אוניברסיטת בן-גוריון בנגב
הפקולטה למדעי הבריאות

מרכז רפואי אוניברסיטאי
סורוקה
Soroka University Medical Center
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Stress Induced Dynamic LVOT Obstruction without LVH

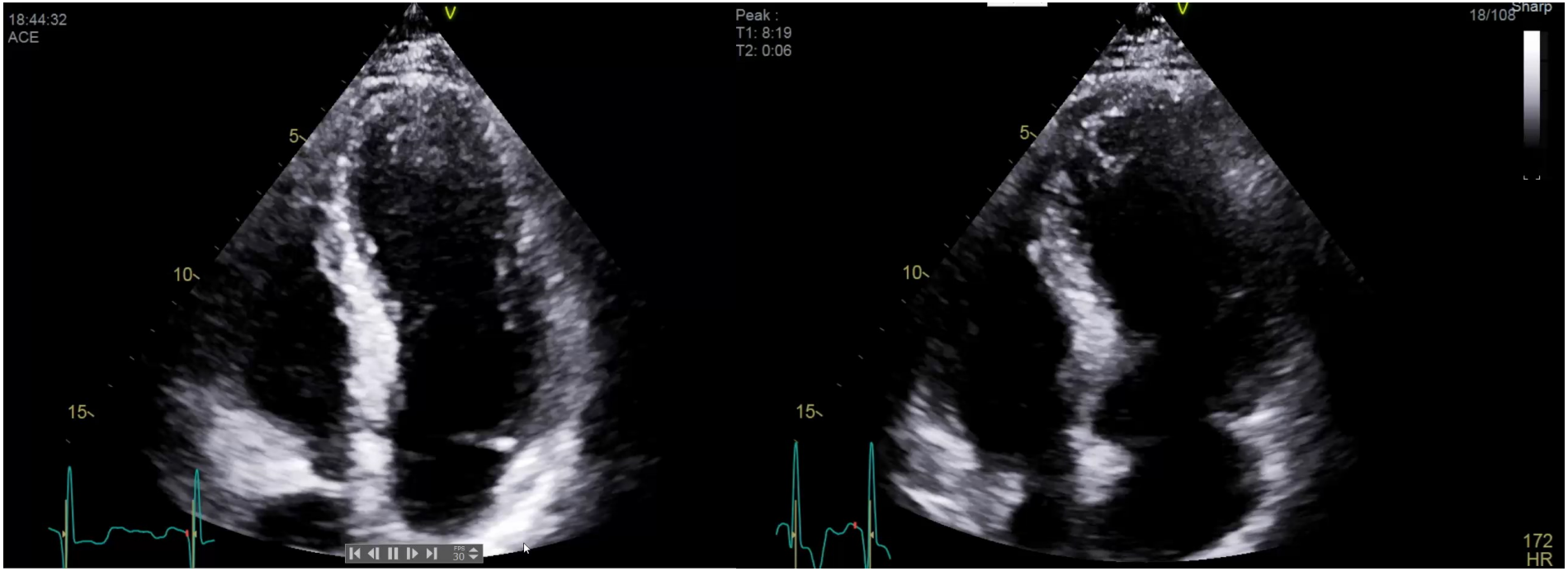
Sergio Kobal, MD, FESC

Soroka University Medical Center

Ben-Gurion University of the Negev

CHEST PAIN

- 54 years old, HTN, dyslipidemia
- Treatment ACEi
- Complains about chest discomfort at relatively high efforts (claims 4 floors) for the last 6 months



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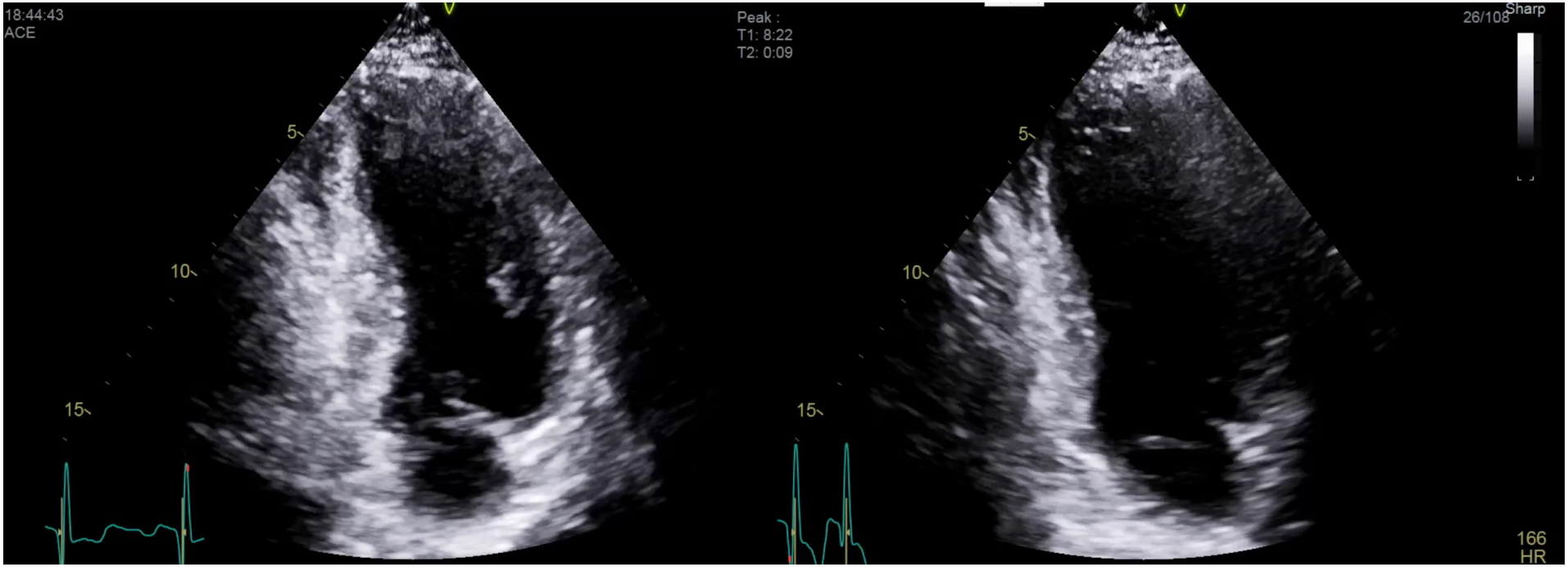

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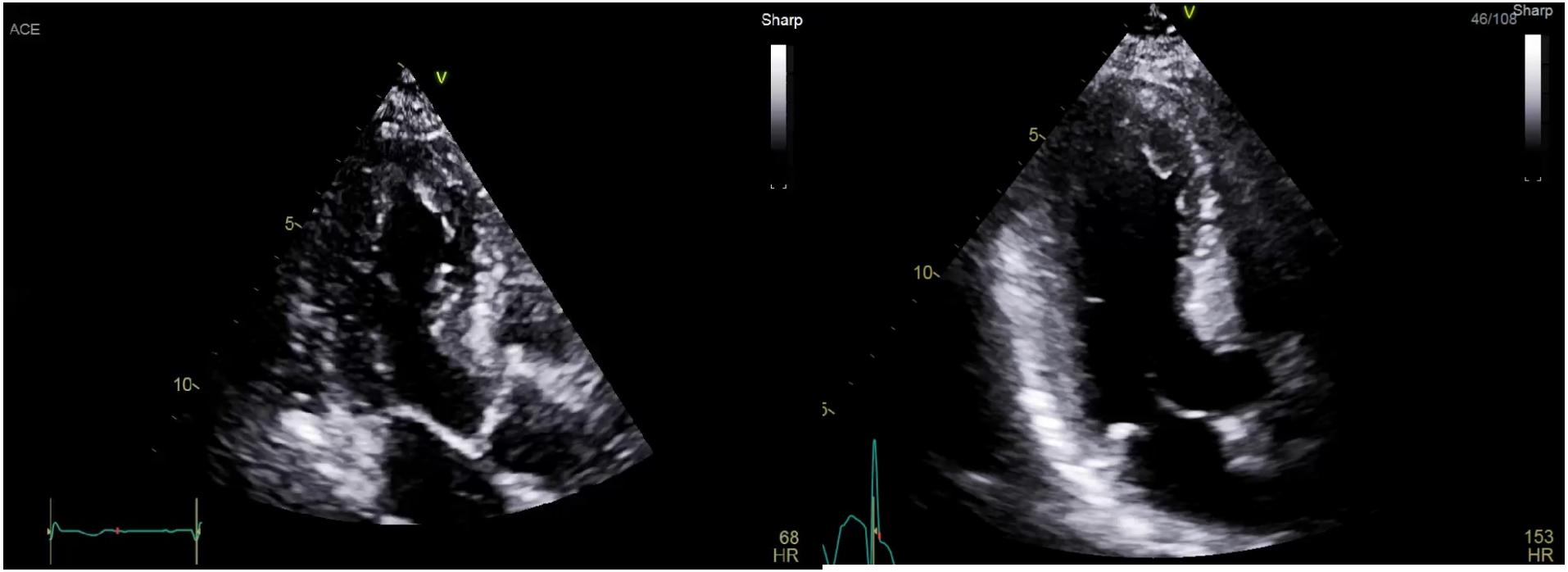

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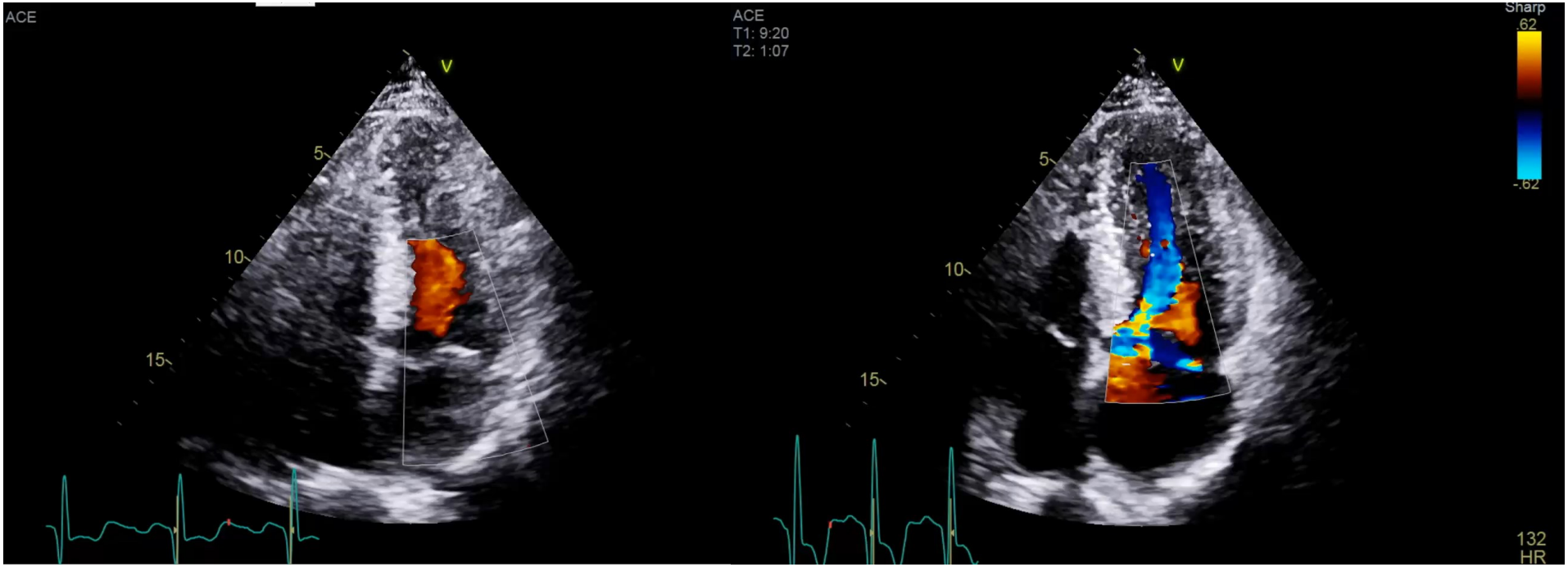

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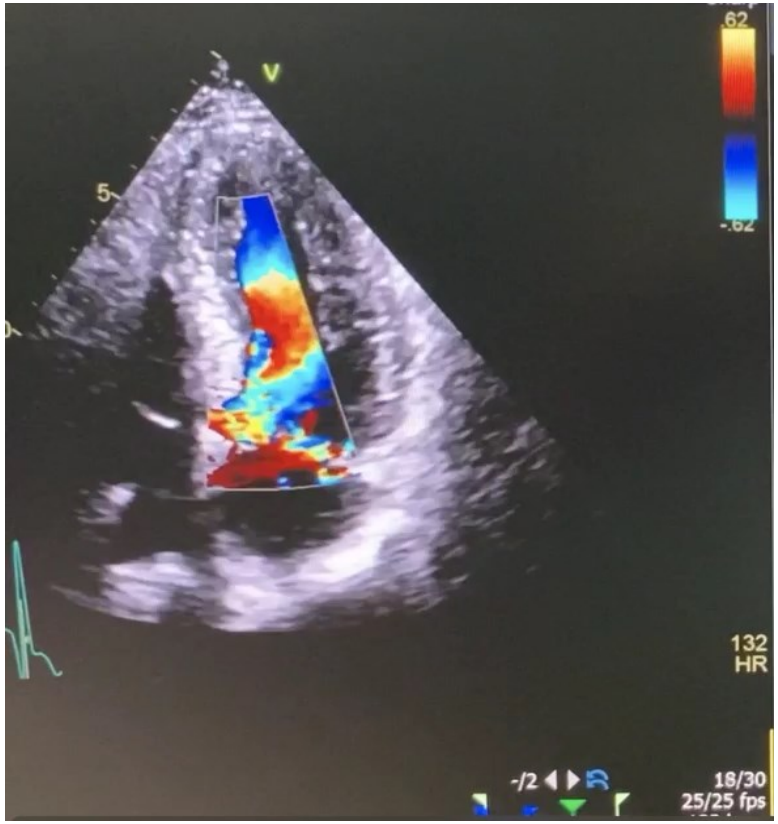
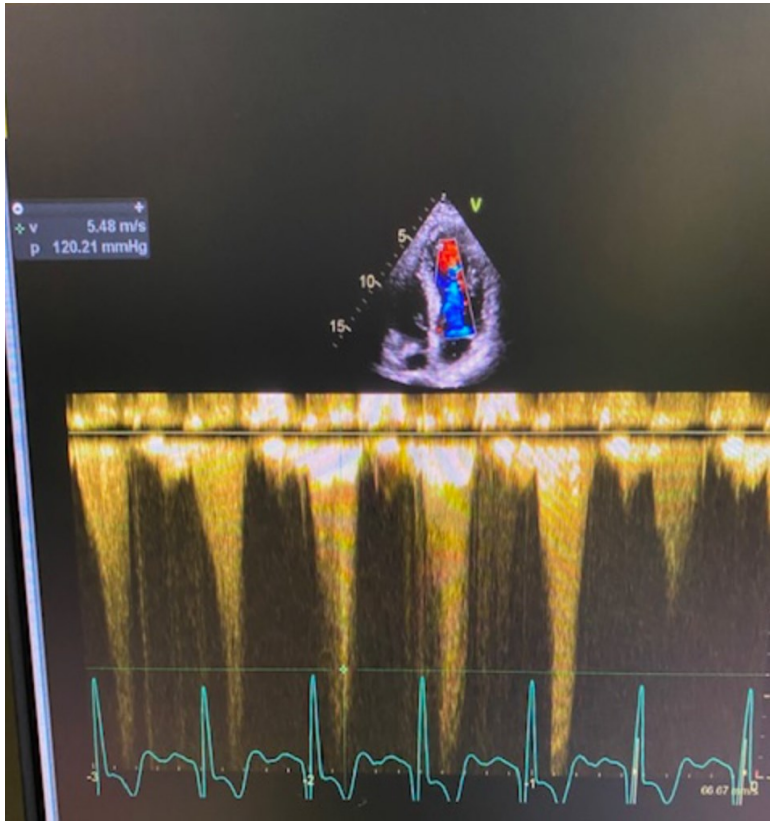

.62
-.62
V
5
132
HR
-/2
18/30
25/25 fps


v 5.48 m/s
p 120.21 mmHg
V
5
10
15

סיכום מחלה/דו"ח צנתור

תאריך הצנתור	03/04/2023 14:57:08		
שם הנבדק		ת.ז	
כתובת		תאריך לידה	
גיל:	54		
טלפון			
מגדר	זכר		
גורם מפנה:	קופת חולים מכבי		
מספר מקרה:			

Right radial artery

תאור העורקים כליליים

Right Dominance

Left Main Coronary Artery Segment

LMCA: Normal .

Left Anterior Decending Artery Segment

Mid LAD: 40 % - 60 % stenosis.

Mid D1: 99 % stenosis with Timi flow 2.

LCX: Normal .

Right Coronary Artery Segment

RCA: Irregular.

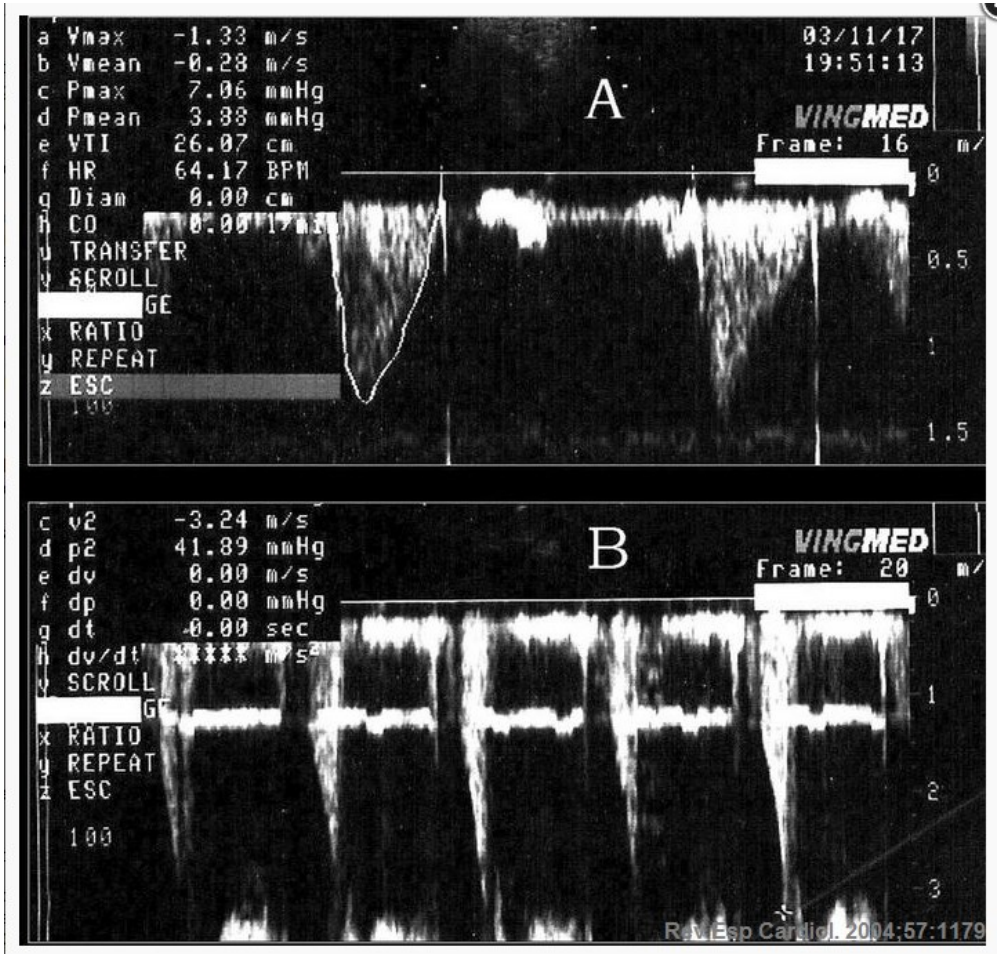
טיפול התערבותי

Dynamic left ventricular outflow tract obstruction

- Seen in almost 50% of patients with hypertrophic cardiomyopathy

- Also in hypertensive heart disease, pheochromocytoma, catecholamine treatment, acute MI, prior mitral valve repair or aortic valve replacement, sepsis, or dehydration

Exercise related?



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סורוקה

Labil Subaortic Obstruction During Exercise Stress Echocardiography

Jesús Peteiro, MD, Lorenzo Montserrat, MD, and Alfonso Castro-Beiras, MD

Although the development of subaortic obstruction has been extensively reported during dobutamine stress testing,[1–3] its appearance during physical dynamic exercise has not been equally studied. Because exercise echocardiography is a method that is increasingly used to evaluate coronary artery disease and associated pathologies, we hypothesized that nonsuspected labil subaortic obstruction may be frequent in patients referred for exercise echocardiography and that this situation can be diagnosed with this approach.

• • •

To study this phenomenon, the patient population of a stress echocardiography laboratory was examined. Between March 1994 and October 1998, 2,280 patients were submitted to treadmill exercise echocardiography (Vingmed CFM, 725, Horton, Norway) according to different protocols. Left ventricular (LV) outflow tract velocity was obtained at rest by continuous-wave Doppler from the apex using the modified Bernouilli equation (4 V^2) to calculate gradient. Rest, peak, and postexercise images were obtained in 5 standard views (parasternal long-, short-axis, and apical 2-, 4-, and 4-chambers plus aorta) and stored in digital format. Patients were encouraged to perform maximal exercise. End points were severe chest pain, severe fatigue, >2.5 mm of ST-segment elevation or depression, systolic or diastolic blood pressure >250 and >130 mm Hg, or systolic blood pressure decrease >20 mm Hg.

Post-exercise
tained within 90 s
ing 2 minutes, w
recumbent positio
measured again. C
performed, both a
gate mitral regur
excluded: 62 wi
accurate LV ou
cise and 5 w
tract Doppl deri

Of the 2,213 p
LV obstruction immediately after exercise, which was absent at rest; 3 had both new LV obstruction and mitral regurgitation due to mitral valve systolic anterior motion, and 2 patients had new mitral regurgitation due to systolic anterior motion without demonstration of obstruction. The characteristic LV ouflow tract velocity pattern of patients with obstruction consisted of a gradual increase, a midsystolic acceleration, and a relatively sharp late systolic peak. LV Doppler-derived gradient increased from 10 ± 3 mm Hg (range 5 to 17) to 69 ± 29 mm Hg (range 34 to 130) after exercise in the 41 patients with obstruction. A mitral valve systolic anterior motion without septal contact was seen in 8 patients at baseline (2 of them

Exercise-induced DLVOTO and/or SAM causing mitral regurgitation were found in 43 of 2,213 patients (2%) assigned to treadmill exercise echocardiography.

From the Service of Cardiology, Juan Canalejo Hospital, A Coruña, Spain. Dr. Peteiro's address is: P/Ronda 5-4° izda, 15011. A Coruña, Spain. E-mail: jpeteiro@pulso.com. Manuscript received March 8, 1999; revised manuscript received and accepted June 10, 1999.

BRIEF REPORT

Effect of Exercise on Systolic Left Ventricular Outflow Velocity in Healthy Adults

Fernando Cabrera Bueno, Isabel Rodríguez-Bailón, Raúl López-Salguero, Juan J. Gómez-Doblas, José M. García-Pinilla, and Eduardo de Teresa Galván

Servicio de Cardiología, Hospital Clínico Universitario Virgen de la Victoria, Málaga, Spain.

The occurrence of exercise-induced dynamic obs
tion of the left ventricular outflow tract in patients wi
cardiomyopathy has recently been reported. Howev
is not known if this phenomenon is a normal respons
exercise in healthy adults. We studied 23 healthy
using exercise Doppler echocardiography. We m
the left ventricular outflow velocity at rest and
mum tolerated exercise. After a mean exe
of 12 min 45 s (2 min 32 s), the heart
(6.71)% of the theoretical maximum.
flow velocity increased from 1.07 (
1.44 m/s) to 1.58 (0.35) m/s
healthy adults, exercise increased the left ventri
outflow velocity by 50%, though in no subject w
greater than 2.5 m/s. This observation appears to rul
the possibility that a high intraventricular pressure
dient is a normal response to exercise in healthy adul

Key words: *Exercise echocardiography. Left intrav
cular pressure gradient. Left ventricle.*

- LVOT velocity increased from 1.1 (0.18) m/s to 1.6 (0.35) m/s
- In healthy adults, exercise increased LVOT velocity by 50%, though in no subject was it greater than 2.5 m/s
- This observation appears to rule out the possibility that a high intra-ventricular pressure gradient is a normal response to exercise in healthy adults

Palabras clave: *Ecocardiografía esfuerzo. Gradiente intraventricular izquierdo. Ventrículo izquierdo.*

Nonobstructive Left Ventricular Ejection Pressure Gradients in Man

Ares Pasipoularides, Joseph P. Murgo, Jerry W. Miller, and William E. Craig

Simultaneous intraventricular pressure gradients and ejection flow patterns were measured by a multisensor catheter in 6 patients with normal left ventricular function and no valve abnormalities, at rest and in exercise. Peak measured intraventricular pressure gradients were attained very early in ejection, amounted to 6.7 ± 1.9 (SD) mm Hg at rest, and were intensified to 13.0 ± 2.3 mm Hg during submaximal supine bicycle exercise. The augmentation of the gradients during exercise was associated with a pronounced accentuation of [illegible]celeration and flow at the instant of peak gradient. At peak flow, the intrave[illegible] during submaximal [illegible] pressure difference a[illegible] A semiempirical flu[illegible] simultaneous outflow[illegible] acceleration effects t[illegible] pressure gradient, wh[illegible] effects (85 ± 5% of [illegible] responsible for the m[illegible] exercise and other hy[illegible] load can be substant[illegible] force-velocity relatio[illegible] ventricular load and [illegible] into account in exploring analytically the loading feedback between the total myocardial load and the acceleration, velocity and extent of shortening, which, along with end-diastolic dimensions, determine ejection flow waveforms. (*Circulation Research* 1987;61:220–227)

- Rest intraventricular pressure gradient at rest 6.7 ± 1.9 mm Hg, submaximal supine bicycle exercise 13.0 ± 2.3 mm Hg
- The augmentation of the IVPG during exercise was associated with a pronounced accentuation of the flow acceleration

European Journal of Echocardiography (2008) 9, 665–671
doi:10.1093/ejechocard/jen070

Dynamic left ventricular outflow tract obstruction evoked by exercise echocardiography: prevalence and predictive factors in a prospective study

K. Zywica[1], R. Jenni[2], P.A. Pellikka[3], A. Faeh-Gunz[1], B. Seifert[4], and C.H. Attenhofer Jost[1]*

[1]*Cardiovascular Center Zurich, Klinik Im Park, Seestr. 220, 8027 Zurich, Switzerland;* [2]*Division of Cardiology, University Hospital Zurich, Zurich, Switzerland;* [3]*Division of Cardiovascular Diseases, Mayo Clinic, Rochester, MN, USA; and* [4]*Biostatistics Unit, University of Zurich, Zurich, Switzerland*

Received 18 October 2007; accepted after revision 20 January 2008; online publish-ahead-of-print 23 April 2008

KEYWORDS
Dynamic left ventricular outflow tract obstruction;
Stress echocardiography;
Prevalence;
Exercise echocardiography;
Ischaemia

Aims In patients without hypertrophic obstructive cardiomyopathy (HOCM), dynamic left ventricular outflow tract obstruction (DLV
of DLVOTO in patients withou
Methods and results In 300
rest and with Valsalva and
was performed. Withi
cant DLVOTO was define
patients with HOCM and 13
years. Coronary artery disea
and 35% had hypertension. A
was present in 21%, SAM in 1
echocardiographic signs of is
multivariate analysis, it was
chordal SAM at peak, smalle
younger age and increased se
and/or ischaemia in at least
Conclusion Haemodynamically significant exercise-induced DLVOTO can occur without HOCM. Chordal SAM at peak, small, hyperdynamic left ventricles, increased septal wall thickness, and younger age are the best predictors.

- Significant DLVOTO defined as late-peaking Doppler velocity of ≥2.5 m/s
- 13 of 280 patients (5%) developed significant DLVOTO

Dynamic left ventricular outflow tract obstruction evoked by exercise echocardiography: prevalence and predictive factors in a prospective study

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Table 2
Comparison of echocardiographic parameters at rest in patients with and without dynamic left ventricular outflow tract obstruction

	All (n = 280)	DLVOTO ≥ 25 mmHg after exercise (n = 13)	No significant DLVOTO after exercise (n = 267)	P-value
Ejection fraction, %	59 ± 9	64 ± 8	59 ± 9	0.06
Shortening fraction, %	39 ± 10	45 ± 7	38 ± 9	0.005
LVEDD, mm	46 ± 6	42 ± 3	46 ± 6	0.007
LVESD, mm	29 ± 14	23 ± 3	30 ± 14	0.0005
LVMMI, g/m^2	101 ± 33	108 ± 24	101 ± 33	0.32
Septum, mm	12 ± 3	14 ± 2	12 ± 3	0.006
Posterior wall, mm	10 ± 2	11 ± 2	10 ± 2	0.02
Left ventricular hypertrophy	58 (21%)	5 (38%)	53 (20%)	0.15
Mitral regurgitation				0.99
None/trivial	235 (83%)	11 (85%)	224 (83%)	
Mild	41 (14%)	2 (15%)	39 (14%)	
Moderate	5 (2%)	0	5 (2%)	
Severe	2 (1%)	0	2 (1%)	
Aortic stenosis[a], any	31 (11%)	1 (8%)	30 (11%)	1.0
Chordal SAM at rest	45 (16%)	8 (62%)*	37 (14%)	0.0002
DLVOTO ≥ 25 mmHg at rest	2 (1%)	2 (15%)	0	0.002

European Journal of Echocardiography (2008) 9, 665–671

Symptomatic Exercise-Induced Left Ventricular Outflow Tract Obstruction without Left Ventricular Hypertrophy

Eyad K. Alhaj, MD, Bette Kim, MD, Deborah Cantales, RDCS, Seth Uretsky, MD, Farooq A. Chaudhry, MD, and Mark V. Sherrid, MD, *New York, New York*

Background: Left ventricular (LV) outflow tract obstruction (LVOTO) is most commonly seen in patients with hypertrophic cardiomyopathy. Postexercise dynamic LVOTO (DLVOTO) has been infrequently identified in symptomatic patients without LV hypertrophy, and its pathophysiology is not well established. The aim of this study was to identify echocardiographic abnormalities that might explain the dynamic development of systolic anterior motion, mitral-septal contact, and LVOTO in these patients.

Methods: Patients with DLVOTO and normal wall thickness were compared with 20 age-matched and gender-matched controls with normal stress echocardiographic findings. Two other groups were also compared: patients with DLVOTO and mild segmental hypertrophy (segmental wall thickness ≤15 mm) and patients with normal left ventricles but DLVOTO after dobutamine stress.

Results: Six symptomatic patients were identified (mean age, 48 ± 9 years; range, 37–60 years; five men) with normal wall thickness who developed DLVOTO after exercise during a 6-year period. Five had been hospitalized for cardiac symptoms. The mean postexercise LV outflow tract gradient caused by systolic anterior motion mitral-septal contact was 107 ± 55 mm Hg (range, 64–200 mm Hg). All patients had echocardiographic LV wall thicknesses in the normal range (≤12 mm). Structural abnormalities of the mitral valve were identified in all six patients. These were elongated posterior leaflets (2.0 vs 1.5 cm, $P < .0005$), elongated anterior leaflets (3.2 vs 2.6 cm, $P = .015$), increased protrusion height of the mitral valve beyond the mitral annular plane (2.6 vs 0.6 cm, $P < .00001$), and residual protruding portions of the mitral valve leaflets (0.85 vs 0.24 cm, $P < .005$). There was anterior positioning of the papillary muscles in the LV cavity, with a greater distance from the plane of the papillary muscles to the posterior wall (1.8 vs 1.3 cm, $P = .03$). In two patients, potentially provoking medications were stopped; two patients received β-blockers, with reductions of angina. Medium-term prognosis was good; no patient had died after 3.5 years. The mitral valve abnormalities in the 10 patients with DLVOTO and mild segmental hypertrophy were qualitatively and quantitatively very similar to those in patients with DLVOTO without hypertrophy. In contrast, the valves of patients with dobutamine stress DLVOTO were not elongated, but 50% had residual mitral leaflets that protruded past the coaptation point by ≥5 mm.

Conclusions: DLVOTO after exercise can occur in the absence of LV hypertrophy and may be associated with high gradients and cardiac symptoms. Elongated, redundant mitral valve leaflets with anterior position of the papillary muscles appear to cause the postexercise obstruction. (J Am Soc Echocardiogr 2013;26:556-65.)

Keywords: Left ventricular outflow obstruction, Left ventricular hypertrophy, Hypertrophic obstructive cardiomyopathy, Hypertrophic cardiomyopathy, Mitral valve disease

(J Am Soc Echocardiogr 2013;26:556-65.)

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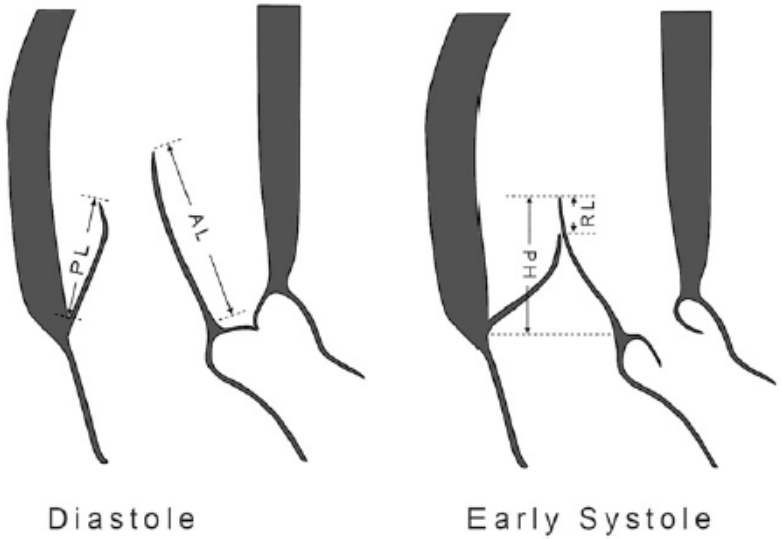

Figure 1 Line drawing of an apical three-chamber view from a representative patient with DLVOTO showing elongated mitral leaflets, increased protrusion height above the mitral annular plane, and increased residual leaflet length. The locations of echocardiographic measurements are shown. (*Left*) Diastole, showing measurements of anterior leaflet length (AL) and posterior leaflet length (PL). (*Right*) Early systole at the moment of coaptation, showing residual leaflet length (RL) and protrusion height (PH) of the most protruding leaflet measured from the mitral annulus to the top of the most protruding leaflet.

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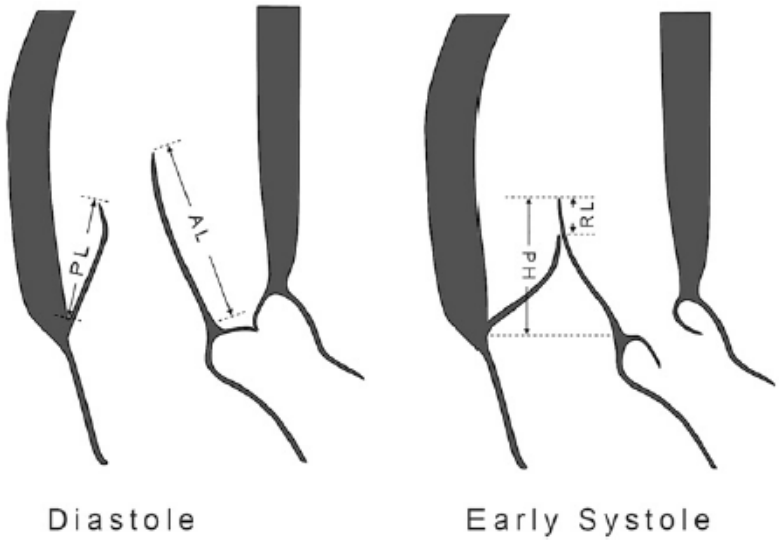

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- Elongated posterior leaflets (2.0 vs 1.5 cm, $P < .0005$)
- Elongated anterior leaflets (3.2 vs 2.6 cm, $P = .015$)
- Increased protrusion height of the mitral valve beyond the mitral annular plane (2.6 vs 0.6 cm, $P < .00001$)
- Residual protruding portions of the mitral valve leaflets (0.85 vs 0.24 cm, $P < .005$)

(J Am Soc Echocardiogr 2013;26:556-65.)

Effort Angina, Normal Coronary Angiogram, and Dynamic Left Ventricular Obstruction

Fernando Cabrera-Bueno, MD, PhD, Juan J. Gómez-Doblas, MD,
Antonio Muñoz-García, MD, José M. García-Pinilla, MD, PhD,
Manuel Jiménez Navarro, MD, PhD, and
Eduardo de Teresa-Galván, MD, PhD, FACC, FESC, *Málaga, Spain*

The development of dynamic left ventricular outflow tract (LVOT) obstruction (DLVOTO) during effort in patients without hypertrophic cardiomyopathy has been described only a few times and its clinical significance has not been established. This study was undertaken to determine DLVOTO during exercise in patients with angina and normal coronary arteries, and to analyze the potential mechanism involved. The study included 23 patients (60.7 ± 7.2 years), with effort angina and normal coronary arteries who underwent exercise echocardiography. DLVOTO during exercise appeared in 7 patients (30.4%), with gradients ranging from 31.1 to 67.2 mm Hg (mean 41.3 ± 12.6). These patients showed more symptoms (effort angina) during testing than the remaining patients (100% vs 47.3%; P = .014). LVOT size was the only predictive factor of DLVOTO (9.1 ± 0.5 vs 10.3 ± 1.2 mm/m^2; P = .017). In patients with angina and no epicardical coronary artery disease DLVOTO is associated with a lower LVOT size. (J Am Soc Echocardiogr 2007;20:415-420.)

Effort Angina, Normal Coronary Angiogram, and Dynamic Left Ventricular Obstruction

Fernando Cabrera-Bueno, MD, PhD, Ju
Antonio Muñoz-García, MD, José M.
Manuel Jiménez Navarro, M
Eduardo de Teresa-Galván, MD, PhD, FA

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DLV
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arte
LVOT size. (J Am Soc Echocardiogr 2007;20:415-420.)

Of 23 pts with effort angina and normal coronary arteries, DLVOTO during exercise appeared in 7 patients (30%)

100% of DLVOTO pts developed effort angina during testing, in 47% of non DLVOTO pts

Cardiovascular Ultrasound

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Research

Open Access

Exercise-induced intra-ventricular gradients as a frequent potential cause of myocardial ischemia in cardiac syndrome X patients

Carlos Cotrim*[1,3], Ana G Almeida[2] and Manuel Carrageta[1,2,3]

Address: [1]Cardiology Department, Garcia de Orta Hospital, Almada, Portugal, [2]Cardiology Department, Santa Maria Hospital, Lisboa, Portugal and [3]Lisboa University Medical School, Lisboa, Portugal

Background: The development of intra-ventricular gradients (IVG) during dobutamine or exercise stress is not infrequent, and can be associated to symptoms during stress.

The purpose of this study was to assess the occurrence of IVG during exercise stress echocardiography in cardiac syndrome X patients.

Methods: We prospectively evaluated 91 patients (pts) mean aged 51 ± 12 years (age ranged 20 to 75 years old), 44 of whom were women. All pts had angina, positive exercise ECG treadmill testing, normal rest echocardiogram and no coronary artery disease on coronary angiogram (cardiac X syndrome). After complete Doppler echocardiographic evaluation with determination of left ventricular outflow tract index (LVOTi), relative left ventricular wall thickness (RLVWT) and left ventricular end-diastolic volume index (LVDVi), all patients underwent stress echocardiography with two-dimensional and Doppler echographic evaluation during and after treadmill exercise.

Results: For analysis purpose patients were divided in 2 groups, according to the development of IVG. Doppler evidence of IVG was found in 33 (36%) of the patients (Group A), with mean age 47 ± 14 years old (age ranged 20 to 72 years) and with a mean end-systolic peak gradient of 86 ± 34 mmHg (ranging from 30 to 165 mmHg). The IVG development was accompanied by SAM of the mitral valve in 23 pts. Three of these pts experienced symptomatic hypotension. Ten were women (30% pts). 58 pts in group B, 34 of whom were women (59%) ($p = 0,01$ vs group A), mean aged 53,5 ± 10,9 years old (age ranged 34 to 75 years) ($p = 0,03$ vs group A), did not develop IVG. LVOTi was 10,29 ± 0,9 mm/m^2 in group A and 11,4 ± 1 mm/m^2 in group B ($p < 0,000$); RLVWT was 0,36 ± 0,068 in group A and 0,33 ± 0,046 in group B ($p < 0,01$); LVDVi was 44,8 ± 10 ml/m^2 in group A and 56 ± 11,6 ml/m^2 in group B ($p = 0,000$).

Conclusion: 1. A significant number of patients with cardiac X syndrome developed IVG during upright exercise in treadmill. These pts (group A) are mainly males and younger than those who did not develop IVG.

2. The development of IVG and mitral valve SAM on exertion seems to be associated with ST segment downsloping during stress testing in patients without epicardial coronary disease.

3. The development of IVG and mitral valve SAM seems to be associated with lower LVOTi, lower LVDVi and higher RLVWT.

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Exercise-induced intra-ventricular gradients as a frequent potential cause of myocardial ischemia in cardiac syndrome X patients

Carlos Cotrim*[1,3], Ana G Almeida[2] and Manuel Carrageta[1,2,3]

Address: [1]Cardiology Department, Garcia de Orta Hospital, Almada, Portugal, [2]Card... and [3]Lisboa University Medical School, Lisboa, Portugal

Background: The development of intra-ventricular gradients ... is not infrequent, and can be associated to symptoms during s...

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- 36%r of patients with cardiac X syndrome developed IVG during upright SE
- The development of IVG and mitral valve SAM on exertion seems to be associated with ST segment down-sloping
- The development of IVG and mitral valve SAM seems to be associated with lower LVOTi, lower LVDVi and higher RLVWT.

Cotrim et al. Cardiovascular Ultrasound 2010, 8:38
http://www.cardiovascularultrasound.com/content/8/1/38

CARDIOVASCULAR ULTRASOUND

RESEARCH Open Access

Efficacy of beta-blocker therapy in symptomatic athletes with exercise-induced intra-ventricular gradients

Carlos Cotrim[1,3,5*], Luís R Lopes[1], Ana R Almeida[1], Rita Miranda[1], Almeida G Ana[2,5], Hortense Cotrim[3,5], José P Andrade[1], Eugenio Picano[4], Manuel Carrageta[1,5]

Abstract

Background: Upright exercise stress echocardiography (SE) induces significant intraventricular gradient (IVG) and systolic anterior motion (SAM) in a large proportion of symptomatic athletes, who may therefore benefit from a negative inotropic therapy.
The purpose of the present study was to assess the effect of chronic oral β blocker therapy on the occurrence of exercise-induced IVG and mitral valve SAM, in symptomatic athletes.

Methods: We enrolled 35 symptomatic athletes (age = 23 ± 11 years) with IVG (>30 mmHg) during SE off therapy. All repeated SE on chronic oral beta-blocker therapy (atenolol up to 50 mg, bisoprolol up to 10 mg, or metoprolol up to 100 mg daily according to physician-driven choice).

Results: On therapy, there was during SE a reduction in IVG (35 off vs 17 on beta blocker, $p < 0.01$), decrease of IVG (102 ± 34 mmHg off vs 69 ± 24 mmHg on beta blocker, $p < 0.01$), peak heart rate (178 ± 15 bpm off vs 157 ± 9 bpm on beta blocker), SAM (24 off vs 9 on beta blocker, $p < 0.001$), symptoms during SE (17 off vs 2 on beta blocker $p < 0.001$), ST segment depression (13 off vs 2 on beta blocker, $p < 0.001$).

Conclusions: In athletes with positive screening on medical evaluation for sports practice and IVG on exertion, treatment with oral beta blockers improved symptoms in the large majority of patients. Symptomatic benefit was mirrored by objective evidence of improvement of echocardiographic signs of obstruction (IVG and SAM) and reduction of ischemia-like electrocardiographic changes.

RESEARCH Open Access

Efficacy of beta-blocker therapy in symptomatic athletes with exercise-induced intra-ventricular gradients

Carlos Cotrim[1,3,5*], Luís R Lopes[1], Ana R Almeida[1], Rita Miranda[1], Almeida G Ana[2,5], Hortense Cotrim[3,5], José P Andrade[1], Eugenio Picano[4], Manuel Carrageta[1,5]

- 139 athletes, aged 22 ± 9.9 y, with a positive screening for sports practice but with normal rest echocardiogram
- In 52 (37%) of these athletes, SE disclosed IVG with a mean end-systolic peak of 95 ± 35 mmHg (50 to 193), combined with mitral valve SAM in 33 of them
- The 35 pts who repeated the SE under treatment with BB were the study group

Table 1 Variables assessed in the two stress echocardiograms

	SE1	SE2	p
Test duration (sec)	762 ± 107	750 ± 86	0,236
Peak exercise HR (bpm)	179 ± 15	157 ± 9	<0,001
Peak exercise SBP (mmHg)	164 ± 20	155 ± 19	<0,001
Peak exercise DP (HRxSBPPeak)	29424 ± 3746	22798 ± 16170	<0,001
Symptoms during SE (n)	17/35 (49%)	2/35(5.5%)	<0.001
Peak IVG (n)	35/35(100%)	17/35(49%)	<0.001
SAM (n)	24/35 (69%)	9/35 (26%)	<0.001
ST - segment alterations (n)	13/35 (37%)	2/35(5.7%)	<0.001

DP: double product; HR: heart rate; IVG: intra-ventricular gradient; SAM: mitral valve systolic anterior motion; SBP: systolic blood pressure; SE: stress echocardiography

ELSEVIER

International Journal of Cardiology 117 (2007) 222 – 226

International Journal of Cardiology

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Beta-blocker therapy for dynamic left ventricular outflow tract obstruction induced by exercise

Fernando Cabrera-Bueno *, José Manuel García-Pinilla, Juan José Gómez-Doblas, Angel Montiel-Trujillo, Isabel Rodríguez-Bailón, Eduardo de Teresa-Galván

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Received 30 December 2005; received in revised form 5 April 2006; accepted 28 April 2006

Abstract

Background: In patients who present with angina
aim of our study was to evaluate the effect of ne
left ventricular outflow tract obstruction induced
Methods: Seventy eight patients with symptoms
were prospectively analysed with exercise echoc
on effort. After treatment with bisoprolol
obstruction during exerci
Results: A
patients). In all patients the
oxygen consumption during exercise was high
following therapy, with a reduction in mean NY
Conclusions: Negative inotropic therapy may re
outflow tract obstruction induced by exercise and identified during exercise echocardiography.

Keywords: Obstruction; Exercise; Ventricular

- 87% reduction in development of DLVOTO
- More METs at effort (7.3 ±1.7 to 8.7 ±1.8)
- Improved symptoms (1.9 ±0.5 50 1.0 ± 0.0)

Stress-Induced Left Ventricular Outflow Tract Obstruction: A Potential Cause of Dyspnea in the Elderly

MICHAEL Y. HENEIN, MD, PHD, FACC, CHRISTINE O'SULLIVAN, BSC, GEORGE C. SUTTON, MD, FRCP, FACC, DEREK G. GIBSON, MB, FRCP, ANDREW J. S. COATS, MD, FRCP, FACC

London and Uxbridge, Middlesex, England, United Kingdom

Objectives. We sought to identify the pattern of disturbed left ventricular physiology associated with symptom development in elderly patients with effort-induced breathlessness.

Background. Limitation of exercise tolerance by dyspnea is common in the elderly and has been ascribed to di… tion when left ventricular cavity size and systolic f… normal.

Methods. Dobutamine s… patients (mean [±SD] age 70 ± 12 years; … exertional dyspnea and negative exercise test re… values were compared with those in 15 control su…

Results. Before stress, left ventricular end-dias… systolic dimensions were reduced, fractional shor… creased, and the basal septum was thickened (2.3 … 0.2 cm, $p < 0.001$, vs. control subjects) in the… posterior wall thickness did not differ from t… subjects. Left ventricular outflow tract diameter, measured as systolic mitral leaflet septal distance, was significantly reduced (13 ± 4.5 vs. 18 ± 2 mm, $p < 0.001$). Isovolumetric relaxation time was prolonged, and peak left ventricular minor axis lengthening rate was reduced (8.1 ± 3.5 vs. 10.4 ± 2.6 cm/s, $p < 0.05$), suggesting diastolic dysfunction. Transmitral velocities and the E/A ratio did not differ significantly. At peak stress, heart rate increased from 66 ± 8 to 115 ± 20 beats/min in the control subjects, but blood pressure did not change. Transmitral A wave velocity increased, but the E/A ratio did not change. Left ventricular outflow tract velocity increased from 0.8 ± 0.1 to 2.0 ± 0.2 m/s, and mitral leaflet septal distance decreased from 18 ± 2 …ate rose from …pressure from …ach), but left …t ventricular …s (at rest) to …n 13 ± 4.5 to …tion of mitral …f the control …action did not …ess, but none …regurgitation. …e criteria for "diastolic heart failure," diastolic dysfunction was not aggravated by pharmacologic stress. Instead, high velocities appeared in the left ventricular outflow tract and were associated with basal septal hypertrophy and systolic anterior motion of the mitral valve. Their appearance correlated closely with the development of symptoms, suggesting a potential causative link.

(J Am Coll Cardiol 1997;30:1301–7)

Dobutamine stress echocardiography was used in 30 patients, age 70 ± 12 years; with exertional dyspnea and criteria of diastolic dysfunction, and the values were compared with those in 15 control subjects

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London and Uxbridge, Middlesex, England, United Kingdom

Table 5. Peak Stress Data in Patients and Control Subjects

	Control Subjects (n = 15)		Patients (n = 30)	
	Rest	Stress	Rest	Stress
HR (beats/min)	66 ± 8	112 ± 15*	80 ± 12	117 ± 18*
SBP (mm Hg)	150 ± 17	156 ± 26	143 ± 22	150 ± 20
DBP (mm Hg)	77 ± 13	72 ± 14	85 ± 10	74 ± 18
RPP (mm Hg/s × 10^{-2})	116 ± 20	183 ± 40*	115 ± 27	205 ± 70*
LV Isovolumetric relaxation time (ms)	80 ± 14	45 ± 12*	100 ± 15†	65 ± 12*‡
LVOT velocity (m/s)	0.8 ± 0.1	2.0 ± 0.5*	1.5 ± 0.5‡	4.2 ± 1.2*
LV mitral leaflet septal distance (mm)	18 ± 2	14 ± 3*	13 ± 4.5‡	2.2 ± 1.9*
Filling velocity (m/s)				
Early diastolic	0.64 ± 0.1	0.71 ± 0.1	0.7 ± 0.26	0.63 ± 0.3
Late diastolic	0.8 ± 0.17	0.97 ± 0.2*	0.84 ± 0.24	1.1 ± 0.2*
E/A ratio	0.8 ± 0.2	0.74 ± 0.1	0.9 ± 0.8	0.6 ± 0.3§‖

*$p < 0.001$, ‖$p < 0.01$, stress versus rest. †$p < 0.005$, ‡$p < 0.001$, §$p < 0.05$, patients versus control subjects. Data presented are mean value ± SD. Abbreviations as in Tables 1 and 2.

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(J Am Coll Cardiol 1997;

- Diastolic dysfunction was not aggravated by pharmacologic stress
- SAM appeared in 24 patients (80%) but in none of the control subjects
- High velocities in the LVOT were associated with the development of symptoms, suggesting a potential causative link

Circulation Journal
Official Journal of the Japanese Circulation Society
http://www.j-circ.or.jp

ORIGINAL ARTICLE
Ischemic Heart Disease

Clinical Significance of Dynamic Left Ventricular Outflow Tract Obstruction During Dobutamine Stress Echocardiography in Women With Suspected Coronary Artery Disease

Seong-Mi Park, MD, PhD; Mi-Na Kim, MD; Su-A Kim, MD; Yong-Hyun Kim, MD, PhD; Myeong Gun Kim, MD; Mi-Seung Shin, MD, PhD; Wan-Joo Shim, MD, PhD

Background: Although dobutamine stress echocardiography (DSE) is frequently associated with dynamic left ventricular outflow tract obstruction (DLVOTO), little is known about its clinical significance in women with suspected coronary artery disease (CAD).

Methods and Results: One hundred and two female patients (57±10 years) who underwent DSE as part of the Korean women's chest pain registry study were included. Doppler echocardiography was performed during DSE to assess the presence of DLVOTO. Patients with DLVOTO (n=52) were older than those without DLVOTO (n=50; P=0.001). Hypertension was more prevalent in patients with DLVOTO (P=0.02). Patients with DLVOTO had smaller LV diameter, but higher LV mass index and relative wall thickness (P<0.05 for all). LV diastolic function (as reflected by late diastolic velocity, deceleration time of early diastolic velocity [E], and ratio of E velocity to early diastolic mitral annular velocity), was worse in patients with DLVOTO (P<0.05 for all). Patients with DLVOTO had shorter exercise time (P=0.02) and lower amount of work (P=0.04) than patients without DLVOTO. DSE-provoked DLVOTO was not related to the presence of CAD in these patients.

Conclusions: In Korean women with suspected CAD, DSE-provoked DLVOTO is correlated with LV concentric remodeling and LV diastolic dysfunction, and may be associated with limited exercise tolerance and symptoms of chest pain. (*Circ J* 2015; **79:** 2255–2262)

Key Words: Diastolic function; Dobutamine stress; Exercise; Left ventricular outflow tract obstruction; Woman

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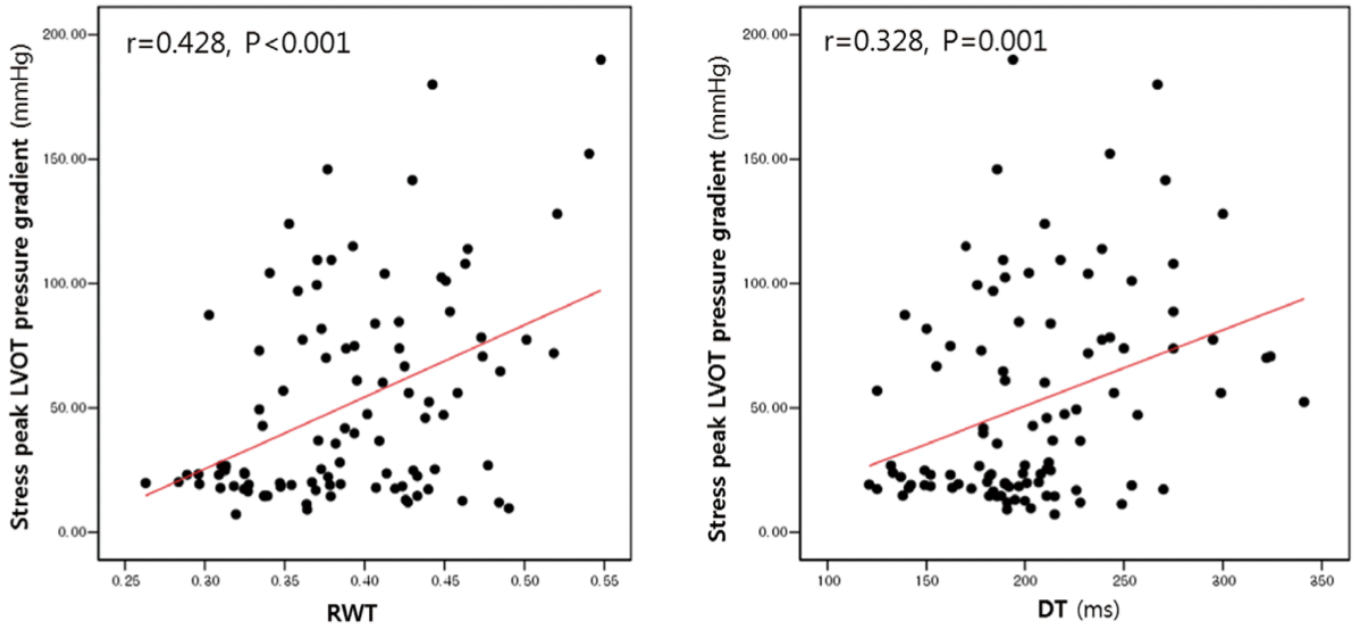

Figure 2. Correlation between stress peak left ventricular outflow tract (LVOT) pressure gradient and relative wall thickness (RWT) and deceleration time (DT).

Circ J 2015; 79: 2255–2262

Circulation Journal
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ORIGINAL ARTICLE
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ventricular outflow tract obstructio
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Methods and Results: One hun
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assess the presence of DLVOT
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LV diameter, but higher LV
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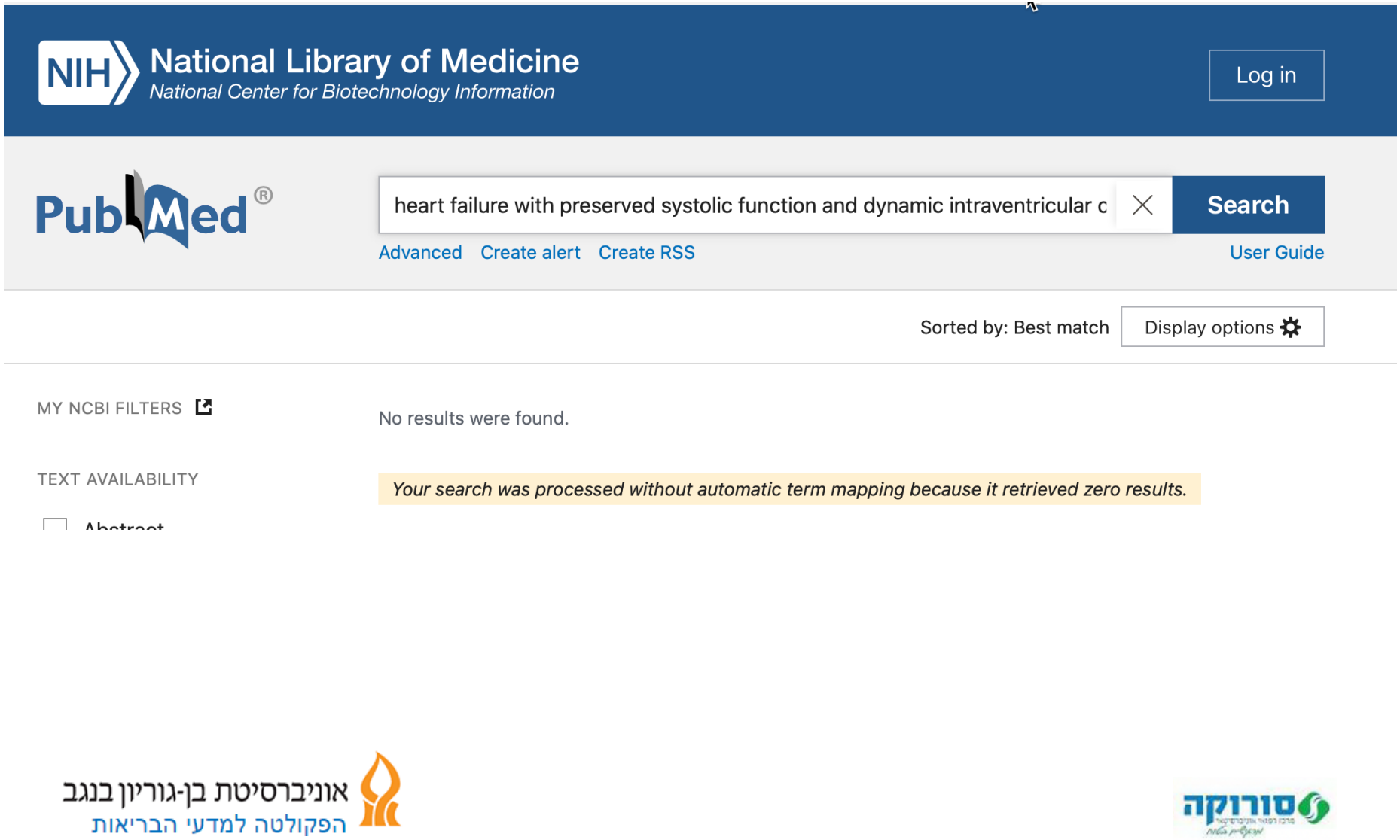
Key Words: Diastolic function; Dobutamine stress; Exercise; Left ventricular outflow tract obstruction; Woman

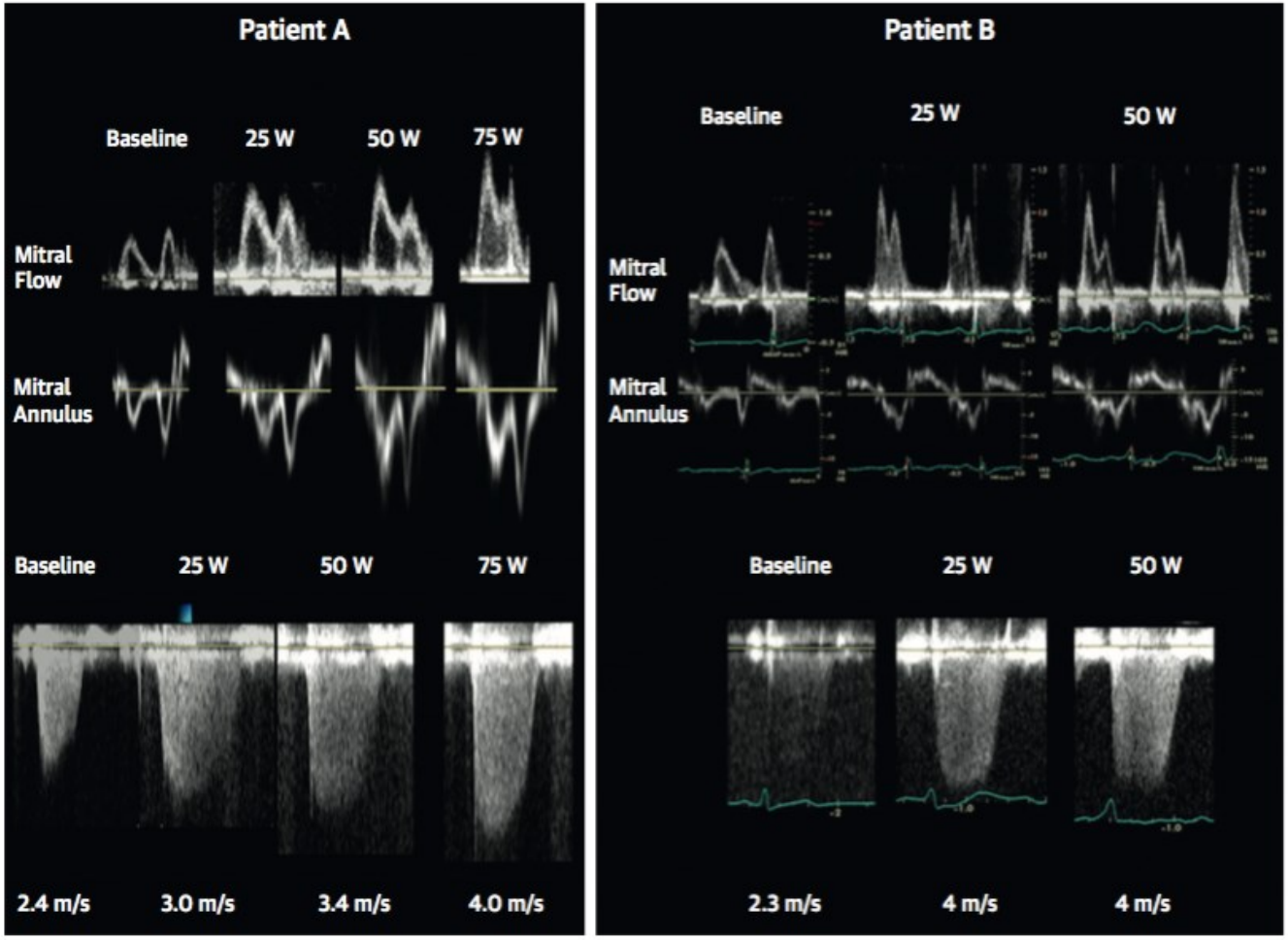
- In the present study, 51% of the patients had DLVOTO
- DSE-provoked DLVOTO is correlated with LV concentric remodeling and LV diastolic dysfunction
- DLVOTO may be associated with limited exercise tolerance and symptoms of chest pain



אוניברסיטת בן-גוריון בנגב
הפקולטה למדעי הבריאות

סורוקה

D


Patient A
Baseline
25 W
50 W
75 W
Mitral Flow
Mitral Annulus
Baseline
25 W
50 W
75 W
2.4 m/s
3.0 m/s
3.4 m/s
4.0 m/s
Patient B
Baseline
25 W
50 W
Mitral Flow
Mitral Annulus
Baseline
25 W
50 W
2.3 m/s
4 m/s
4 m/s

Exercise Induced Dynamic LV Outflow Tract Obstruction (DLVOTO)

- Exercise induced DLVOTO is a non physiologic phenomena
- Predisposing factors are small and hyperdynamic left ventricles, LVH, redundant and elongated mitral leaflets
- DLVOTO can cause significant symptoms mimicking CAD or HF
- Relevance of DLVOTO induced by exercise in asymptomatic patients is unknown, even thought the condition has not been associated with increased risk of mortality

Exercise Induced Dynamic LV Outflow Tract Obstruction (DLVOTO)

- The prevalence of DLVOTO in patients with effort dyspnea and/or chest pain without CAD was reported as 30–36% detected by treadmill exercise echocardiography

- DLVOT during DSE is frequently seen in elderly women with HTN, concentric remodeling, and diastolic dysfunction

- When diagnosed, BB proved as an effective treatment

Thank you

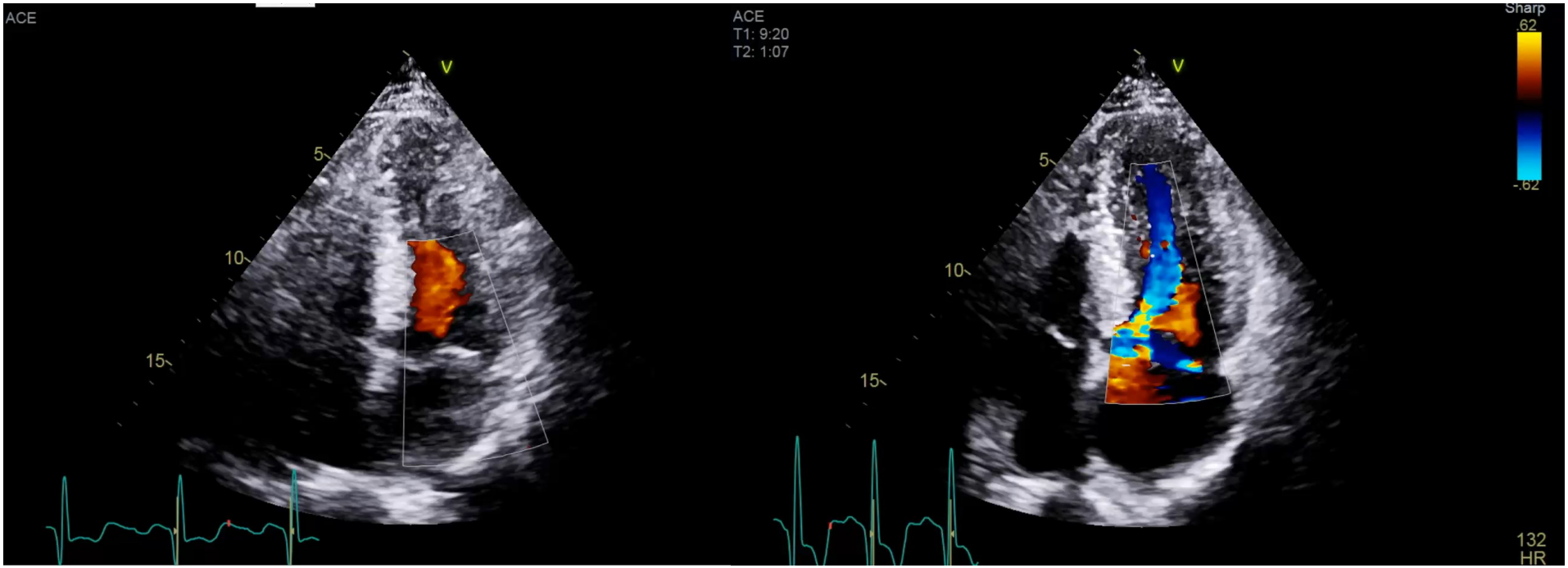
אוניברסיטת בן-גוריון בנגב
הפקולטה למדעי הבריאות

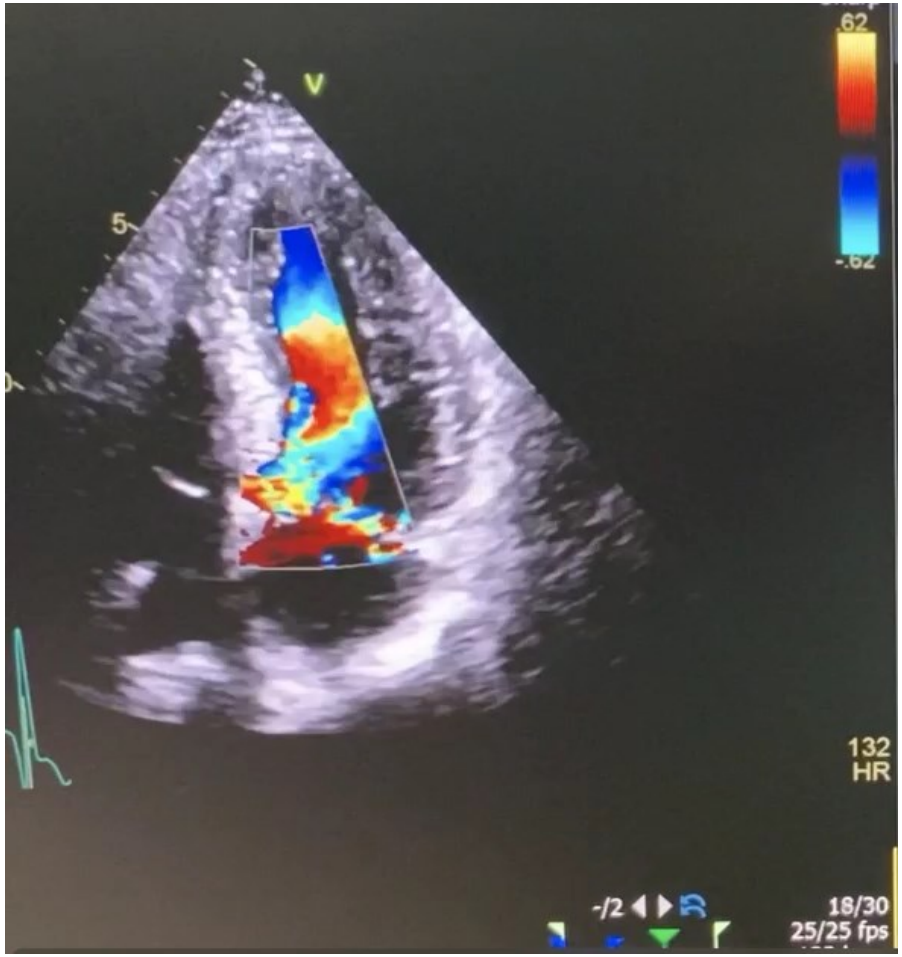
סורוקה

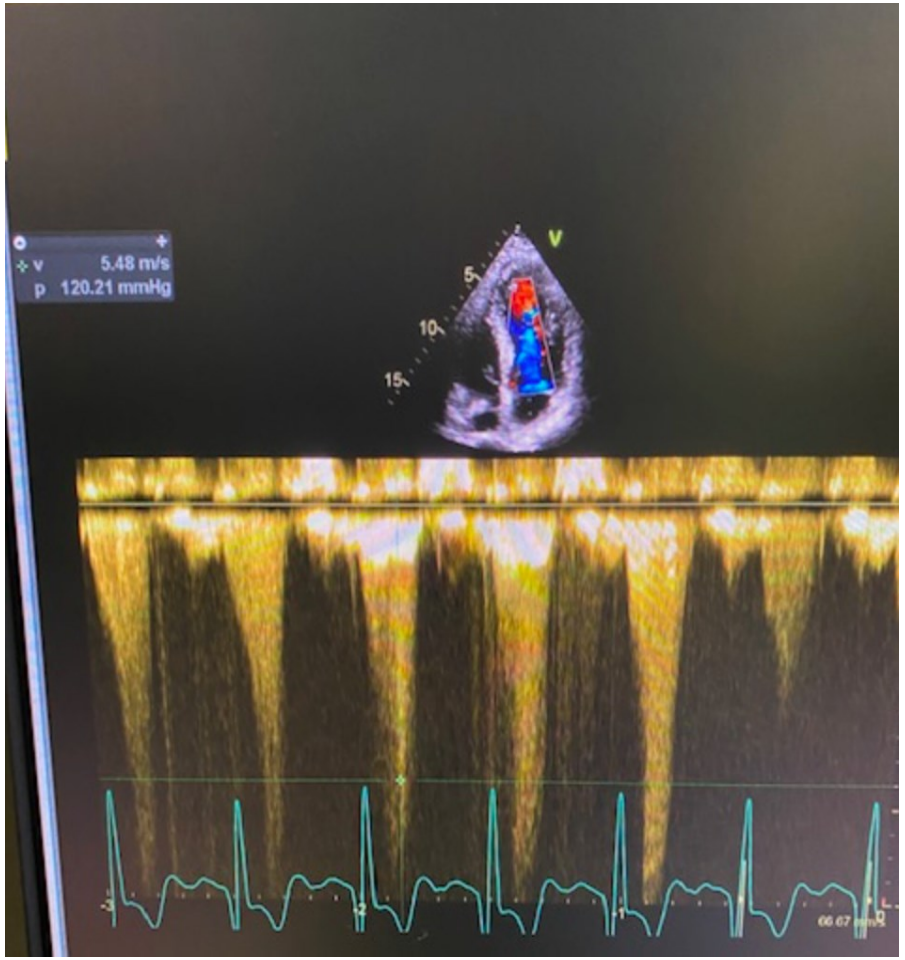
- Hemodynamically significant systolic LV obstructions are often associated with symptoms and should be differ- entiated from physiological gradients. Asymptomatic DLVOTO and midcavity obstruction may occur during peak DSE, or minutes after stopping exercise during ex- ercise echocardiography. Its clinical significance has been somehow debated, and if not interpreted cautiously in the context of symptoms, there is a risk of false positivity
- Although exercise-induced DLVOTO may cause sig- nificant symptoms for patients and affect their quality of life, the condition has not been associated with increased risk of mortality

- In elderly hypertensive women with unexplained chest pain and shortness of breath and with no evidence of an- giographic significant coronary artery disease, DLVOTO and midcavity obstruction should be ruled out by ei- ther exercise echocardiography or DSE.
- Recent studies have indicated that in women with unex- plained chest pain or shortness of breath, DSE-induced DLVOTO was not related with the presence of coronary artery disease, but to concentric LV remodeling and dia- stolic dysfunction [28], which both are known features of hypertensive heart disease

- **Established Facts**
- Dynamic left ventricular outflow tract obstruction (DLVOTO) can occur in patients with structurally normal hearts.
- DLVOTO can cause significant symptoms mimicking coronary artery disease or heart failure.
- DLVOTO can be easily assessed by exercise or dobutamine stress echocardiography.
- **Novel Insights**
- Dynamic left ventricular outflow tract obstruction is frequently seen in elderly women with hyperten- sion, concentric remodeling, and diastolic dysfunction.
- Symptoms are caused by obstruction rather than coronary ischemia.
- Optimal antihypertensive treatment, preferably with a betablocker improves symptoms.


ACE
V
5
10
15
ACE
T1: 9:20
T2: 1:07
V
5
10
15
Sharp
.62
-.62
132
HR


62
-.62
132
HR
18/30
25/25 fps


v 5.48 m/s
p 120.21 mmHg

סיכום מחלה/דו"ח צנתור

תאריך הצנתור	03/04/2023 14:57:08		
שם הנבדק		ת.ז	
כתובת		תאריך לידה	
גיל:	54		
טלפון			
מגדר	זכר		
גורם מפנה:	קופת חולים מכבי		
מספר מקרה:			

Right radial artery

תאור העורקים כליליים

Right Dominance

Left Main Coronary Artery Segment

LMCA: Normal .

Left Anterior Decending Artery Segment

Mid LAD: 40 % - 60 % stenosis.

Mid D1: 99 % stenosis with Timi flow 2.

LCX: Normal .

Right Coronary Artery Segment

RCA: Irregular.

טיפול התערבותי

Dynamic left ventricular outflow tract obstruction evoked by exercise echocardiography: prevalence and predictive factors in a prospective study

K. Zywica[1], R. Jenni[2], P.A. Pellikka[3], A. Faeh-Gunz[1], B. Seifert[4], and C.H. Attenhofer Jost[1]*

Table 4
Summary of univariate and multivariate predictors of significant DLVOTO with exercise

	P-values of univariate analysis	*P*-values, OR with 95% CI multivariate analysis
Chordal SAM peak	<0.0001	0.0009, OR 15.4 (95% CI, 3.1–77.9)-
Chordal SAM rest	0.0002	
LVESD (mm)	0.005	0.003, OR 22.6 (2.9–177.7)
EF peak (%)	0.005	
Shortening fraction (%)	0.005	
DLVOTO Valsalva	0.006	
Septal wall thickness (mm)	0.006	0.006, OR 0.004 (0.0006–0.20)
Male gender	0.006	
Systolic BP, peak	0.006	0.03, OR 0.97 (0.95–1.0)
LVEDD (mm)	0.007	
Heart rate, peak	0.01	
Posterior wall thickness (mm)	0.02	
EF rest (%)	0.06	
Age (years)	0.14	0.004, OR 1.15 (1.05–1.27)
LVH	0.16	

- EF, ejection fraction; DLVOTO, dynamic left ventricular outflow tract obstruction; LVEDD, left ventricular end-sdiastolic diameters; LVH, left ventricular

Cardiology

Cardiovascular Imaging: Novel Insights from Clinical Experience

Cardiology 2021;146:441–450
DOI: 10.1159/000516188

Received: February 9, 2021
Accepted: March 26, 2021
Published online: May 18, 2021

Usefulness of Stress Echocardiography in Assessment of Dynamic Left Ventricular Obstructions: Case Series and Review of the Literature

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[a]Department of Heart Disease, Haukeland University Hospital, Bergen, Norway; [b]Department of Internal Medicine, Ålesund Hospital, Ålesund, Norway

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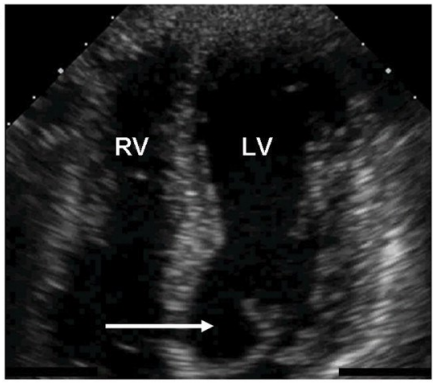
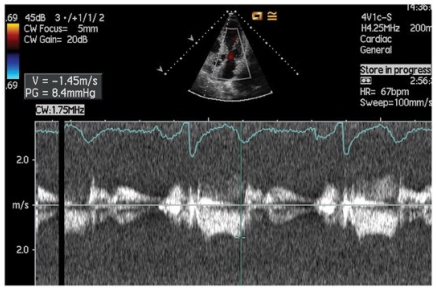
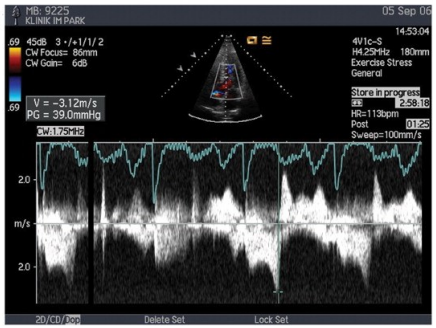
(A)



(B)



(C)



European Journal of Echocardiography (2008) 9, 665–671

- *30 pts with* diastolic heart failure and 15 control group underwent DSE
- Diastolic dysfunction was not aggravated by pharmacologic stress
- SAM appeared in 24 patients (80%) but in none of the control subjects
- High velocities in the LVOT were associated with basal septal hypertrophy and systolic anterior motion of the mitral valve
- Their appearance correlated closely with the development of symptoms, suggesting a potential causative link

...ar Outflow Tract Obstruction: ... in the Elderly

...CHRISTINE O'SULLIVAN, BSc,
...DEREK G. GIBSON, MB, FRCP,

...dom

...bed left ...ment in ...pnea is ...dysfunc- ...appear ...ed in 30 ...en) with ...and the ...nd end-

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SBP (mm Hg)	150 ± 17	156 ± 26	143 ± 22	150 ± 20
DBP (mm Hg)	77 ± 13	72 ± 14	85 ± 10	74 ± 18
RPP (mm Hg/s × 10^{-2})	116 ± 20	183 ± 40*	115 ± 27	205 ± 70*
LV Isovolumetric relaxation time (ms)	80 ± 14	45 ± 12*	100 ± 15†	65 ± 12*‡
LVOT velocity (m/s)	0.8 ± 0.1	2.0 ± 0.5*	1.5 ± 0.5‡	4.2 ± 1.2*
LV mitral leaflet septal distance (mm)	18 ± 2	14 ± 3*	13 ± 4.5‡	2.2 ± 1.9*
Filling velocity (m/s)				
Early diastolic	0.64 ± 0.1	0.71 ± 0.1	0.7 ± 0.26	0.63 ± 0.3
Late diastolic	0.8 ± 0.17	0.97 ± 0.2*	0.84 ± 0.24	1.1 ± 0.2*
E/A ratio	0.8 ± 0.2	0.74 ± 0.1	0.9 ± 0.8	0.6 ± 0.3§‖

*$p < 0.001$, ‖$p < 0.01$, stress versus rest. †$p < 0.005$, ‡$p < 0.001$, §$p < 0.05$, patients versus control subjects. Data presented are mean value ± SD. Abbreviations as in Tables 1 and 2.

- The prevalence of DLVOTO varies in different echo- cardiography studies and the stress echocardiography modality used (DSE vs. exercise stress echocardiography). In one study of unselected patients referred for ex- ercise echocardiography, the prevalence of DLVOTO was 6% [10]. By contrast, in studies including only women and at tertiary hospitals (highly selected), the prevalence of DLVOTO during DSE was reported as high as 51% [28]. In other cohorts of patients with effort angina and structurally normal hearts by conventional echocardiog- raphy and normal coronary arteries by coronary angiog- raphy, the prevalence was reported as 30–36%, detected by treadmill exercise echocardiography [9, 11]. However, the prevalence of DLVOTO in patients undergoing exer- cise echocardiography is generally lower than DSE [6, 16, 24].

- In Korean women with suspected CAD, DSE-provoked DLVOTO is correlated with LV concentric remodeling and LV diastolic dysfunction, and may be associated with limited exercise tolerance and symptoms of chest pain.
- The prevalence of DLVOTO during DSE is reported in 13–23% of all study patients.4–6 In one study, DLVOTO dur- ing DSE developed in 20 of 52 patients (38%) with normal coronary arteries and unexplained chest pain.16 In the present study, 51% of the patients had DLVOTO, which is signifi- cantly higher than in other published studies. One possible explanation for this is that we studied women only. It has previously been shown that dynamic LV cavity obliteration is associated with female sex and smaller LV,

Relevance of an intraventricular pressure gradient induced by exercise: Potential Mechanisms

1. Mid-systolic obstruction due to systolic anterior motion (SAM) of the mitral valve with restriction of ejection flow
2. End-systolic obstruction secondary to ventricular cavitary obliteration
3. Augmentation of physiologic non-obstructive intraventricular pressure gradients
4. Simultaneous intraventricular pressure gradients and ejection flow patterns were measured by a multisensor catheter in 6 patients with normal left ventricular function and no valve abnormalities, at rest and in exercise. Peak measured intraventricular pressure gradients were attained very early in ejection, amounted to 6.7 +/- 1.9 (SD) mm Hg at rest, and were intensified to 13.0 +/- 2.3 mm Hg during submaximal supine bicycle exercise. The augmentation of the gradients during exercise was associated with a pronounced accentuation of the flow acceleration and flow at the instant of peak gradient.

ANGINA: mechanisms

ELEVATED DEMAND

- Elevated LVED pressure
- Hypertrophy

REDUCED SUPPLY

- Atherosclerotic CAD
- Vasospastic angina
- Endothelial dysfunction (X syndrome)

European Journal of Echocardiography (2008) 9, 665–671
doi:10.1093/ejechocard/jen070

Dynamic left ventricular outflow tract obstruction evoked by exercise echocardiography: prevalence and predictive factors in a prospective study

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Received 18 October 2007; accepted after revision 20 January 2008; online publish-ahead-of-print

KEYWORDS
Dynamic left ventricular outflow tract obstruction;
Stress echocardiography;
Prevalence;
Exercise echocardiography;
Ischaemia

Aims In patients without hypertrophic obstructiv
outflow tract obstruction (DLVOTO) can ca
of DLVOTO in patients without HO
Methods and results In
rest and with Valsalva and o
was performed. Within 90 s post-exercis
cant DLVOTO was defined as late-peaking Dopple
patients with HOCM and 13 with inadequate im
years. Coronary artery disease was found in 38%
and 35% had hypertension. At rest, ejection frac
was present in 21%, SAM in 16%, DLVOTO ≥25 mmHg at rest in 0.7%, and with Valsalva in 3%. At peak, echocardiographic signs of ischaemia occurred in 44%, and significant DLVOTO in 5% (13 patients). By multivariate analysis, it was found that independent predictors of significant DLVOTO at peak were chordal SAM at peak, smaller left ventricle at end-systole, higher systolic blood pressure at peak, younger age and increased septal wall thickness. Significant DLVOTO was a possible cause of symptoms and/or ischaemia in at least 6 of the 13 patients.
Conclusion Haemodynamically significant exercise-induced DLVOTO can occur without HOCM. Chordal SAM at peak, small, hyperdynamic left ventricles, increased septal wall thickness, and younger age are the best predictors.

Independent predictors of significant dynamic LVOTO

- Younger age
- Small LV end-systole diameter
- Hyperdynamic LV
- increased septal wall thickness

Dynamic Left Ventricular Outflow Tract Obstruction Induced by Exercise

Fernando Cabrera Bueno, Isabel Rodríguez Bailón, Raúl López Salguero, Juan J. Gómez Doblas, Alejandro Pérez Cabeza, José Peña Hernández, Antonio Domínguez Franco, Luis Morcillo Hidalgo, and Eduardo de Teresa Galván

Servicio de Cardiología, Hospital Universitario Virgen de la Victoria, Málaga, Spain.

Introduction and objectives. Dyn
cular outflow tract obstruction occurs
tients without hypertrophic cardiomyo
sized that dynamic intraventricular
occur during effort in patients with an
hout evident disease. The objective
study was to investigate: *a)* whether it
b) its incidence, magnitude and dete
c) its clinical course.

Patients and method. We perfo
stress Doppler echocardiography in 2
gina, dyspnea, or both with exercise
vious myocardial infarction, valvula
cular dysfunction or ventri
hypertension were excl
truction was defin

Results.
age was 58 (9) years; history of hyper
in 69.7%, dyslipidemia in 35.8%, and
Dynamic intraventricular obstruction
tients (13.4%), with gradients ranging between 25 and 53 mm Hg (mean, 32.19 [6.6]). Demographic variables, cardiovascular risk factors, and exercise performed were similar in group A (with obstruction) and group B (without obstruction). No patient in group A had evidence of ischemia. Five patients in this group had symptoms during exercise; the gradients were greater in these patients (42.65 [10.5] vs 28.15 [2.37] mm Hg; *P*<.0001) than in the remaining group A patients. Left ventricular outflow tract size was found to be the only independent predictive factor in the multivariate analysis. After 369.9 (133.5) days of follow-up, no cardiac events were recorded.

Conclusions. Our study suggests that some patients with angina or dyspnea without evidence of ischemia may develop dynamic left ventricular outflow tract obstruction induced by effort.

Key words: *Obstruction. Exercise. Ventricular.*

con una edad de 58 ± 9 años; el 69,7% tenía antecedentes de hipertensión, el 35%, dislipemia y el 24,6%, diabetes. Apareció obstrucción intraventricular en 18 (13,4%) pacientes, con un gradiente entre 25 y 53 mmHg (media, 32,19 ± 6,6). Las variables demográficas, los factores de riesgo y el ejercicio realizado fueron similares en el grupo A (con obstrucción) y B (sin obstrucción). En el grupo A, ningún paciente tuvo evidencia de isquemia y los 5 que presentaron síntomas durante el esfuerzo tuvieron mayores gradientes (42,65 ± 10,5 frente a 28,15 ± 2,37 mmHg; p < 0,0001) que el resto del grupo A. El análisis multivariante identificó el diámetro del tracto de salida como único factor predictor independiente. Tras un seguimiento de 369,9 ± 133,5 días, no se registraron eventos.

Conclusiones. Nuestros datos sugieren que algunos pacientes con angina o disnea de esfuerzo sin evidencia de isquemia pueden tener obstrucción dinámica ventricular izquierda inducida por esfuerzo.

- **134 patients with angina, dyspnea or both**
- **DLVOTO : systolic flow with ≥ 2.5 m/s**
- **DLVOTO appeared in 18 patients (13%) with gradients ranging between 25 and 53 mmHg**

Rev Esp Cardiol 2004;57(12):1179-87

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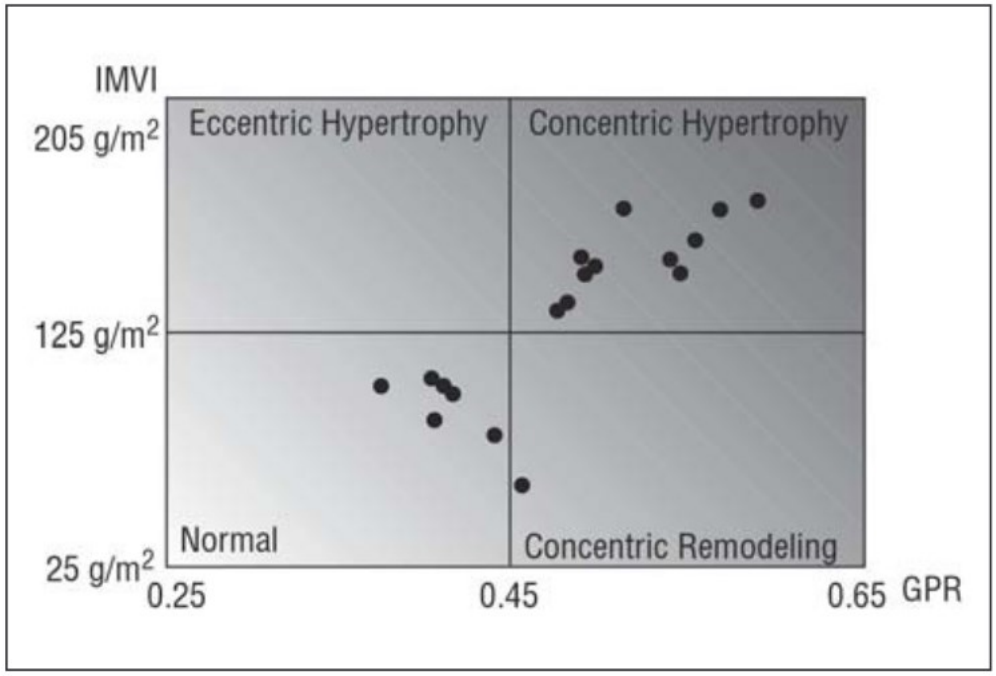

Figure 2. Distribution of patients with dynamic left ventricular outflow tract obstruction, according to ventricular morphology. RWT indicates relative wall thickness; LVMI, left ventricular mass index.

Symptomatic Exercise-Induced Left Ventricular Outflow Tract Obstruction without Left Ventricular Hypertrophy

Eyad K. Alhaj, MD, Bette Kim, MD, Deborah Cantales, RDCS, Seth Uretsky, MD, Farooq A. Chaudhry, MD, and Mark V. Sherrid, MD, *New York, New York*

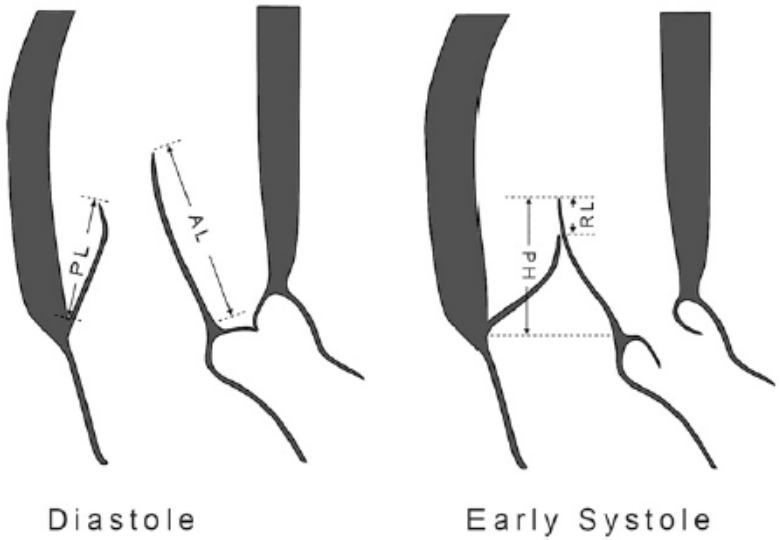

Figure 1 Line drawing of an apical three-chamber view from a representative patient with DLVOTO showing elongated mitral leaflets, increased protrusion height above the mitral annular plane, and increased residual leaflet length. The locations of echocardiographic measurements are shown. (*Left*) Diastole, showing measurements of anterior leaflet length (AL) and posterior leaflet length (PL). (*Right*) Early systole at the moment of coaptation, showing residual leaflet length (RL) and protrusion height (PH) of the most protruding leaflet measured from the mitral annulus to the top of the most protruding leaflet.

- Elongated posterior leaflets (2.0 vs 1.5 cm, $P < .0005$)
- Elongated anterior leaflets (3.2 vs 2.6 cm, $P = .015$)
- Increased protrusion height of the mitral valve beyond the mitral annular plane (2.6 vs 0.6 cm, $P < .00001$)
- Residual protruding portions of the mitral valve leaflets (0.85 vs 0.24 cm, $P < .005$)
- Anterior positioning of the papillary muscles in the LV cavity, with a greater distance from the plane of the papillary muscles to the posterior wall (1.8 vs 1.3 cm, $P = .03$)

(J Am Soc Echocardiogr 2013;26:556-65.)

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International Journal of Cardiology 117 (2007) 222–226

International Journal of Cardiology

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Beta-blocker therapy for dynamic left ventricular outflow tract obstruction induced by exercise

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Received 30 December 2005; received in revised form 5 April 2006; accepted 28 April 2006
Available online 17 July 2006

Abstract

Background: In patients who present with angina, dynamic left ventricular outflow tract obstruction may be responsible of symptoms. The aim of our study was to evaluate the effect of negative inotropic therapy on ventricular physiology and symptoms of patients with dynamic left ventricular outflow tract obstruction induced by exercise in the absence of hypertrophic cardiomyopathy.
Methods: Seventy eight patients with symptoms of angina, normal exercise SPECT test and normal resting left ventricular systolic function were prospectively analysed with exercise echocardiography. Fifteen of them developed high outflow tract velocities (greater than 2.57 m/s) on effort. After treatment with bisoprolol (mean dose 6.9±3.5 mg) in these patients, symptoms and dynamic left ventricular outflow tract obstruction during exercise were re-evaluated.
Results: After negative inotropic therapy, there was a significant reduction of 86.6% in the development of intracavitary gradient (15 to 2 patients). In all patients the left ventricular outflow tract velocities decreased (2.91±0.4 m/s to 1.92±0.46 m/s, $p=0.001$). However, the oxygen consumption during exercise was higher (7.3±1.7 METs to 8.5±1.8 METs, $p=0.005$), and symptoms improved significantly following therapy, with a reduction in mean NYHA class from 1.9±0.5 to 1.0±0.0 ($p=0.001$).
Conclusions: Negative inotropic therapy may represent a beneficial therapeutic approach in selected patients with dynamic left ventricular outflow tract obstruction induced by exercise and identified during exercise echocardiography.

Keywords: Obstruction; Exercise; Ventricular

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International Journal of Cardiology 117 (2007) 222 – 226

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Abstract

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Methods: Seventy eight patients with sympto
were prospectively analysed with exercise ec
on effort. After treatment with bisoprolol (m
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Results: After negative inotropic therapy, the
patients). In all patients the left ventricular
oxygen consumption during exercise was h
following therapy, with a reduction in mean
Conclusions: Negative inotropic therapy may
outflow tract obstruction induced by exercis

Keywords: Obstruction; Exercise; Ventricular

- 78 patients with symptoms of angina, normal exercise SPECT test and normal resting LVEF were prospectively analyzed
- 15 of them (19%) developed DLVOTO on effort
- Re-evaluated after treatment with bisoprolol

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International Journal of Cardiology 117 (2007) 222 – 226

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outflow tract obstruction induced by exercise and identified during exercise echocardiography.

Keywords: Obstruction; Exercise; Ventricular

- 87% reduction in development of DLVOTO
- More METs at effort (7.3 ±1.7 to 8.7 ±1.8)
- Improved symptoms (1.9 ±0.5 50 1.0 ± 0.0)

Physiologic systolic intraventricular gradient

Exists a pressure differences of 3 to 5 mm Hg between the apex and the LVOT in the normal heart at rest

Due to

1. Acceleration of blood due to myocardial contraction (initial ventricular impulse)
2. Physiologic disproportion between the chamber diameter and the LVOT diameter (ventriculo-annular disproportion)

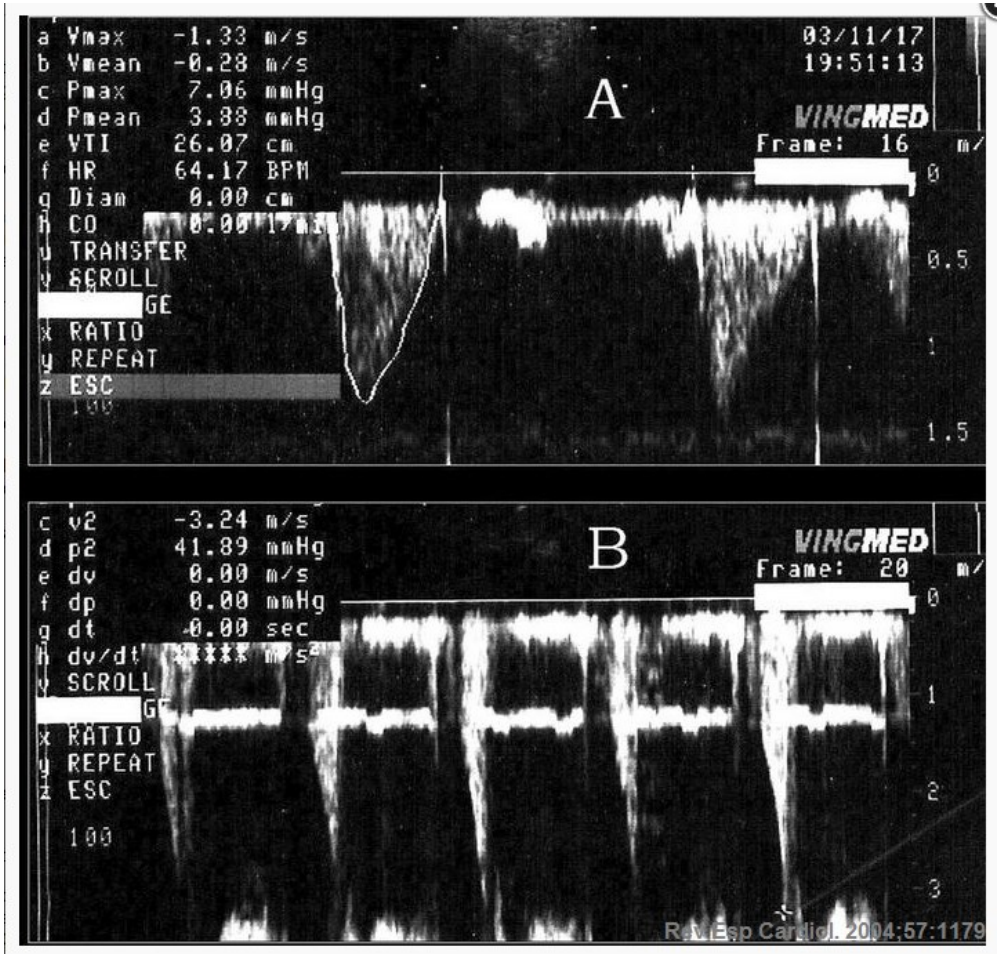
The physiologic intraventricular gradients is closely related to left ventricular systolic function

Exercise Induced Dynamic LV Outflow Tract Obstruction

Exercise related?

YES

YEEES



Cardiology

Cardiovascular Imaging: Novel Insights from Clinical Experience

Cardiology 2021;146:441–450
DOI: 10.1159/000516188

Received: February 9, 2021
Accepted: March 26, 2021
Published online: May 18, 2021

Usefulness of Stress Echocardiography in Assessment of Dynamic Left Ventricular Obstructions: Case Series and Review of the Literature

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Cardiology 2021;146:441–450
DOI: 10.1159/000516188

Received: February 9, 2021
Accepted: March 26, 2021
Published online: May 18, 2021

Case 1

A 66-year-old woman with previously known hyperten
presented to the Cardiology Clinic following a many-year his
of exertion dyspnea and reduced functional capacity. She was an
and no upstream flow-limiting coronary stenose
ical SAM with subsequent significant DLVOTC
ed. Furthermore, her symptoms were also reproc

Case 2

A 64-year-old man with chronic kidney dis
mated glomerular filtration rate [eGFR] at 48 mL/
creatinine 134 mmol/L), treated for hypertensio
lesterolemia, presented to the Cardiology Clinic f
history of effort angina. A CT coronary angiogram had shown only mild atherosclerosis in coronary arteries and no flow-limiting lesions.

tractility and no signs of hypokinesia. Therefore, obstructive coronary disease was unlikely. However, DSE confirmed a significant SAM with developing DLVOTO, with accompanying symptoms.

Case 3

A 63-year-old woman was referred to the Cardiology Clinic for evaluation of her symptoms that had started 16 months earlier while being on a mountain hike. She suddenly developed shortness of breath, dizziness, nausea, and chest tightness. Later on, she typically developed the same symptoms during moderate exercise was unlikely. However, DSE confirmed a significant SAM with DLVOTO and reproduction of symptoms. Atenolol 50 mg daily was administered. After few days, she reported side effects

Case 4

A 71-year-old woman presented to the Outpatient Cardiology Clinic with a 6-year history of chest pain and dyspnea on exertion. Apart from a mild hypertension, which she did not
(SonoVue) images (Fig. 6a, b). Blood pressure at peak stress was 130/78 mm Hg. Peak midcavitary and LVOT velocities reached >5 m/s (Fig. 6c). The patient felt some chest discomfort. There