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Hemodynamic Effect of Transcatheter Aortic Valve Replacement in Low Gradient Severe Aortic Stenosis

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Background: Patients with aortic valve area (AVA) <1.0 cm2, low transvalvular gradient and normal ejection fraction (EF) may represent a subgroup with an advanced stage of aortic stenosis with poor prognosis. We retrospectively evaluated the hemodynamic outcomes of transcatheter aortic valve replacement (TAVR) in patients with high operative risk and low-gradient aortic stenosis (LGSAS) defined as AVA <1.0 cm2 and mean gradient ≤40 mm Hg.
Methods: The hemodynamic effect of TAVR in patients with LGSAS was compared to effect of TAVR in patients with typical severe aortic stenosis (AVA <0.1 cm2; mean gradient > 40 mm Hg) using echocardiography.
Results: Among 104 symptomatic patients (mean age, 83±7 years; EuroScore 31±15), baseline echocardiography revealed typical severe aortic stenosis in 72 (69%) patients and LGSAS in 32 (31%). Baseline EF was higher in patients with LGSAS than in those with typical severe aortic stenosis (54±13% versus 62±6%; P<0.01). All patients underwent successful TAVR. At 30 months of follow-up, there was a significant reduction of end systolic volume in patients with typical severe aortic stenosis (46±23ml to39±22ml, p<0,001), and patients with LGSAS (32±10ml to 28±11ml, P<0.001). Similarly, both patients with typical severe aortic stenosis and with LGSAS experienced increase in EF (52±12% to 60±13%, p<0.001 and 62±6% to 67±7%, p<0.001 respectively). There was reduction of systolic pulmonary artery pressure in the patients with typical aortic stenosis (43±13mmHg to 38±13mmHg, p=0.003), and the patients with LGSAS (41±14mmHg to35±11mmHg, p=0.003).
Conclusion: TAVR provides similar hemodynamic benefit in patients with high risk LGSAS to that in patients with typical aortic stenosis.

Myocardial Mechanics in Asymptomatic Versus Symptomatic Patients with Severe Aortic Stenosis

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Background: Symptomatic patients (pts) with severe aortic stenosis (AS) demonstrate abnormal left ventricular (LV) mechanics. We compared LV mechanics in asymptomatic and symptomatic pts with severe AS using 2-D myocardial strain imaging.
Methods: The study group included 53 pts with severe AS (aortic valve area [AVA] ≤1.0cm2), normal LV ejection fraction (LVEF>50%), and without segmental wall motion abnormalities. LV longitudinal and circumferential strain and rotation were measured in 21 asymptomatic pts and compared to 32 age and gender-matched pts with AS-related symptoms and to 21 normal subjects without AS.
Results: Patients with asymptomatic severe AS demonstrated less decreased longitudinal strain, higher (supernormal) apical circumferential strain, and extreme (supernormal) apical rotation, compared to symptomatic patients.

* p<0.05, compared to normal; †p<0.05, compared to symptomatic pts.

Conclusions: Compensatory mechanisms of myocardial mechanics in asymptomatic pts with severe AS (increased apical circumferential strain and rotation) are lost with the appearance of symptoms. Thus, myocardial mechanics may help in the follow up of pts with severe AS and timing of valve surgery.

Determinants of Symptoms in Aortic Stenosis: Influence of Longitudinal Strain

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Background: Global and Basal Longitudinal strain (GLS/BLS) as assessed using two-dimensional speckle-tracking imaging have been proposed as subtle marker of left ventricular (LV) systolic dysfunction with a promising prognostic value in asymptomatic patients with aortic stenosis (AS). However, the relationship between longitudinal strain, functional status, AS severity and LV ejection fraction (LVEF) remained unclear.
Methods: GLS and BLS were measured in 171 patients with pure, isolated, and at least mild AS prospectively enrolled at two institutions. We divided our population into 4 groups: asymptomatic non-severe AS (N=55), asymptomatic severe AS with preserved LVEF (N=37), symptomatic severe AS with preserved LVEF (N=60) and severe AS with reduced LVEF (< 50%) (N=19).
Results: GLS was significantly different among the 4 groups ($p<0.0001$) but the difference was mainly due to patients with reduced LVEF. In addition, there was an important overlap between groups and in multivariate analysis, after adjustment for age, gender, AS severity and LVEF, GLS was not an independent determinant of the functional status ($p>0.07$). BLS was also significantly different between the 4 groups ($p<0.0001$) but in contrast to GLS, BLS was an independent determinant of the functional status ($p< 0.01$). However, as for GLS, there was an important overlap and differences between groups were close to intra- or inter observer variability (1.3±1.1% and 2.0±1.6% respectively).
Conclusions: In this prospective multicenter cohort of patients with AS, we showed that BLS but not GLS was independently associated with symptomatic status. However, there was an important overlap between groups and differences were small, close to measurements' reproducibility raising caution regarding the use of longitudinal strain in the decision-making process of patients with severe AS.

Routine Use of Energy Loss Index to Correct for Pressure Recovery May Overestimate Aortic Valve Area

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Background: Pressure recovery phenomenon can potentially cause underestimation of effective aortic valve area (AVA) by transthoracic echocardiography (TTE). It was therefore recommended to use the energy loss index (ELI) for assessment of aortic stenosis (AS). ELI=AVA×AA/(AA-AVA, AA=proximal aortic area. The aim of this study was to compare ELI and AVA using TTE and cardiac computed tomography angiography (CCTA).

Methods: We prospectively studied 25 patients (72±14y, 11 males) with AS. AVA was estimated using: 1) TTE and the continuity equation assuming a circular left ventricular outflow tract (LVOT) 2) TTE using CCTA measured LVOT area (LVOTa) in the continuity equation, since in most cases the LVOT is oval and not circular ($AVA_{CCTA\text{-}LVOTa}$) 3) ELI using CCTA measured AA and $AVA_{CCTA\text{-}LVOTa}$ in the equation 4) CCTA planimetry AVA. TTE estimated AVA and ELI were correlated with CCTA AVA.

Results: TTE AVA (assuming a circular LVOT) was 0.92±0.44 cm 2. AVA CCTA-LVOTa was 1.08±0.54 cm 2, which was very similar to CCTA AVA (1.14±0.68 cm 2,p=0.3). There was excellent correlation between AVA CCTA-LVOTa and CCTA AVA (r=0.94). ELI was 1.35±0.83 cm 2, and although there was still a good correlation with CCTA AVA (r=0.91), it significantly overestimated AVA compared to CCTA (p=0.0004, Figure). Sixteen patients (64%) had a small proximal aorta (<3 cm). Even in this group, ELI overestimated AVA (+0.22±0.26 cm 2, p=0.003).

Conclusions: Routine use of ELI in patients with AS to compensate for pressure recovery may cause overestimation of TTE AVA when using the correct LVOTa measurement in the continuity equation. In cases with small proximal aorta in whom underestimation of AVA by TTE is suspected, invasive hemodynamic assessment is indicated.

Valve Area Versus Pressure Gradient in Aortic Stenosis with Preserved Left Ventricular Function

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Background: Recent studies have shown a high frequency of discordance between aortic valve area (AVA) and trans-valvular pressure gradients (PG) in patients (pts) with severe aortic stenosis (AS) and preserved left ventricular ejection fraction (LVEF).
Methods: Consecutive pts with moderate or severe AS (AVA ≤1.5 cm2) and preserved LVEF (≥50%) were identified and the relationship between AVA and mean PG was examined. The characteristics of pts with severe AS (AVA <1.0 cm2) and low PG (<40 mmHg) were compared to those of pts with severe AS and high PG (≥40 mmHg).
Results: During 3 years 619 pts fulfilled the inclusion criteria (age 76±11 yr, 40% male). Among 265 pts with severe AS, 193 had high PG (73%) and 72 had low PG (27%) (Figure). Among 354 pts with moderate AS (AVA 1.0-1.5 cm2), 303 had low PG (86%) and 51 had high PG (14%). AVA and PG were concordant (high PG in pts with severe AS and low PG in pts with moderate AS) in 496 (80%) pts; concordance was similar (77%) when AVA was indexed to body surface area (severe AS = AVA <0.6 cm2/m2). <IMAGE03>
Pts with severe AS and low PG were older (80±10 vs. 76±11 yr), had a higher frequency of atrial fibrillation (21% vs. 9%), had larger AVA (0.86±0.12 vs. 0.74±0.15 cm2) and indexed AVA (0.51±0.08 vs. 0.42±0.09 cm2/m2) and smaller stroke volume (77±14 vs. 90±19 ml) and relative wall thickness (0.41±0.09 vs. 0.49±0.09), compared to pts with high PG (all P values <0.05). There were no differences in gender, body size, heart rate, LVEF, left ventricular (LV) mass, LV outflow tract diameter, severe right ventricular dysfunction, or severe valve regurgitation (aortic, mitral or tricuspid).
Conclusions: The concordance between AVA and PG in pts with moderate or severe AS is higher than previously reported. The discordance between AVA and PG in pts with severe AS is partial explained by differences in age, heart rhythm, AS severity (less severe AS in pts with low PG), stoke volume (lower stroke volume in pts with low PG), and LV remodeling.

Cardiac Remodeling in Patients after TAVI: Left Ventricular Mass Regression and Survival

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Background: The influence of left ventricular mass regression on survival of patients with severe aortic stenosis after transcatheter aortic valve implantation (TAVI) is not known.
Methods: Echocardiography was performed at baseline, after one month, and at one-year follow-up in 58 consecutive patients with severe aortic stenosis who underwent TAVI. The LV mass was calculated using the Devereux formula and indexed to body surface area. Pairwise comparisons for repetitive measures with Bonferroni post-hoc adjustment of confidence intervals were used to test significance of LV mass regression on survival.
Results: Average age of patients was 80.6± 6.6 years. At the baseline, average peak aortic valve gradient was 75 ±20 mmHg, average mean 47 ± 12 mmHg. Overall mortality was 21%. The LV mass index decreased from 134 ± 6.1 g/m2 at baseline to 112 ± 6.3 g/m2after one month follow-up ($p < 0.001$) and 97±4.7 g/m2 after one year follow-up ($p < 0.0001$). Average LV mass reduction of 21 g/m2 after one month and 37 g/m2 after one year was significantly correlated with overall survival ($p=0.026$).
Conclusion: TAVI had positive effect on cardiac remodeling and LV regression was associated with better survival of patients with severe AS.

Is Mitral Regurgitation Reversible in Patients Undergoing TAVI?

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Background: Significant Mitral Regurgitation (MR) is often present in pts with severe aortic stenosis (AS) undergoing Transcatheter Aortic Valve Implantation (TAVI). Detection of MR in such pts is crucial as it can independently affect functional status and prognosis.
Aim: To define the short term effect of TAVI on MR severity.
Methods: Comprehensive echocardiographic studies were performed in all TAVI pts before procedure and before hospital discharge. MR was classified according to vena contracta (VC) and visual assessment as absent, mild, moderate or severe.
Results: In our department, 75 pts underwent TAVI since 2008. A balloon expandable valve was implanted (Edwards-Sapien- 69 pts, Medtronic-6pts); 59 by retrograde transfemoral, 15 by anterograde transapical and 1 by subcalvian approach. Aortic peak/mean gradient in pre and post TAVI were 87.1±26/49.8±18mmHg and 22.4±11 /12.4±7mmHg respectively ($p<0.0001$ for both). Mild aortic incompetence (AI) post TAVI was observed in 24(31%) pts, moderate in 16(20%) pts. No patient had severe AI. Severity of MR: visual assessment (see Table).

	Absent	Mild	Moderate	Severe
Pre TAVI	11 (15%)	16 (21%)	27 (36%)	21 (28%)
Post TAVI	19 (25%)	22 (29%)	21 (28%)	13 (17%)

Mean VC was 0.42±0.17cm before TAVI and 0.37±0.16cm after procedure ($p=0.005$).31(41%) of pts had coronary artery disease (CAD), 60(80%) had mitral annulus calcification (MAC) and 34(45%) had organic mitral valve disease (OMVD). No relation was found between presence of CAD, MAC or OMVD and improvement of MR degree or VC ($p>0.1$ for all). In 19 (25%) pts MR improved by 1 grade, 7 (9%) by 2 grades, no change in 38 (51%) and worsening in 9 (21%) pts.
Conclusions: Degree of MR improves post TAVI, regardless of etiology of MR and pathology of the mitral valve. Long term assessment of MR should be performed in order to confirm persistence of MR improvement.

Trans-Esophageal Echocardiography in Patients with Low Gradient Severe Aortic Stenosis

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Background and purpose: Grading aortic stenosis (AS) and management decisions are challenging when echocardiographic data is discordant. The aim of the study was to assess the value of Trans-Esophageal Echocardiography (TEE) in patients with low gradient severe AS and normal LV systolic function.
Methods: Retrospective study of patients who had TEE within 6 months of having a Trans-Thoracic Echocardiography (TTE) for the evaluation of AS. Patients with normal left ventricular systolic function, aortic valve area (AVA) corresponding to a severe grade of stenosis as assessed by the continuity equation but gradients corresponding to non-severe AS were included.
Results: 39 patients had TTE and mean time to TEE was 53 ± 52 days. Age was 76 ± 10 years and 72% were female. Functional capacity class was 2.7 ± 0.7. The main symptom was dyspnea in 67% of patients. There was no difference between TTE and TEE aortic valve peak and mean gradients (54±9 and 54±11; 34±6 and 33±7mmHg, respectively) nor between TTE and TEE AVA assessed by the continuity equation (0.78 cm^2±0.15 and 0.77 cm^2±0.20, respectively). AVA planimetry was measured in 8% of patients at TTE and in 85% at TEE. There was a trend for a larger left ventricular outflow tract diameter (LVOTd) in TEE compared to TTE (21.9±2.5mm vs. 19.8±2.1mm, respectively; $p = 0.06$). AVA assessed by planimetry in TEE was significantly larger than AVA assessed by the continuity equation in TTE (0.89±$0.^2$vs. 0.78±0.15cm^2, respectively; $p = 0.01$). 15 patients underwent aortic valve replacement or implantation of a stented valve at 8.5 ±11 months from TTE. 12 patients died at a mean time of 20.1 ± 19 months from TTE.
Conclusion: TEE provides valuable data for the assessment of patients with low gradient severe AS. AVA planimetry and accurate measurement of LVOTd are extremely important when decision for intervention is necessary in this group of symptomatic patients with poor functional class and high morbidity and mortality.