

Research Article

Electrocardiographic Strain Sign as a Symptom Equivalent for the Severity of Aortic Stenosis

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Abstract

Objectives: Aortic stenosis is a disorder characterized by inflammation, atherosclerosis, and calcium deposition in the aortic valve. The asymptomatic patients with severe aortic stenosis with normal left ventricular function (C1 stage) have been recommended clinical monitoring according to American guidelines. However, symptom definition by the patients may be challenging. Besides, the symptom-dependent decision for the selection of the therapy can be late for valve intervention. In this study, we evaluated the use of electrocardiographic strain sign as equivalent of aortic stenosis symptoms.

Methods: In this retrospective study, 102 consecutive patients with AS were examined between October 2014 to September 2019. According to electrocardiographic strain sign, the patients were divided into group I (strain sign exist) and group II (without strain sign). These groups were studied in terms of trans-aortic gradient and symptoms (angina, syncope, and dyspnea).

Results: The relationship between strain availability and higher gradient was found statistically important. Strain sign sensitivity and specificity in prediction ≥ 80 mmHg gradient had 76.3% and 83.3%, respectively. The relationship between strain and symptoms availability was found statistically important ($p < 0.001$).

Conclusion: Electrocardiographic strain sign is linked to symptom presence in aortic stenosis. This non-invasive finding can help the clinician as symptom equivalent of aortic stenosis.

Keywords: Aortic stenosis, strain sign, symptom

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Aortic stenosis (AS) is a disorder known by inflammation, atherosclerosis, calcium deposition.^[1] The American Heart Association (AHA)/American College of Cardiology (ACC) guidelines have proposed staging for the management of AS.^[2] While the symptomatic patients having serious, high-gradient aortic stenosis (D stages) have been recommended aortic valve intervention, the asymptomatic patients having serious aortic stenosis with normal left ventricular function (C1 stage) have been recommended symptom and echocardiographic monitoring. Therefore,

symptom presence in the AS is very important. The most important symptoms of severe AS are angina, congestive heart failure, syncope.^[3] In AS, the position from asymptomatic to symptomatic occurs by fibrosis and myocyte degeneration partially compensated by left ventricular hypertrophy (LVH).^[4, 5] However, symptom definition by the patients may be problematical. Besides, the symptom-dependent decision for the selection of the therapy can be late for valve intervention. This study argues that ECG strain would be a symptom equivalent in AS.

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Methods

In this retrospective study, 102 consecutive patients with aortic stenosis were included in from March 2014 to September 2019. Severe aortic stenosis was accepted as reduced leaflet motion; Vmax of ≥ 4 m/s or mean trans-aortic pressure gradient of ≥ 40 mm Hg with ejection fraction $\geq 50\%$.^[2] Medica International Ankara Hospital Ethics (2019/05) Committee approved the study protocol. This study was administered in accordance with the principles set forth in the Helsinki Declaration 2008.

The patients with hypertension ($>140/90$ mmHg), severe mitral and aortic insufficiency, depressed left ventricular systolic function, severe coronary artery disease, S-T segment affected drugs, cerebrovascular disease, left bundle branch block, and pre-excitation were excluded. The patients were divided into group I (strain sign exist) and group II (without strain sign). These groups were compared in terms of trans-aortic gradient and symptoms (angina, syncope, and dyspnea).

Electrocardiographic Criteria

A standard 12-lead ECG was took for the patients, and clarification of the ECG was completed independently by 2 observers who were blinded to the clinical information and imaging findings. ECG strain was accepted as ≥ 1 mm concave down sloping ST-segment depression with asymmetrical T-wave inversion in the V4-V6 leads.^[6]

Echocardiography Measurements

Transthoracic echocardiography (TTE) was conducted for all the patients. Maximum aortic valve velocity and mean pressure gradient were made by velocity-time integral spectral tracing and the aortic valve area was calculated derived with the continuity equation. The severity of aortic stenosis was defined according to the American Heart Association (AHA)/American College of Cardiology (ACC) guidelines.^[2]

All the patients underwent coronary angiography and left ventricular catheterization.

Statistical Analysis

Continuous variables were calculated as mean \pm SD. Student's t-test was used to compare mean variables among groups for parametric assumptions. Comparisons of the groups with categorical data were made through continuity-corrected chi-square and Yate's continuity equation. P value of <0.05 was accepted statistically important.

Results

102 patients with aortic stenosis were male (70 patients, 59%). Mean ages were 72.74 ± 5.02 (min 50-max 80). Group I

Table 1. Characteristics of the patients according to strain availability

	Patients with strain (n=61)	Patients without strain (n=41)	p
Age, years	71.86 \pm 5.47	74.04 \pm 3.99	>0.05
Peak aortic gradient, mmHg	83.19 \pm 6.44	70.97 \pm 5.35	<0.001
LVMI (g/m ²)	206.44 \pm 7.59	167.37 \pm 5.17	<0.001

LVMI: Left ventricular mass index.

Table 2. The relationship between strain and trans-aortic gradient

Strain	Gradient			χ^2	p
	<80 mmHg	≥ 80 mmHg	Total		
No				20.21	<0.001
f	18	23	41		
%	43.9	56.1	100.0		
Yes					
f	4	57	61		
%	6.6	93.4	100.0		

(strain availability) had 61 patients, while Group II (without strain) had 41 patients (Table 1). The interventricular septum thickness in Group I was 13.77 ± 0.63 , while in Group II it was 12.56 ± 0.62 ($p < 0.005$). Group I had higher left ventricular mass index (LVMI) than Group II, (206.44 ± 7.59 , 167.37 ± 5.17 , $p < 0.001$, respectively).

The patients were divided into trans-aortic gradient ≥ 80 mmHg and <80 mmHg (Table 2). The relationship between strain availability and higher gradient was found statistically important ($p < 0.001$). Of the patients, 93.4% the patients with strain had above 80 mmHg, and 56.1% of the patients without strain had lesser 80 mmHg gradients.

Strain sign sensitivity and specificity in prediction ≥ 80 mmHg gradient had 76.3% and 83.3%, respectively (Fig. 1).

The relationship between strain and symptoms availability was found statistically important ($p < 0.01$). The symptomatic patients had electrocardiographic strain sign by 80%, the patients without symptoms had it by 31% (Table 3).

Discussion

At present, as AHA/ACC guidelines for the management of AS show, aortic valve intervention has been endorsed in patients with severe aortic stenosis who have symptoms or evidence of left ventricular decompensation with an ejection fraction $<50\%$.^[2] Nevertheless, the symptoms are frequently individual and reduced ejection fraction may be a delayed finding to reversible. Therefore, more objective markers to symptoms in AS are need.

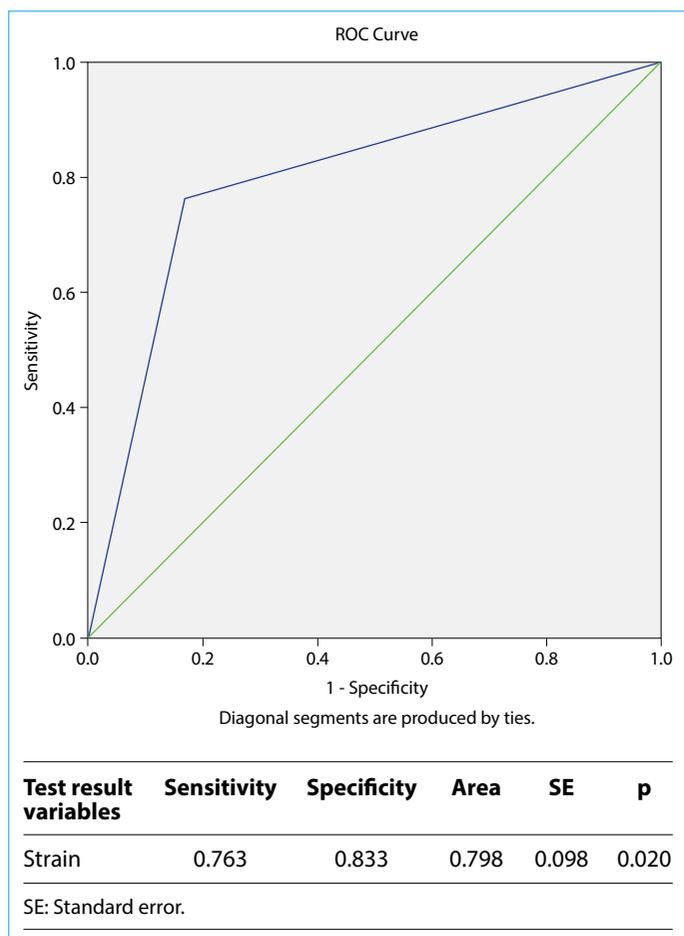


Figure 1. The sensitivity and specificity values of electrocardiographic strain sign in prediction ≥ 80 mmHg gradient.

Table 3. The relationship between strain and symptoms availability

Symptom	Strain			χ^2	p
	No	Yes	Total		
No				27.72	<0.001
f	29	13	42		
%	69.0	31.0	100.0		
Yes					
f	12	48	60		
%	20.0	80.0	100.0		

The commonly symptoms of AS are composed of angina, congestive heart failure, and syncope.^[3] The incidence of angina in AS is 52%.^[7] It is thought that the possible mechanism increases the demand for oxygen by hypertrophied myocardium.^[8, 9, 10] Syncope occurs due to decreased cerebral perfusion related to systemic vasodilatation in the presence of fix cardiac output. Besides, baroreceptor mechanism dysfunction has a part to play.^[11] The syncope is the first clinical manifestation in 15% of the patients of the AS.^[12]

ECG strain sign is connected with increased myocardial injury and deteriorated left ventricular performance. Shah et al. stated that ECG strain was a dominant biomarker of left ventricular decompensation in aortic stenosis, with the ability to classify an at-risk population who may benefit from earlier valve replacement.^[13]

In AS, left ventricular hypertrophy is characterized ST-segment depression, and T wave inversion.^[14] The presence of ST-T abnormalities is connected with larger values for left ventricular muscle amount and greater risks of cardiovascular problems and mortality than a rise in QRS voltage alone.^[15] Furthermore, Shah AS et al. reported a near relationship between ECG strain and myocardial damage and fibrosis.^[13] Danielsen et. al. reported that the sensitivity of severe AS prediction of strain sign was 80%. They accepted mean gradient as >50 mmHg in AS.^[16] Shah AS et. al. stated that the patients with moderate to severe aortic stenosis, the positive and negative predictive values of LVH with ECG strain for mid-wall fibrosis were 91% and 72%, respectively. We found a relationship between gradient and strain sign in ECG, when the patients were divided into trans-aortic gradient ≥ 80 mmHg and <80 mmHg ($p < 0.001$). The specificity and sensitivity were 76.3% and 83.3%, respectively.

Conclusion

Electrocardiographic strain had higher values of left ventricular muscle index and aortic pressure gradient than those without. The strain sign is associated with symptom presence in aortic stenosis. This non-invasive finding can help the clinician as symptom equivalent of aortic stenosis.

Disclosures

Ethics Committee Approval: Medicana International Ankara Hospital Ethics (2019/05) Committee approved the study protocol.

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Authorship Contributions: Concept – E.S.; Design – E.S.; Supervision – E.S., A.O.; Materials – E.S.; Data collection &/or processing – E.S.; Analysis and/or interpretation – E.S., A.O.; Literature search – E.S., A.O.; Writing – E.S.; Critical review – A.O.

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