JMS 2018:1(2):9-14
UDC: 616.132-007.271-089.843-073.432.19

Evaluation of the Left Ventricular Global Longitudinal Strain in Patients with Severe Aortic Stenosis that undergo Surgical Aortic Valve Replacement: a Case Report

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Abstract

Degenerative aortic stenosis is the most common valvular disease for which treatment of choice is stil surgery. Without the presence of symptoms, evaluation of systolic function of the left ventricle (LV) is crucial in surgical treatment decision making. Global longitudinal strain (GLS) is a valuable marker for subclinical systolic dysfunction delivering promising conditions for the right timing of the surgical aortic valve replacement (SAVR).

We present a case of a 57-year old male with severe aortic stenosis. Detailed echocardiographic examination was performed including GLS of the LV with 2D speckle tracking before and after SAVR.

The ejection fraction before and after the surgical treatment was normal. GLS before the surgical treatment was -15, 1%, for 3-chamber GLS the value was -15,3%; for 4-ch it was -14,2% and 2-ch counted -16%. After replacement of the aortic valve with mechanical prosthesis, the echocardiographic assessment done 4 months later showed improvement of the GLS values to -17,1% (-18,5% for 3-ch, -15,0% for 4-ch and -17,1% for 2-ch).

Global longitudinal strain (GLS) of the LV is abnormal in patients with severe aortic stenosis. Surgical treatment of aortic stenosis improves GLS of the LV implicating improvement of the subclinical systolic dysfunction of the LV.

Key words: aortic valvular stenosis, longitudinal strain, systolic function, echocardiography

Introduction

Aortic stenosis(AS) is one of the most common valvular heart disease, most often caused by degeneration [1]. It is considered that in Western countries 3% of the population aged over 75 years have severe aortic stenosis [2].The assessment of symptoms and left ventricular (LV) function are key components in risk stratification and clinical decision making for timing of treatment of the valvular disease [3]. Current guidelines indicate ejection fraction (EF) as key marker for indication of surgical treatment[4,5]. However, patients with AS have evidence of subclinical LV systolic dysfunction despite preserved EF [6,7]. In patients with AS, EF may remain normal for years despite the occurrence of deep structural and functional changes that may affect the clinical outcome [8].

One of most valuable method for assessing subclinical dysfunction is echocardiographic assessment of longitudinal myocardial strain with 2D-speckle tracking [9,10,11]. Strain and strain rate are parameters of myocardial deformation and therefore can detect subclinical impairment [11,12,13,14]. Several studies suggested that global longitudinal strain (GLS) of the LV is impaired in AS [11,15,16,17.18]. GLS is the most accurate marker of myocardial fibrosis and compared to other indexes of LV systolic function, the parameters of LV longitudinal kinetics are superior in detecting myocardial dysfunction and damage. GLS represents an important parameter for prediction of AS severity, symptom appearance, exercise intolerance and worse prognosis [19,20]. According to latest guidelines in general, values less than -20% are considered reduced and there are different cut off values suggested for different vendors [21,22,23,24].

Case Presentation

A 57-year old man presented with complains of fatigue that started 2 years prior and dizziness that is progressing for the last couple of months. The patient had hypertension and dyslipidemia being on regular therapy with angiotensin receptor blockers, beta blocker, statin and aspirin 5 years prior. Analysis of the electrocardiogram reveals signs of left ventricular hypertrophy.

Transthoracic 2D echocardiography was performed showing normal left ventricular inner dimensions, preserved left ventricular ejection fraction, concentric hypertrophy with increased LV mass, increased left atrial indexed volume (LAVI) and diastolic dysfunction of second degree (Table 1).
Echocardiographic evaluation of the aortic valve suggested severely calcified valve creating severe stenosis with maximal velocity of 4.2 m/s, mean gradient of 50 mmHg and aortic valve area (AVA) of 0.9 cm^2 as well as indexed AVA of 0.4 cm2. Evaluation of the global longitudinal left ventricular deformation was performed using 2D speckle tracking according to the guidelines of profesional societies (Table 2).

Preoperatively coronary angiography was performed that didn't show significant coronary disease. Considering the severity of the aortic valve disease, the progression of symptoms and absence of contraindications for surgical treatment, the patient was referred for surgical aortic valve replacement (SAVR).

Table 1. 2D echocardiography before and aftr (4 months after) surgery of the aortic valve (SAVR)

Parameters	**Before SAVR**	**After SAVR**
LVEDd (mm)	61	59
LVEDs (mm)	44	40
IVSd (mm)	19	12
LPWd (mm)	14	12
LVM/BSA (g/m^2)	222.07	138.84
LVEF (%)	75	60
LA/BSA (mm/m^2)	22.27	20.45
LAV/BSA (ml/m^2)	62.96	49.17
E/A	0.76	1.0
DT (ms)	167	70
E/e' avarage	16.2	7.4

LVEDd-left ventricular end-diastolic dimension; LVEDs-left ventricular end-systolic dimension; IVSd –interventricular septum in diastole; LPWd- posterior wall in diastole LVM- left ventricular mass; BSA- body surface area; LVEF- left ventricular ejection fraction; LA-left atrium; LAV- left atrial volume; E/A – trans mitral flow; DT- deceleration time; E/e'= early mitral inflow velocity and early diastolic mitral annular Tissue Doppler velocity ratio

Following general anaesthesia, SAVR was performed under cardiopulmonary bypass without cardiac arrest under normothermic conditions (> 34ºC) applying bicaval venous cannulation, coronary sinus (CS) cannulation and continuous retrograde and ante grade tepid blood perfusion - beating heart methodology.

We controlled the mean systemic arterial pressure at 65 mmHg and used a blood auto-reinfusion system (auto trans®). Mechanical aortic valve was implanted and early postoperative period was uneventful.

Four months after surgical treatment echocardiographic and clinical re-evaluation was performed. The patient reported that he was feeling well, denying any dizziness or fatigue having regular physical activity like walking 4-5 kilometers at least 3 times per week. After 4 months echocardiographic examination was done and results are shown in Table 1 and Table 2. There was normal positioning of the mechanical valve in the aortic valve position without paravalvular leak. Maximal velocity through the aortic valve was 1.7 m/s. There was marked reduction in the concentric hypertrophy and indexed LV mass, reduction of LA volume and reduction of the left ventricular filling pressure.

Left ventricular GLS values after 4 months showed improvement in terms of higher negative values in the 17 segments model (Table 2, Figure 1).

Table 2. GLS values before and 4 month after SAVR

Parameters	Before SAVR	After SAVR
3ch GLS (%)	-15.3	-18.5
4ch GLS (%)	-14.2	- 15.0
2ch GLS (%)	-16.0	-17.1
GLS (%)	-15.1	-17.1

GLS-Global Longitudinal Strain

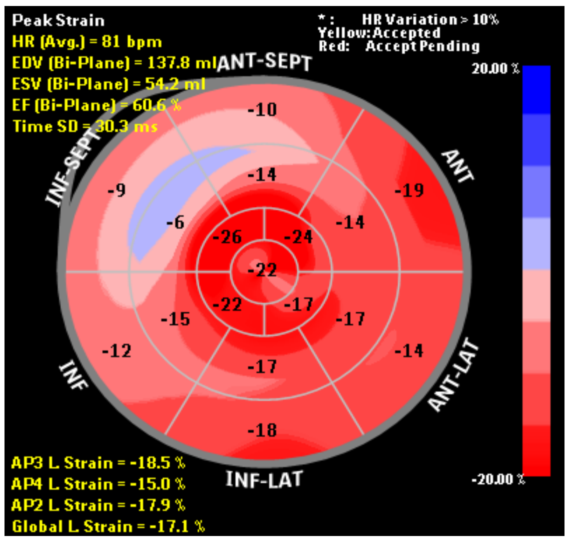

Figure 1. "Bull's eye" presenting GLS values of the17 segments of the left ventricle 4 months after SAVR

Discussion

Aortic stenosis develops as a result of inflammatory, fibrotic and osteogenic processes which leads to fibrosis that manifest as impairment of myocardial contractility and reduced EF [25]. Current guidelines recognize reduction of EF as a class I indication for SAVR [26]. However, reduction in EF in patients with AS is a late event that may lead to irreversible myocardial dysfunction. The new era in cardiology also recognizes forms of heart failure with preserved ejection fraction (Hf-PEF) as well as dysfunction of left ventricle with normal EF with left ventricular hypertrophy and small left ventricular cavity [27]. Thus, more sensitive, new markers of early subclinical systolic dysfunction are needed to allow proper timing of the aortic valve stenosis treatment. GLS is a promising and sensitive marker of the subclinical systolic dysfunction [28,29].

In our case there was an impairment of the GLS in the patient with severe AS before the surgery even though the EF was normal. Kearney at al [30] showed that GLS is a strong independent predictor of all-cause mortality while Delgado and Ng [31] suggests that many patients who do not fulfill criteria for SAVR have increased mortality risk if left untreated.

Before and after SAVR the EF was within the normal limits but significant improvement of GLS after the treatment implying that GLS is more sensitive marker of systolic dysfunction of the LV.

Observing this data one should wonder: Should we allow further myocardial damage waiting for symptoms to appear or we will send our patients to earlier surgery? Also, let's keep in mind that symptoms can be very subjective and very often patients are subconsciously giving us a wrong picture of their objective situation.

Conclusion

The GLS of the LV is abnormal in severe AS patients and precedes LVEF deterioration. SAVR improves the LV GLS implicating an improvement of the subclinical systolic dysfunction.

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