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Ventriculo-arterial coupling in severe aortic stenosis: does the flow-gradient pattern play a role?

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Funding Acknowledgement: This work was supported by CREDO Project - ID: 49182, financed through the SOP IEC -A2-0.2.2.1-2013-1 cofinanced by the ERDF

Background: Ventriculo-arterial coupling (VAC) assesses the interplay between ventricular contractility and afterload and it is calculated as the ratio between arterial elastance (Ea) and end-systolic left ventricular elastance (EES). Severe aortic stenosis (AS) carries different configurations according to transvalvular flow rates and pressure gradients and each of these entities has its particularities in terms of physiology and clinical outcome. Little has been studied so far regarding the changes of VAC in severe AS.

Purpose: We sought to assess the VAC non-invasively in patients (pts) with severe AS and to characterize it according to the flow-gradient pattern.

Methods: We included 61 consecutive pts with severe AS (78±13 years, 30 men, indexed aortic valve area <0.6 cm^2/m^2), for whom we performed a comprehensive echocardiography. VAC was determined as the ratio between Ea and EES. Patients were divided in 4 groups, depending on stroke volume index (low-flow [LF] vs. normal-flow [NF]: 35 ml/m^2) and mean transaortic pressure gradient (low-gradient [LG] vs. normal gradient [NG]: 40 mm Hg). This resulted in the following flow-gradient patterns: LFLG, LFNG, NFLG, NFNG. Data were compared between groups with one-way analysis of variance and then with a Tukey test.

Results: There were 11 pts (18%) in the LFLG group, 20 pts (32.8%) in the LFNG group, 8 pts (13.2%) in the NFLG group and 22 pts (36%) in the NGNG group. The arterial elastance was highest in the LFLG group: 3.37±1.49 vs. 2.79±0.92 in the LFNG, 2.05±0.57 in the NFLG and 1.54±0.49 in the NFNG group ($p<0.001$). The ventricular elastance was also highest in the LFLG group (4.03±2.46) vs. 3.16±1.33 in the LFNG, 2.21±1.22 in the NFLG and 2.29±0.78 in the NFNG group (p=0.007). VAC was most impaired in the NFLG group (1.35±1.08), followed by LFNG group (1.00±0.47), LFLG group (0.93±0.27) and NFNG group (0.70±0.14) (p=0.01). Valvulo-arterial impedance (ZVA) was highest in the LFNG group: 7.78±2.15, followed by 7.38±2.17 in the LFLG group, 4.93±1.17 in the NFLG group and 4.33±1.23 in the NFNG group ($p<0.001$). VAC and ZVA showed no significant correlation (p=0.27), with VAC being significantly more impaired in patients with abnormal ZVA (>4.5 mm Hg/ml/m^2): 0.99±0.60 vs. 0.73±0.20 (p=0.02).

Conclusion: The ventriculo-vascular interaction in severe AS varies noticeably according to the flow-gradient pattern. Low-gradient states, particularly NFLG, have the most impaired VAC. This study supports the idea that these 4 configurations are different clinical entities and it highlights the importance of integrating the flow-gradient pattern for a comprehensive evaluation of AS severity.

	LFLG	LFNG	NFLG	NFNG	
Ea	3.37±1.49	2.79±0.92*	2.05±0.57§	1.54±0.49§	P<0.001
EES	4.03±2.46	3.16±1.33	2.21±1.22§	2.29±0.78§	P=0.007
VAC	0.93±0.27	1.00±0.47	1.35±1.08*	0.70±0.14	P=0.01
ZVA	7.38±2.17	7.78±2.15*¤	4.93±1.17§	4.33±1.23§	P<0.001

* significant difference with NFNG group; § significant difference with LFLG group;
¤ significant difference with NFLG group