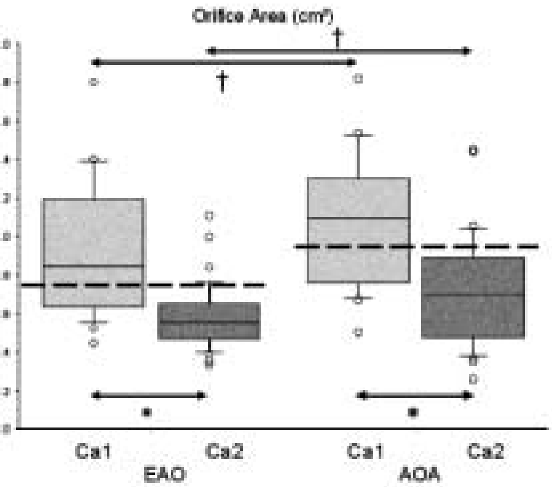

*Figure 6: Box and whisker plots. The box is defined by the lower and upper quartiles; the horizontal line in the center of the box is the median. The bars at the end of each vertical line are the lower and upper deciles, and the open dots are individual values outside these deciles. Dashed lines are cut-off values for significant aortic stenosis evaluation by Doppler TTE and 64-slice CT planimetry. Heavily (Ca2) and mildly (Ca1) calcified valves are in separate columns for each method. †, p <0.002; *, p <0.001; difference between methods of area measurement are independent of calcium score (p = 0.610). AOA: Anatomic orifice area; EOA: Effective orifice area.*

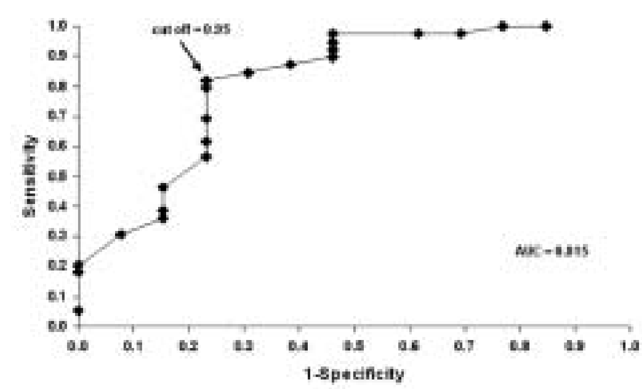

Figure 7: Receiver operating characteristic (ROC) curve for detection of a significant aortic stenosis by 64-slice CT planimetry (significant aortic stenosis is an effective area ≤0.75 cm^2 on Doppler TTE). AUC: Area under the ROC curve.

Table I: Baseline patient characteristics and principal echocardiographic results.

Patient	Gender	Age (years)	Rhythm	AVD	Valve morphology	SV (ml)	Mean gradient (mmHg)	EOA (cm^2)	Symptoms	Treatment
1	F	85	SR	-	Tri	107	25	1.13	A	No surgery
2	F	69	SR	-	Tri	90	78	0.60	D	Aortic valve surgery
3	M	65	SR	-	Tri	85	37	0.86	D	Aortic valve surgery
4	F	67	SR	-	Tri	69	35	0.69	D, A	Aortic valve surgery, CABG
5	F	77	SR	-	Tri	57	55	0.55	D	Aortic valve surgery, CABG
6	F	82	SR	-	Tri	96	100	0.60	D, A	Aortic valve surgery, CABG
7	F	81	SR	-	Tri	59	70	0.48	D	Aortic valve surgery, CABG
8	F	85	SR	-	Tri	51	85	0.40	CHF, A	Aortic valve surgery
9	F	88	SR	-	Tri	53	54	0.45	D	Aortic valve surgery
10	M	75	SR	-	Tri	80	20	1.32	S	No surgery
11	M	79	PM	-	Tri	87	25	1.38	A	Aortic valve surgery, CABG
12	M	71	AF	MS	Tri	87	42	1.00	TIS	Aortic and mitral surgery
13	M	70	AF	MS	Tri	60	94	0.40	D	Aortic and mitral surgery
14	M	73	SR	-	Tri	50	32	0.65	CHF, A	Aortic valve surgery
15	F	75	SR	-	Tri	139	59	1.11	D	Aortic valve surgery
16	M	72	SR	-	Tri	62	51	0.51	D, A	Aortic valve surgery, AAG
17	M	70	SR	-	Tri	104	26	1.40	A	CABG
18	F	89	SR	-	Tri	38	65	0.35	D	Aortic valve surgery, AAG
19	F	30	SR	-	Tri	39	90	0.33	D, S	Aortic valve surgery
20	M	88	AF	-	Tri	51	62	0.45	A	Declined surgery, coronary angioplasty
21	F	80	SR	-	Tri	76	20	1.20	A	No surgery
22	M	82	SR	-	Tri	51	59	0.40	A	Aortic valve surgery, CABG
23	F	78	SR	-	Tri	68	51	0.60	D, S	Aortic valve surgery, CABG
24	M	69	SR	-	Tri	55	69	0.47	D	Aortic valve surgery, CABG
25	F	70	AF	-	Bi	56	43	0.74	D, A, S	Aortic valve surgery
26	F	68	SR	-	Tri	55	67	0.52	D, A	Aortic valve surgery, myomectomy
27	F	82	SR	-	Tri	82	47	0.70	D	Aortic valve surgery
28	M	74	SR	-	Tri	68	40	0.65	D, A	Aortic valve surgery
29	M	78	SR	-	Tri	94	53	0.64	A	Aortic valve surgery, CABG
30	F	75	SR	-	Bi	54	28	0.71	D	Aortic valve surgery
31	F	75	SR	-	Tri	57	52	0.61	D, A	Aortic valve surgery
32	M	67	SR	-	Tri	52	55	0.49	CHF	Aortic valve surgery
33	M	61	PM	-	Tri	73	35	0.84	CHF	Aortic valve surgery
34	M	62	SR	-	Tri	68	14	1.80	A	Coronary angioplasty
35	M	68	SR	-	Tri	87	27	1.16	D, A	Coronary angioplasty
36	F	75	SR	-	Tri	66	37	0.62	CHF	Aortic valve surgery
37	F	71	AF	-	Tri	59	49	0.58	CHF	Aortic valve surgery
38	M	81	SR	-	Tri	59	43	0.55	D, S	Declined surgery
39	M	71	SR	MS	Tri	46	50	0.50	CHF	Aortic and mitral surgery
40	M	77	SR	-	Tri	80	62	0.66	D, A	Aortic valve surgery
41	M	58	SR	-	Bi	68	44	0.73	D, A, S	Aortic valve surgery
42	F	82	PM	-	Tri	68	71	0.46	D	Aortic valve surgery, CABG
43	M	81	SR	-	Tri	59	46	0.54	A	Aortic valve surgery, CABG
44	F	79	SR	MS	Tri	47	35	0.58	CHF	Aortic and mitral surgery
45	F	69	SR	-	Bi	65	34	0.69	D, A	Aortic valve surgery, AAG
46	M	72	AF	-	Tri	48	67	0.39	D, S	Aortic valve surgery, CABG
47	F	80	SR	-	Tri	85	27	0.92	CHF	Coronary angioplasty
48	M	78	SR	-	Tri	70	33	0.74	D	Aortic valve surgery
49	M	79	SR	-	Tri	59	50	0.58	D	Aortic valve surgery
50	M	65	SR	-	Tri	83	46	0.69	D	Aortic valve surgery
51	M	83	SR	-	Tri	112	55	0.84	A	Aortic valve surgery, CABG
52	F	85	SR	-	Tri	63	63	0.50	CHF	Declined surgery

A: Angina; AAG: Ascending aortic graft; AF: Atrial fibrillation; AVD: Associated valvular disease; Bi: Bicuspid; CABG: Coronary artery bypass graft; CHF: Congestive heart failure; D: Dyspnea; EOA: Effective orifice area; MS: Mitral stenosis; PM: Pacemaker; S: Syncope; SR: Sinus rhythm; SV: Stroke volume; TIS: Transient ischemic stroke; Tri: Tricuspid.

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Flow variation

Previous studies have shown the effect of instantaneous systolic flow on AOA (3) and EOA (14,15,18); one experimental protocol also confirmed the real change in EOA (19) and AOA (20) with flow. In the present study, the two evaluations were not made simultaneously, and 64-slice CT necessitated an iodine injection (95 ml) which may have modified the stroke volume and cardiac output compared to the steady state. Beta-blockers were not administered prior to 64-slice CT. In the present study, among patients in whom cardiac output might have varied the most (EF <35%, mitral stenosis, AF), the difference between the two evaluations of AOA and EOA was within the confidence interval found for the remainder of the population. No linear correlation was found between the difference of the two evaluations and cardiac output (range 3.2 to 7.9 l/min).

LVOT area

TTE assumed a circular outflow tract area, and underestimated the LVOT planimetry. This last section drawn on 64-slice CT always appeared elliptical, as noted previously by Baumgartner et al. on TTE (21). However, no linear correlation was found between the LVOT area planimetry and the difference between the two evaluations of aortic valve area ($p = 0.40$). Therefore, 64-slice CT can be used to identify a significant aortic stenosis after correcting for a larger threshold value (0.95 cm^2) than the effective area, and to identify valvular calcifications which are important for predicting events and evaluating surgical risk. Although the present planimetry was shown to be highly reproducible, 64-slice CT evaluation has some limitations as it provides an instantaneous picture of the maximal aperture of the stenotic valve. As suggested previously, the dynamic flow through the aortic stenosis may explain why some patients with the same anatomic area are symptomatic, while others are not (14). Symptoms for the same valve area may be due to many factors, including left ventricular function, the shape and area of the outflow tract, the shape of the stenotic valve (22), the degree of valvular calcification (17), and valvulo-arterial impedance (23). However, Doppler TTE seems more appropriate for following and predicting the progression of an aortic stenosis by the rate of change of the EOA during a cardiac cycle (18).

Study limitations

The primary limitation was that the calcium evaluation was subjective and only semi-quantitative following contrast injection to avoid additional radiation exposure on unenhanced acquisition. The substantial radiation level (20 mSv) was tolerated by the elderly population, with an unlikely long-term radiation risk. The decision was taken to reconstruct images at 10% of the R-R interval; this corresponded to a mean interval of 85 ms, which is about half the temporal resolution for creating one image. It cannot be excluded that a closer interval (e.g., 5% of the R-R interval) may have been slightly more accurate when determining the maximal aperture of the aortic valve, but this would have increased substantially the number of images required (up to 6000 per patient), thereby increasing the time of analysis and lengthening the routine clinical evaluation.

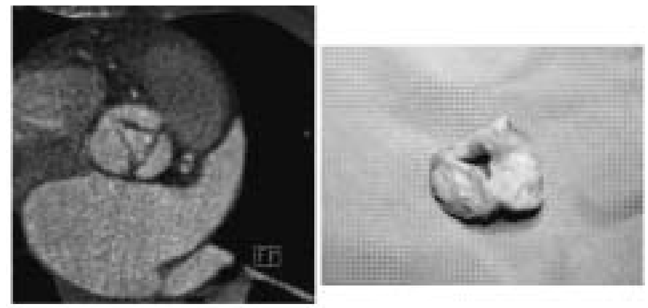

Figure 8: Comparison of aortic valve stenosis at 64-slice CT (left) and at surgery (right).

A second point was that 64-slice CT- and TEE-derived aortic valve planimetries were not compared due to previously described limitations of TEE in heavily calcified valves (16), and because the study was intended to be non-invasive. However, the calcifications did not preclude measuring the aortic valve area in 64-slice CT, which is in agreement with the results of Alkhadi et al. (8) on 20 aortic stenoses evaluated by 16-slice CT.

The third point was that the continuity equation assumes the same level for measuring LVOT diameter and velocity, and assumes a laminar flow in the LVOT, which may be inaccurate. It is also possible that the maximal pressure gradient across the aortic valve was missed, despite being measured in three different views for each patient. Finally, no evaluation was made of the reproducibility of TTE as a reference method, as was performed for 64-slice CT. Although a close correlation ($r = 0.92$, $p < 0.001$) had been demonstrated previously (24), the major source of disagreement was in the measurement of the LVOT diameter.

Clinical implications

From a clinical standpoint, it may in future prove useful to employ 64-slice CT in patients with a dynamic subaortic gradient, when there is inadequate measurement of the LVOT or a poor acoustic window, and/or where the evaluation of aortic stenosis using Doppler TTE is more difficult. Multi-slice CT has also been shown valuable for assessing concomitant coronary artery disease (25) and evaluating the atheromatous burden of the aortic arch in a preoperative setting.

In conclusion, planimetry of the aortic valve area using 64-slice CT is not only reproducible but can also be used in the accurate identification of patients with severe aortic stenosis. This provides an additional and complementary approach in the evaluation of these patients.

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