ORIGINAL ARTICLE

Polish Multicenter Registry (Pol-LAS-SE registry). Stress echocardiography in low-gradient aortic stenosis in Poland: numbers, settings, results, complications and clinical practice

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ABSTRACT

Background: The diagnostic workup of low-gradient aortic stenosis (LG AS) is a challenge in clinical practice.

Aims: Our goal was to assess the diagnostic value of stress echocardiography (SE) performed in patients with undefined LG AS with low and preserved ejection fraction (EF) and the impact of its result on therapeutic decisions in Polish third level of reference.

Methods: All the patients with LG AS and with SE performed were recruited in 16 Polish cardiology departments between 2016 and 2019. The main exclusion criteria were as follows: moderate or severe aortic or mitral regurgitation and mitral stenosis.

Results: The study group included 163 patients (52% males) with LG AS who underwent SE for adequate diagnostic and therapeutic decision. In 14 patients DSE was non-diagnostic. The mean aortic valve (AV) pressure gradient was 24.1 (7.3) mm Hg, while an AV area was 0.86 (0.2) cm^2. Among 149 patients with conclusive DSE, severe AS was found in 59.8%, pseudo-severe in 22%, and moderate AS in 18%. There were no cases of death or vascular events related to DSE. Among 142 patients 63 (44%) patients had an aortic valve intervention in a follow-up (median: 208 days; lower-upper quartile: 73–531 days). Based on the result of the DSE test, severe AS was significantly more often associated with qualification to interventional treatment compared to the moderate and pseudo-severe subgroups (P <0.0001).

Conclusions: The DSE test in severe AS is a valuable diagnostic tool in patients with LG AS in Poland.

Key words: aortic stenosis, dobutamine stress echocardiography, low gradient aortic stenosis, stress echocardiography

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WHAT'S NEW?

The Pol-LAS-SE registry was the first initiative in Poland investigating application of stress echocardiography (SE) in low-gradient aortic stenosis. Despite the time-consuming nature and the lack of reimbursement in Poland, SE is an important method used in the case of low gradient aortic stenosis. The dobutamine SE provided complete hemodynamic information that enabled the division of aortic stenosis into subgroups, however, the registry showed that in everyday practice advanced calculations, e.g. aortic valve projected area is not performed. Only 8.6% of exams were non-diagnostic. In doubtful cases, the final decision was additionally made taking into account the entire clinical presentation, which was reflected in the 2017 Valvular Heart Disease Guidelines, although the study was conducted in previous years. The survey has documented that SE has direct implications for clinical and therapeutic decisions. In our opinion, the observations are trustworthy and reflect current approaches to aortic stenosis in Poland.

INTRODUCTION

Low-flow low-gradient aortic stenosis (LFLG AS) is a frequent hemodynamic type of aortic valve disease, accounting for 30%–50% of all cases of severe aortic stenosis (AS) [1, 2]. The risk of adverse outcome in patients with LFLG AS has been reported to be even higher than in high-gradient AS patients [3]. Low-flow low-gradient aortic stenosis is defined by the coexistence of mean transvalvular gradient <40 mm Hg, effective aortic valve area (AVA) <1.0 cm^2 (0.6 cm^2/m^2 BSA) and stroke volume (SV) index <35 ml/m^2, and may occur with reduced or preserved left ventricular ejection fraction (LVEF): classical and paradoxical type, respectively. Given the discrepant values of valve area and gradient metrics that are a feature of the LFLG profile, a challenging part of the diagnostic process is to determine whether the stenosis is true-severe or pseudo-severe [4, 5]. Recent ESC guidelines endorse a practical stepwise approach for the assessment of AS severity, in which dobutamine stress echocardiography (SE) and CT calcium scoring help to identify candidates for surgery among patients with LFLG AS [5, 6]. According to these recommendations, dobutamine SE using a low-dose protocol plays a crucial role in stratifying the degree of valve stenosis in classical LFLG AS [2, 4, 5]. The inotropic stimulation of left ventricular (LV) myocardium with dobutamine by increasing aortic flow permits a distinction between true-severe and non-severe AS, which is possible in the presence of LV contractile reserve defined as >20% increase in LV stroke volume, as well as, in a proportion of cases not satisfying this criterion by calculating the projected valve area at a normal flow rate, i.e. 250 ml/s [8–10]. A recently published Polish registry of SE showed that dobutamine SE (DSE) was the most commonly used stress echo method, however, its use in non-coronary indications, including LFLG AS, was relatively rare [11].

The current study is the first registry of SE performed in patients with low-gradient aortic stenosis (LG AS) in Poland. This study aimed to evaluate indications, the diagnostic utility of SE, and the impact of information obtained from this test on therapeutic decisions in Polish cardiology centers.

METHODS

Patient population

A total of 163 patients were recruited by 16 Polish cardiology centers dedicated to heart valve disease between 2016 and 2019. Patients were included in the Pol-LAS-SE registry if they had aortic stenosis with mean aortic gradient (MPG) <40 mm Hg on a resting echocardiogram. Patients were excluded if they had more than mild aortic regurgitation, moderate and severe mitral regurgitation, or mild mitral stenosis, as assessed by the multiparametric integrative approach recommended in the current guidelines for native valve regurgitation and stenosis. The treatment (aortic valve replacement [AVR], transcatheter aortic valve implantation [TAVI] or medical management) was left to the discretion of the treating physician who was aware of the results of resting and stress echocardiogram. Based on hospital registries, clinical data were collected and included age, sex, body mass index, co-morbidities, symptoms, heart rate/rhythm, and blood pressure measurements.

Echocardiography

SE was performed using commercially available ultrasound systems. Dobutamine infusion protocol consisted of 5-min (including ca. 3 min for image recording) stages with increments of 10 μg/kg/min up to a maximum dosage of 20 μg/kg/min. Beta-blockers were not withdrawn before stress echo. Left ventricular outflow tract (LVOT) diameter was measured at rest and considered constant during stress echo. The following measurements were performed at rest and each SE stage:

- stroke volume (SV) was measured in the LV outflow tract (LVOT VTI × LVOT area);
- aortic valve area was calculated by the continuity equation;
- mean aortic gradient was obtained by the Bernoulli formula;
- left ventricular ejection fraction was measured using the biplane Simpson method. For all these parameters, we averaged the measures of 3 cycles in normal sinus rhythm and 5 cycles in the presence of irregular rhythm.

The image recordings performed at each stage could be subsequently displayed for offline analysis on quad

— 4 screen mode. The presence of flow reserve was assumed if ΔSV (i.e. peak SV–resting SV) was >20% of resting SV value. The non-diagnostic group includes tests whose technical quality or lack of data prevented being assigned to one of the categories. True severe AS was confirmed if stimulated values were as follow (increase of SV >20% and any increase of EF, MPG ≥40 mm Hg, AVA ≤1.0 cm^2) while pseudo severe AS was confirmed if (an increase of SV >20% and any increase of EF, MPG <40 mm Hg, AVA >1.0 cm^2) was observed. Patients without SV increase by more than 20%, stimulated MPG <40 mm Hg, any AVA change, any EF increase were considered as undefined AS (non-conclusive AS). Moderate AS was defined as AVA >1.0 cm^2 and MPG <40 mm Hg at baseline, and 1.5 cm^2 >AVA >1.0 cm^2 and MPG <40 mm Hg during dobutamine infusion.

The bioethics committee approval was not required.

Statistical analysis

Results were expressed as numbers and percentages for categorical variables and as mean (SD) or median (interquartile range) for continuous variables. The distribution of continuous variables was tested for normality with the Shapiro-Wilk test. In cases of slight deviations, skewness determined the choice of tests. Non-parametric tests were used when the skewness was greater than <–1.7 or >1.7. Comparisons between frequencies were made using the chi-square test of independence or Fisher's exact test (when the number of expected events was less than 5). Differences between means were assessed using Student's t-tests or Satterthwaite's method — or by one-way analysis of variance (ANOVA) when the number of compared groups was greater than two — followed by the Tukey multiple comparison test. In the case of high skewness, the analyzes were performed with non-parametric Mann-Whitney or Kruskal-Wallis tests.

All statistical tests were performed at α = 0.05 (2-sided). Analyses were performed using SAS software version 9.4. Data with normal distribution are presented at mean (SD).

RESULTS

Characteristics of the study group

Clinical characteristics

The multicentre Pol-LAS-SE registry involved 163 patients, including 85 (52.1%) males, with LG AS who underwent SE for adequate diagnostic and therapeutic facilities.

Fourteen (8.6%) out of the 163 SE tests performed within the Pol-LAS-SE registry were non-diagnostic and did not allow the evaluation of LG AS severity (Figure 1). Of the 14 non-diagnostic tests, 13 were tests with dobutamine, and 1 was an exercise test. Based on the SE results, the remaining 149 patients were divided into three categories: 89 (59.8%) patients with severe AS (severe subgroup); 33 (22.1%) to pseudo-severe AS (pseudo-severe subgroup) and 27 (18.1%) to the moderate AS group (moderate subgroup).

Table S1 (Supplementary material, *Table S1*) summarises the clinical characteristics of the overall cohort and subgroups according to the LG AS category. The most common co-morbidities in all the study groups were arterial hypertension and coronary artery disease (CAD); 52 (32.9%) patients were diagnosed with atrial fibrillation. The vast majority of patients presented symptoms of heart failure (94%).

Parameters of resting and stress echocardiography test

Overall, stress echocardiography test was performed in 163 patients; 157 (96.3%) subjects underwent a dobutamine test, while 6 (3.7%) had an exercise stress test. The mean (SD) dobutamine maximal dose was 19.7 (2.8) μg/kg/min, while a mean (SD) exercise load was 58.3 (12.9) Watts. Table S2 (Supplementary material, *Table S2*) shows the hemodynamic data of the SE test conducted in the study cohort overall and three subgroups by the severity of the LG AS (severe, pseudo-severe, and moderate). There was no statistically significant difference in the dobutamine dose used in each study group; however, differences in the blood pressure (BP) values were found.

In the overall cohort, average mean pressure gradient value was 24.1 (7.3) mm Hg, while an AVA was 0.86 (0.2) cm^2. Overall, a mean (SD) SV index was 29.9 (8.8) ml/m^2. During a SE test, we have observed a significant increase in the transaortic Pmax, MPG, and SV as well as a significant shortening of the LV ejection time (ET) (P <0.0001). The mean (SD) relative increase in SV at peak stress was 27.8 (24.6),

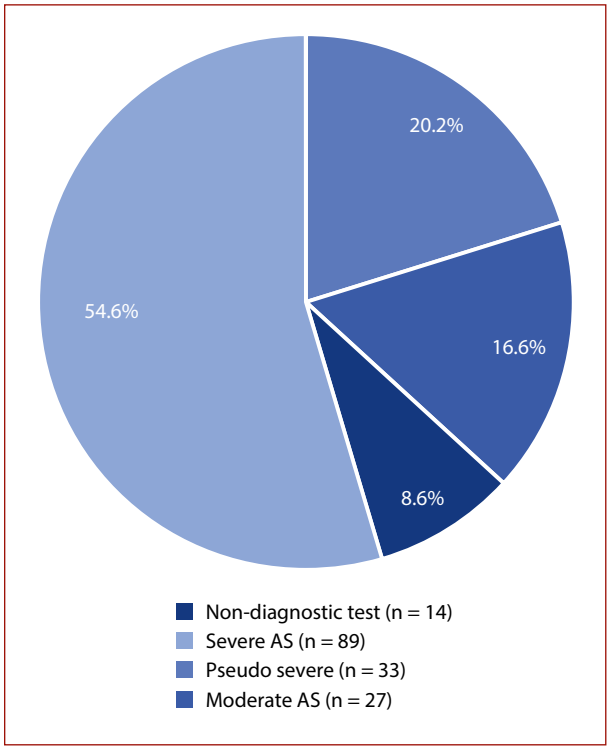

Figure 1. Results of the stress echo test in patients enrolled into Pol-LAS-SE registry.

Abbreviations: AS, aortic stenosis

Table 1. Differences in the echocardiographic and haemodynamic parameters between stress and resting tests by the severity of aortic stenosis (absolute deltas unadjusted for the baseline measurement)

	Moderate AS (n = 27)	Pseudo-severe AS (n = 33)	Severe AS (n = 89)	*P* — overall test	Moderate vs pseudo--severe	Moderate vs severe	Pseudo-severe vs severe
HR, mean (SD), bpm	31.2 (24.5)	23.1 (17.1)	23.5 (15.3)	0.14	—	—	—
SBP, mean (SD), mm Hg	8.5 (16.1)	15.0 (13.4)	11.1 (19.1)	0.39	—	—	—
DBP, mean (SD), mm Hg	–0.9 (12.8)	0.9 (8.6)	1.6 (11.8)	0.64	—	—	—
LVEF, mean (SD), %	7.8 (6.4)	8.8 (5.5)	8.7 (6.4)	0.82	—	—	—
Pmax, mean (SD), mm Hg	13.6 (14.2)	13.5 (9.6)	23.6 (13.0)	<0.001	0.99	0.001	0.001
MPG, mean (SD), mm Hg	9.5 (8.2)	8.3 (6.2)	15.3 (8.2)	<0.001	0.82	0.003	<0.001
VTI LVOT, mean (SD), cm	2.50 (2.4)	7.25 (5.32)	2.92 (4.14)	<0.001	0.003	0.92	<0.001
VTI LVOT / VTI AV, mean (SD)	0.04 (0.06)	0.08 (0.09)	0.02 (0.06)	0.001	0.21	0.47	0.001
AVA, mean (SD), cm^2	0.12 (0.22)	0.32 (0.14)	0.02 (0.13)	<0.001	<0.001	0.008	<0.001
SV, mean (SD), ml	11.7 (10.8)	20.3 (10.4)	13.8 (10.2)	0.002	0.005	0.64	0.007
ET, mean (SD), ms	–15.0 (33.4)	–38.8 (51.7)	–39.7 (46.5)	0.06	—	—	—

Abbreviations: AS, aortic stenosis; AV, aortic valve; AVA, aortic valve area; DBP, diastolic blood pressure; ET, ejection time; HR, heart rate; LVEF, left ventricle ejection fraction; LVOT, left ventricle outflow tract; MPG, mean transvalvular gradient; Pmax, maximal transvalvular gradient; SBP, systolic blood pressure; SV, stroke volume; VTI, time velocity integral

and the presence of a contractile (flow) reserve at 20% threshold was confirmed in 111 (68.5%) patients.

Table 1 summarises the differences in the hemodynamic data and the values of the echocardiographic parameters measured during the peak stage of SE compared to a resting echo test in three subgroups of patients defined by the severity of AS. Patients with severe AS had significantly higher changes in the transaortic gradient compared to the moderate and pseudo-severe subgroups. In the moderate and pseudo-severe subgroups, significantly higher changes in the aortic valve area were observed.

Reasons for the SE termination and complications of the SE test in the overall cohort

In all the patients, the main reason for the termination of the SE test was meeting the study's protocol requirements.

We did not observe any severe cardiovascular events (death, myocardial infarction, or cerebral stroke/TIA) during SE.

One subject developed a non-sustained ventricular tachycardia episode which resolved spontaneously.

In total, 143 patients (87.7%) did not experience any important symptoms during SE.

Mild symptoms (dyspnoea, fatigue, weakness, headache, mild arrhythmia) were reported during the SE only in 20 (12.3%) patients, however, they did not result in the cessation of the SE test and resolved spontaneously.

Characteristics of patients depending on haemodynamic type of aortic stenosis

The patients included in the registry (MPG at rest <40 mm Hg) were divided into subgroups depending on the hemodynamic type of the valve defect based on the resting SVI, LVEF and AVA measurements.

Group A involved LG AS with AVA <1 cm^2, including patients with SVI <35 ml/m^2 and EF <50%, SVI <35 ml/m^2 and LVEF >50% as well as SVI >35 ml/m^2 and LVEF >50%, that form the A1, A2 and A3 subgroups, respectively. The remaining LG AS patients with AVA above 1 cm^2 formed group B which comprised subjects with reduced LVEF <50%, and group C involving patients with LVEF >50% (Figure 2).

The A1 subgroup involved 81 (56.2%) patients with a classical LFLG AS.

The A2 subgroup involved 25 (17.4%) patients with a paradoxical LFLG AS.

The A3 subgroup involved 14 (9.7%) patients with normal flow, low gradient (NFLG) AS.

Group B was formed by 20 LG AS patients (13.9%) with an AVA above 1 cm^2 at rest (1.0 to 1.2 cm^2) and LV impairment.

The remaining patients, 4 (2.8%), with an LG AS and AVA above 1 cm^2 (1.1–1.2 cm^2) at rest and LVEF >50% represented group C.

Table 2 shows the differences in hemodynamic and echocardiographic parameters measured at rest and peak exercise in the groups/subgroups defined based on the haemodynamic type of aortic stenosis.

It was demonstrated that more patients with severe LG AS belonged to the A1 and A2 subgroups, while the B subgroup involved more patients with moderate AS (*P* <0.001). Of the patients with a hemodynamic type of severe LG AS (n = 120), 67.5% subjects presented classical LFLG AS (A1 subgroup); 21.3% had a paradoxical LFLG AS (A2); and 7.5% had NFLG AS (A3 subgroup) with an AVA <1 cm^2, while 3.7% of patients had a borderline AVA (1–1.2 cm^2).

Characteristics of patients according to the transaortic flow

Of the 163 AS patients, 128 subjects had a reduced SVI (LF AS group – SVI <35 ml/m^2); 35 patients had normal SVI (NF AS group; SVI >35 ml/m^2). The most common co-morbidities in both groups were arterial hypertension and CAD.

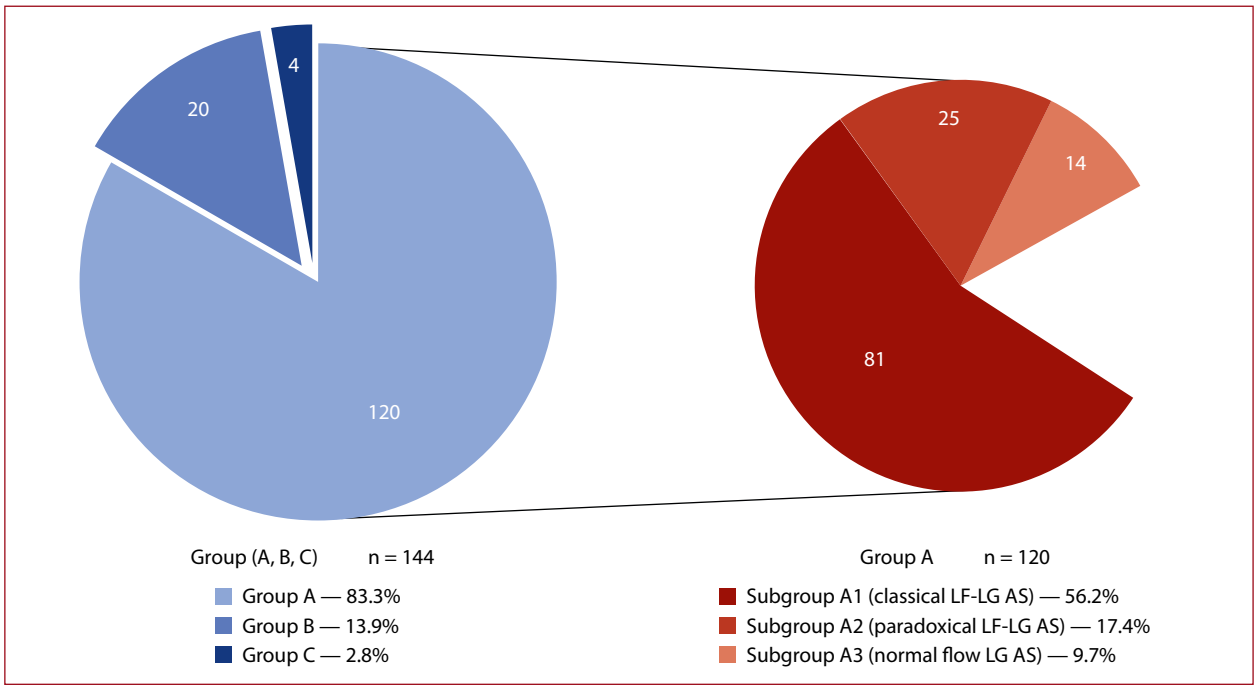

Figure 2. Distribution of low-gradient aortic stenosis patients by the haemodynamic type of the defect (n = 144). Group A: AVA <1.0 cm^2, Group B: AVA >1.0 cm^2, LVEF <50%. Group C: AVA >1.0 cm^2, LVEF >50%. Subgroup A1: classical LFLG AS. Subgroup A2: paradoxical LFLG AS. Subgroup A3: NFLG AS.

Abbreviations: AVA, aortic valve area; LF, low flow, NF, normal flow, LG, low gradient

Table 2. Differences in echocardiographic and haemodynamic measurements between the stress and resting conditions by the haemodynamic type of the low-gradient aortic stenosis (absolute deltas, unadjusted for the baseline)

	A1 (n = 81)	A2 (n = 25)	A3 (n = 14)	B (n = 20)	*P* overall test	A1 vs A2	A1 vs A3	A1 vs B	A2 vs A3	A2 vs B	A3 vs B
HR, mean (SD), bpm	22.5 (15.3)	26.2 (21.3)	26.7 (20.9)	35.3 (27.4)	0.09	—	—	—	—	—	—
SPB, mean (SD), mm Hg	11.4 (16.9)	17.1 (16.9)	4.5 (17.8)	3.3 (15.50	0.05	0.52	0.61	0.26	0.21	0.06	1.00
DBP, mean (SD), mm Hg	1.0 (11.6)	6.1 (7.2)	1.2 (12.1)	–2.1 (12.3)	0.13	—	—	—	—	—	—
LVEF, mean (SD), %	8.8 (6.1)	8.0 (6.9)	5.8 (9.2)	8.2 (4.1)	0.46	—	—	—	—	—	—
Pmax, mean (SD), mm Hg	17.5 (12.6)	23.5 (12.6)	26.6 (17.2)	13.8 (16.1)	0.01	0.22	0.10	0.71	0.90	0.09	0.040
MPG, mean (SD), mm Hg	11.5 (8.5)	14.0 (11.5)	13.6 (11.5)	10.6 (9.5)	0.45	—	—	—	—	—	—
VTI LVOT / VTI AV mean (SD)	0.03 (0.07)	0.07 (0.12)	0.02 (0.14)	0.05 (0.05)	0.32	—	—	—	—	—	—
AVA, mean (SD), cm^2	0.10 (0.20)	0.12 (0.29)	0.19 (0.14)	0.07 (0.21)	0.37	—	—	—	—	—	—
SV, mean (SD), ml	14.3 (11.7)	13.8 (9.8)	11.6 (10.8)	13.4 (10.1)	0.86	—	—	—	—	—	—
ET, mean (SD), ms	–32.5 (40.0)	–2.6 (47.3)	–74.6 (70.1)	–15.4 (25.3)	0.002	0.76	0.007	0.47	0.14	0.21	0.002

Abbreviations: see Table 1 and Figure 2

The LF AS group included more patients with a severe AS (78 [60.9%] vs 11 [31.4%] patients; *P* <0.002).

Table 3 shows the absolute differences in the hemodynamic and echocardiographic parameters measured in the resting and stress conditions in LF AS and NF AS groups.

Stress echocardiography test results and clinical interventions

Comparison of the severe, moderate and pseudo-severe subgroups by the intervention

In total, 142 patients were followed up for potential qualification to aortic valve interventions (AVI) including TAVI, BAV (balloon aortic valvuloplasty), AVR. Sixty-three (44.4%) patients underwent an aortic valve intervention. No intervention was performed in 79 (55.6%) patients. The median follow-up time in the overall cohort was 208 days (interquartile range, 73–531 days). However, all interventions were performed between 3-303 days after stress echo test.

During the follow-up, 63 (84%) patients from the severe group (n = 75), when defined based on the results of the stress echo test, qualified for the aortic valve procedures (TAVI, BAV, AVR); 52 (69.3%) underwent AVI; 5 (6.7%) patients were awaiting intervention; while 6 (8%) subjects did not consent to undergo AVI. Twelve (16%) patients from the severe group did not undergo aortic valve intervention.

In the moderate group (n = 26), aortic valve intervention (along with coronary arteries revascularisation) was

Table 3. Differences in the echocardiographic and haemodynamic measurements between stress and resting conditions by trans-aortic flow (absolute deltas)

	LF AS n = 128 (SVI <35 ml/m²)	NF AS n = 35 (SVI ≥35 ml/m²)	*P*
HR, mean (SD), bpm	26.2 (18.2)	24.8 (18.9)	0.69
SBP, mean (SD), mm Hg	8.4 (17.4)	11.8 (17.3)	0.35
DBP, mean (SD), mm Hg	–0.1 (12.3)	1.5 (11.3)	0.50
LVEF, mean (SD), %	7.2 (7.2)	8.7 (6.0)	0.24
Pmax, mean (SD), mm Hg	19.2 (14.7)	18.8 (13.4)	0.87
MPG, mean (SD), mm Hg	11.0 (8.5)	12.4 (8.5)	0.40
VTI LVOT/ VTI, mean (SD)	0.04 (0.10)	0.04 (0.08)	0.97
AVA, mean (SD), cm²	0.20 (0.18)	0.08 (0.22)	0.004
SV, mean (SD), ml	11.6 (11.8)	14.2 (11.2)	0.22
ET, mean (SD), ms	–48.3 (59.3)	–31.5 (41.5)	0.07

Abbreviations: LF, low flow; NF, normal flow. Other abbreviations: see Table 1

performed in as few as 4 patients (15.4%), while 22 (84.6%) did not undergo intervention.

During the follow-up, only 3 (10%) out of 30 patients in the pseudo-severe subgroup underwent intervention (TAVI) with associated revascularization of coronary arteries. One patient (3.3%) did not consent to intervention. In total, 27 (86.7%) of the patients in the pseudo-severe group did not undergo aortic valve intervention.

After exclusion non-conclusive results, the final diagnosis of severe AS based on the SE test result contributed to the appropriate selection of interventional treatment, much more frequent in this group of patients compared to the subgroups: with moderate or pseudo-severe AS (P <0.0001).

Regarding the SE test results, the patients with severe AS group were more often scheduled for the AVR procedure (25 patients; 33.3%; including one awaiting patient) compared to the pseudo-severe (0) and moderate subgroups (1 subject; 3.8%; P <0.0001).

Similarly, patients in the severe AS group, defined on the results of the SE test, were more often qualified for the TAVI procedure (31 patients; 41.3%; including 3 awaiting patients) compared to the pseudo-severe (3 patients; 9.7%) and moderate subgroups (2 subjects; 7.4%; P <0.003).

In total, only 7 patients underwent the BAV procedure, including 5 patients in the severe group, as a bridge therapy (P = 0.381).

DISCUSSION

This study demonstrated that in Polish hospitals, SE was performed in accordance with the European guidelines for valvular heart disease. The most common indication for SE was classical LFLG-AS. SE testing was safe, with a low rate of side-effects being reported. The information provided by SE was useful in decision-making on the interventional treatment of LG-AS.

Data obtained from a recent Pol-STRESS ECHO registry show that stress echocardiography performed in valvular heart diseases accounts for 4.4% of all echocardiographic stress tests in Poland, with low gradient AS and asymptomatic AS being the most frequent underlying reasons for this diagnostic approach [11]. Analogous data from the European Registry VHD II demonstrated similar numbers for Western Europe (5.4%, including 3.1% in AS), and a much lower proportion of stress echo with "valvular" indications in Eastern European countries reaching only 0.6% [13].

AS is the most common valvular heart disease leading to surgery or catheter intervention, and its prevalence has increased when comparing the results of VHD and VHD II registries [13, 14].

According to the guidelines, the indications for SE in AS are the verification of asymptomatic status in patients with no determined timing of surgery (exercise) or clarification of stenosis severity in the setting of a low-flow state (dobutamine) [2, 4, 5, 6, 11, 14].

Numbers, settings, safety of Pol-LAS-SE registry

The present registry included 163 patients from 16 centers in Poland. The most frequently used modality was stress with dobutamine, and only in the minority of cases (3.7%), an exercise test was conducted. It should be underscored that the collection of data for the registry started in 2016, i.e. before the publication of updated recommendations that limited the use of DSE to the classical LFLG-AS. Thus, this is the reason why a number of DSE tests were carried out in the paradoxical type of LFLG-AS. In the vast majority of patients (86%) SE was conclusive, significantly adding to the diagnostic process and facilitating subsequent decision making. Even though coronary artery disease was diagnosed in 63.6% of patients, including 36.8% with multivessel disease, the rate of SE-associated adverse events was low. In our report, 87.7% of patients completed the test without any complications, while serious arrhythmias in the form of unstable ventricular tachycardia occurred only in 0.6% of patients.

In our registry, the median time between DSE and invasive treatment was 208 days (interquartile range, 73–531 days). This result has several reasons: the beginning of the diagnostic pathway, the need for diagnosis and treatment of concomitant diseases (i.e. gastrointestinal

Table 4. Haemodynamic characteristics of pseudosevere aortic stenosis group at baseline and during the dobutamine stress echocardiography

Pseudo-severe AS	REST	STRESS	*P*
HR, mean (SD), bpm	73.9 (10.9)	97.0 (20.6)	<0.0001
SPB, mean (SD), mm Hg	131.5 (14.4)	146.5 (17.3)	<0.0001
DBP, mean (SD), mm Hg	78.0 (11.0)	78.9 (14.1)	0.587
Pmax, mean (SD), mm Hg	36.7 (13.5)	50.2 (14.3)	<0.0001
MPG, mean (SD), mm Hg	20.5 (6.6)	28.8 (8.5)	<0.0001
VTI AV, mean (SD), cm	63.4 (17.8)	68.3 (16.8)	0.032
VTI LVOT, mean (SD)	18.8 (4.7)	26.0 (8.0)	<0.0001
VTI LVOT / VTI AV, mean (SD)	0.305 (0.112)	0.383 (0.077)	<0.0001
AVA, mean (SD), cm^2	0.89 (0.09)	1.21 (0.17)	<0.0001
SV, mean (SD), ml	57.1 (15.8)	77.4 (19.4)	<0.0001
ET, mean (SD), ms	305.8 (39.7)	266.9 (53.7)	0.0002

Abbreviations: see Table 1

bleeding, hyperthyroidism, lower leg skin ulceration, etc.) and the initial refusal of surgical treatment, especially in patients with minor symptoms. However, the waiting time for TAVI is long.

Interpretation of SE results

A prerequisite for a reliable interpretation of DSE in LFLG-AS is the presence of contractility reserve. Its reduction due to LV scaring or fibrosis may complicate determining the degree of stenosis because of the inability to sufficiently increase SV, i.e. by >20%. In the current registry, the presence of flow (contractile) reserve was demonstrated in 111 subjects (68.5%). Despite the lack of adequate increase in LV flow in response to dobutamine, the test in the vast majority of remaining subjects was interpreted as diagnostic, and 75 patients were finally diagnosed with severe aortic stenosis and scheduled for interventional treatment. The final interpretation of AS severity in the group without contractility reserve was done arbitrarily by the echocardiographer based on the comprehensive patient assessment including both imaging and clinical data i.e. borderline gradient or SV, significant valvular calcification, presence of AF, age, etc. Eventually, severe low gradient AS requiring valvular intervention was diagnosed in 89 patients (54.6%). This registry showed that the calculation of projected AVA — an alternative approach permitting in some patients unable to increase SV by 20% a conclusive evaluation with DSE — is not a standard part of diagnostic strategies assessing AS severity in Poland.

There was no statistically significant difference in dobutamine dose among the groups identified on the basis of stenosis severity. However, the response of systolic and diastolic blood pressure to the administration of dobutamine was blunted in patients with severe AS, which is consistent with the progression of hemodynamic disturbances with an increasing stenosis degree.

The stress-assisted diagnosis of severe aortic stenosis was most common in the classical (67.5%) and paradoxical low-flow low gradient AS categories (21.3%). In recent years, the latter group has been of particular interest to clinicians because of the challenges associated with adequate quantification of AS severity and prognostic stratification. In our registry, the prevalence of paradoxical low flow severe AS diagnosed with stress echocardiography was higher than previously published rates of 3%–13% [16–18]. The reason for this difference might be the fact that the presented data from our registry were direct findings from DSE, with no further verification by other imaging modalities or intraoperative inspection as was the case with the above-referenced studies.

Pol-LAS-SE results and the decision for interventional treatment

The crucial importance of stress echocardiography is to help in the decision-making for interventional treatment. Accordingly, the final diagnosis of severe AS, being an indication for surgery or catheter intervention, was established in 84% of patients from our registry. Another contribution from SE to the diagnostic process was the distinction between trivial and moderate AS in patients undergoing surgical revascularization since in this case concomitant aortic valve replacement should be considered when confirming moderate AS [5]. In our registry, this scenario took place in 15.4% of patients diagnosed to have moderate AS.

The most interesting group is the pseudosevere AS. These patients are rarely referred for surgery after the stress test. However, SE in this subset might provide meaningful information by examining whether there is "stretch" in AVA (Table 4).

Limitations

The SE protocols used by the participating centers did not include some of the echocardiographic parameters proposed for the assessment of aortic valve hemodynamics, such as transvalvular flow rate and projected AVA, which might improve the accuracy of the diagnostic process. As all of 16 participating centers were recruited on a voluntary basis, the data may not be fully representative of the entire country, however, the majority of university centers in Poland were involved.

CONCLUSIONS

SE used in Polish cardiology centers proved to be a valuable diagnostic procedure in the evaluation of patients with LFLG-AS, delivering relevant information in the context of subsequent patient management, especially valvular interventions.

The proportion of non-diagnostic/inconclusive tests unable to stratify the severity of aortic stenosis was low.

The protocols of SE used in Polish cardiology centers were in line with the European guidelines for valvular heart disease.

The SE-related adverse events of the stress test in patients with aortic stenosis were rarely reported and SE did not require discontinuation.

Supplementary material

Supplementary material is available at: https://journals.viamedica.pl/kardiologia_polska.

Article information

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