Systolická dysfunkce levé komory

Kdy si nevystačím jen s echokardiografií?

Martin Hutyra

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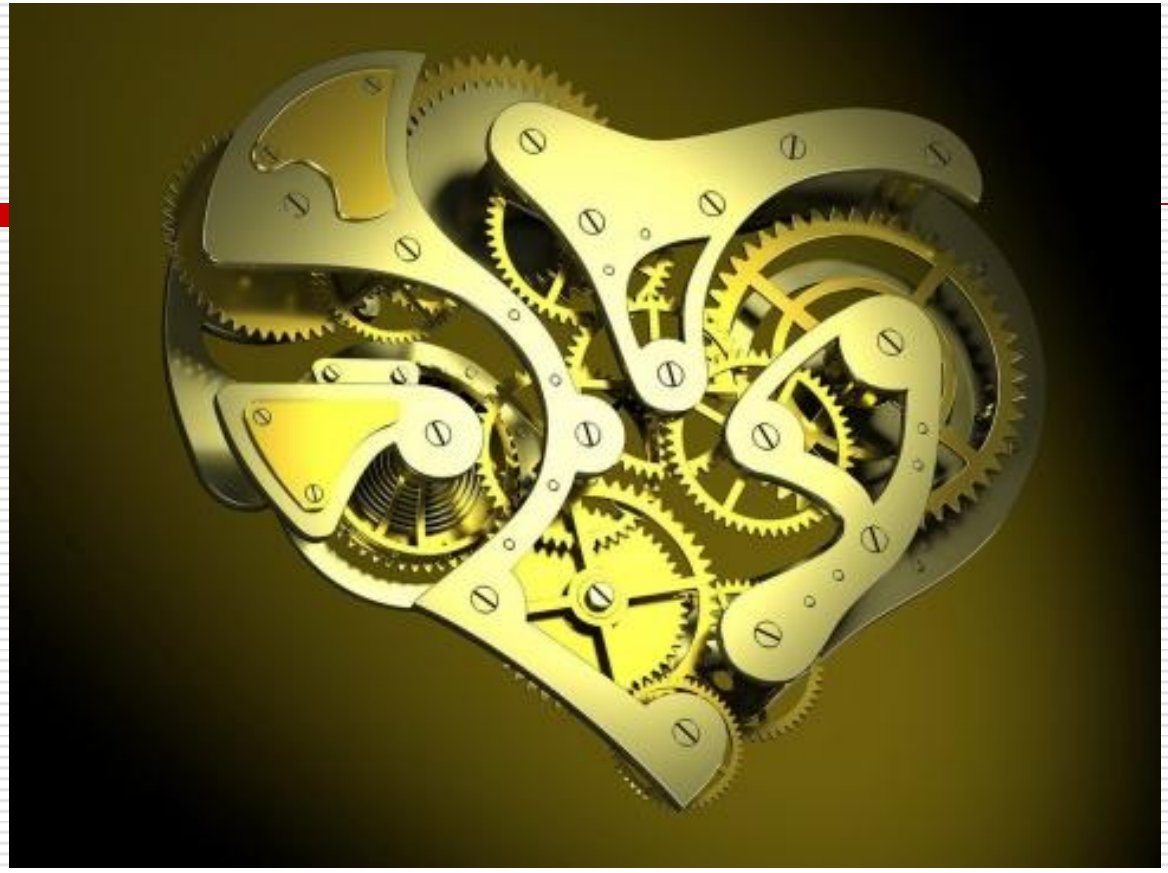
I. INTERNÍ KLINIKA
KARDIOLOGIE
FAKULTNÍ NEMOCNICE OLOMOUC

Osnova přednášky:

1. Co **představuje** systolická (dys)funkce levé komory?
2. Jaké máme k dispozici **echokardiografické metody** pro její evaluaci?
3. Je echokardiografické stanovení ejekční frakce **problematické**?
4. Jaké jsou **alternativní metody** pro její stanovení a jejich ne/výhody?
5. Jaké jsou **důvody a indikace** evaluace systolické funkce LK (EF)?
6. Kdy echokardiografie **nestačí**?



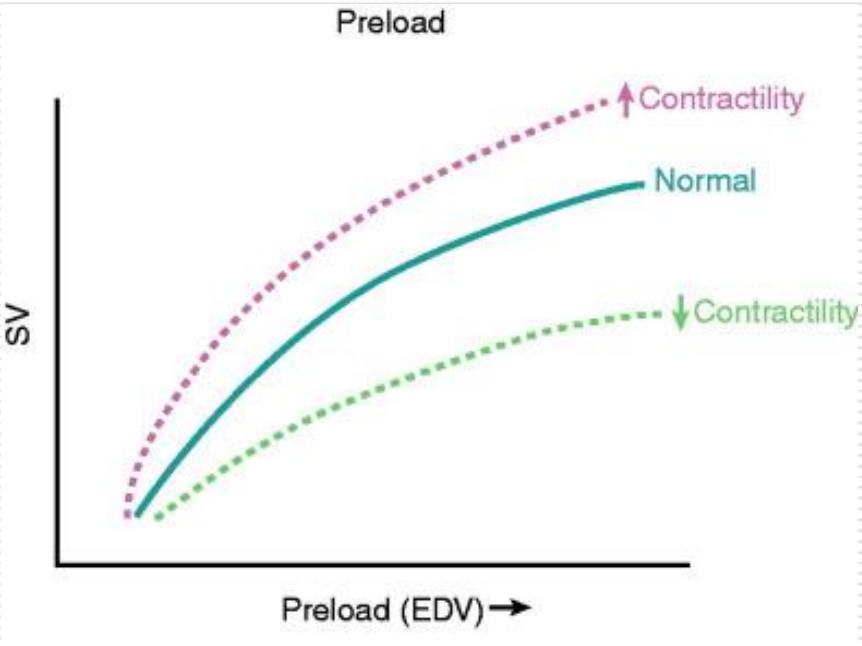
Co je systolická (dys)funkce levé komory?

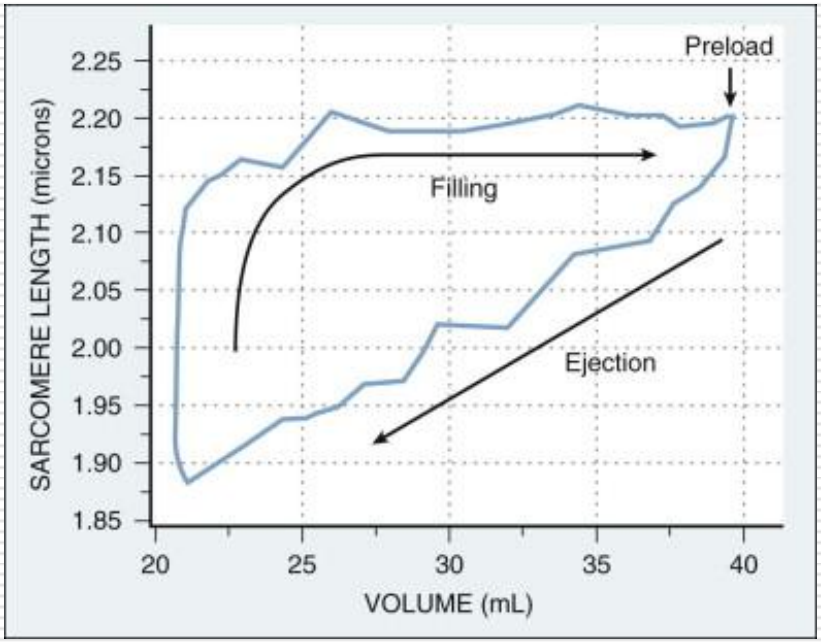
Stanovení systolické funkce levé komory

Funkční schopnost levé komory je závislá:

1. Adekvátní plnění *(preload)*
2. Normální sekvence elektrické aktivace *(funkční převodní systém)*
3. Normální srdeční struktura zachovávající adekvátní plnění srdce a přirozený dopředný tok krve *(chlopně, myokard, perikard)*
4. Přiměřená periferní cévní rezistence *(afterload)*

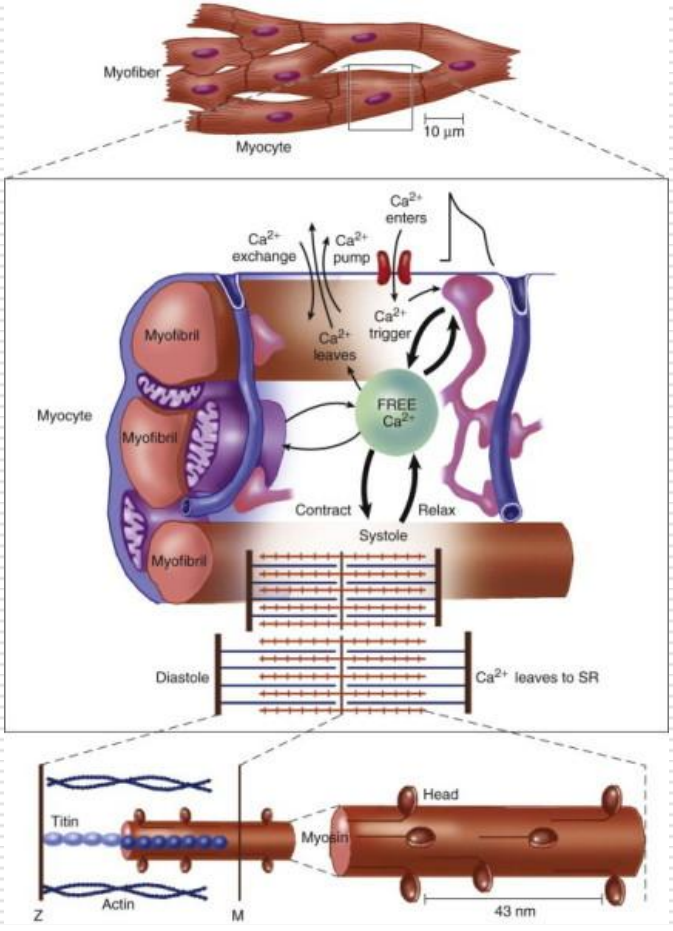
Preload

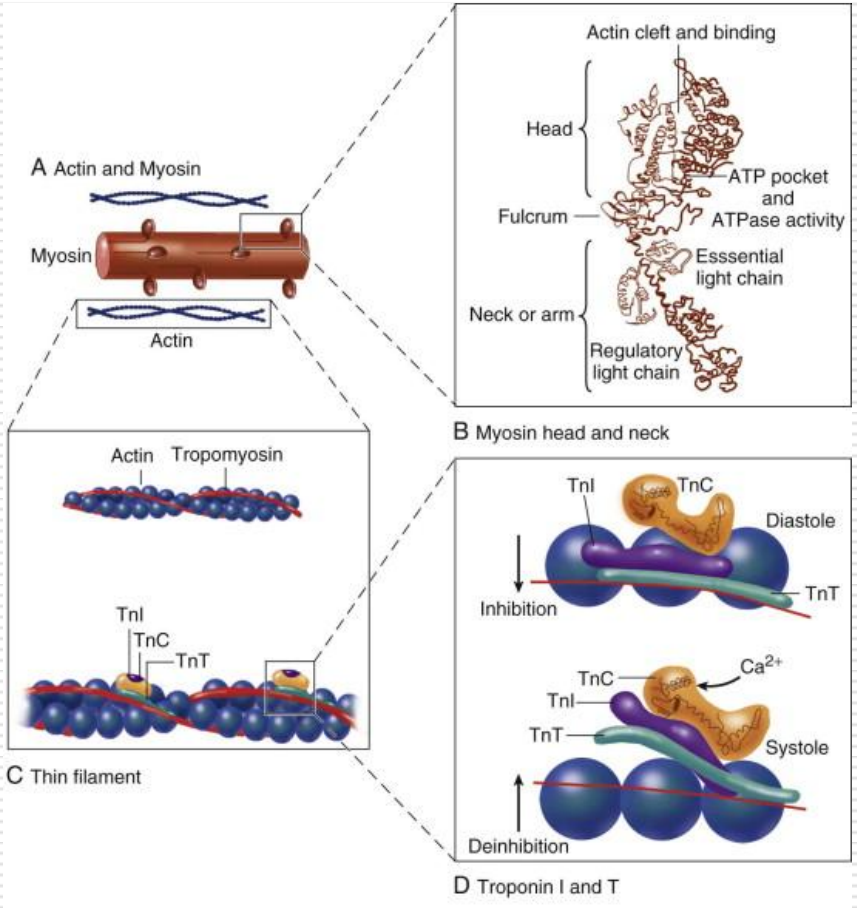




Otto: Textbook of Clinical Echocardiography, 4th Edition

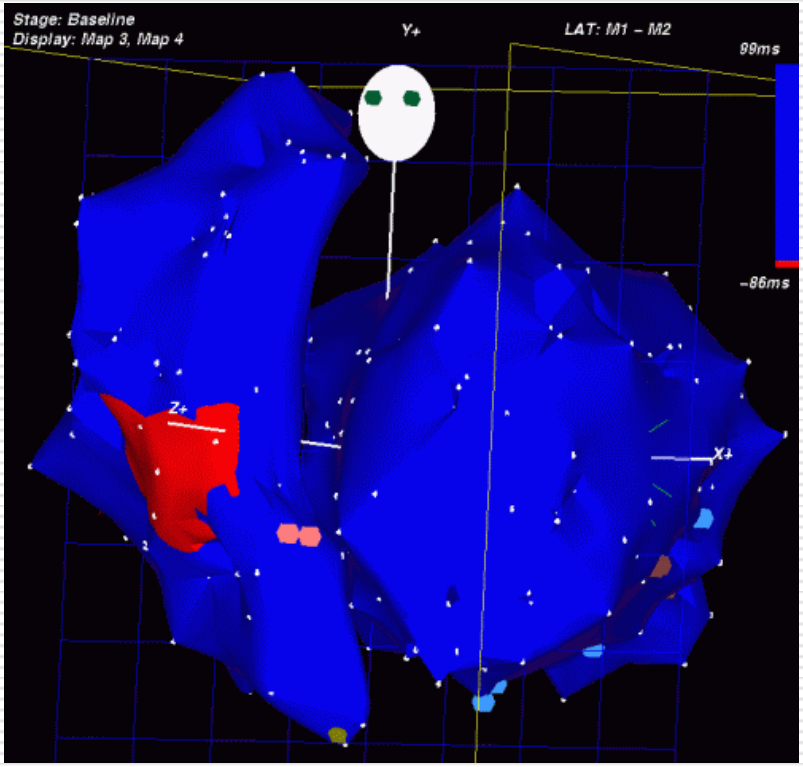
Kontraktilita myokardu



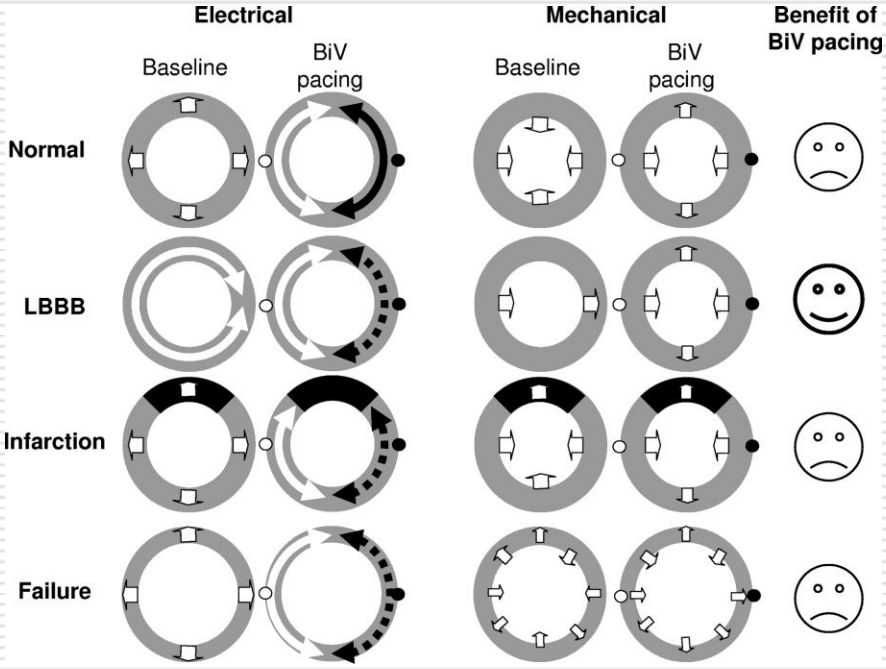


Bonow RO, Mann DL, Zipes DP, Libby P: Braunwald´s Heart Disease, 9th Edition

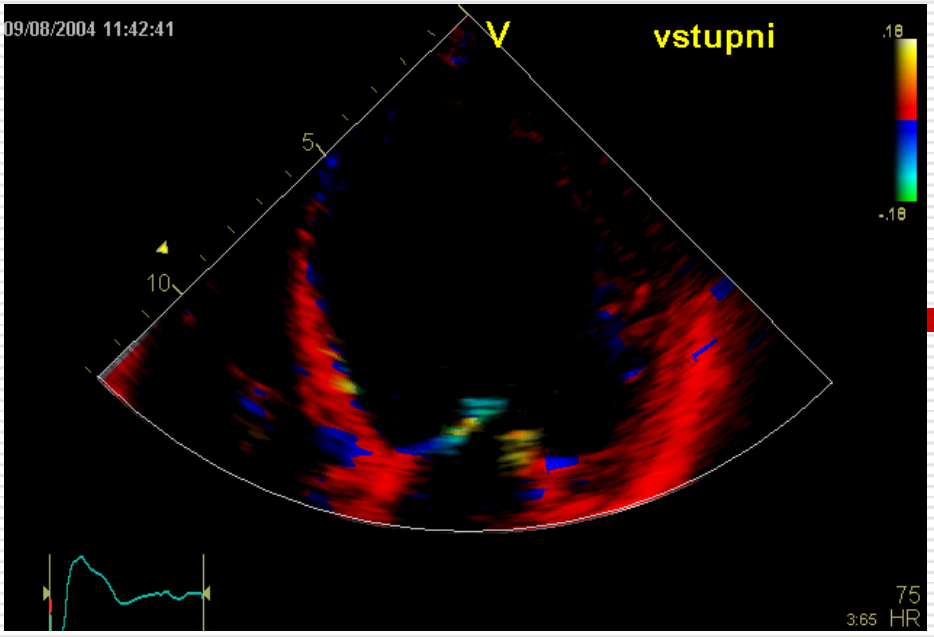
Spřažení elektrické aktivace a mechanické kontrakce LK



Schematic representation of the sequence of electrical activation and contraction during baseline and during biventricular pacing in the LV.



Prinzen FW, Auricchio A. Is echocardiographic assessment of dyssynchrony useful to select candidates for cardiac resynchronization therapy? Echocardiography Is Not Useful Before Cardiac Resynchronization Therapy if QRS Duration Is Available. Circ Cardiovasc Imaging 2008;1:70-78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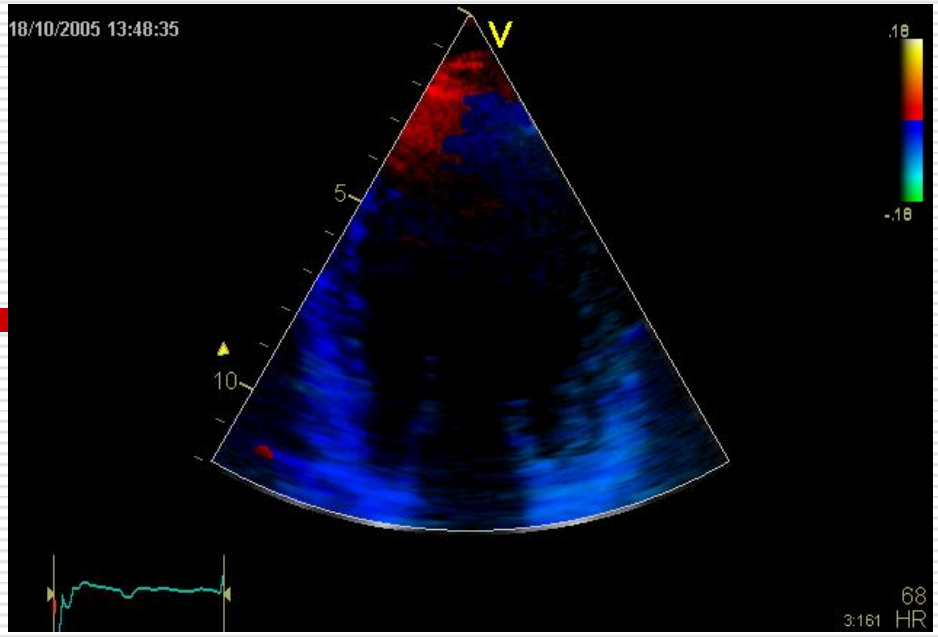
18/10/2005 13:48:35
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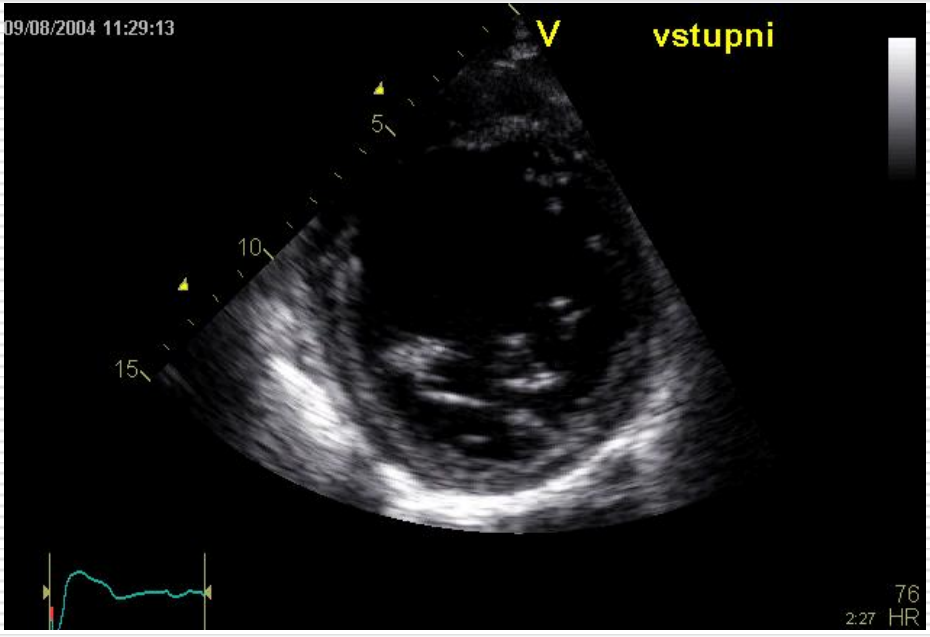
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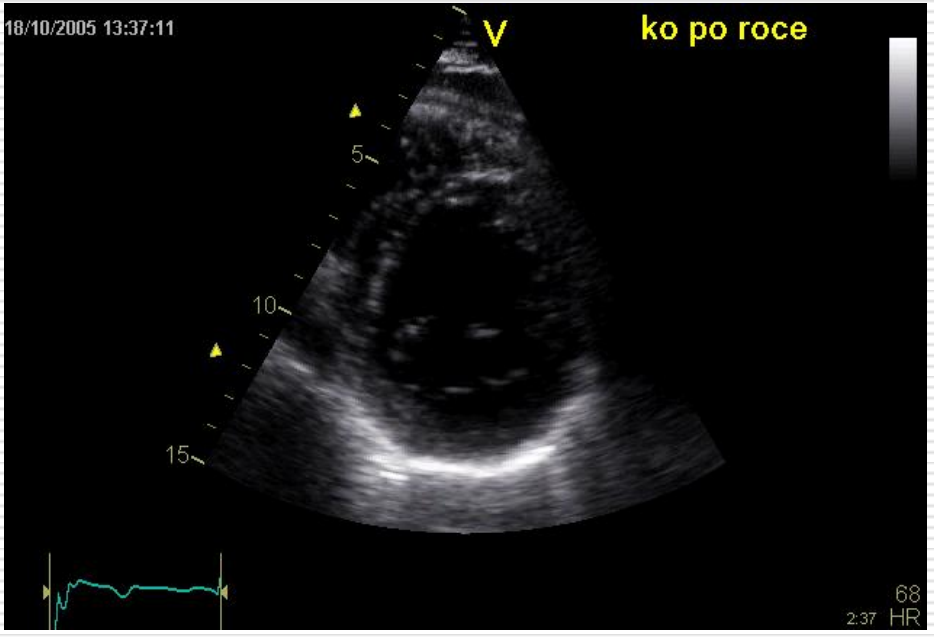
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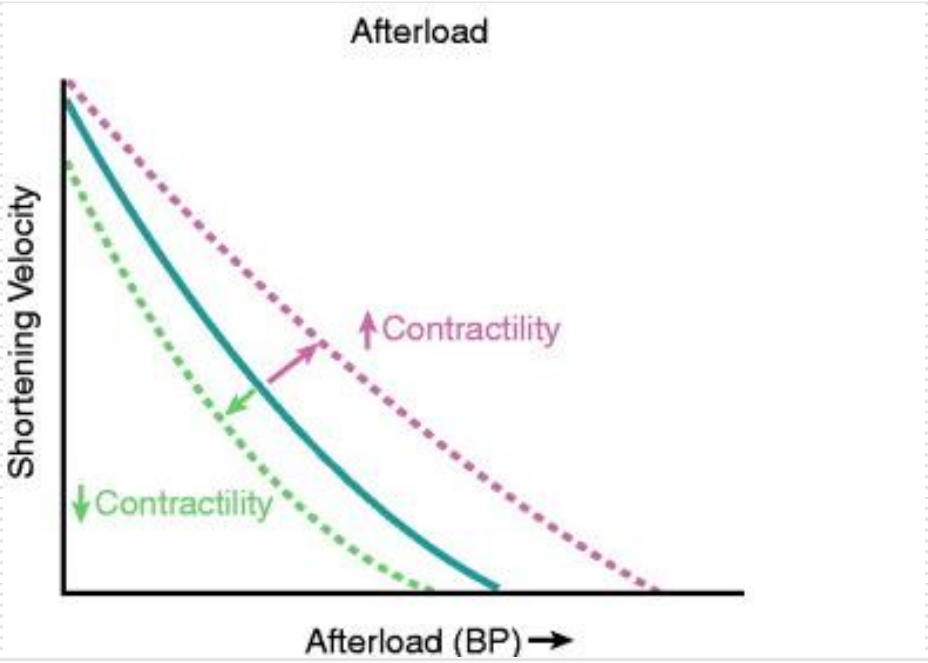
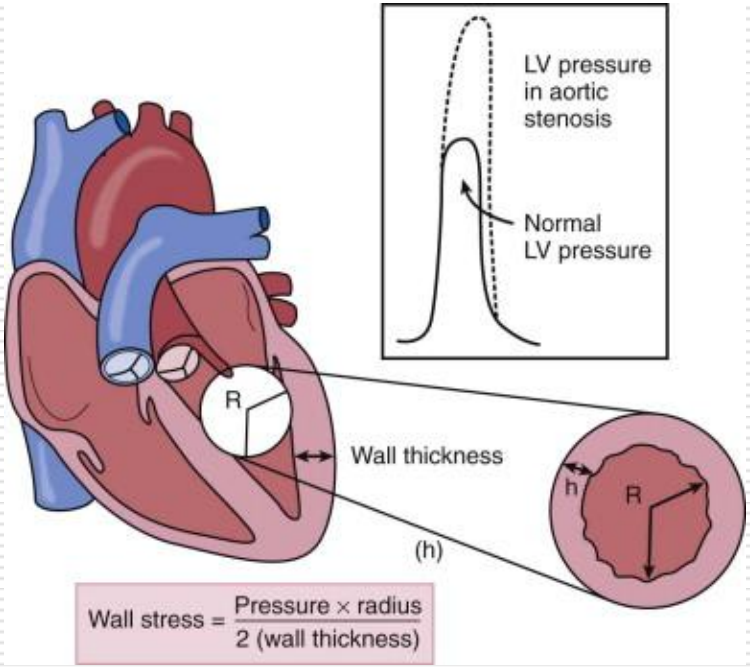
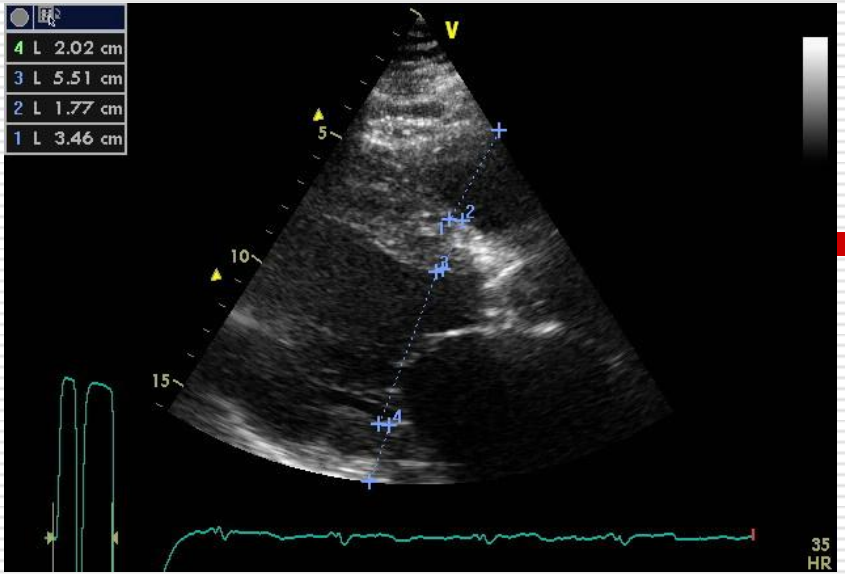
Afterload





Otto: Textbook of Clinical Echocardiography, 4th Edition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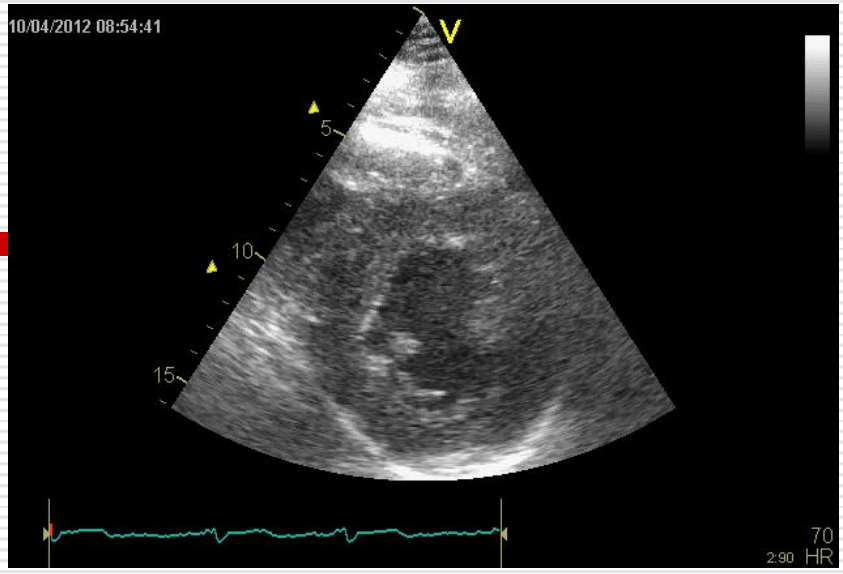
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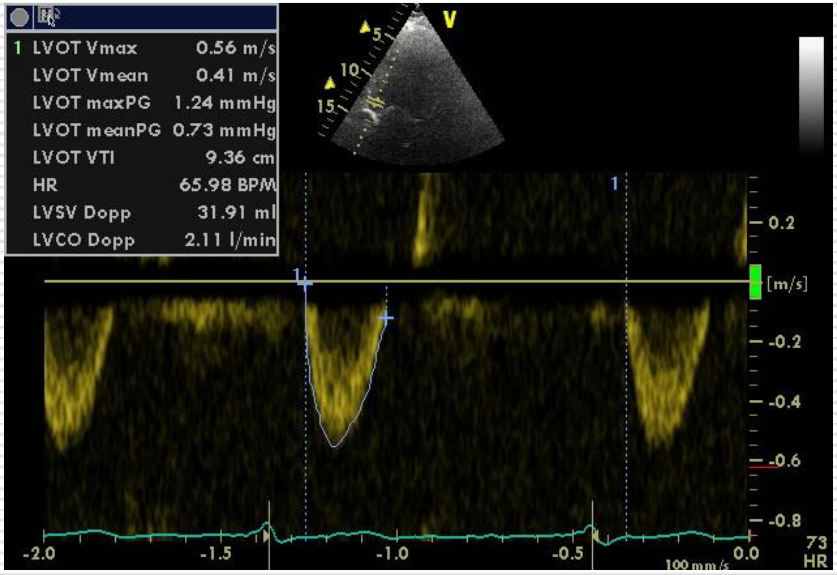
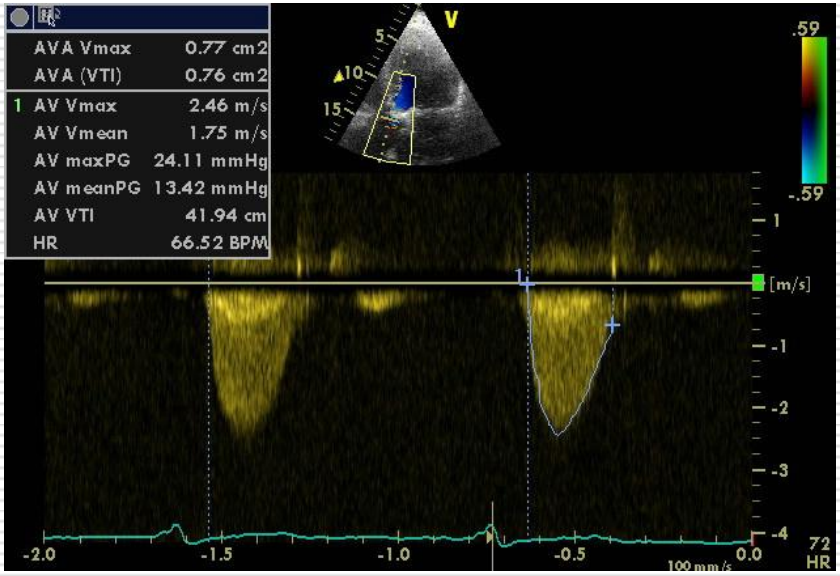
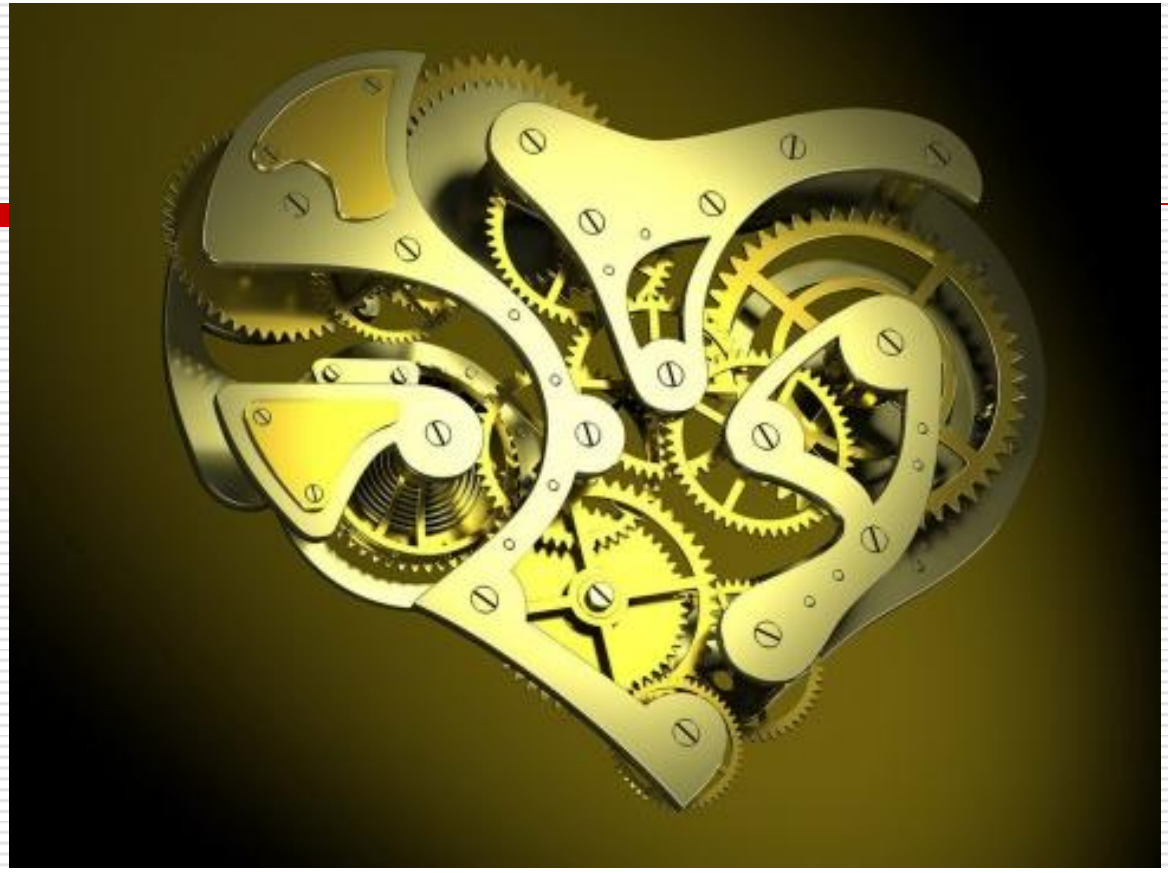

1 LVOT Vmax 0.56 m/s
LVOT Vmean 0.41 m/s
LVOT maxPG 1.24 mmHg
LVOT meanPG 0.73 mmHg
LVOT VTI 9.36 cm
HR 65.98 BPM
LVSV Dopp 31.91 ml
LVCO Dopp 2.11 l/min
[m/s]
73
HR

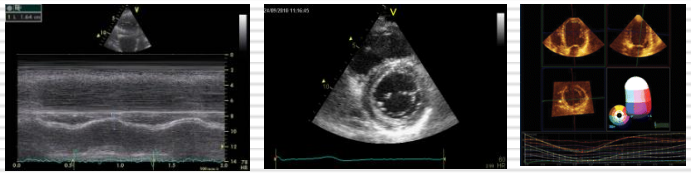

AVA Vmax 0.77 cm2
AVA (VTI) 0.76 cm2
1 AV Vmax 2.46 m/s
AV Vmean 1.75 m/s
AV maxPG 24.11 mmHg
AV meanPG 13.42 mmHg
AV VTI 41.94 cm
HR 66.52 BPM
[m/s]
72
HR



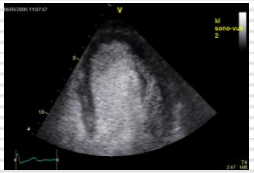
Jaké máme k dispozici echokardiografické metody pro evaluaci systolické funkce LK?

Echokardiografie - modality

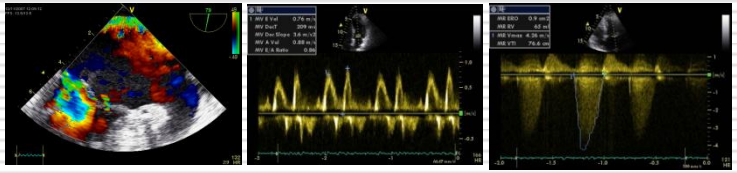
- **MM/2DE/RT 3DE**



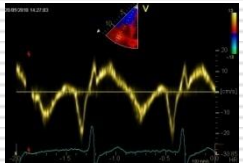
- **CEE**



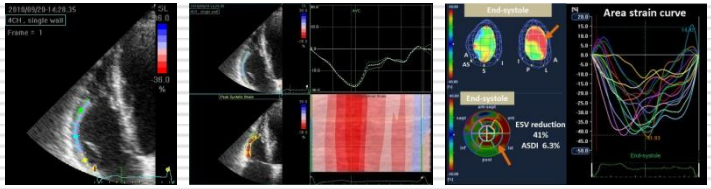
- **Doppler (CFM, PWD, CWD)**



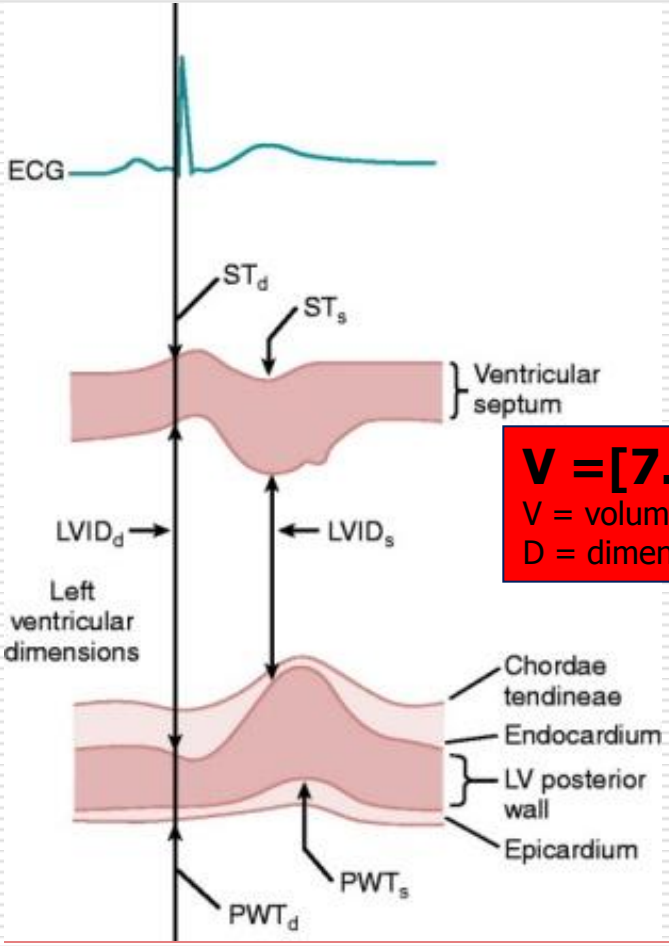
- **Tissue Doppler imaging**



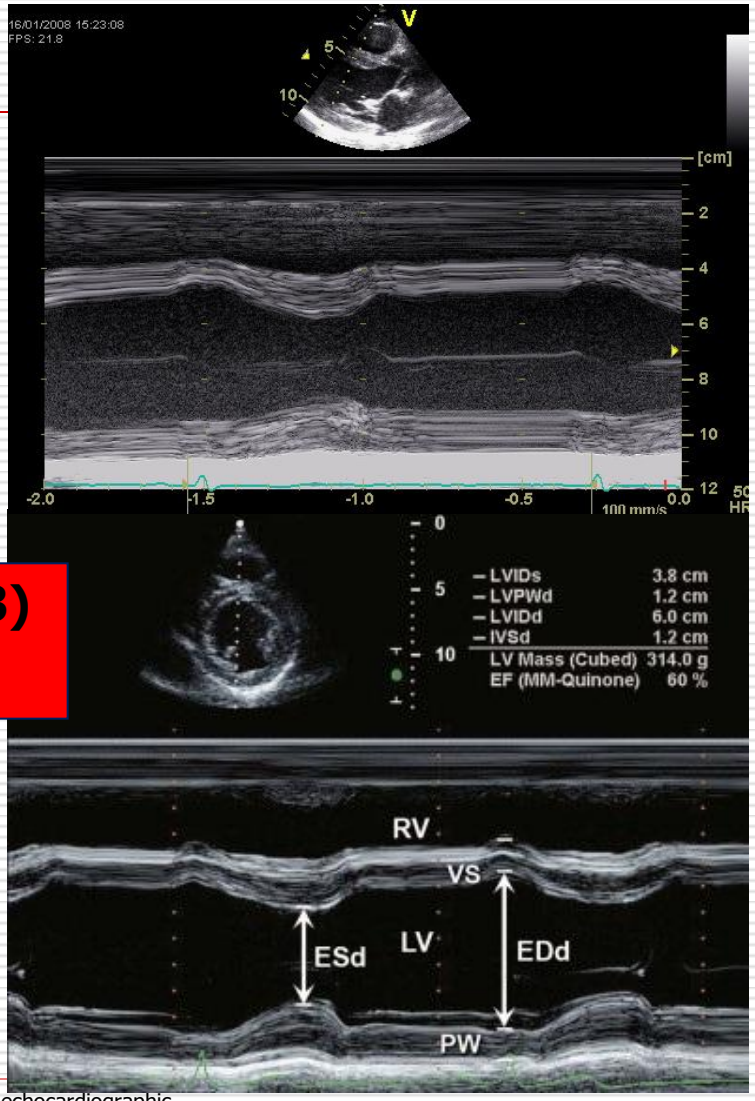
- **2D/3D strain**



Ejekční frakce LK
Teichholz



V =[7.0/2.4+d] (D3)
V = volume
D = dimension



Teichholz LE, Kreulen T, Herman MV, Gorlin R. Problems in echocardiographic volume determinations: echocardiographic-angiographic correlations in the presence of absence of asynergy. Am J Cardiol 1976;37:7e11.

Ejekční frakce LK
Quinones

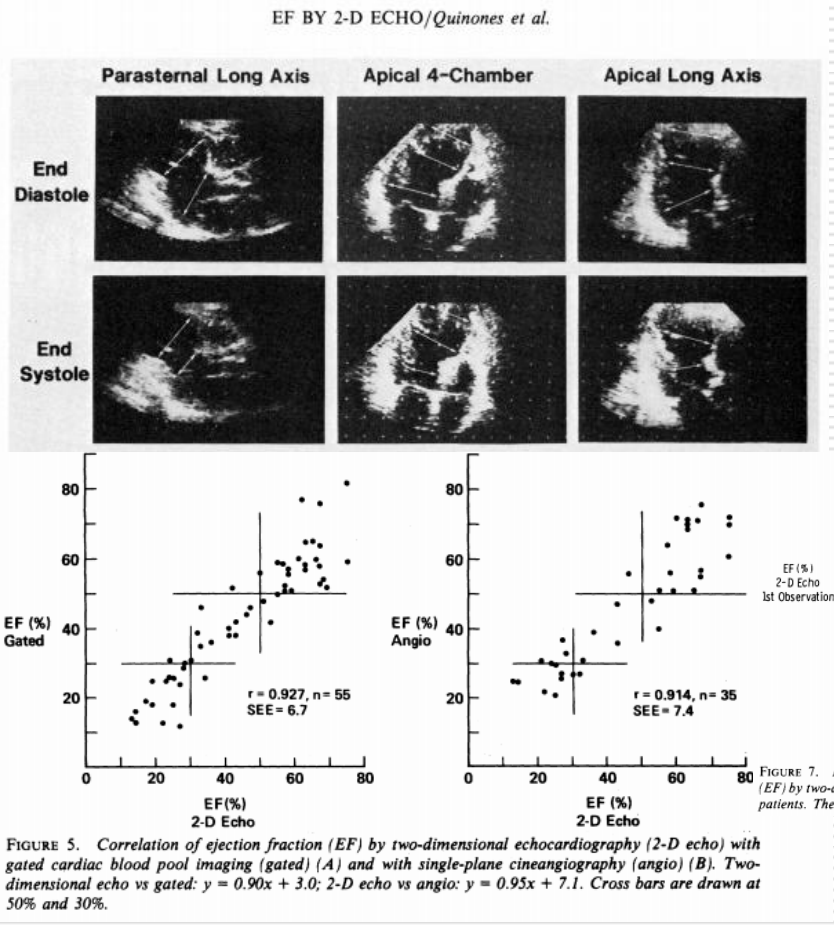


FIGURE 5. *Correlation of ejection fraction (EF) by two-dimensional echocardiography (2-D echo) with gated cardiac blood pool imaging (gated) (A) and with single-plane cineangiography (angio) (B). Two-dimensional echo vs gated: y = 0.90x + 3.0; 2-D echo vs angio: y = 0.95x + 7.1. Cross bars are drawn at 50% and 30%.*

FIGURE 7. *Intraobserver comparison of ejection fraction (EF) by two-dimensional echocardiography (2-D echo) in 20 patients. The line drawn represents the line of identity.*

A New, Simplified and Accurate Method for Determining Ejection Fraction with Two-dimensional Echocardiography

MIGUEL A. QUINONES, M.D., ALAN D. WAGGONER, R.D.M.S., LAWRENCE A. REDUTO, M.D., JEAN G. NELSON, R.D.M.S., JAMES B. YOUNG, M.D., WILLIAM L. WINTERS, JR., M.D., LAIR G. RIBEIRO, M.D., AND RICHARD R. MILLER, M.D.

SUMMARY A new method to determine left ventricular (LV) ejection fraction (EF) with wide-angle, two-dimensional echocardiography (2-D echo) has been developed using the parasternal long-axis, apical four-chamber and apical long-axis views. End-diastolic and end-systolic measurements of LV short axes at the base and mid-LV cavity in the parasternal long-axis view and at the upper, middle and lower thirds of the cavity in the apical views are made, from which an averaged minor axis at end-diastole and at end-systole is calculated. Fractional shortening of the LV long axis (ΔL) is estimated from apical contraction. Satisfactory 2-D echoes were obtained in 55 of 58 nonselected patients (all three views in 32 patients, two views in 22 and one view in one); 42 of 55 patients had coronary artery disease. EF by 2-D echo was compared with EF by gated cardiac blood pool imaging in all patients (r = 0.927, SEE = 6.7%) and to EF by single-plane cineangiography (angio) in 35 of 55 patients (r = 0.913, SEE = 7.4%). LV dyssynergy was frequently present and involved the apex in 29 of 55 patients. Using angio as the standard for evaluating wall motion at the apex, 2-D echo was 100% sensitive and specific in detecting abnormal apical wall motion. We conclude that EF can be determined accurately with 2-D echo in a large group of patients with and without dyssynergy by a simple method that eliminates the need for planimetry or computer assistance.

DETERMINATIONS of L
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were obtained directly from

LV volumes may be measured using a simplification of the ellipsoidal formula as

$$\pi/6 \times D^2 \times L \quad (1)$$

where D = the LV minor axis and L = the LV long axis. EF = (Ved − Ves)/Ved, so EF may be measured as

$$\frac{\pi/6[Ded^2 \times Led) - (Des^2 \times Les)]}{\pi/6\,(Ded^2 \times Led)} \quad (2)$$

where Ded = LV minor axis at end-diastole, Led = LV long axis at end-diastole, Des = LV minor axis at end-systole, and Les = LV long axis at end-systole.

Equation 2 may be algebraically converted into

$$\left[\frac{(Ded^2 - Des^2)}{Ded^2}\right] + \left[1 - \frac{(Ded^2 - Des^2)}{(Ded^2)}\right]$$

$$\left[\frac{(Led - Les)}{Led}\right] \times 100 \quad (3)$$

Equation 3 expresses EF as a function of two components, one representing the fractional shortening of the square of the minor axis (%ΔD²) and one the fractional shortening of the long axis (%ΔL). Thus, equation 3 may be expressed as

$$(\%\Delta D^2) + [(1 - \%\Delta D^2)\,(\%\Delta L)] \quad (4)$$

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60 frames/sec.
All patients were studied in the left lateral recum-

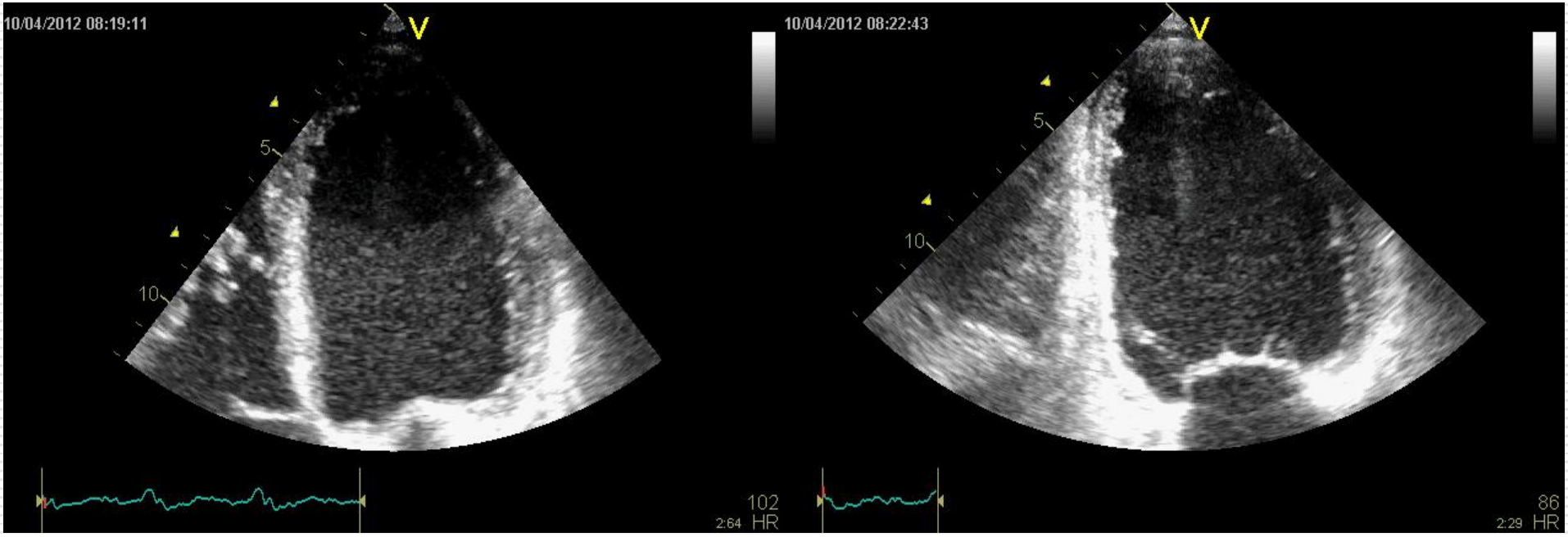
nia.
Address for correspondence: Mi
of Cardiology, MS. F1001, The M
Boulevard, Houston, Texas 77030
Received May 9, 1980; revision
Circulation 64, No. 4, 1981.

Quinones MA, Waggoner AD, Reduto LA, Nelson JG, Young JB, Winters Jr WL, et al. A new, simplified and accurate method for determining ejection fraction with two-dimensional echocardiography. Circulation 1981;64:744e53.

$$\int_a^b f(x)\,dx \approx \frac{b-a}{6}\left[f(a) + 4f\left(\frac{a+b}{2}\right) + f(b)\right].$$

Ejekční frakce LK *(EDV-ESV)/EDV)*

2D measurements for volume calculations using the biplane method of discs (modified Simpson's rule), in the A4C and A2C views at end diastole (LV ED) and at end-systole (LV ES)



Helak JW, Reichek N. Quantitation of human left ventricular mass and volume by two-dimensional echocardiography: In vitro anatomic validation. Circulation 1981;63:1398e407.
Schiller NB, Shah PM, Crawford M, DeMaria A, Devereux R, Feigenbaum H, et al. Recommendations for quantitation of the left ventricle by two-dimensional echocardiography. American Society of Echocardiography Committee on Standards, Subcommittee on Quantitation of Two-Dimensional Echocardiograms. J Am Soc Echocardiogr 1989;2:358e67.

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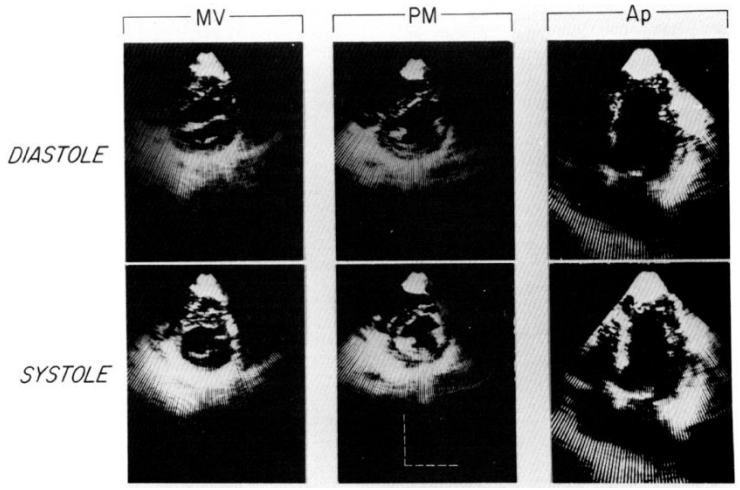
Assessment of left ventricular ejection fraction and volumes by real- time, two-dimensional echocardiography. A comparison of cineangiographic and radionuclide techniques

ED Folland, AF Parisi, PF Moynihan, DR Jones, CL Feldman and DE Tow

Circulation 1979, 60:760-766
doi: 10.1161/01.CIR.60.4.760
Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514

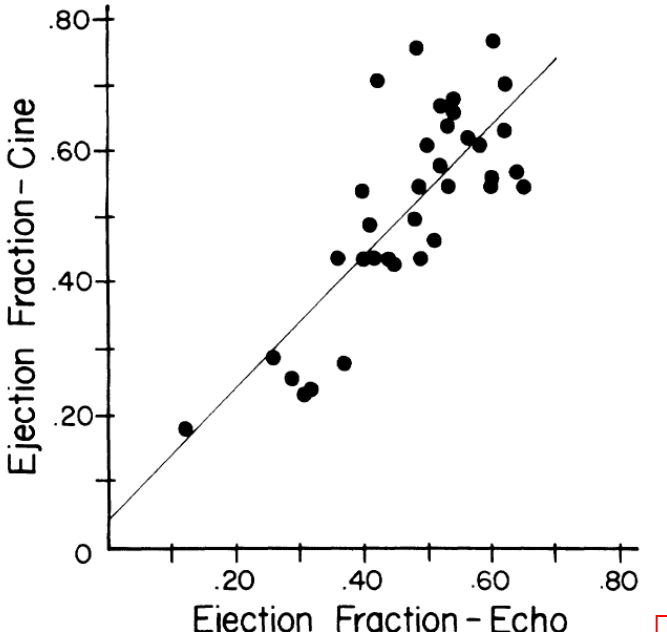


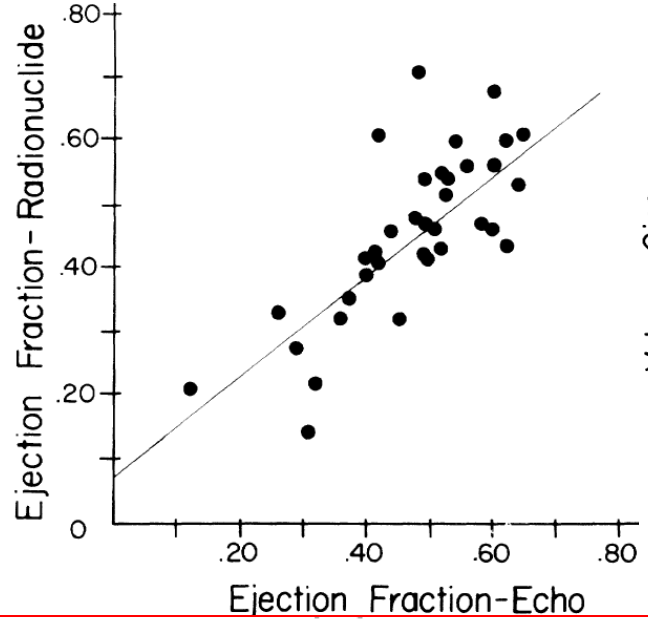
Assessment of Left Ventricular Ejection Fraction and Volumes by Real-time, Two-dimensional Echocardiography

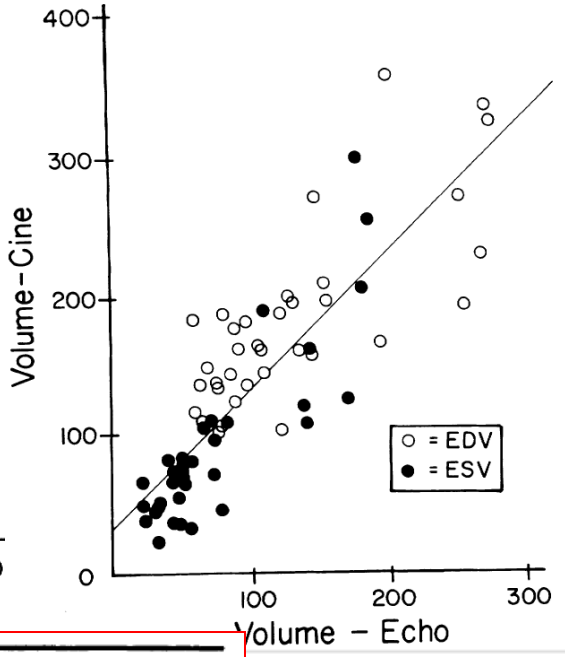
A Comparison of Cineangiographic and Radionuclide Techniques

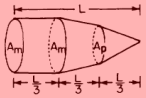
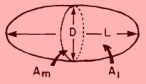
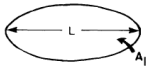
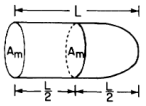
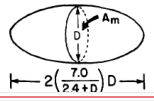
EDWARD D. FOLLAND, M.D., ALFRED F. PARISI, M.D., PAUL F. MOYNIHAN, B.S., D. RAY JONES, M.S., CHARLES L. FELDMAN, D.SC., AND DONALD E. TOW, M.D.

SUMMARY Five different algorithms for determining left ventricular (LV) ejection fraction (EF) and volumes from two-dimensional echocardiographic examination (TDE) were compared with standard methods for obtaining EF and volume from x-ray cineangiography (cine) and EF from radionuclide ventriculography (RVG) in 35 patients. Although all methods correlated positively, the degree of correlation varied with the algorithm used. For EF determination, TDE algorithms (especially those using multiple planes of section) were superior to unidimensional algorithms commonly used with M-mode echocardiography. The best algorithm (modified Simpson's rule) correlated well enough with cine EF (r = 0.78; SEE 0.097) and RVG EF (r = 0.75; SEE 0.087) to make clinically useful estimates. TDE volumes also correlated meaningfully with cine end-diastolic and end-systolic volumes (r = 0.84; n = 70) but were associated with a large standard error of the estimate (43 ml) and offered less advantage over unidimensional volume estimations. Quantitative application of TDE appears to be a useful noninvasive method of evaluating LVEF, but is not as useful for estimating LV volumes.







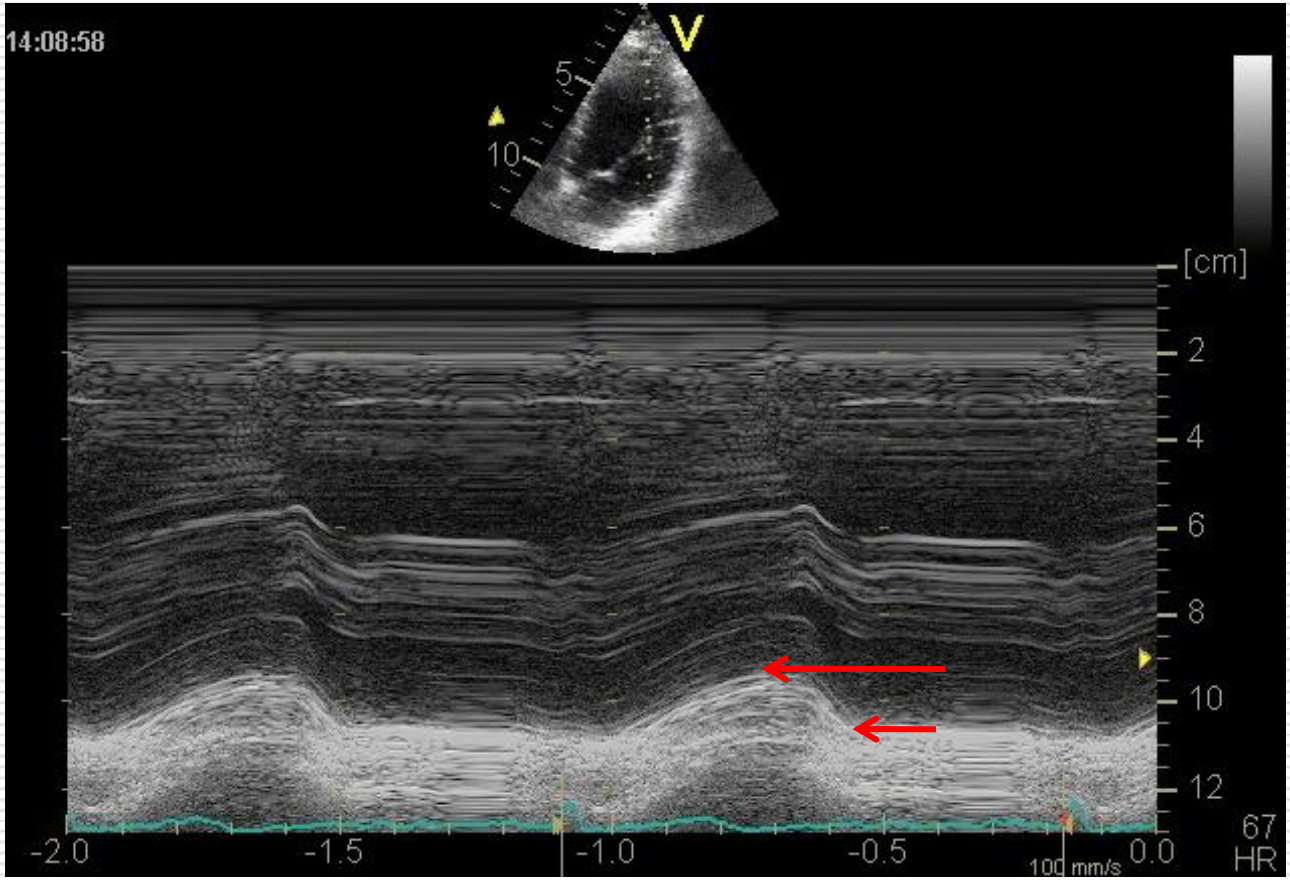
Algorithm	Formulation	Geometric Model
Simpson's Rule	$V=(A_m)\frac{L}{3}+(\frac{A_m+A_p}{2})\frac{L}{3}+\frac{L}{3}(A_p)\frac{L}{3}$	
Ellipsoid – Biplane	$V=\frac{\pi}{6}L(\frac{4A_m}{\pi D})(\frac{4A_l}{\pi L})$	
Ellipsoid – Single Plane	$V=\frac{8(A_l)^2}{3\pi L}$	
Hemisphere – Cylinder	$V=(A_m)\frac{L}{2}+\frac{2}{3}(A_m)\frac{L}{2}$	
Modified Ellipsoid	$V=(\frac{70}{2.4+D})D^3$	

Echo algorithm	Cine*		RVG	
	r	(SEE)	*r*	(SEE)
Modified Simpson's rule	0.78	(0.097)	0.75	(0.087)
Ellipsoid biplane	0.78	(0.098)	0.73	(0.089)
Ellipsoid single plane	0.76	(0.101)	0.71	(0.092)
Hemisphere-cylinder	0.66	(0.116)	0.58	(0.107)
Modified ellipsoid (Teichholz)	0.55	(0.130)	0.46	(0.117)

*X-ray cineangiographic vs RVG ejection fractions (linear regression): $r = 0.88$; SEE = 0.073.

Abbreviations: Cine = x-ray contrast cineangiography; RVG = radionuclide ventriculography.

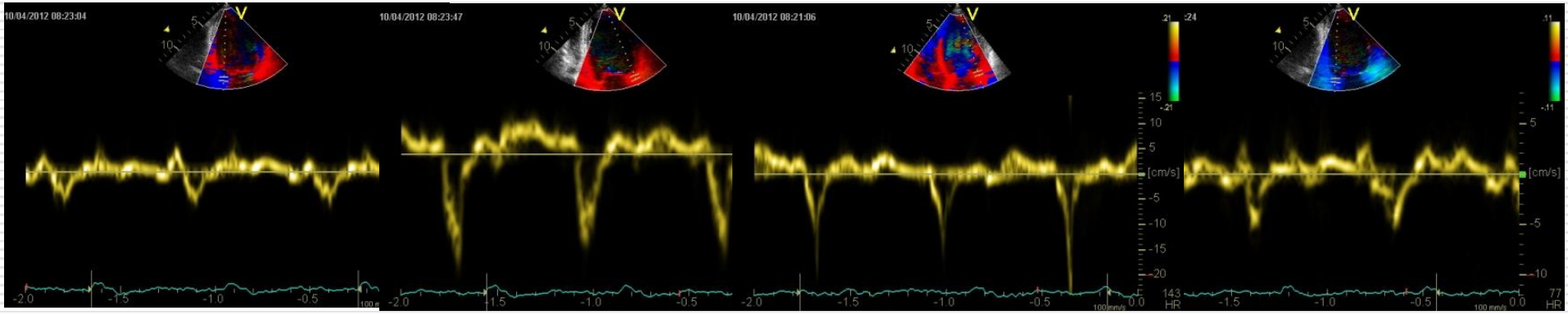
MAPSE – systolic excursion amplitude



Tissue Doppler imaging

- Rychlost pohybu mitrálního anulu reflektuje globální systolickou funkci LK (při absenci regionální poruchy kinetiky)

Peak myocardial systolic velocity averaged from 6 sites around the mitral annulus correlates well with LVEF, and a cut-off of 7.5 cm/s had a sensitivity of 79% and a specificity of 88% in predicting normal global LV function



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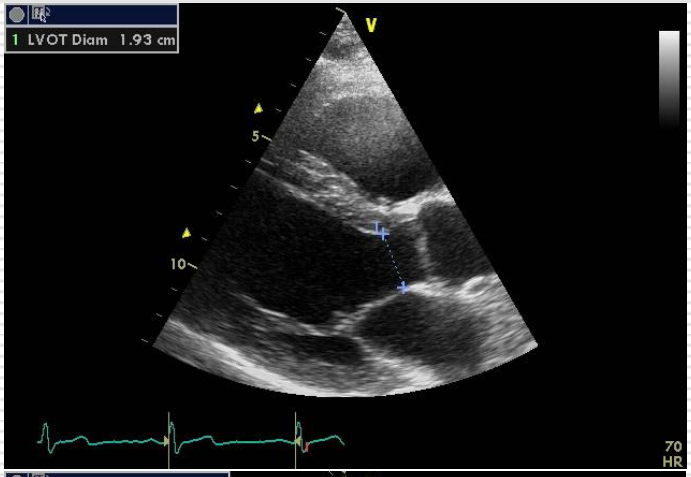
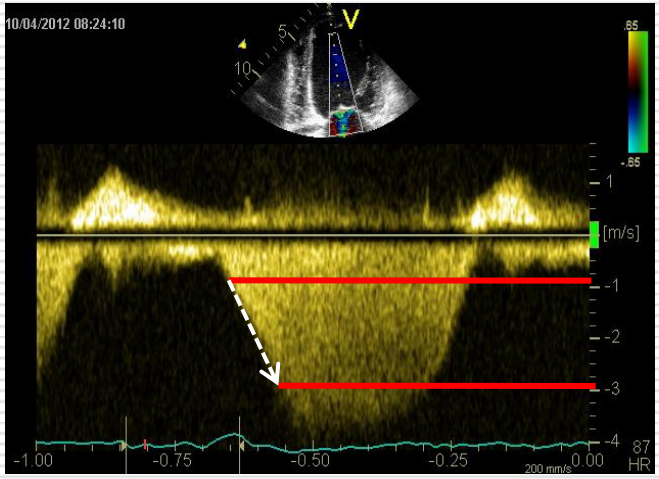
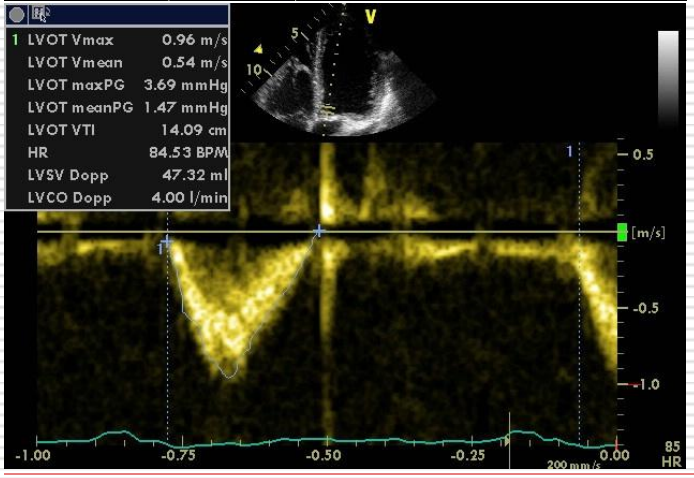
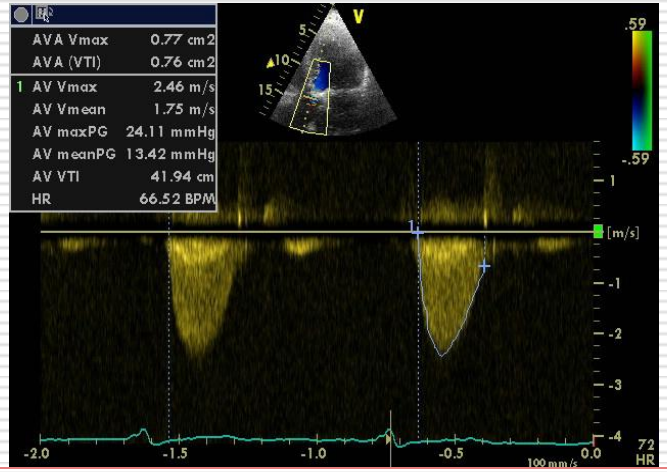
Doppler

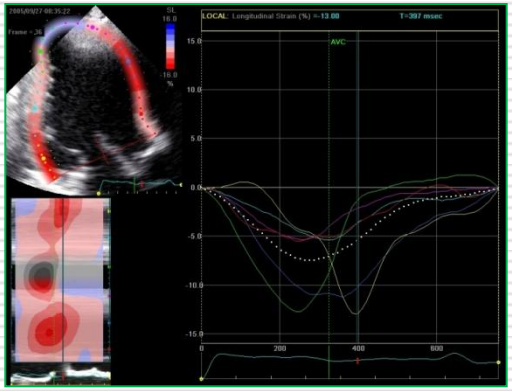

1 LVOT Diam 1.93 cm
70
HR

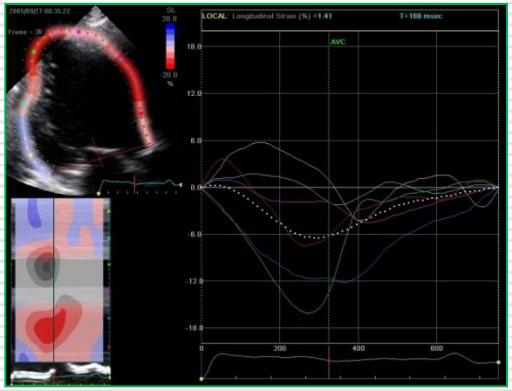

10/04/2012 08:24:10
[m/s]
-1.00
-0.75
-0.50
-0.25
0.00
200 mm/s
87
HR

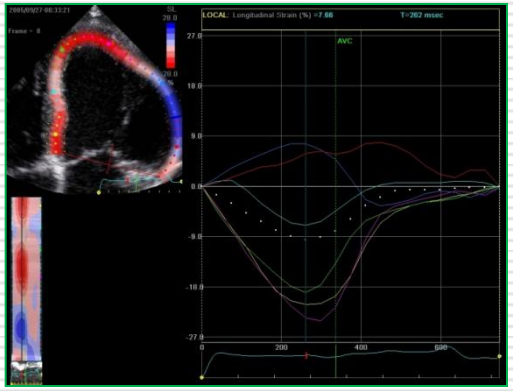

1 LVOT Vmax 0.96 m/s
LVOT Vmean 0.54 m/s
LVOT maxPG 3.69 mmHg
LVOT meanPG 1.47 mmHg
LVOT VTI 14.09 cm
HR 84.53 BPM
LVSV Dopp 47.32 ml
LVCO Dopp 4.00 l/min
[m/s]
-1.00
-0.75
-0.50
-0.25
0.00
200 mm/s
85
HR

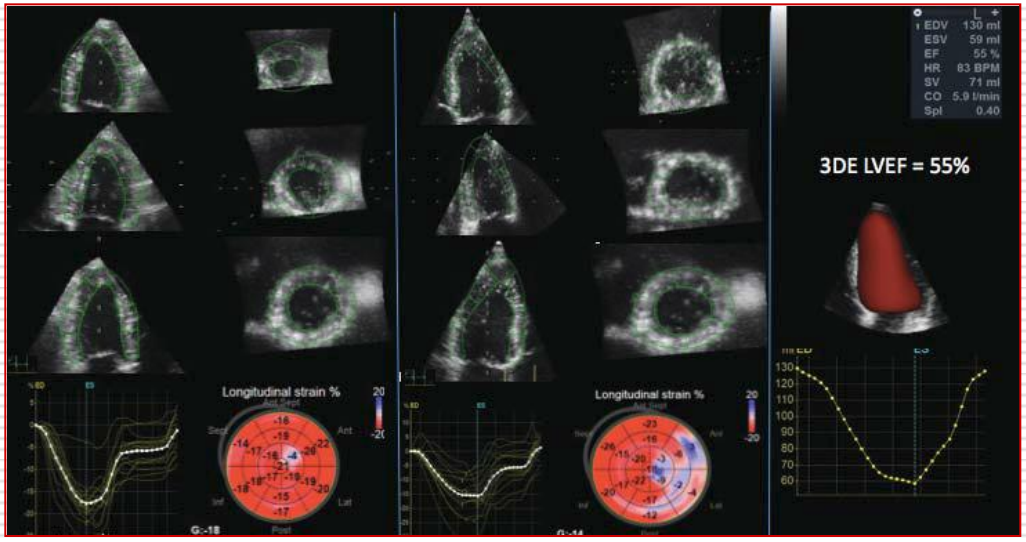

AVA Vmax 0.77 cm2
AVA (VTI) 0.76 cm2
1 AV Vmax 2.46 m/s
AV Vmean 1.75 m/s
AV maxPG 24.11 mmHg
AV meanPG 13.42 mmHg
AV VTI 41.94 cm
HR 66.52 BPM
[m/s]
-2.0
-1.5
-1.0
-0.5
0.0
100 mm/s
72
HR

2D/3D strain – deformační analýzy myokardu









RT 3D GLS LK

+

RT 3D EDV/ESV - EF

Eur J Echocardiography (2006) 7, 79–108

ELSEVIER

EUROPEAN SOCIETY OF CARDIOLOGY®

GUIDELINES

Recommendations for chamber quantification☆

Roberto M. Lang, Michelle Bierig, Richard B. Devereux, Frank A. Flachskampf*, Elyse Foster, Patricia A. Pellikka, Michael H. Picard, Mary J. Roman, James Seward, Jack Shanewise, Scott Solomon, Kirk T. Spencer, Martin St. John Sutton, William Stewart

GUIDELINES AND STANDARDS

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Roberto M. Lang, MD, FASE, FESC, Luigi P. Badano, MD, PhD, FESC, Victor Mor-Avi, PhD, FASE, Jonathan Afilalo, MD, MSc, Anderson Armstrong, MD, MSc, Laura Ernande, MD, PhD, Frank A. Flachskampf, MD, FESC, Elyse Foster, MD, FASE, Steven A. Goldstein, MD, Tatiana Kuznetsova, MD, PhD, Patrizio Lancellotti, MD, PhD, FESC, Denisa Muraru, MD, PhD, Michael H. Picard, MD, FASE, Ernst R. Rietzschel, MD, PhD, Lawrence Rudski, MD, FASE, Kirk T. Spencer, MD, FASE, Wendy Tsang, MD, and Jens-Uwe Voigt, MD, PhD, FESC, *Chicago, Illinois; Padua, Italy; Montreal, Quebec and Toronto, Ontario, Canada; Baltimore, Maryland; Créteil, France; Uppsala, Sweden; San Francisco, California; Washington, District of Columbia; Leuven, Liège, and Ghent, Belgium; Boston, Massachusetts*

The rapid technological developments of the past decade and the changes in echocardiographic practice brought about by these developments have resulted in the need for updated recommendations to the previously published guidelines for cardiac chamber quantification, which was the goal of the joint writing group assembled by the American Society of Echocardiography and the European Association of Cardiovascular Imaging. This document provides updated normal values for all four cardiac chambers, including three-dimensional echocardiography and myocardial deformation, when possible, on the basis of considerably larger numbers of normal subjects, compiled from multiple databases. In addition, this document attempts to eliminate several minor discrepancies that existed between previously published guidelines. (J Am Soc Echocardiogr 2015;28:1-39.)

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European Heart Journal – Cardiovascular Imaging (2015) **16**, 233–271
doi:10.1093/ehjci/jev014

POSITION PAPER

Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

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Table 2 Normal values for 2D echocardiographic parameters of LV size and function according to gender

Parameter	Male		Female	
	Mean ± SD	2-SD range	Mean ± SD	2-SD range
LV internal dimension				
Diastolic dimension (mm)	50.2 ± 4.1	42.0–58.4	45.0 ± 3.6	37.8–52.2
Systolic dimension (mm)	32.4 ± 3.7	25.0–39.8	28.2 ± 3.3	21.6–34.8
LV volumes (biplane)				
LV EDV (mL)	106 ± 22	62–150	76 ± 15	46–106
LV ESV (mL)	41 ± 10	21–61	28 ± 7	14–42
LV volumes normalized by BSA				
LV EDV (mL/m^2)	54 ± 10	34–74	45 ± 8	29–61
LV ESV (mL/m^2)	21 ± 5	11–31	16 ± 4	8–24
LV EF (biplane)	62 ± 5	52–72	64 ± 5	54–74

BSA, body surface area; *EDV,* end-diastolic volume; *EF,* ejection fraction; *ESV,* end-stystolic volume; *LV,* left ventricular; *SD,* standard deviation.

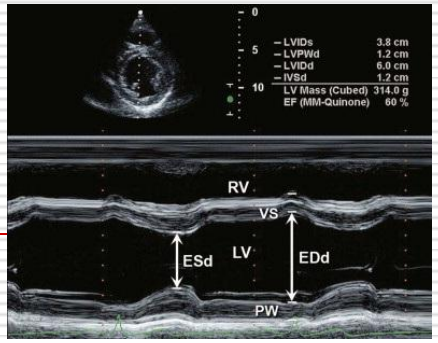


Table 3 Normal values for LV parameters obtained with 3DE

	Aune *et al.* (2010)	Fukuda *et al.* (2012)	Chahal *et al.* (2012)	Muraru *et al.* (2013)
Number of subjects	166	410	978	226
Ethnic makeup of population	Scandinavian	Japanese	51% European white, 49% Asian Indian	White European
EDVi (mL/m^2)				
Men, mean (LLN, ULN)	66 (46, 86)	50 (26, 74)	White: 49 (31, 67); Indian: 41 (23, 59)	63 (41, 85)
Women, mean (LLN, ULN)	58 (42, 74)	46 (28, 64)	White: 42 (26, 58); Indian: 39 (23, 55)	56 (40, 78)
ESVi (mL/m^2)				
Men, mean (LLN, ULN)	29 (17, 41)	19 (9, 29)	White: 19 (9, 29); Indian: 16 (6, 26)	24 (14, 34)
Women, mean (LLN, ULN)	23 (13, 33)	17 (9, 25)	White: 16 (8, 24); Indian: 15 (7, 23)	20 (12, 28)
EF (%)				
Men, mean (LLN, ULN)	57 (49, 65)	61 (53, 69)	White: 61 (49, 73); Indian: 62 (52, 72)	62 (54, 70)
Women, mean (LLN, ULN)	61 (49, 73)	63 (55, 71)	White: 62 (52, 72); Indian: 62 (52, 72)	65 (57, 73)

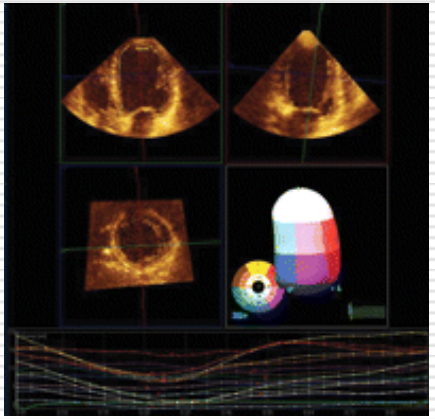
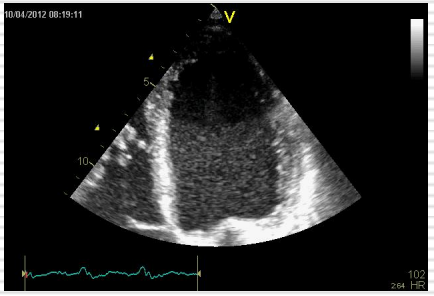
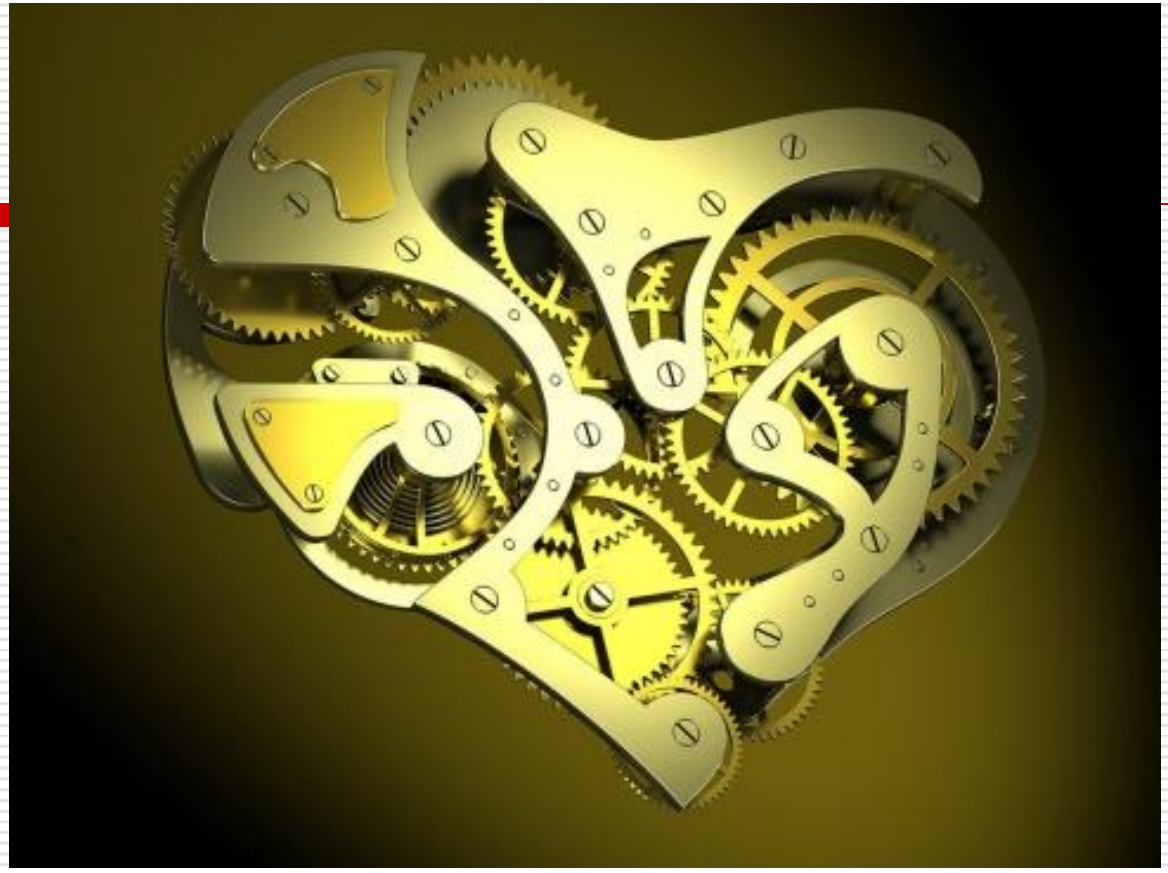


Table 4 Normal ranges and severity partition cutoff values for 2DE-derived LV EF and LA volume

	Male				Female			
	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal	Normal range	Mildly abnormal	Moderately abnormal	Severely abnormal
LV EF (%)	52–72	41–51	30–40	<30	54–74	41–53	30–40	<30
Maximum LA volume/BSA (mL/m^2)	16–34	35–41	42–48	>48	16–34	35–41	42–48	>48



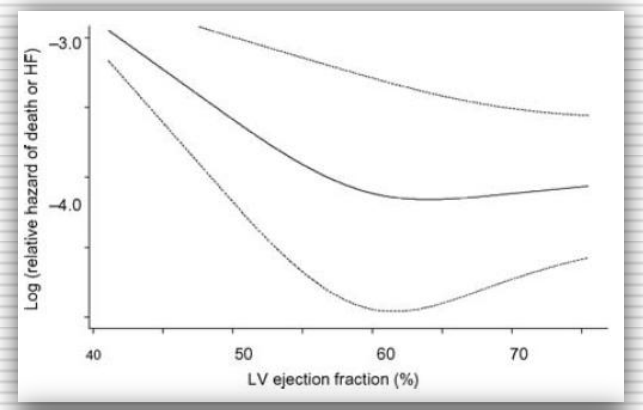


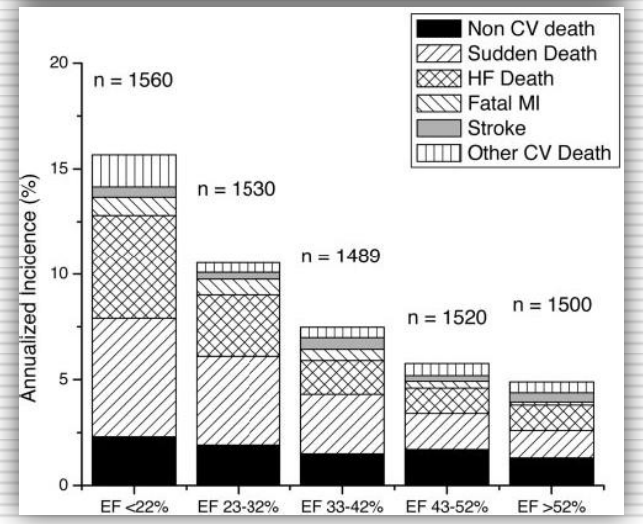
Je echokardiografické stanovení EF LK problematické a jaké jsou možnosti řešení?

Problém 2D stanovení

Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION
American Heart Association. Learn and Live.

Results of the Predictors of Response to CRT (PROSPECT) Trial
Eugene S. Chung, Angel R. Leon, Luigi Tavazzi, Jing-Ping Sun, Petros Nihoyannopoulos, John Merlino, William T. Abraham, Stefano Ghio, Christophe Leclercq, Jeroen J. Bax, Cheuk-Man Yu, John Gorcsan, III, Martin St John Sutton, Johan De Sutter and Jaime Murillo
Circulation 2008;117:2608-2616; originally published online May 5, 2008;





***PROSPECT* conclusions:**

1. Interindividual **variability ESV** (CV 14.5%) and **LVEF** (mean LVEF 23.6±7%, corlab 29.3±10%)
2. 20% patients indicated for CRT implantation have **corlab LVEF >35%**
3. 1/3 suboptimal 2D **image quality** for ESV estimation
4. No **QC**
5. 40%: old ultrasound machines
6. 37% GE, 50% Philips, 12% Siemens

Nicolosi JL. Et al. Effects of perindopril on cardiac remodelling and prognostic value of pre-discharge quantitative echocardiographic parameters in elderly patients after acute myocardial infarction: the PREAMI echo sub-studyEuropean Heart Journal (2009) 30, 1656–1665

Solomon SD et al. Influence of Ejection Fraction on Cardiovascular Outcomes in a Broad Spectrum of Heart Failure Patients Circ 2005; 112; 3738-44

Chung, E. S. et al. Circulation 2008;117:2608-2616

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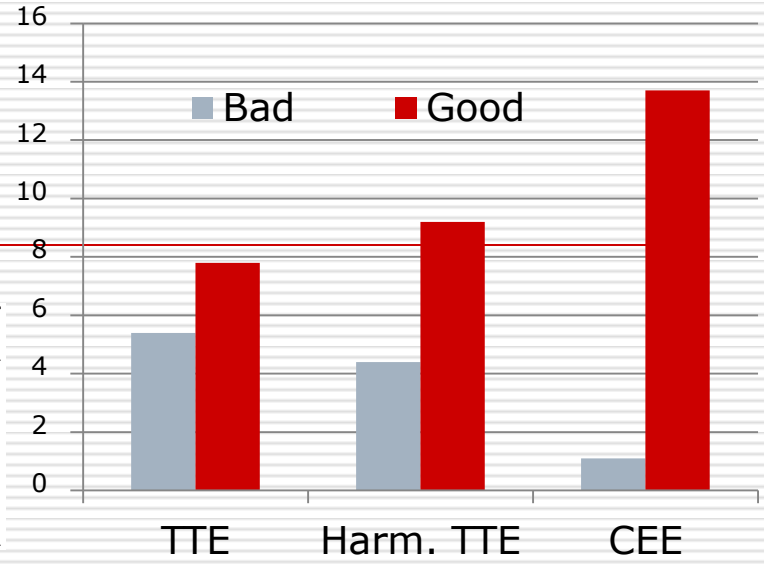
PII S0735-1097(99)00558-6

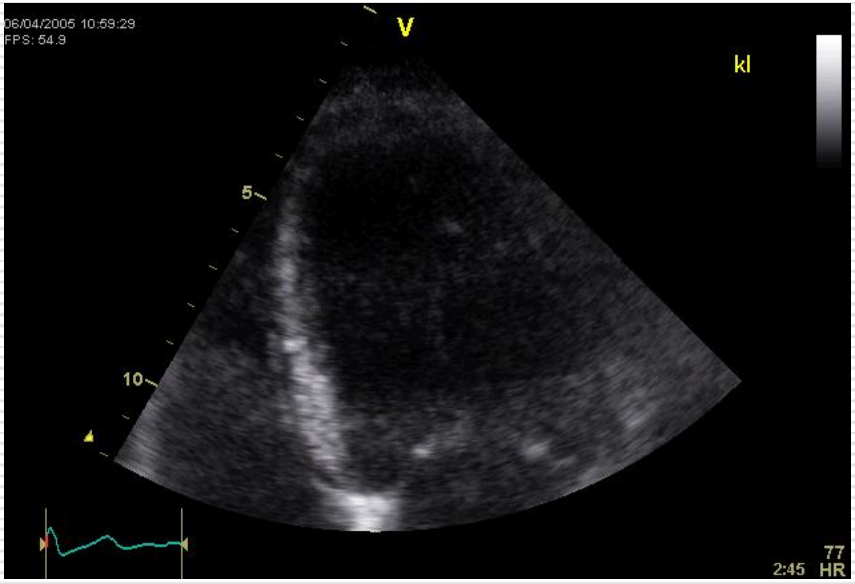
Contrast Echocardiography Clarifies Uninterpretable Wall Motion in Intensive Care Unit Patients

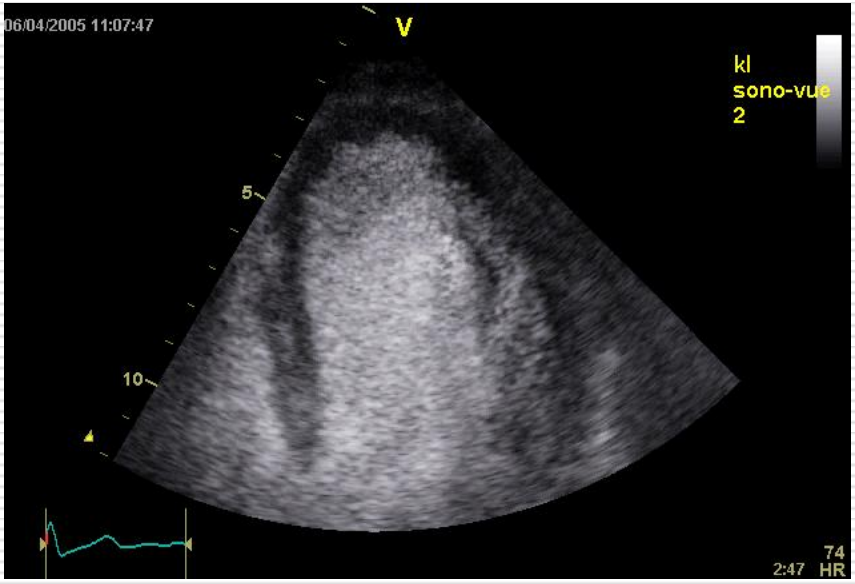
John P. Reilly, MD, Paul A. Tunick, MD, FACC, Robert J. Timmermans, MD, Bruce Stein, MD, Barry P. Rosenzweig, MD, FACC, Itzhak Kronzon, MD, FACC

New York, New York

	Standard	Harmonic	Contrast	Contrast vs. Standard	Contrast vs. Harmonic
Wall Motion: n = 16 segments/patient					
Average no. segments/patient with wall motion Confidence Score A	5.4 (34%)	4.4 (28%)	1.1 (7%)	$p < 0.0001$	$p < 0.0001$
Average no. segments/patient with wall motion Confidence Score C	7.8 (49%)	9.2 (58%)	13.7 (86%)	$p < 0.0001$	$p < 0.0001$
Ejection fraction: n = 70 patients					
No. patients with E.F. Confidence Score A	16 (23%)	9 (13%)	0 (0%)	$p < 0.0001$	$p = 0.002$
No. patients with E.F. Confidence Score C	39 (56%)	42 (62%)	64 (91%)	$p < 0.0001$	$p < 0.0001$







Reilly JP, et al. Contrast echocardiography clarifies uninterpretable wall motion in intensive care unit patients. J Am Coll Cardiol 2000;35:485–90.

RT-3D EF LK

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doi:10.1016/j.jacc.2004.05.050

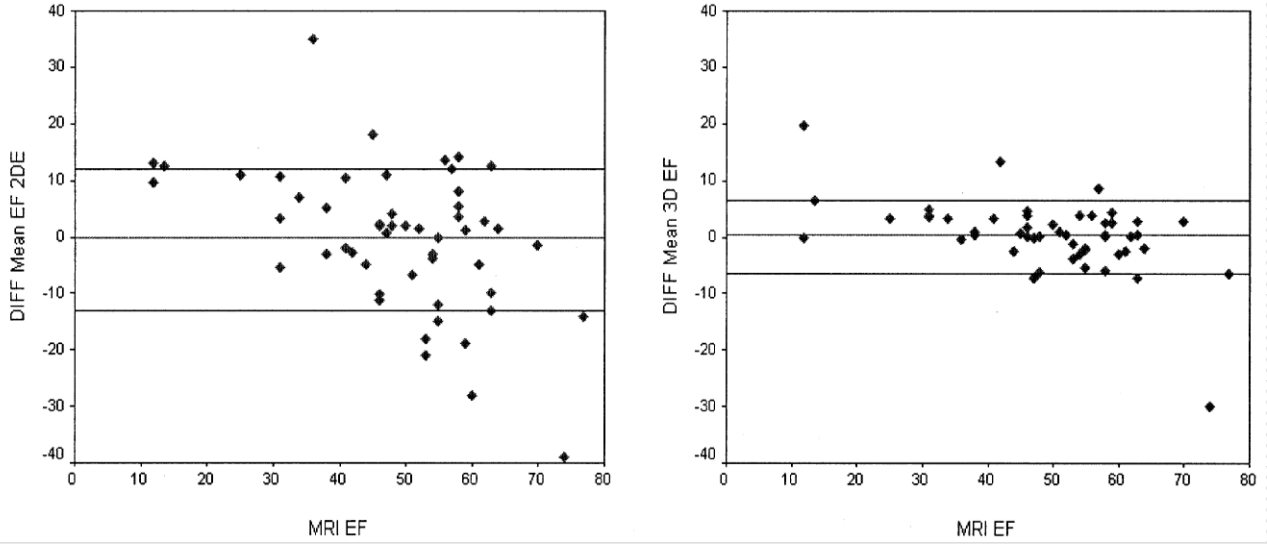
Echocardiography

Reproducibility and Accuracy of Echocardiographic Measurements of Left Ventricular Parameters Using Real-Time Three-Dimensional Echocardiography

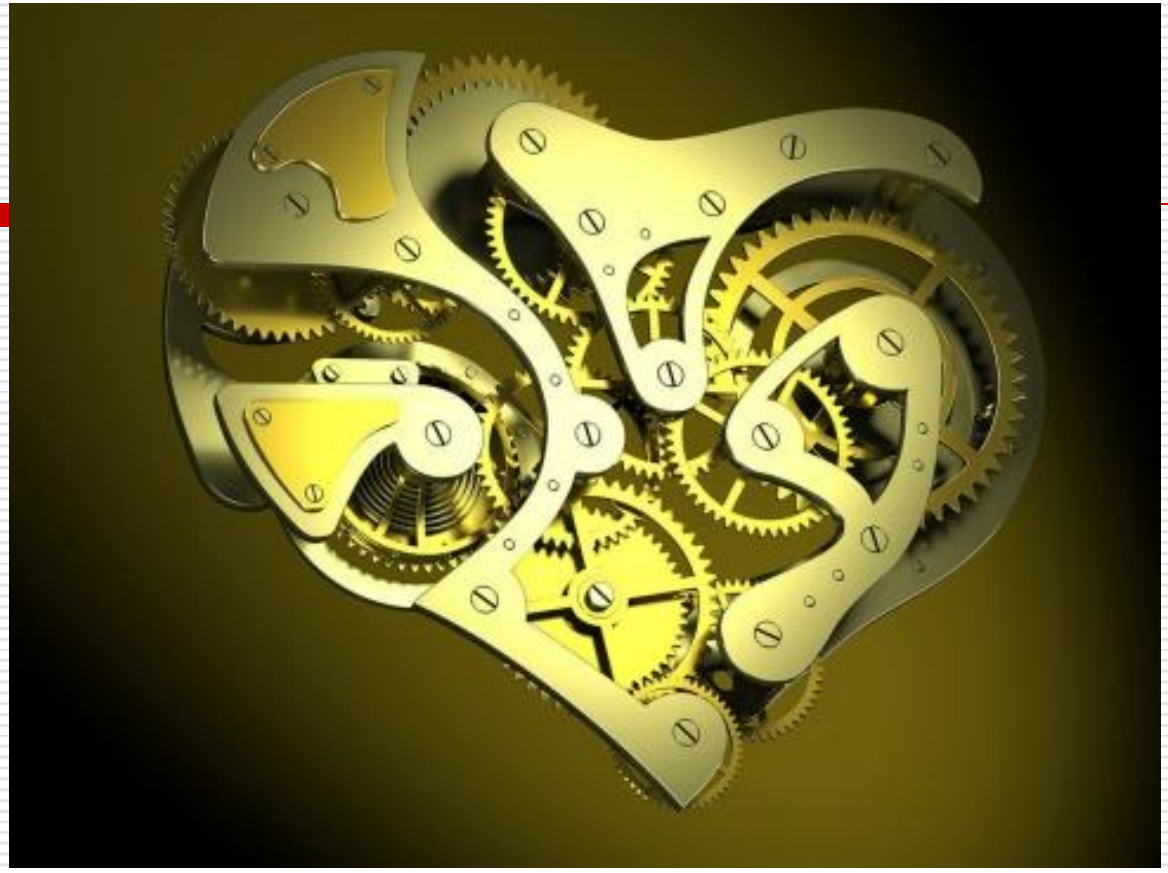
Carly Jenkins, BS, Kristen Bricknell, BS, Lizelle Hanekom, MD, Thomas H. Marwick, MD, PHD, FACC

Table 5. Mean Difference Between Echocardiographic and MRI Measurements (n = 50)

	RT-3DE		2DE		Difference in Variance Between MRI and RT-3DE or 2DE	
End-diastolic volume (172 ± 53 ml)	−4 ± 29	p = 0.31	−54 ± 33	p < 0.01	F = 1.31	p = 0.17
End-diastolic volume (91 ± 53 ml)	−3 ± 18	p = 0.23	−28 ± 28	p < 0.01	F = 2.38	p = 0.001
Ejection fraction (50 ± 14%)	0 ± 7	p = 0.74	−1 ± 13	p = 0.76	F = 3.82	p < 0.0001
LV mass (183 ± 50 g)	0 ± 38	p = 0.94	16 ± 57	p = 0.04	F = 2.25	p < 0.003

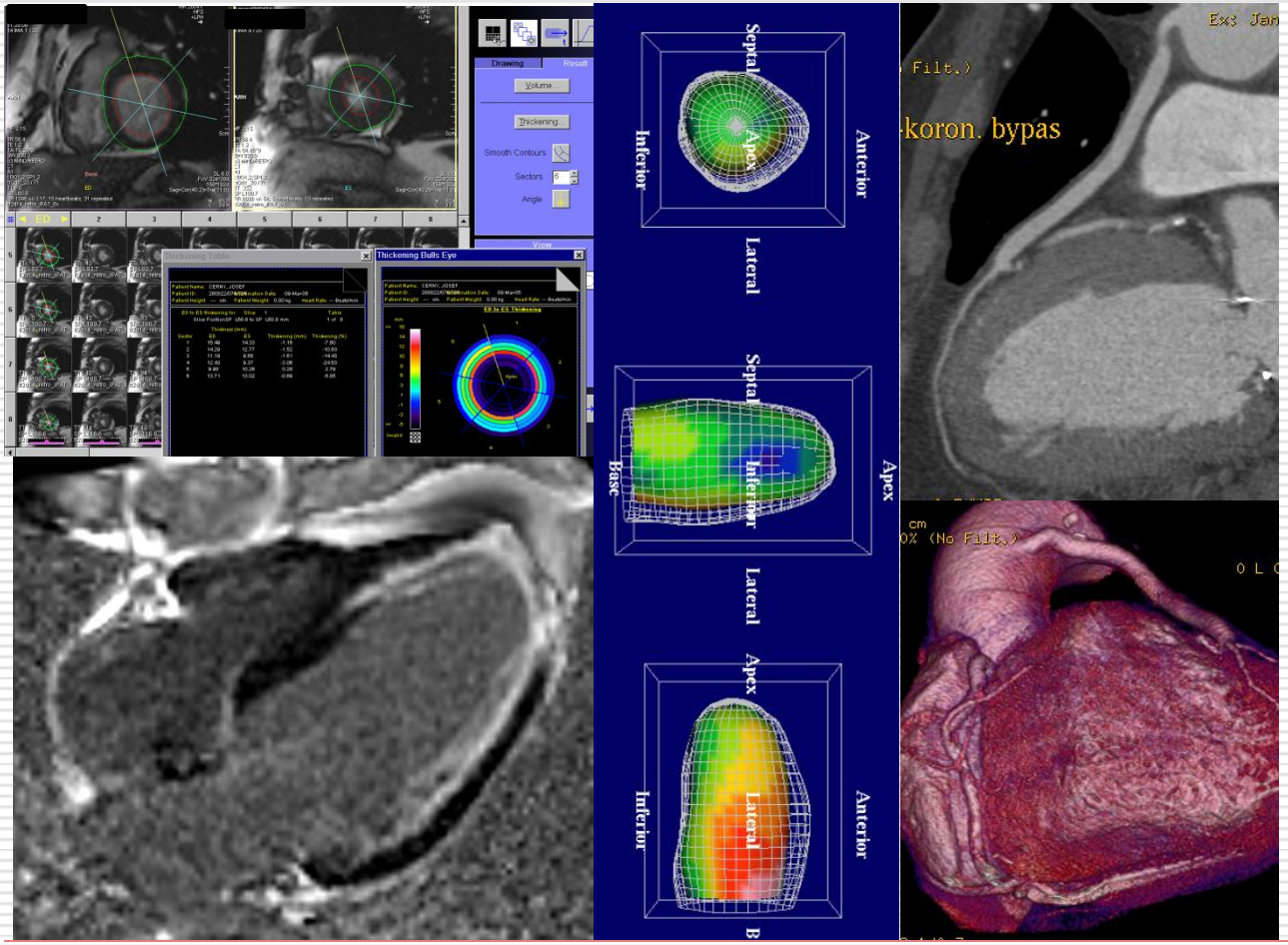


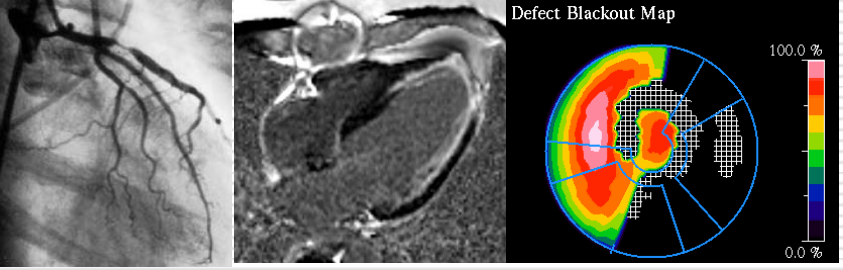
Jenkins C. et al. Reproducibility and Accuracy of Echocardiographic Measurements of Left Ventricular Parameters Using Real-Time Three-Dimensional Echocardiography. J Am Coll Cardiol 2004;44:878–86

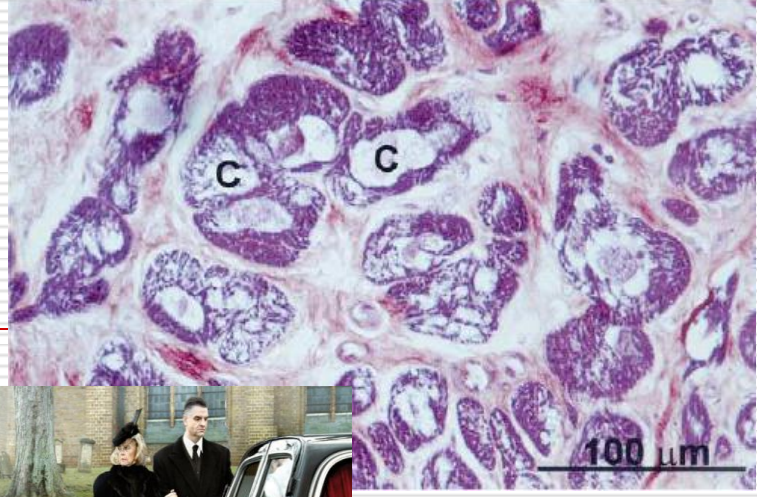


Jaké jsou alternativní metody pro stanovení systolické funkce/EF LK a jejich ne/výhody?

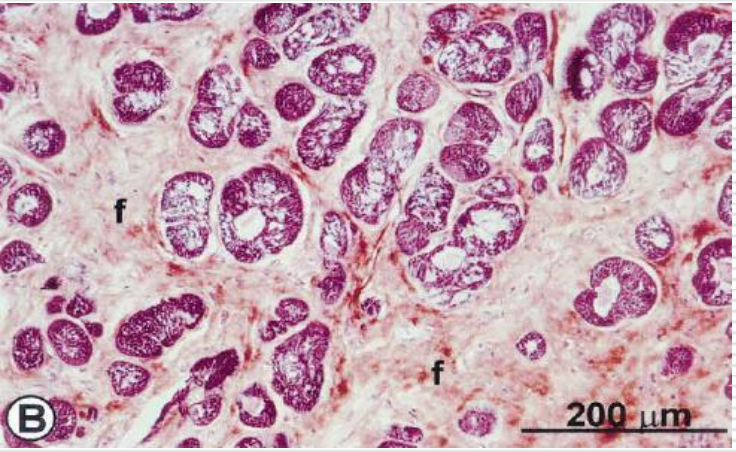
CMR, gated SPECT/RLVG a CCT/A







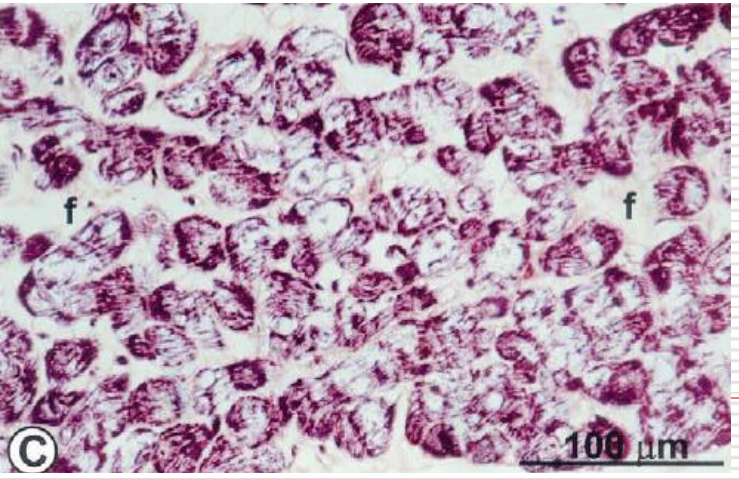
Norma

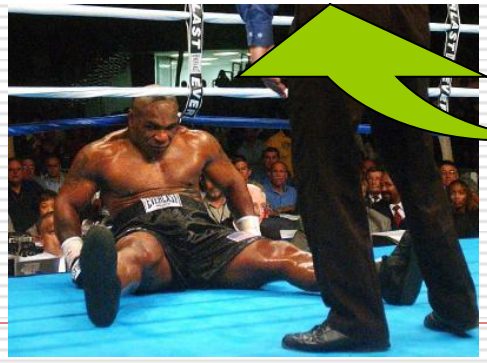


Jizva

Stunning

Hibernace





Sheppard, Nicholas et al. The histology of viable and hibernating myocardium in relation to imaging characteristics. J. Am. Coll. Cardiol. 2002;39;428-435

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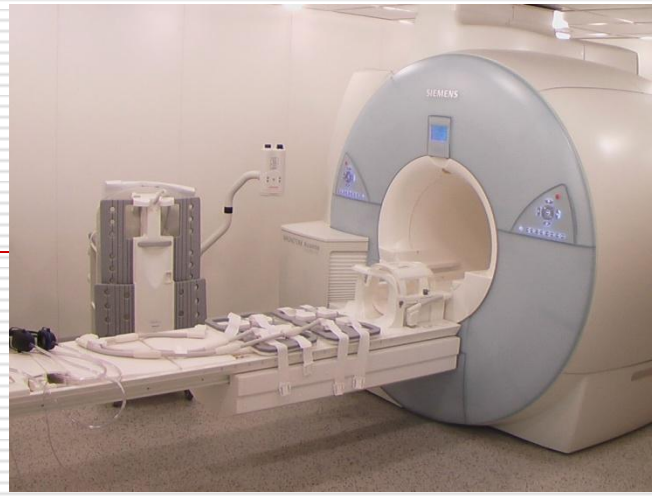
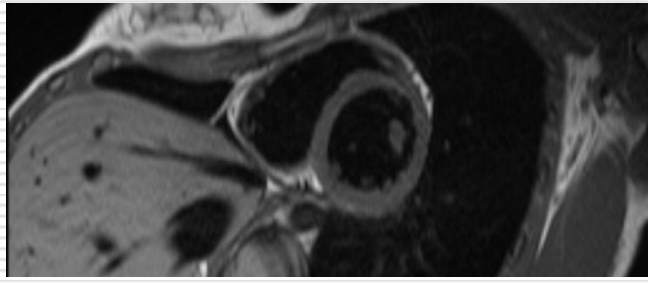
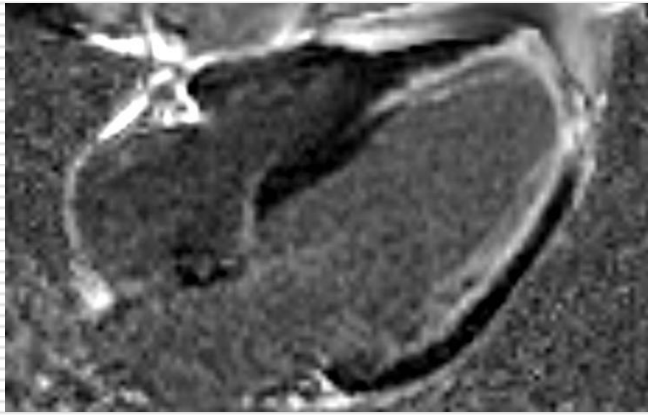
Magnetická rezonance srdce

- **Výhody:** Orientace vrstev zobrazení není, na rozdíl od CT, ničím limitována, vzdálenost vyšetřované oblasti od povrchu těla, na rozdíl od echokardiografie, není důležitá.
- **Limitace:** Časová náročnost (40 min), cena/dostupnost, artefakty, kontraindikace.

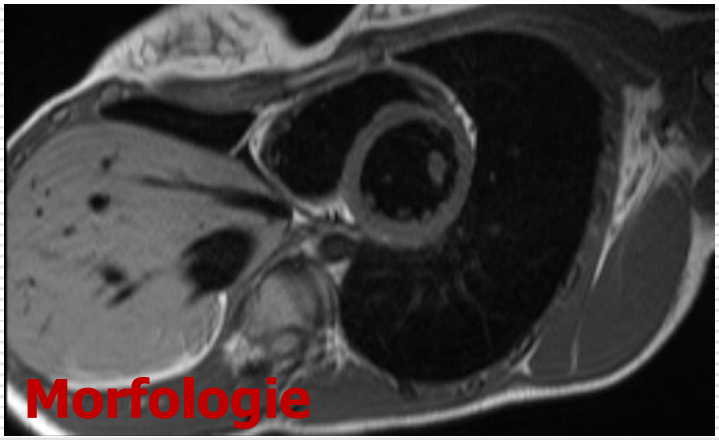






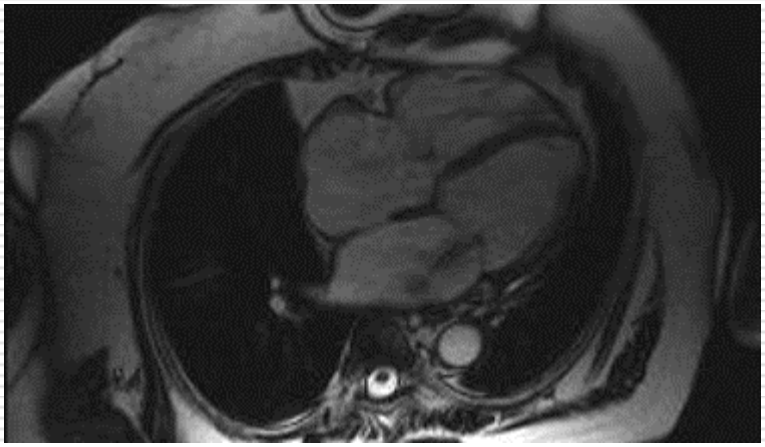
- **Statický obraz** – sekvence spinového echa - potlačení artefaktů způsobených pohybem srdce a prouděním krve, výsledkem jsou obrazy s nulovým signálem krve v srdečních dutinách - metoda **„tmavé krve".**
- **Dynamické studie** (cineMR) - sekvence gradientního echa (GE) - naopak signál proudící krve vyšší než signál komorových a síňových stěn - **„světlá krev".**
- **Zobrazení časových fází srdce**. Jedno (breath-hold) měření 12–20s, s časovým rozlišením 30–50 ms.

CMR - techniky

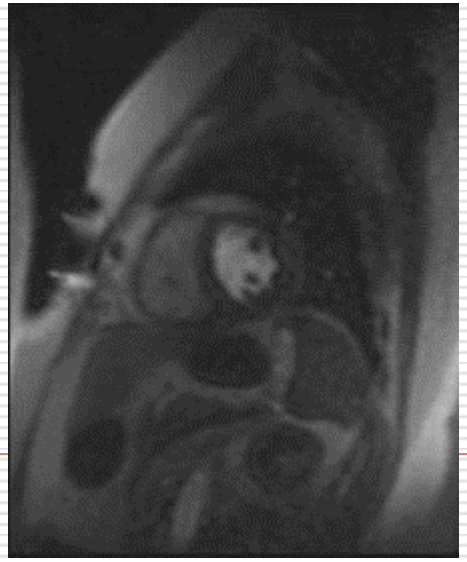


Morfologie

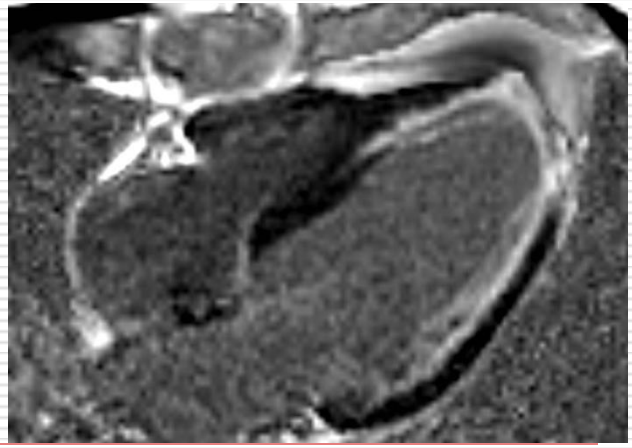
Funkce



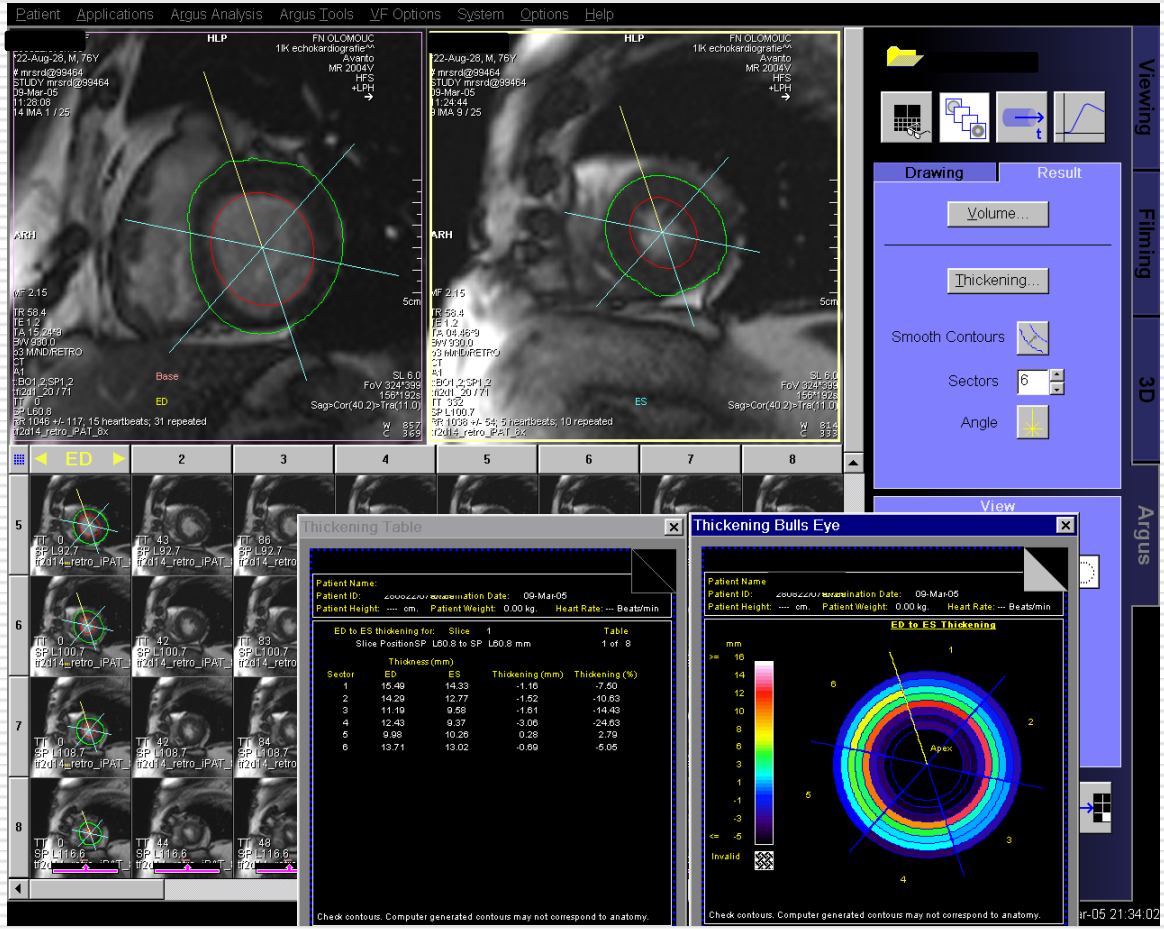
First
-pass
perfúze



Delayed
enhancement



CMR – kinetické studie



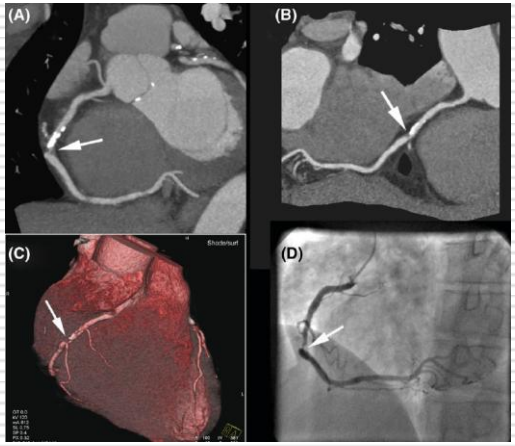
Hodnocení EF (změny EF již od 2 %), volumů LK, tepového objemu.

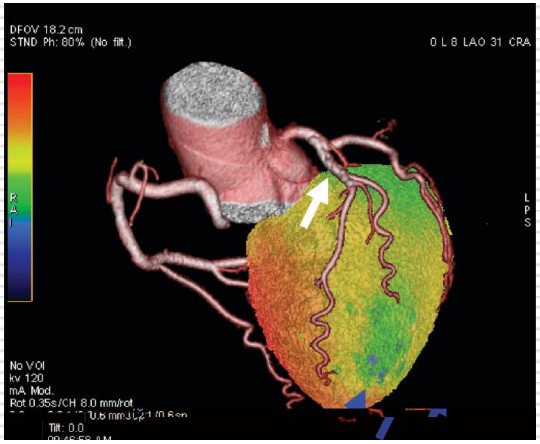
Intra-observer **variabilita** stanovení objemů LK 3,5%, inter-observer variabilita 5,2%.

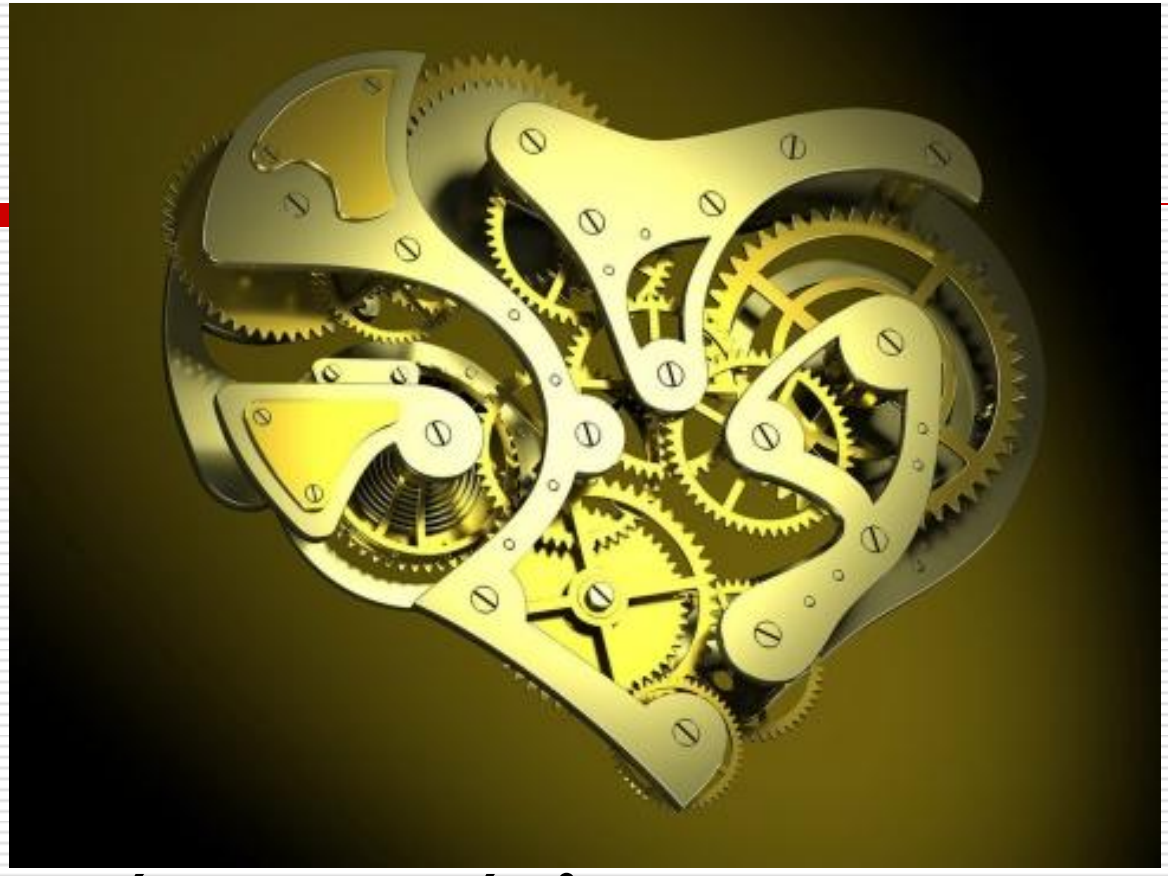
Matheijssen NA, Baur LH, Reiber JH, van der Velde EA, van Dijkman PR, van der Geest RJ, de Roos A, van der Wall EE, Assessment of left ventricular volume and mass by cine magnetic resonance imaging in patients with anterior myocardial infarction intra-observer and inter-observer variability on contour detection., Int J Card Imaging 1996; 12(1): 11–19.

CT srdce – CT koronarografie (CCTA)

- Se vzrůstající kvalitou přístrojové techniky - dostatečně robustní, rychlá a spolehlivá metoda zobrazení koronárních tepen.
- **Limitace**: TF <65/min., BB při vyšší TF, omezené použití u FS/ES.
- **Radiační zátěž:** 64 MDCT - 11-22 mSv, při EKG kontrolované modulaci dávky snížení expozice na 7-11 mSv. Srovnatelné se 100-160x RTG S+P, 3-4x přirozená radiační zátěž/rok (2.5 mSv). Pro srovnání – diagnostická SKG střední efektivní radiační zátěž 2.5-5 mSv, SPECT 15-20 mSv.







Jaké jsou klinické důvody evaluace systolické dysfunkce LK?

Důvody evaluace systolické funkce LK (1)

Stanovení EF LK je důležité pro určení **diagnózy, prognostickou stratifikaci, management** a **sledování** pacientů v různých klinických situacích. Přesné stanovení EF LK hraje klíčovou úlohu v těchto situacích.

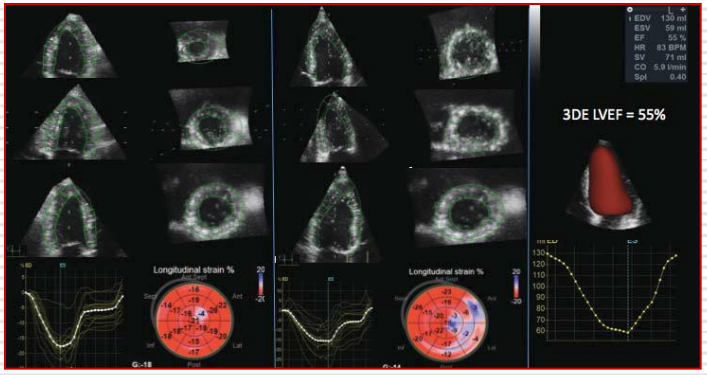
1.<u>Symtomy a příznaky srdečního onemocnění:</u>

✓Suspektní symptomy a abnormality, které svědčí pro organické srdeční onemocnění jako **palpitace, klinicky relevantní EKG abnormality, embolizační příhody**.
✓Symptomy a známky **srdečního selhání**. Informace o systolické, diastolické funkci, geometrii, morfologii, regionálních poruchách kinetiky je důležitá z diagnostických a prognostických důvodů (HFpEF - LVEF ≥50%, HFrEF LVEF ≤40%, HFmrEF LVEF 41-49%) a tato informace má zásadní vliv na management pacientů s HF.
✓Symptomy a známky **ischemické choroby srdeční.** Hodnocení klidové/zátěžové globální a regionální funkce LK je součástí managementu pacientů s ICHS.
✓Manifestace **komorových arytmií** je častou indikací stanovené EF LK a průkaz *<u>organického srdečního onemocnění</u>* má zásadní vliv na další management.

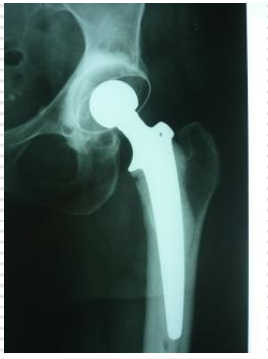
2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. Eur Heart J. 2016;37(27):2129.
2013 ACCF/AHA guideline for the management of heart failure: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. Circulation. 2013;128(16):1810.

Důvody evaluace systolické funkce LK (2)

2. **<u>Plánovaná nebo následující expozice potenciálně kardiotoxické terapii.</u>**
   Pacienti podstupující léčbu potenciálně kardiotoxickou chemoterapii podstupují opakovaně vyšetření EF LK (a dalších parametrů globální systolické funkce LK – GLS) a výsledek těchto vyšetření může mít zásadní dopad na jejich onkologickou léčbu v případě detekce kardiotoxického efektu.

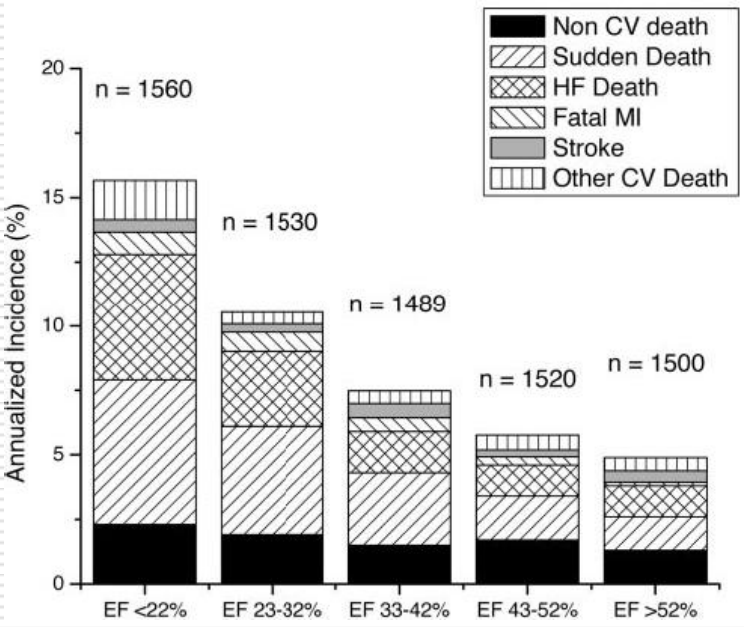


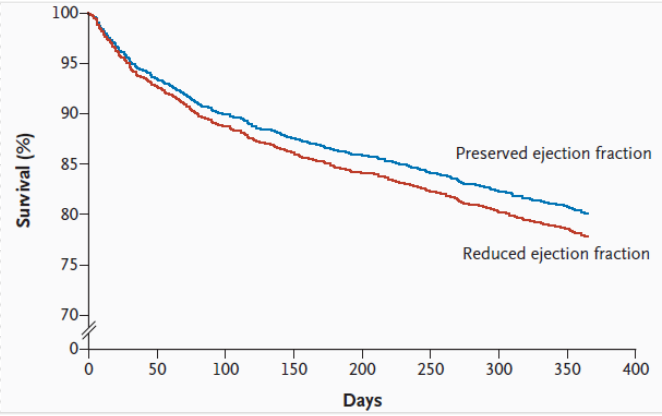
3. **<u>Stanovení systolické funkce před procedurou, kdy průkaz systolické dysfunkce představuje její kontraindikaci.</u>**
   Např. v případě nekardiálních elektivních operací, kdy operační riziko je neadekvátně vysoké potenciálnímu profitu pacienta z operačního výkonu.

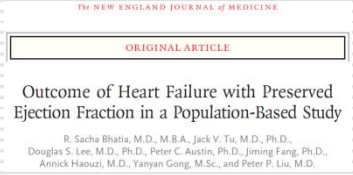


Prognostické aspekty systolické funkce LK

- 7599 pacientů studie CHARM
- Zvýšení relativního rizika celkové mortality o 39% s poklesem EF LK o 10% až do hodnoty EF LK 45%
- Od hodnoty EF LK 45% je riziko celkové a KV mortality stabilní






The NEW ENGLAND JOURNAL of MEDICINE

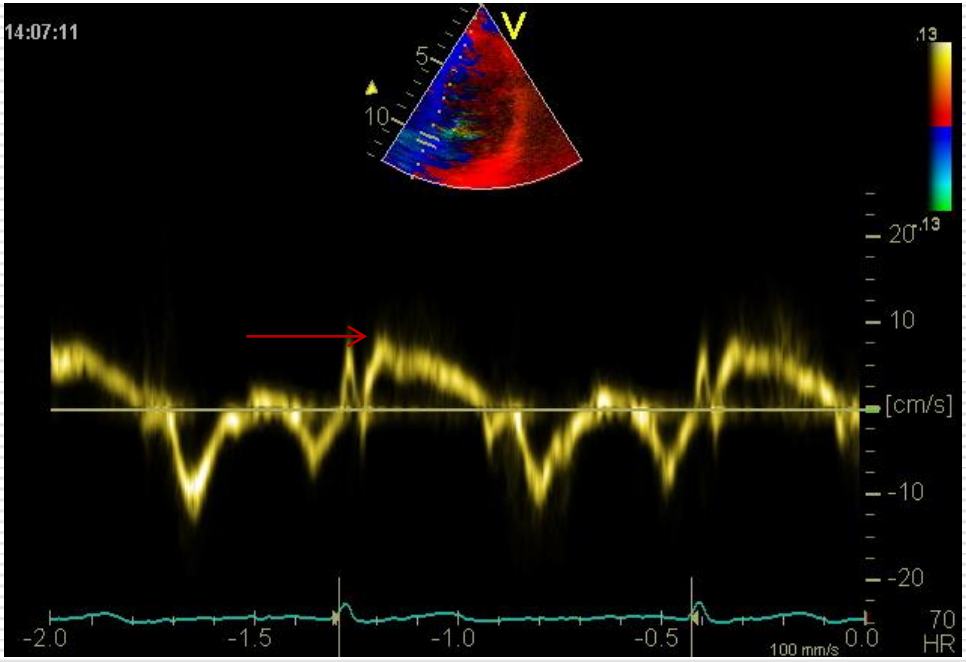
ORIGINAL ARTICLE

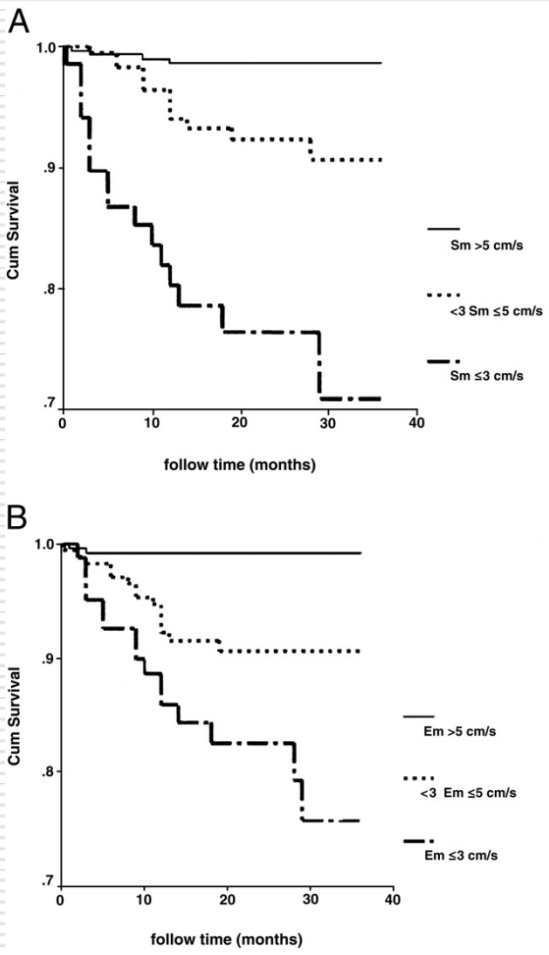
Outcome of Heart Failure with Preserved Ejection Fraction in a Population-Based Study

R. Sacha Bhatia, M.D., M.B.A., Jack V. Tu, M.D., Ph.D., Douglas S. Lee, M.D., Ph.D., Peter C. Austin, Ph.D., Jiming Fang, Ph.D., Annick Haouzi, M.D., Yanyan Gong, M.Sc., and Peter P. Liu, M.D.

Scott D. Solomon, Nagesh Anavekar, Hicham Skali et al. Influence of Ejection Fraction on Cardiovascular Outcomes in a Broad Spectrum of Heart Failure Patients Circulation 2005; 112; 3738-3744

Přežívání pacientů s KV onemocněním rozdělených do tercilů (Sm) a (Em).



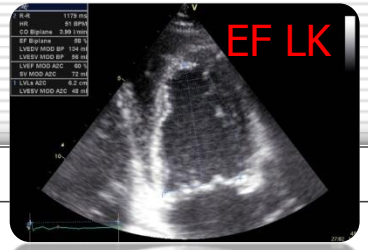


Wang M, Yip G, Yu CM, et al. Independent and incremental prognostic value of early mitral annulus velocity in patients with impaired left ventricular systolic function. J Am Coll Cardiol 2005;45: 272–7.

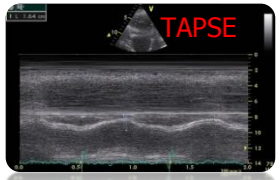
Dg.: STEMI 29%/NSTEMI 49%/NAP 22%
TTE: 1.-12. hod. od přijetí
Parametry: EF LK, TAPSE, ULC
EP: MCE
FU: medián 5 měsíců

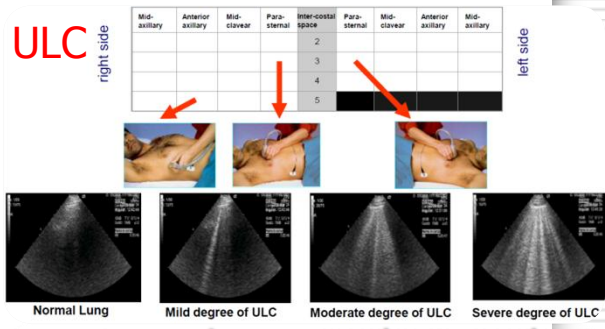
Comparison of Prognostic Value of Echocardiacgraphic Risk Score With the Thrombolysis In Myocardial Infarction (TIMI) and Global Registry In Acute Coronary Events (GRACE) Risk Scores in Acute Coronary Syndrome

Gigliola Bedetti, MD[a,*], Luna Gargani, MD[b], Rosa Sicari, MD, PhD[b], Maria Luisa Gianfaldoni, MD[c], Sabrina Molinaro, BSc[b], and Eugenio Picano, MD, PhD[b]



Variable	HR (95% CI)	p Value	HR (95% CI)	p Value
Ejection fraction	1.86 (1.58–2.19)	<0.0001	1.45 (1.02–2.08)	0.040
Wall motion score index	1.75 (1.39–2.20)	<0.0001		
Mitral annular plane systolic excursion	2.09 (1.60–2.73)	<0.0001		
Left ventricular end-diastolic diameter	1.14 (0.88–1.49)	0.312		
Left ventricular end-systolic diameter	1.36 (1.13–1.65)	0.001		
Left ventricular end-diastolic diameter/body surface area	1.26 (1.00–1.58)	0.048		
Left ventricular end-diastolic volume	1.22 (1.02–1.47)	0.033		
Left ventricular end-systolic volume	1.33 (1.15–1.54)	<0.0001		
Left atrium	1.37 (1.14–1.65)	0.001		
Mitral regurgitation	1.96 (1.59–2.41)	<0.0001		
Left ventricular mass index	1.40 (1.19–1.66)	<0.0001		
Diastolic dysfunction	2.03 (1.65–2.50)	<0.0001		
Tricuspid annular plane systolic excursion	2.54 (2.01–3.22)	<0.0001	1.66 (1.13–2.45)	0.010
Right ventricular end-diastolic diameter	1.37 (0.96–1.95)	0.085		
Pulmonary artery systolic pressure	1.60 (1.30–1.96)	<0.0001		
Ultrasound lung comets	1.97 (1.66–2.33)	<0.0001	1.69 (1.25–2.27)	0.001





Bedetti G et al. Comparison of Prognostic Value of Echocardiacgraphic Risk Score With the Thrombolysis In Myocardial Infarction (TIMI) and Global Registry In Acute Coronary Events (GRACE) Risk Scores in Acute Coronary Syndrome. Am J Cardiol 2010;106:1709 –1716

Dg.: 1. STEMI
TTE: před PCI a 3. den
Parametry: GLS STE
EP: mortalita a HF
FU: 6m

Prognostic Value of Serial Global Longitudinal Strain Measured by Two-Dimensional Speckle Tracking Echocardiography in Patients With ST-Segment Elevation Myocardial Infarction

Jong Shin Woo, MD, Woo-Shik Kim, MD, PhD*, Tae-Kyung Yu, MD, Sang Jin Ha, MD, Seok Yeon Kim, MD, Jong-Hoa Bae, MD, PhD, and Kwon Sam Kim, MD, PhD

Relativní změna GLS

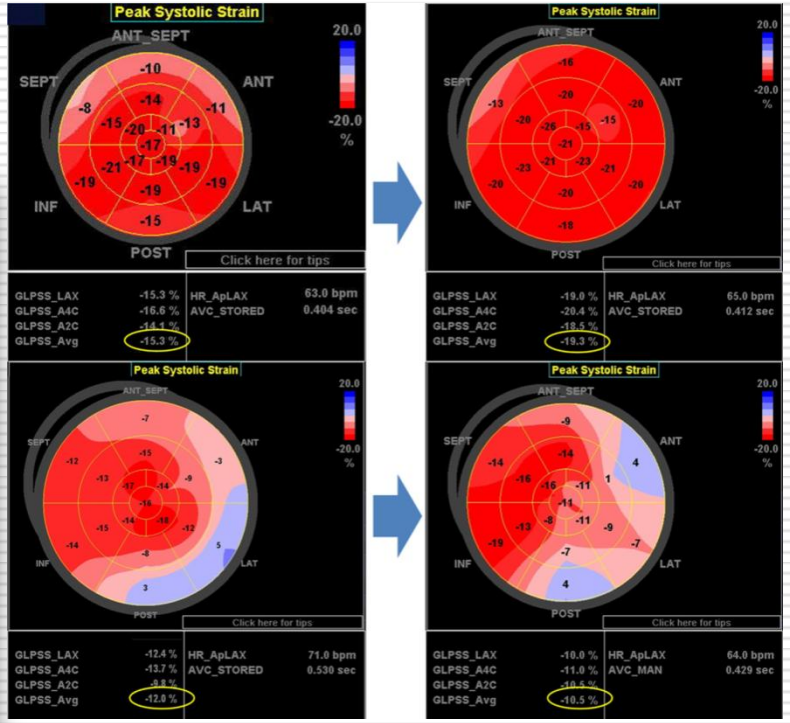
↑ GLS > 10%

GLS -10 -10%

↓ GLS < 10%

Demographic characteristics

Variables	Group (n = 29)	Group 2 (n = 55)	Group 3 (n = 14)	p Value
Age (years)	63.4 ± 11.9	65.3 ± 11.6	62.6 ± 13.1	0.47
Men	17 (59%)	38 (69%)	10 (71%)	0.33
Systolic blood pressure (mm Hg)	140.3 ± 27.8	129.3 ± 28.0	111.1 ± 25.6	<0.05
Diastolic blood pressure (mm Hg)	81.0 ± 14.2	76.9 ± 14.9	67.9 ± 13.6	<0.05
Heart rate (beats/min)	80.5 ± 14.7	79.6 ± 19.6	82.4 ± 23.7	0.65
Killip class >II	5 (17%)	14 (25%)	5 (36%)	0.18
Symptom-to-balloon time (minutes)	229.5 ± 76.2	231.2 ± 66.6	252.3 ± 164.6	0.56
Door-to-balloon time (minutes)	66.8 ± 14.8	68.4 ± 13.9	67.8 ± 15.2	0.77
Previous ischemic heart disease	2 (7%)	2 (4%)	1 (7%)	0.87
Hypertension	17 (59%)	34 (62%)	7 (50%)	0.72
Diabetes mellitus	8 (27%)	15 (27%)	3 (21%)	0.72
Dyslipidemia	8 (27%)	9 (16%)	2 (14%)	0.22
Smoking	18 (62%)	26 (47%)	6 (43%)	0.40
Culprit lesion—left anterior descending coronary artery	19 (65%)	24 (44%)	11 (78%)	<0.05
Multivessel coronary disease	15 (52%)	27 (49%)	12 (86%)	0.15
Type B2/C lesion	23 (79%)	36 (65%)	13 (93%)	0.72
Initial creatine kinase-MB (ng/ml)	32.5 ± 66.3	45.4 ± 83.4	53.4 ± 90.1	0.50
Peak creatine kinase-MB (ng/ml)	116.4 ± 114.7	122.5 ± 178.6	150.8 ± 118.6	0.23
Initial troponin I (ng/ml)	4.8 ± 14.5	8.7 ± 22.1	10.8 ± 26.3	0.47
Initial high-sensitivity C-reactive protein (mg/L)	2.9 ± 5.8	3.6 ± 3.7	3.5 ± 3.5	0.07
Initial N-terminal pro–B-type natriuretic peptide (pg/ml)	321.8 ± 282.6	609.1 ± 827.9	769.9 ± 727.8	0.07
Medications during admission				
Aspirin	29 (100%)	55 (100%)	14 (100%)	1
Clopidogrel	29 (100%)	55 (100%)	14 (100%)	1
Cilostazol	6 (21%)	11 (20%)	5 (36%)	0.37
β Blocker	19 (65%)	36 (65%)	7 (50%)	0.42
Angiotensin-converting enzyme inhibitor or angiotensin II receptor blocker	21 (72%)	45 (82%)	11 (78%)	0.49
Statins	25 (86%)	44 (80%)	11 (78%)	0.48



Před PCI

3. den

Woo JS et al. Prognostic Value of Serial Global Longitudinal Strain Measured by Two-Dimensional Speckle Tracking Echocardiography in Patients With ST-Segment Elevation Myocardial Infarction. Am J Cardiol 2011;xx:xxx – in press

I. INTERNÍ KLINIKA KARDIOLOGIE
FAKULTNÍ NEMOCNICE OLOMOUC

Chlopenní vady

Kvantifikace závažnosti a indikace intervence

ESC European Society of Cardiology

European Heart Journal (2017) **00**, 1–53
doi:10.1093/eurheartj/ehx391

ESC/EACTS GUIDELINES

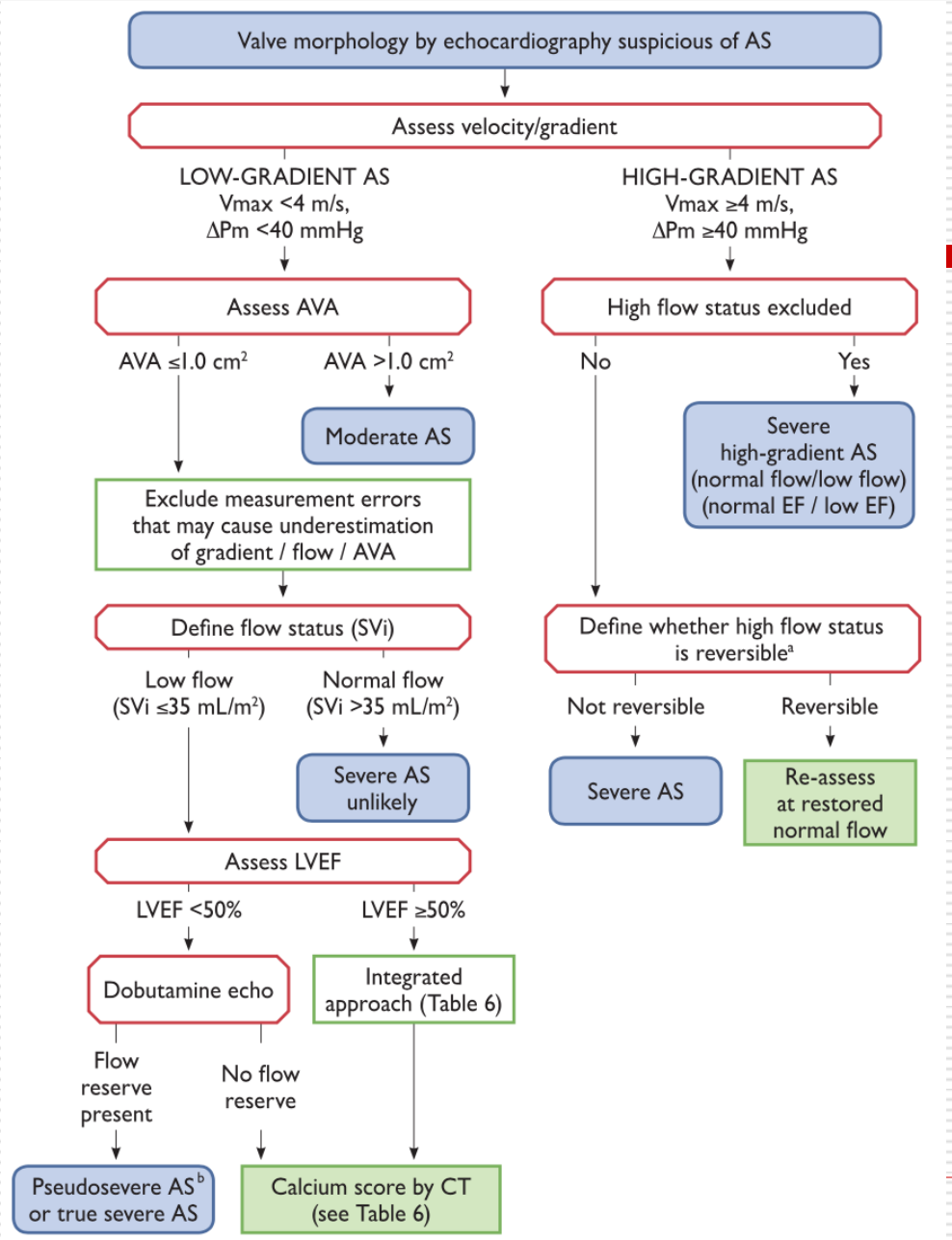
2017 ESC/EACTS Guidelines for the management of valvular heart disease

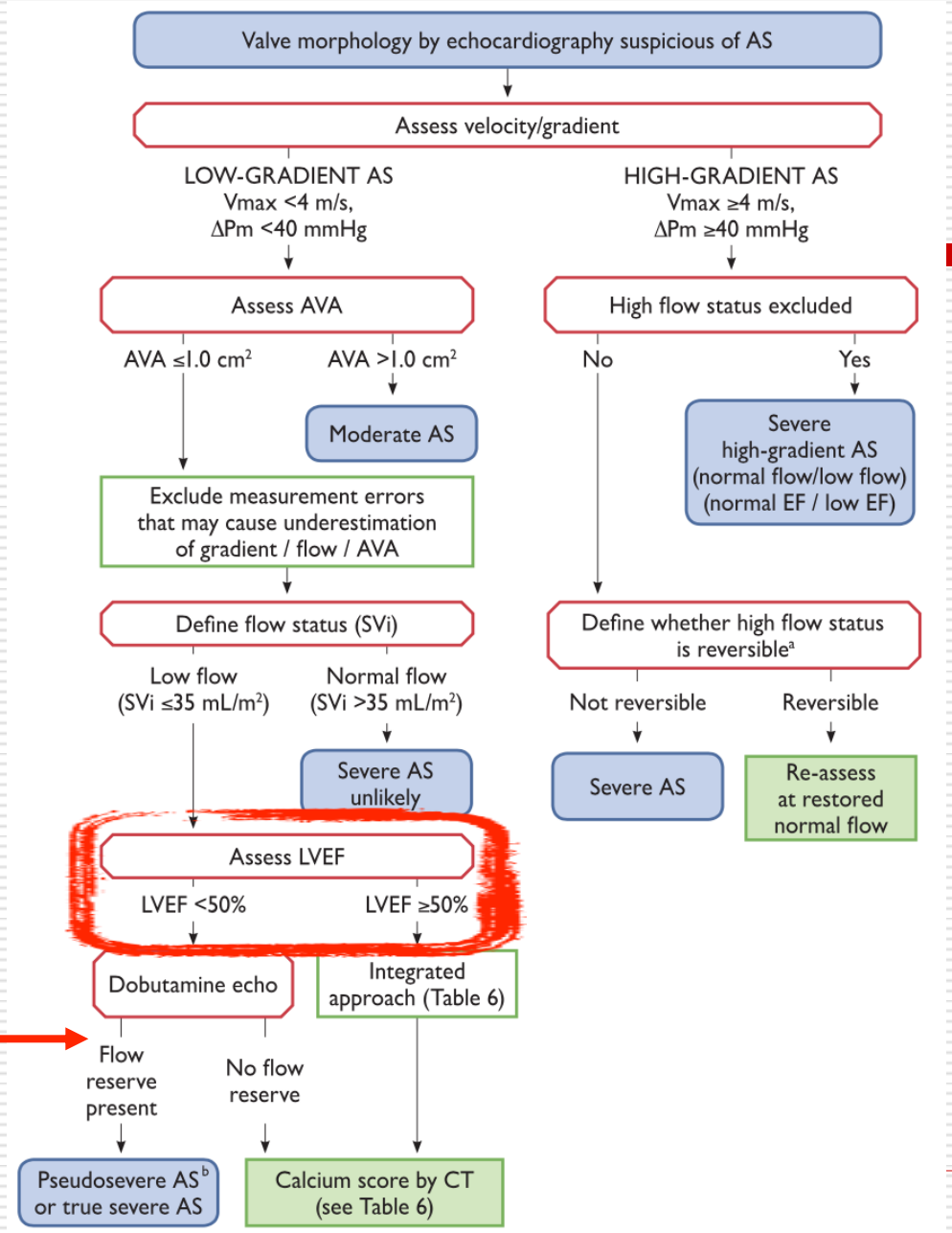
The Task Force for the Management of Valvular Heart Disease of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

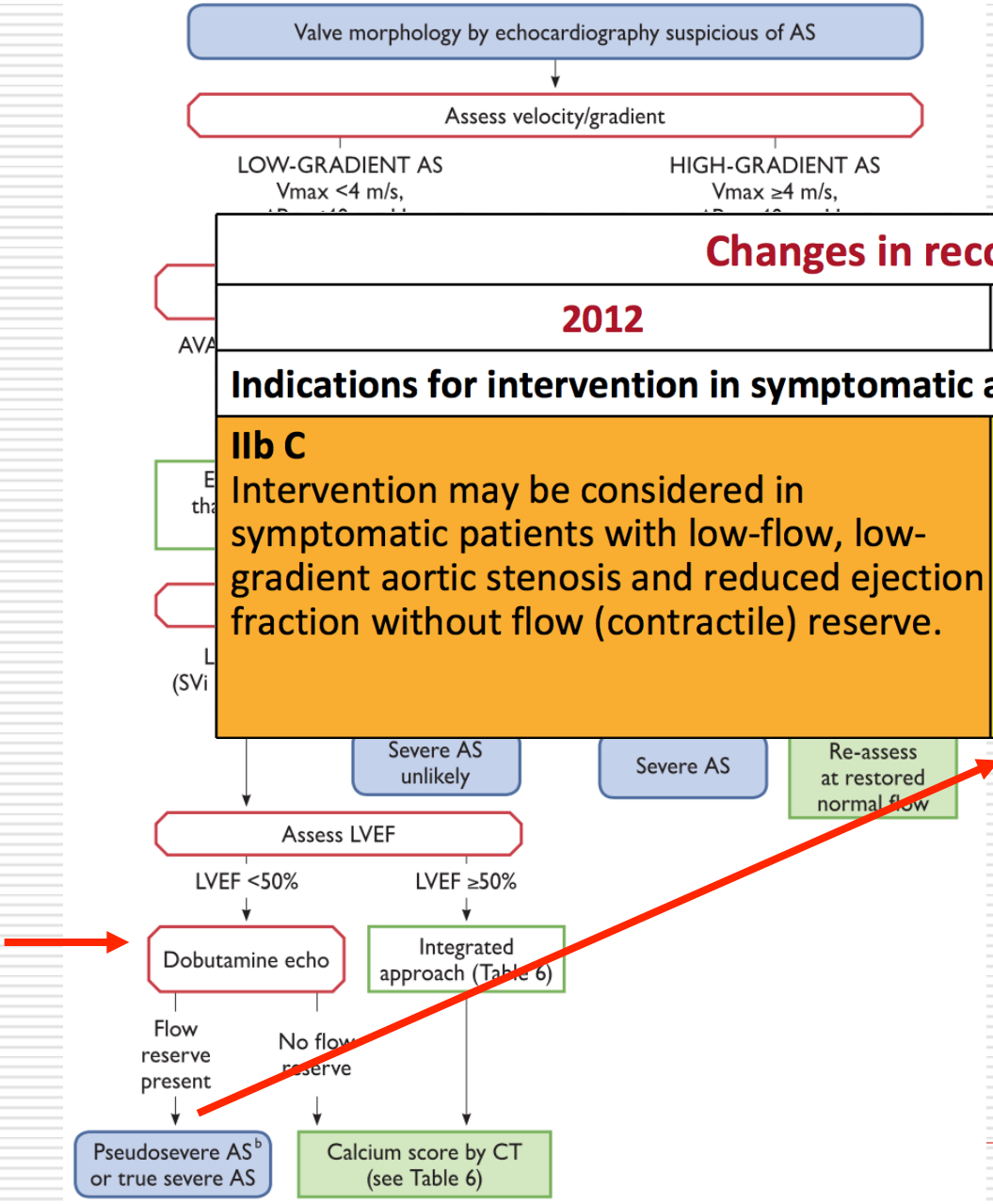
Authors/Task Force Members: Helmut Baumgartner* (ESC Chairperson) (Germany), Volkmar Falk*[1] (EACTS Chairperson) (Germany), Jeroen J. Bax (The Netherlands), Michele De Bonis[1] (Italy), Christian Hamm (Germany), Per Johan Holm (Sweden), Bernard Iung (France), Patrizio Lancellotti (Belgium), Emmanuel Lansac[1] (France), Daniel Rodriguez Muñoz (Spain), Raphael Rosenhek (Austria), Johan Sjögren[1] (Sweden), Pilar Tornos Mas (Spain), Alec Vahanian (France), Thomas Walther[1] (Germany), Olaf Wendler[1] (UK), Stephan Windecker (Switzerland), Jose Luis Zamorano (Spain)

Aortální stenóza

Kvantifikace vady

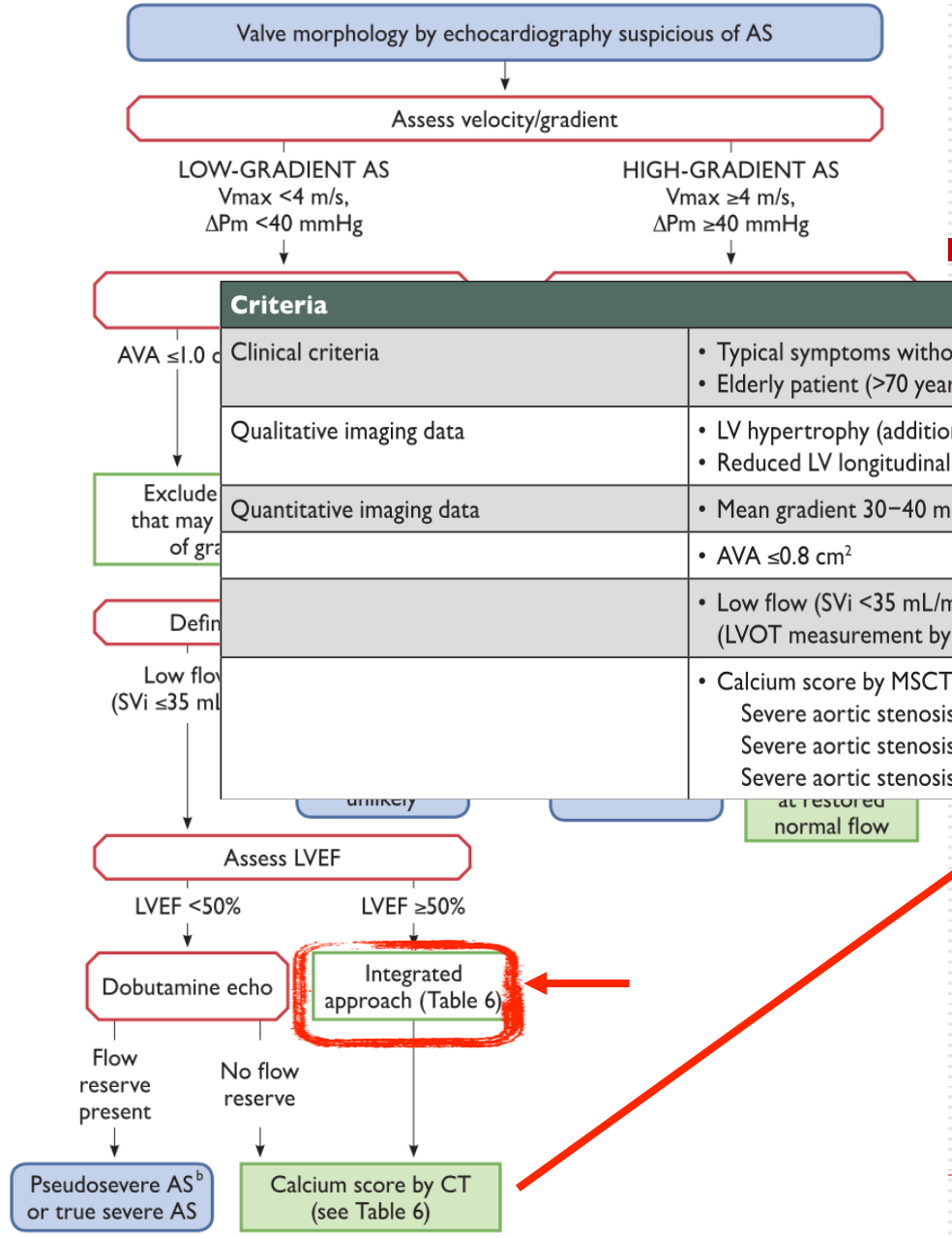



Valve morphology by echocardiography suspicious of AS
Assess velocity/gradient
LOW-GRADIENT AS
Vmax <4 m/s,
ΔPm <40 mmHg
HIGH-GRADIENT AS
Vmax ≥4 m/s,
ΔPm ≥40 mmHg
Assess AVA
High flow status excluded
AVA ≤1.0 cm²
AVA >1.0 cm²
No
Yes
Moderate AS
Severe high-gradient AS (normal flow/low flow) (normal EF / low EF)
Exclude measurement errors that may cause underestimation of gradient / flow / AVA
Define flow status (SVi)
Define whether high flow status is reversible[a]
Low flow (SVi ≤35 mL/m²)
Normal flow (SVi >35 mL/m²)
Not reversible
Reversible
Severe AS unlikely
Severe AS
Re-assess at restored normal flow
Assess LVEF
LVEF <50%
LVEF ≥50%
Dobutamine echo
Integrated approach (Table 6)
Flow reserve present
No flow reserve
Pseudosevere AS[b] or true severe AS
Calcium score by CT (see Table 6)



Changes in recommendations

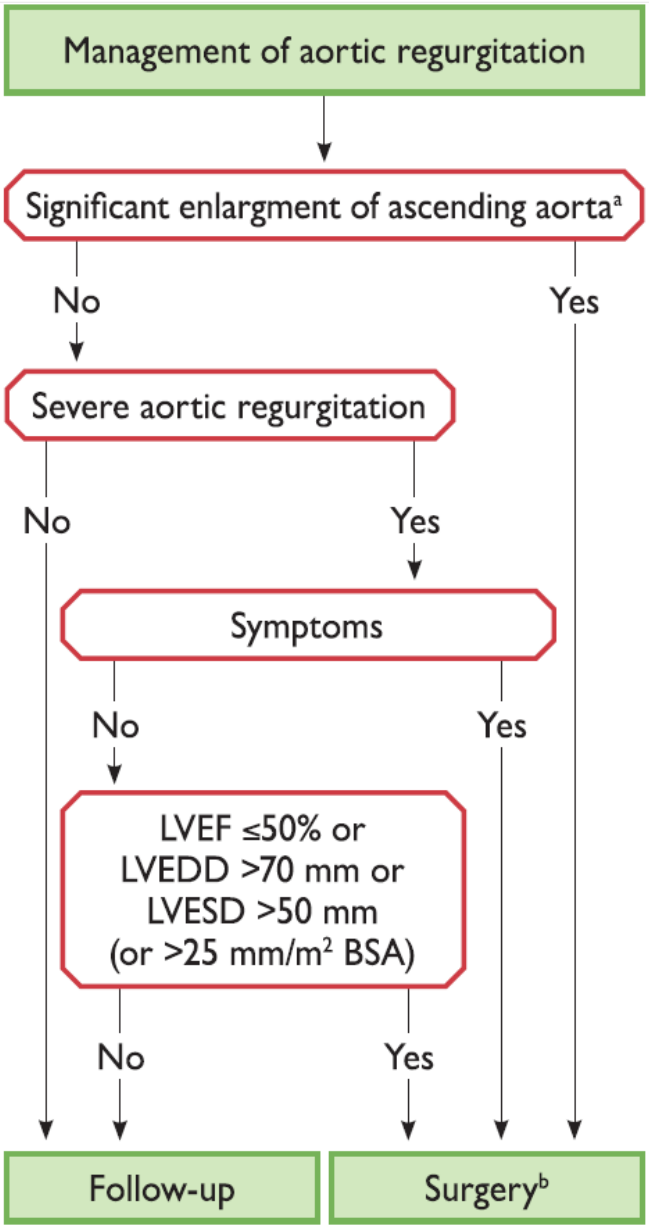
2012	2017
Indications for intervention in symptomatic aortic stenosis	
IIb C Intervention may be considered in symptomatic patients with low-flow, low-gradient aortic stenosis and reduced ejection fraction without flow (contractile) reserve.	**IIa C** Intervention should be considered in symptomatic patients with low-flow, low-gradient aortic stenosis and reduced ejection fraction without flow (contractile) reserve, particularly when CT calcium scoring confirms severe aortic stenosis.



Criteria	
Clinical criteria	• Typical symptoms without other explanation • Elderly patient (>70 years)
Qualitative imaging data	• LV hypertrophy (additional history of hypertension to be considered) • Reduced LV longitudinal function without other explanation
Quantitative imaging data	• Mean gradient 30–40 mmHg[a]
	• AVA ≤0.8 cm^2
	• Low flow (SVi <35 mL/m^2) confirmed by techniques other than standard Doppler technique (LVOT measurement by 3D TOE or MSCT; CMR, invasive data)
	• Calcium score by MSCT[b] Severe aortic stenosis very likely: men ≥3000; women ≥1600 Severe aortic stenosis likely: men ≥2000; women ≥1200 Severe aortic stenosis unlikely: men <1600; women <800

Aortální regurgitace
Indikace intervence

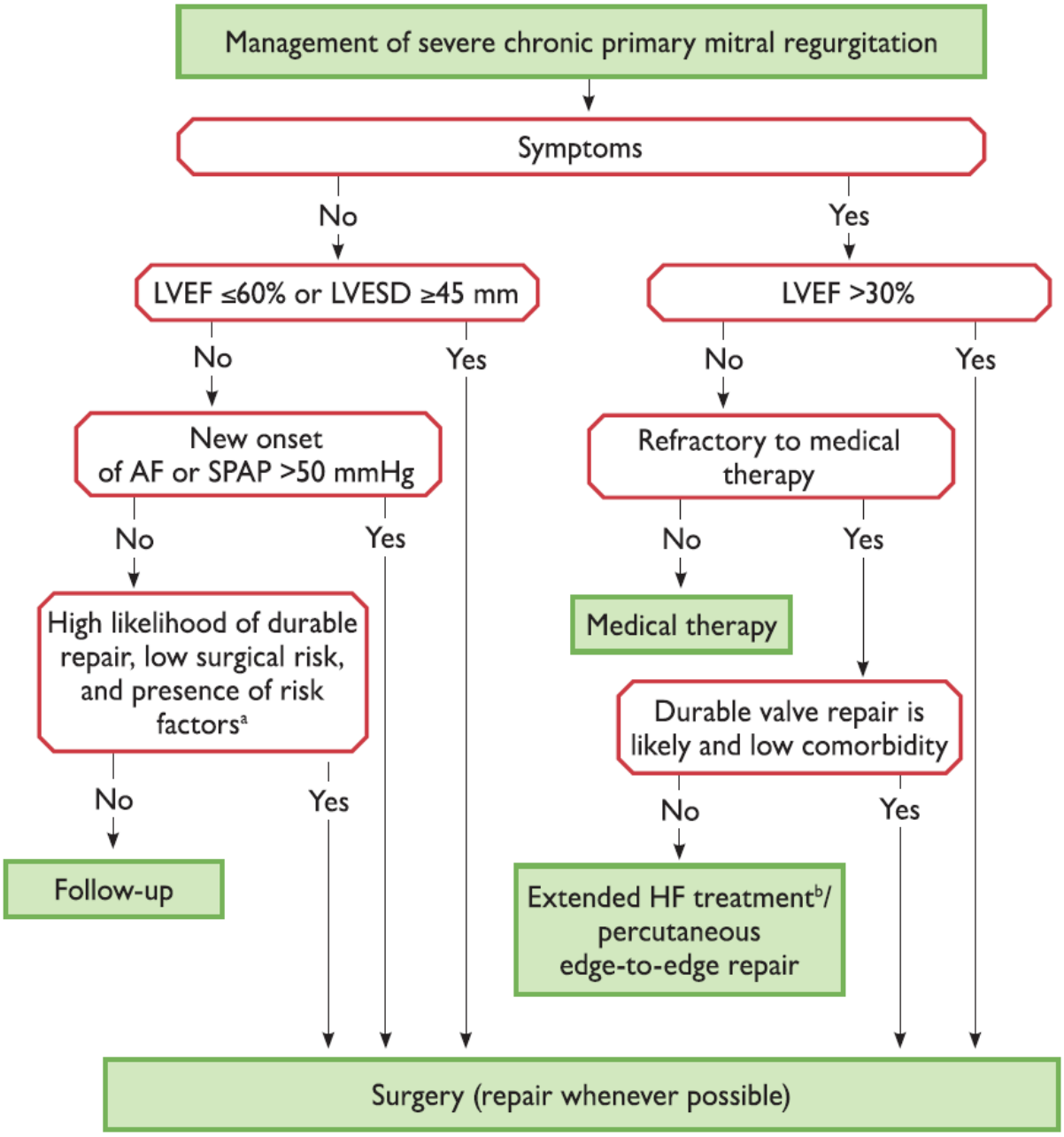
Indications for surgery	Class[a]	Level[b]
A. Severe aortic regurgitation		
Surgery is indicated in symptomatic patients.[57,58,66,67]	I	B
Surgery is indicated in asymptomatic patients with resting LVEF ≤50%.[57,58]	I	B
Surgery is indicated in patients undergoing CABG or surgery of the ascending aorta or of another valve.	I	C
Heart Team discussion is recommended in selected patients[c] in whom aortic valve repair may be a feasible alternative to valve replacement.	I	C
Surgery should be considered in asymptomatic patients with resting ejection fraction >50% with severe LV dilatation: LVEDD >70 mm or LVESD >50 mm (or LVESD >25 mm/m^2 BSA in patients with small body size).[58,66]	IIa	B



Mitrální regurgitace - primární

Indikace intervence

Changes in recommendations	
2012	**2017**
Indications for intervention in asymptomatic severe primary mitral regurgitation	
IIb C Surgery may be considered in asymptomatic patients with preserved LV function, high likelihood of durable repair, low surgical risk, and: • Left atrial dilatation (volume index ≥60 mL/m² BSA) and sinus rhythm.	**IIa C (modified!)** Surgery should be considered in asymptomatic patients with preserved LVEF (>60%) and LVESD 40–44 mm when a durable repair is likely, surgical risk is low, the repair is performed in heart valve centres, and the following finding is present: presence of significant LA dilatation (volume index ≥60 mL/m² BSA) in sinus rhythm.
Pulmonary hypertension on exercise (SPAP ≥60 mmHg at exercise).	Taken out


Management of severe chronic primary mitral regurgitation
Symptoms
No
Yes
LVEF ≤60% or LVESD ≥45 mm
LVEF >30%
No
Yes
No
Yes
New onset of AF or SPAP >50 mmHg
Refractory to medical therapy
No
Yes
No
Yes
High likelihood of durable repair, low surgical risk, and presence of risk factors[a]
Medical therapy
Durable valve repair is likely and low comorbidity
No
Yes
No
Yes
Follow-up
Extended HF treatment[b]/ percutaneous edge-to-edge repair
Surgery (repair whenever possible)

Mitrální regurgitace - sekundární

Indikace intervence

Changes in recommendations	
2012	**2017**
Indications for mitral valve intervention in secondary mitral regurgitation	
IIa C Surgery should be considered in patients with moderate secondary mitral regurgitation undergoing CABG	Taken out
IIb C When revascularization is not indicated, surgery may be considered in patients with severe secondary mitral regurgitation and LVEF >30%,who remain symptomatic despite optimal medical management (including CRT if indicated).	**IIb C (modified)** When revascularization is not indicated, surgery may be considered in patients with severe secondary mitral regurgitation and LVEF >30%, who remain symptomatic despite optimal medical management (including CRT if indicated) and have a low surgical risk.

Mitrální regurgitace - sekundární
Indikace intervence

Changes in recommendations	
2012	**2017**
Indications for mitral valve intervention in secondary mitral regurgitation *(continued)*	
	IIb C (modified) *(continued)* When revascularization is not indicated and surgical risk is not low, a percutaneous edge-to-edge procedure may be considered in patients with severe secondary mitral regurgitation and LVEF >30%, who remain symptomatic despite optimal medical management (including CRT if indicated) and who have a suitable valve morphology by echocardiography, avoiding futility.

Mitrální regurgitace - sekundární

Indikace intervence

Changes in recommendations	
2012	**2017**
Indications for mitral valve intervention in secondary mitral regurgitation *(continued)*	
	IIb C (modified*) (continued)* In patients with severe secondary mitral regurgitation and LVEF <30% who remain symptomatic despite optimal medical management (including CRT if indicated) and who have no option for revascularization, the Heart Team may consider percutaneous edge-to-edge procedure or valve surgery after careful evaluation for ventricular assist device or heart transplant according to individual patient characteristics.

Viabilita myokardu

Indikace revaskularizace myokardu

European Heart Journal (2014) **35**, 2541–2619
doi:10.1093/eurheartj/ehu278

ESC/EACTS GUIDELINES

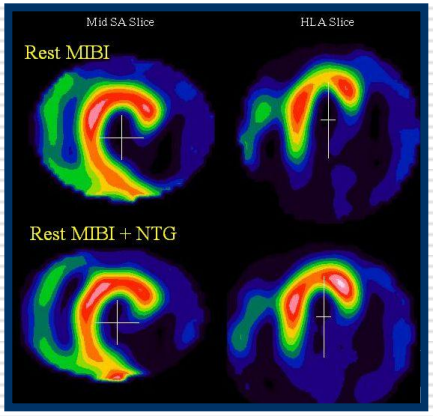
2014 ESC/EACTS Guidelines on myocardial revascularization

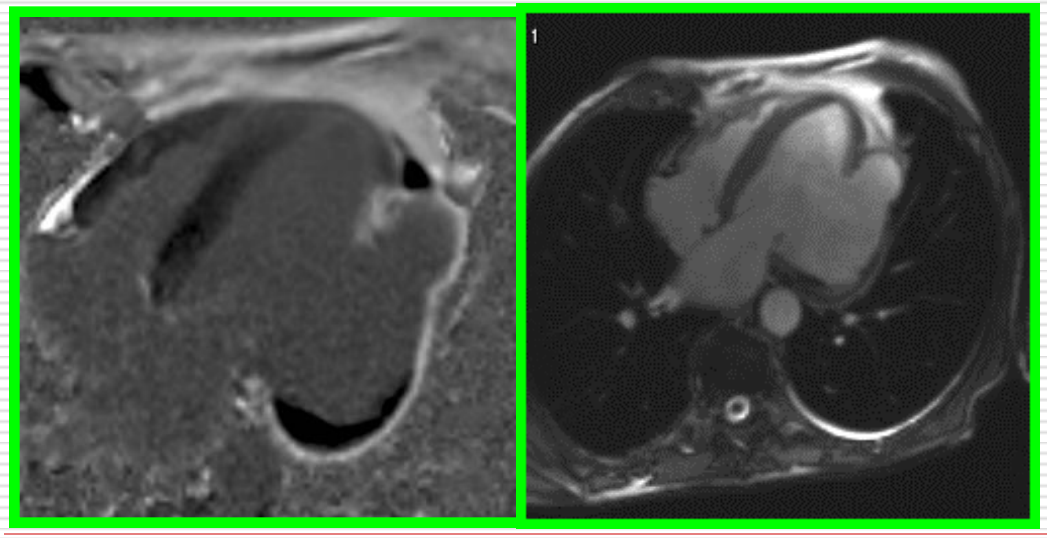
The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

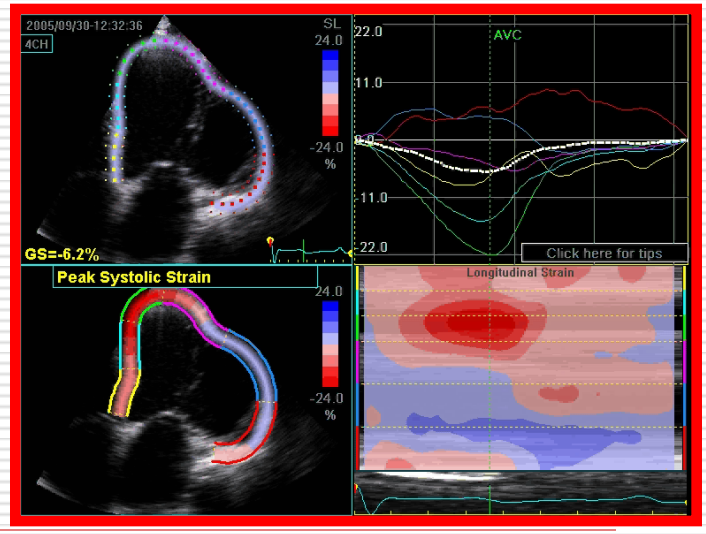
Developed with the special contribution of the European Association of Percutaneous Cardiovascular Interventions (EAPCI)

Zobrazovací metody na viabilitu myokardu LK

- **Echokardiografie**
- **SPECT/PET**
- **CeCMR** je referenční metodou v zobrazení lokalizace, distribuce a rozsahu jizvy a má vysokou přesnost v predikci (ne)viabilního myokardu.



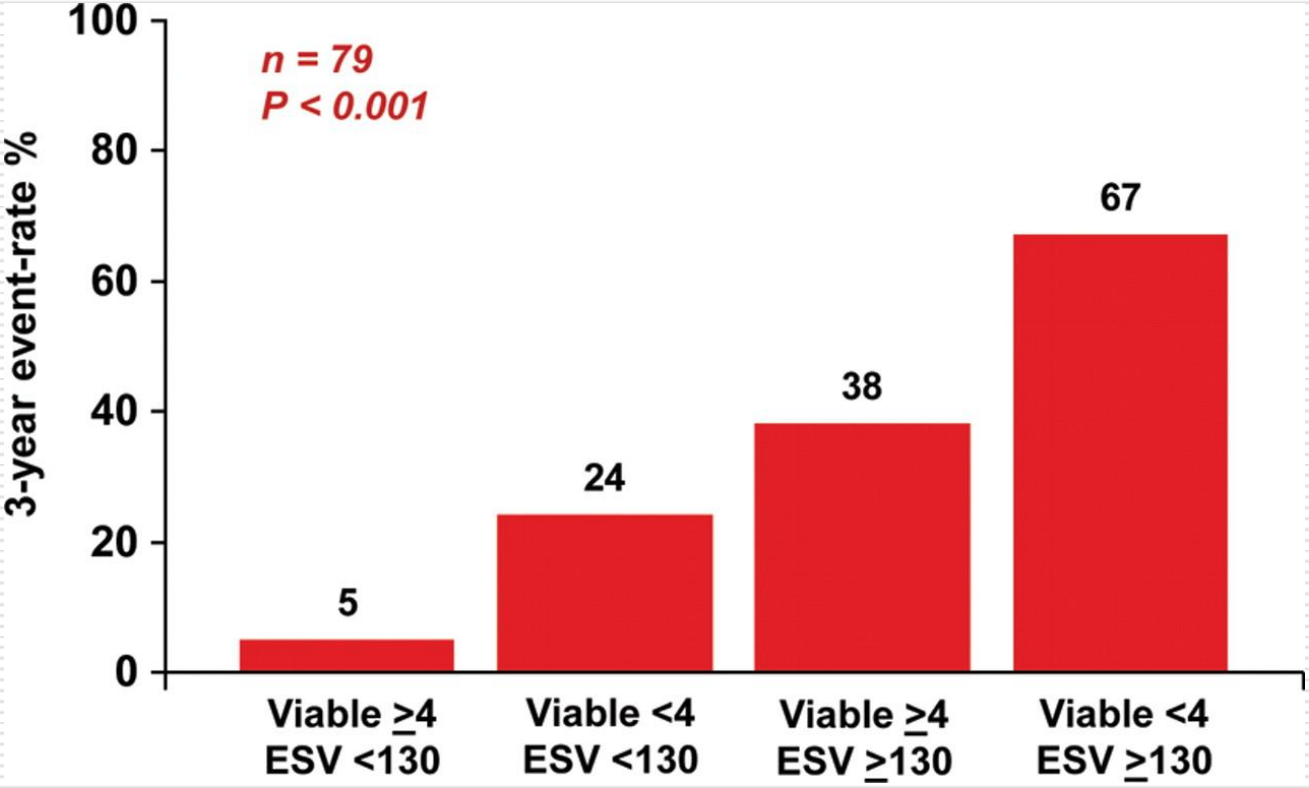




1. Kim RJ, et al. Relationship of MRI delayed contrast enhancement to irreversible injury, infarct age, and contractile function. Circulation 1999;100:1992–2002.
2. Kim RJ, et al. The use of contrast-enhanced magnetic resonance imaging to identify reversible myocardial dysfunction. N Engl J Med 2000;343:1445–53.
3. Becker M, et al. Myocardial Deformation Imaging Based on Ultrasonic Pixel Tracking to Identify Reversible Myocardial Dysfunction. J Am Coll Cardiol 2008;51;1473-1481
4. Becker M. et al. Eur Heart J. 2006 Nov;27(21):2560-6. Epub 2006 Oct 11.

Prognostický význam rozsahu viabilního myokardu a ESV LK

Cardiac events (cardiac death, myocardial infarction, and hospitalization for heart failure) at 3-year follow-up for four different patient categories with ischemic LV dysfunction according to the presence of substantial viable myocardium (>4 segments) at dobutamine stress echo and the left ventricular end-systolic volume.



Cortigiani L et al. Eur J Echocardiogr 2011;ejechocard.jer237
Bax JJ, Schinkel AF, Boersma E et al. Extensive left ventricular remodeling does not allow viable myocardium to improve in left ventricular ejection fraction after revascularization and is associated with worse long-term prognosis. Circulation 2004;110(11 Suppl 1):II18–22.

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PII S0735-1097(02)01726-6

Coronary Revascularization

Myocardial Viability Testing and Impact of Revascularization on Prognosis in Patients With Coronary Artery Disease and Left Ventricular Dysfunction: A Meta-Analysis

Kevin C. Allman, MB, BS, FRACP, FACC,* Leslee J. Shaw, PHD,† Rory Hachamovitch, MD, FACC,† James E. Udelson, MD, FACC‡

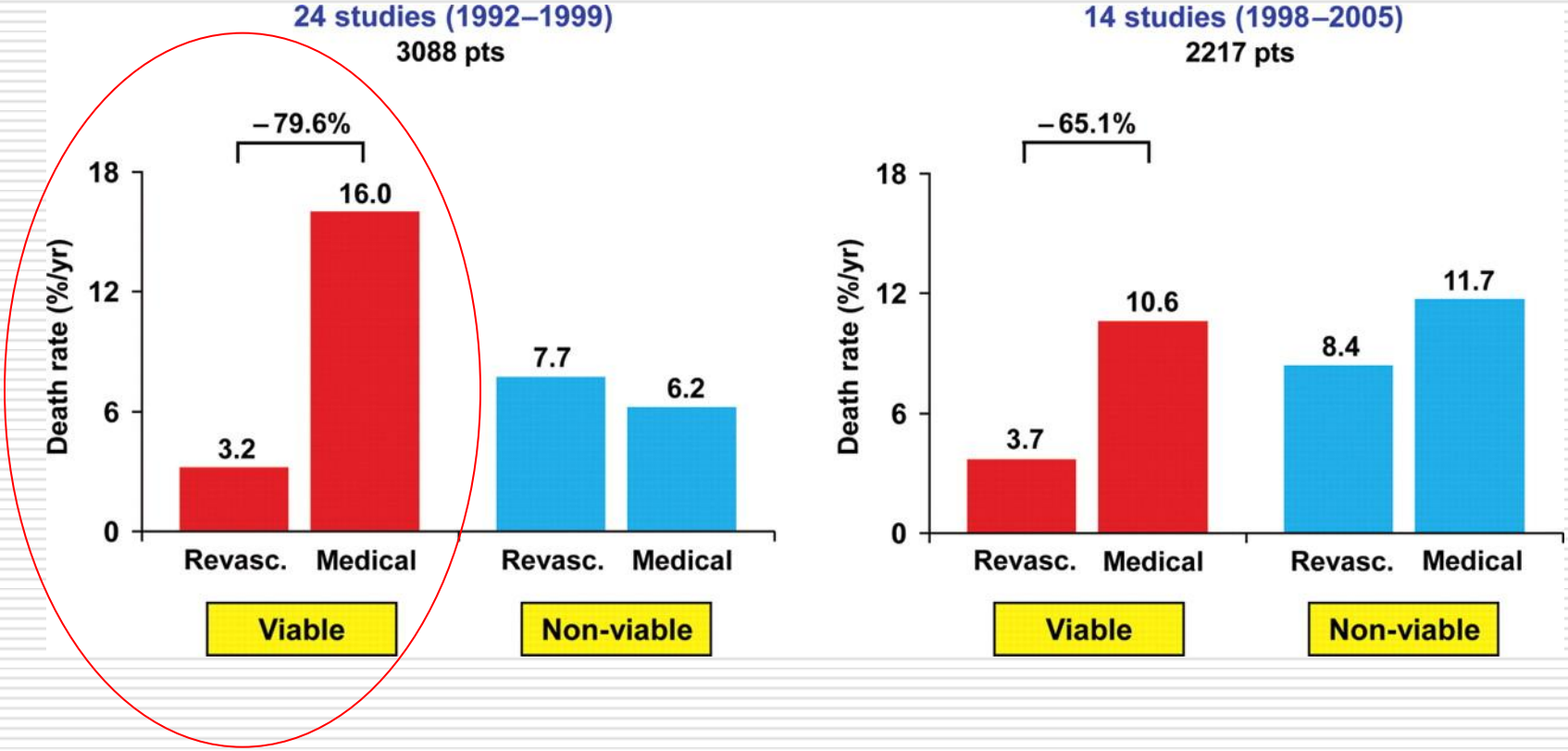
European Journal of Echocardiography
doi:10.1093/ehechocard/jer237

Is viability still viable after the STICH trial?

Lauro Cortigiani[1], Riccardo Bigi[2], and Rosa Sicari[3]*

[1]Cardiovascular Unit, Campo di Marte Hospital, Lucca, Italy; [2]Department of Cardiovascular Sciences, University School of Medicine, Milan, Italy; and [3]Institute of Clinical Physiology, CNR, Via G. Moruzzi 1, 56124 Pisa, Italy

Received 26 August 2011; accepted after revision 17 October 2011

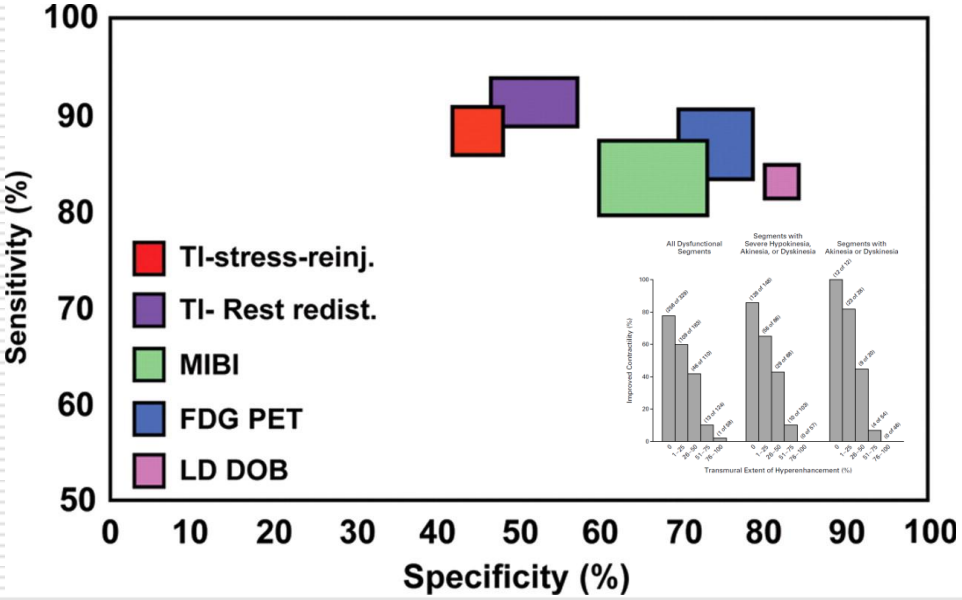


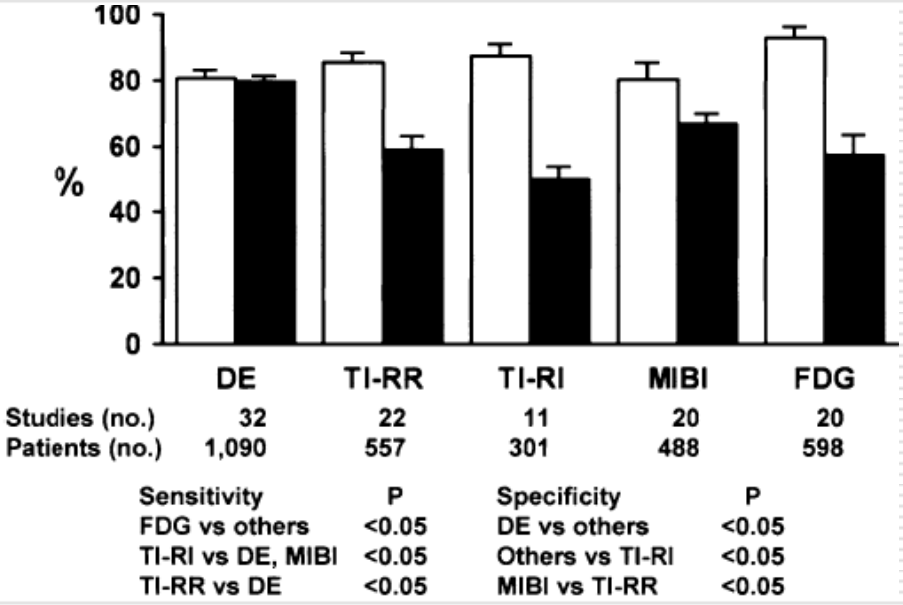
Results of two meta-analysis on 3088 and 2217 patients with ischaemic cardiomyopathy, assessing the effect of revascularization and medical therapy according to the presence of viability at dobutamine echo or nuclear techniques

Allman KC. et al. Myocardial Viability Testing and Impact of Revascularization on Prognosis in Patients With Coronary Artery Disease and Left Ventricular Dysfunction: A Meta-Analysis. J Am Coll Cardiol 2002;39:1151-8
Cortigiani L, Bigi R, Sicari R. Is viability still viable after the STICH trial? Eur J Echocardiogr 2011;ejechocard.jer237

Diagnostická přesnost zobrazovacích metod

Sensitivity/specificity of **CMR, nuclear techniques, DSE** in predicting functional recovery after revascularization in patients with ischemic LV dysfunction.





Cortigiani L et al. Eur J Echocardiogr 2011;ejechocard.jer237
Bax JJ, Cornel JH, Visser FC, Fioretti PM, van Lingen A, Reijs AE et al. Prediction of recovery of myocardial dysfunction after revascularization. Comparison of fluorine-18 fluorodeoxyglucose/thallium-201 SPECT, thallium-201 stress-reinjection SPECT and dobutamine echocardiography. J Am Coll Cardiol 1996;28:558–64.
Chareonthaitawee P. Revascularization in Severe Left Ventricular Dysfunction: The Role of Viability Testing. JACC, 2005;46;567-574
Kim RJ, Wu E, Rafael A, Chen EL, Parker MA, Simonetti O et al. The use of contrast-enhanced magnetic resonance imaging to identify reversible myocardial dysfunction. NEJM 2000;343:1445–53.

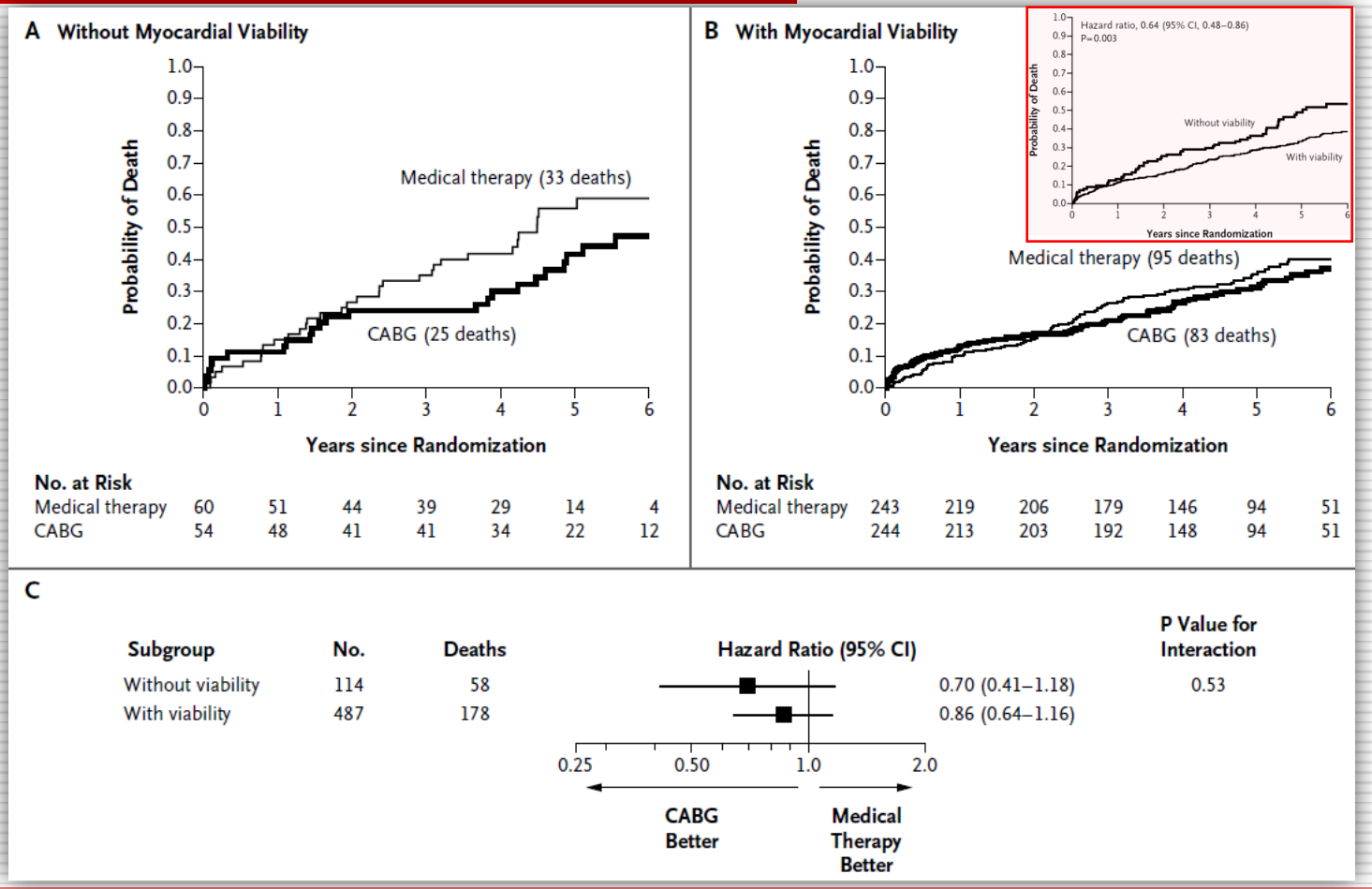
The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Dg.: ICHS, EF LK 32±8%
Parametry: viabilita myokardu (SPECT, DSE)
EP: mortalita
FU: 5,1r

Myocardial Viability and Survival in Ischemic Left Ventricular Dysfunction

Robert O. Bonow, M.D., Gerald Maurer, M.D., Kerry L. Lee, Ph.D.



Bonow RO et al. Myocardial Viability and Survival in Ischemic Left Ventricular Dysfunction. N Engl J Med 2011;364:1617-25.

Extent of CAD (anatomical and/or functional)		Class[b]	Level[c]
For prognosis	Left main disease with stenosis >50%[a]	I	A
	Any proximal LAD stenosis >50%[a]	I	A
	Two-vessel or three-vessel disease with stenosis > 50%[a] with impaired LV function (LVEF<40%)[a]	I	A
	Large area of ischaemia (>10% LV)	I	B
	Single remaining patent coronary artery with stenosis >50%[a]	I	C
For symptoms	Any coronary stenosis >50%[a] in the presence of limiting angina or angina equivalent, unresponsive to medical therapy	I	A

European Heart Journal (2014) 35, 2541–2619
doi:10.1093/eurheartj/ehu278

ESC/EACTS GUIDELINES

2014 ESC/EACTS Guidelines on myocardial revascularization

The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS)

Recommendations	Class[a]	Level[b]
CABG is recommended for patients with significant LM stenosis and LM equivalent with proximal stenosis of both LAD and LCx arteries.	I	C
CABG is recommended for patients with significant LAD artery stenosis and multivessel disease to reduce death and hospitalization for cardiovascular causes.	I	B
LV aneurysmectomy during CABG should be considered in patients with a large LV aneurysm, if there is a risk of rupture, large thrombus formation or the aneurysm is the origin of arrhythmias.	IIa	C
Myocardial revascularization should be considered in the presence of viable myocardium.	IIa	B
CABG with surgical ventricular restoration may be considered in patients with scarred LAD territory, especially if a post-operative LVESV index <70 mL/m² can be predictably achieved.	IIb	B
PCI may be considered if anatomy is suitable, in the presence of viable myocardium, and surgery is not indicated.	IIb	C

5.3 Detection of myocardial viability

Non-invasive assessment of myocardial viability has been used to guide the management of patients with chronic ischaemic systolic LV dysfunction. Multiple imaging techniques, including PET, SPECT, and dobutamine stress echocardiography, have been evaluated for assessment of viability and prediction of clinical outcome after myocardial revascularization.[55] In general, nuclear imaging techniques have a high sensitivity, whereas techniques evaluating contractile reserve have a somewhat lower sensitivity but higher specificity. MRI has a high diagnostic accuracy for assessing the transmural extent of myocardial scar tissue and can also assess contractile reserve, but its ability to detect viability and predict recovery of wall motion is no better than other imaging techniques. The differences in performance between the various imaging techniques are small, and experience and availability commonly determine which technique is used. The evidence is mostly based on observational studies or meta-analyses. One RCT, relating to PET imaging, showed that patients with a substantial amount of dysfunctional but viable myocardium are likely to benefit from myocardial revascularization.[56]

Srdeční selhání

Diagnóza, prognóza a terapie

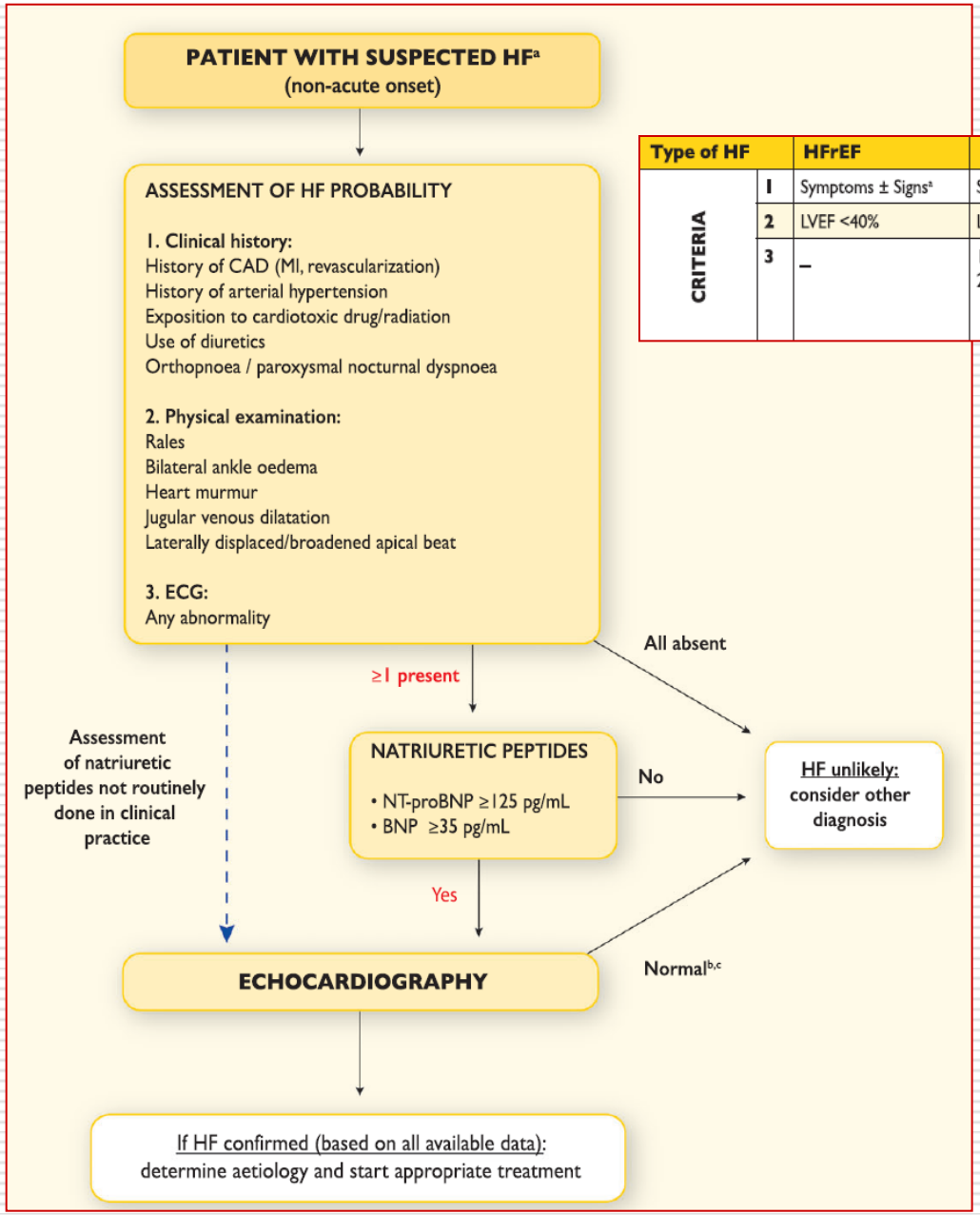
European Heart Journal (2016) **37**, 2129–2200
doi:10.1093/eurheartj/ehw128

ESC GUIDELINES

2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

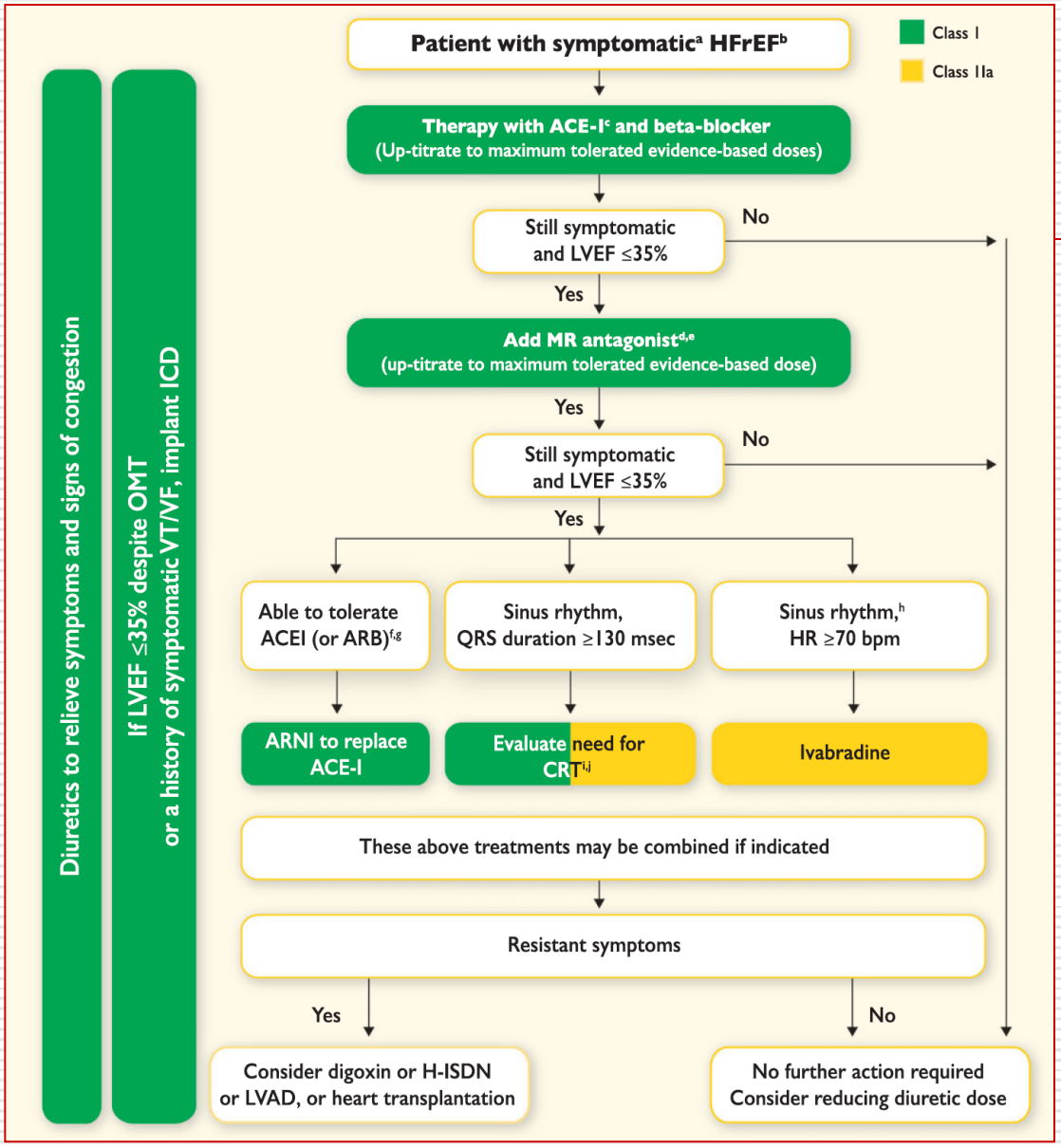
The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)

Developed with the special contribution of the Heart Failure Association (HFA) of the ESC



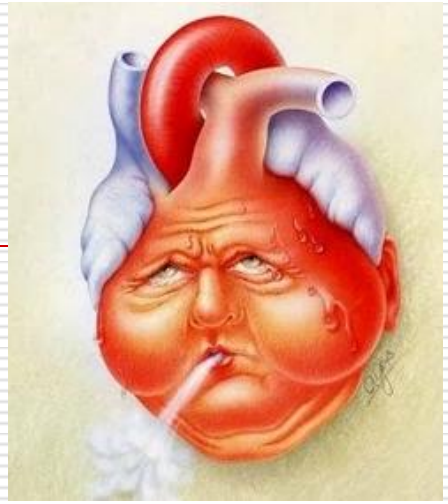
Type of HF		HFrEF	HFmrEF	HFpEF
CRITERIA	1	Symptoms ± Signs[a]	Symptoms ± Signs[a]	Symptoms ± Signs[a]
	2	LVEF <40%	LVEF 40–49%	LVEF ≥50%
	3	–	1. Elevated levels of natriuretic peptides[b]; 2. At least one additional criterion: a. relevant structural heart disease (LVH and/or LAE), b. diastolic dysfunction (for details see Section 4.3.2).	1. Elevated levels of natriuretic peptides[b]; 2. At least one additional criterion: a. relevant structural heart disease (LVH and/or LAE), b. diastolic dysfunction (for details see Section 4.3.2).

Recommendations	Class[a]	Level[b]
TTE is recommended for the assessment of myocardial structure and function in subjects with suspected HF in order to establish a diagnosis of either HFrEF, HFmrEF or HFpEF.	I	C
TTE is recommended to assess LVEF in order to identify patients with HF who would be suitable for evidence-based pharmacological and device (ICD, CRT) treatment recommended for HFrEF.	I	C
TTE is recommended for the assessment of valve disease, right ventricular function and pulmonary arterial pressure in patients with an already established diagnosis of either HFrEF, HFmrEF or HFpEF in order to identify those suitable for correction of valve disease.	I	C
TTE is recommended for the assessment of myocardial structure and function in subjects to be exposed to treatment which potentially can damage myocardium (e.g. chemotherapy).	I	C
Other techniques (including systolic tissue Doppler velocities and deformation indices, i.e. strain and strain rate), should be considered in a TTE protocol in subjects at risk of developing HF in order to identify myocardial dysfunction at the preclinical stage.	IIa	C
CMR is recommended for the assessment of myocardial structure and function (including right heart) in subjects with poor acoustic window and patients with complex congenital heart diseases (taking account of cautions/contra-indications to CMR).	I	C
CMR with LGE should be considered in patients with dilated cardiomyopathy in order to distinguish between ischaemic and non-ischaemic myocardial damage in case of equivocal clinical and other imaging data (taking account of cautions/contra-indications to CMR).	IIa	C
CMR is recommended for the characterization of myocardial tissue in case of suspected myocarditis, amyloidosis, sarcoidosis, Chagas disease, Fabry disease non-compaction cardiomyopathy, and haemochromatosis (taking account of cautions/contra-indications to CMR).	I	C
Non-invasive stress imaging (CMR, stress echocardiography, SPECT, PET) may be considered for the assessment of myocardial ischaemia and viability in patients with HF and CAD (considered suitable for coronary revascularization) before the decision on revascularization.	IIb	B
Invasive coronary angiography is recommended in patients with HF and angina pectoris recalcitrant to pharmacological therapy or symptomatic ventricular arrhythmias or aborted cardiac arrest (who are considered suitable for potential coronary revascularization) in order to establish the diagnosis of CAD and its severity.	I	C
Invasive coronary angiography should be considered in patients with HF and intermediate to high pre-test probability of CAD and the presence of ischaemia in non-invasive stress tests (who are considered suitable for potential coronary revascularization) in order to establish the diagnosis of CAD and its severity.	IIa	C
Cardiac CT may be considered in patients with HF and low to intermediate pre-test probability of CAD or those with equivocal non-invasive stress tests in order to rule out coronary artery stenosis.	IIb	C
Reassessment of myocardial structure and function is recommended using non-invasive imaging: - in patients presenting with worsening HF symptoms (including episodes of AHF) or experiencing any other important cardiovascular event; - in patients with HF who have received evidence-based pharmacotherapy in maximal tolerated doses, before the decision on device implantation (ICD, CRT); - in patients exposed to therapies which may damage the myocardium (e.g. chemotherapy) (serial assessments).	I	C


Class I
Class IIa
Patient with symptomatic[a] HFrEF[b]
Therapy with ACE-I[c] and beta-blocker
(Up-titrate to maximum tolerated evidence-based doses)
Still symptomatic and LVEF ≤35%
No
Yes
Add MR antagonist[d,e]
(up-titrate to maximum tolerated evidence-based dose)
Yes
Still symptomatic and LVEF ≤35%
No
Yes
Able to tolerate ACEI (or ARB)[f,g]
Sinus rhythm, QRS duration ≥130 msec
Sinus rhythm,[h] HR ≥70 bpm
ARNI to replace ACE-I
Evaluate need for CRT[i,j]
Ivabradine
These above treatments may be combined if indicated
Resistant symptoms
Yes
No
Consider digoxin or H-ISDN or LVAD, or heart transplantation
No further action required
Consider reducing diuretic dose
Diuretics to relieve symptoms and signs of congestion
If LVEF ≤35% despite OMT or a history of symptomatic VT/VF, implant ICD

Recommendations for implantable cardioverter-defibrillator in patients with heart failure

Recommendations	Class [a]	Level [b]
Secondary prevention An ICD is recommended to reduce the risk of sudden death and all-cause mortality in patients who have recovered from a ventricular arrhythmia causing haemodynamic instability, and who are expected to survive for >1 year with good functional status.	I	A
Primary prevention An ICD is recommended to reduce the risk of sudden death and all-cause mortality in patients with symptomatic HF (NYHA Class II–III), and an LVEF ≤35% despite ≥3 months of OMT, provided they are expected to survive substantially longer than one year with good functional status, and they have:		
• IHD (unless they have had an MI in the prior 40 days – see below).	I	A
• DCM.	I	B
ICD implantation is not recommended within 40 days of an MI as implantation at this time does not improve prognosis.	III	A
ICD therapy is not recommended in patients in NYHA Class IV with severe symptoms refractory to pharmacological therapy unless they are candidates for CRT, a ventricular assist device, or cardiac transplantation.	III	C
Patients should be carefully evaluated by an experienced cardiologist before generator replacement, because management goals and the patient's needs and clinical status may have changed.	IIa	B
A wearable ICD may be considered for patients with HF who are at risk of sudden cardiac death for a limited period or as a bridge to an implanted device.	IIb	C



Recommendations for cardiac resynchronization therapy implantation in patients with heart failure

Recommendations	Class [a]	Level [b]
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration ≥150 msec and LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	A
CRT should be considered for symptomatic patients with HF in sinus rhythm with a QRS duration ≥150 msec and non-LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIa	B
CRT is recommended for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	I	B
CRT may be considered for symptomatic patients with HF in sinus rhythm with a QRS duration of 130–149 msec and non-LBBB QRS morphology and with LVEF ≤35% despite OMT in order to improve symptoms and reduce morbidity and mortality.	IIb	B
CRT rather than RV pacing is recommended for patients with HFrEF regardless of NYHA class who have an indication for ventricular pacing and high degree AV block in order to reduce morbidity. This includes patients with AF (see Section 10.1).	I	A
CRT should be considered for patients with LVEF ≤35% in NYHA Class III–IV[d] despite OMT in order to improve symptoms and reduce morbidity and mortality, if they are in AF and have a QRS duration ≥130 msec provided a strategy to ensure bi-ventricular capture is in place or the patient is expected to return to sinus rhythm.	IIa	B
Patients with HFrEF who have received a conventional pacemaker or an ICD and subsequently develop worsening HF despite OMT and who have a high proportion of RV pacing may be considered for upgrade to CRT. This does not apply to patients with stable HF.	IIb	B
CRT is contra-indicated in patients with a QRS duration < 130 msec.	III	A

Infarkt myokardu s elevacemi ST

Diagnóza, prognóza a terapie

ESC European Society of Cardiology

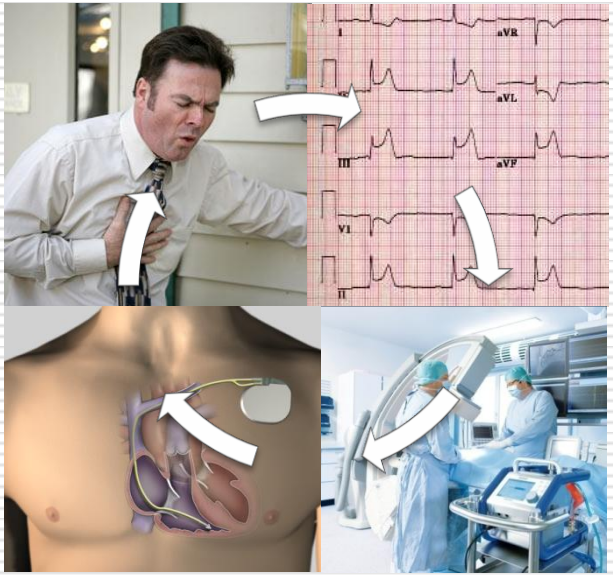
European Heart Journal (2018) **39**, 119–177
doi:10.1093/eurheartj/ehx393

ESC GUIDELINES

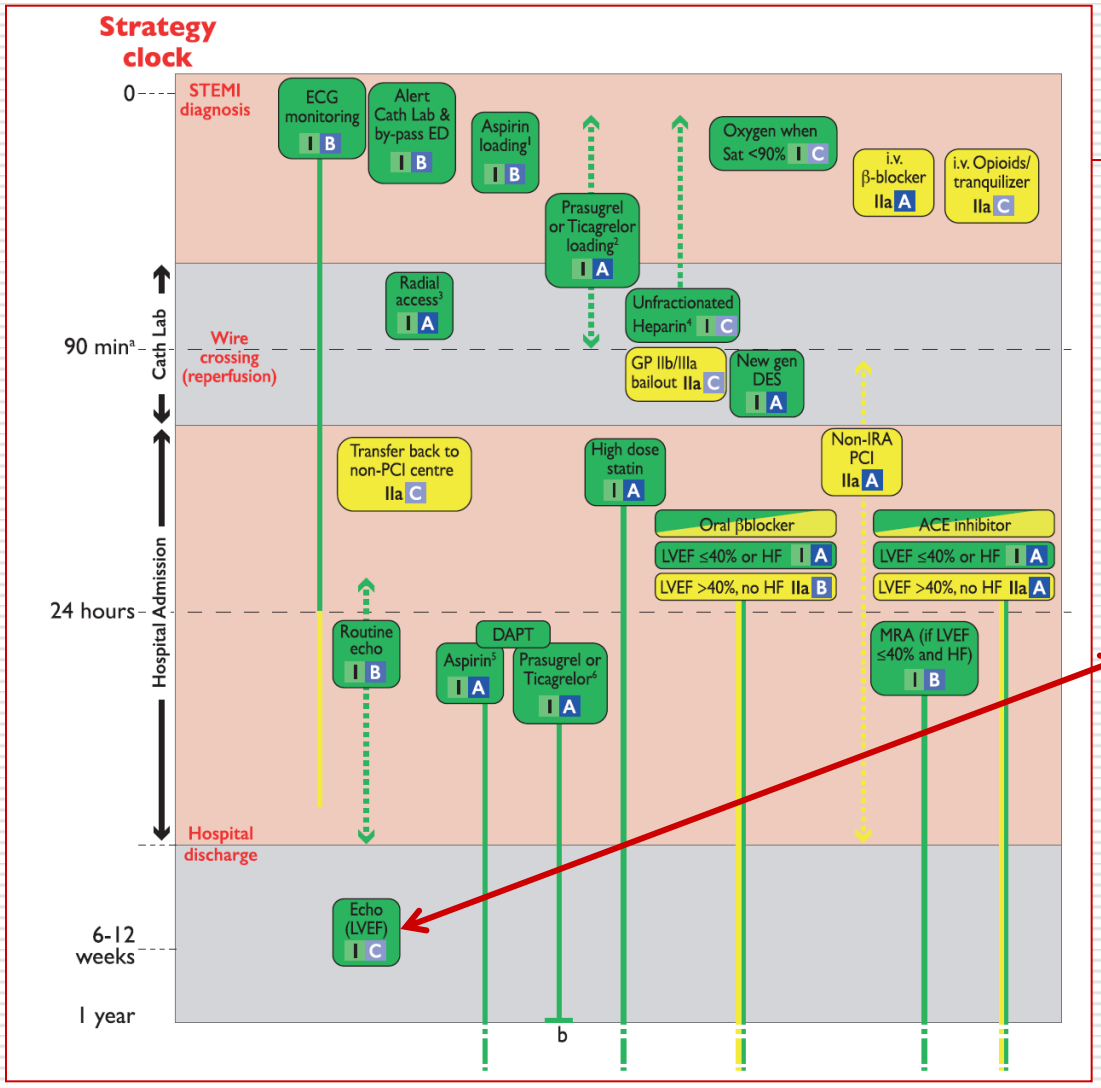
2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation

The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC)

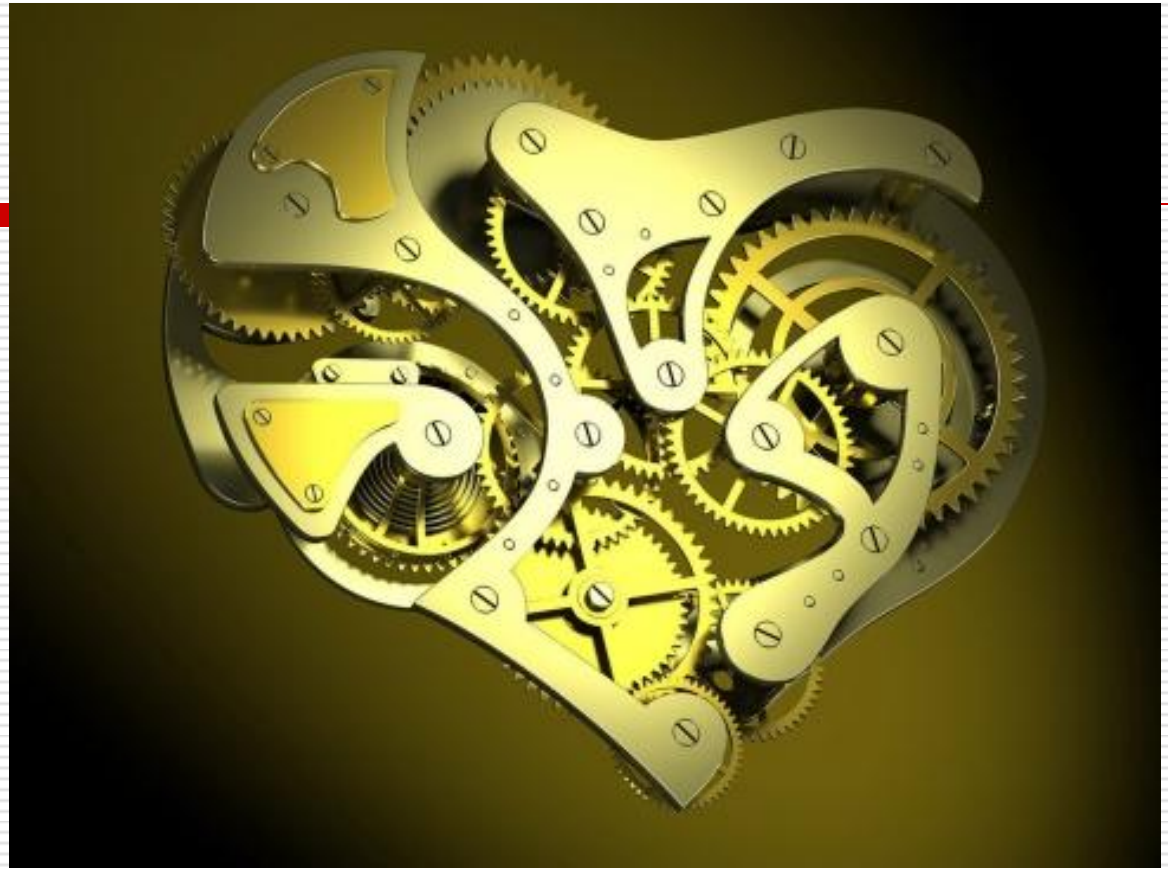
Recommendations	Class[a]	Level[b]
At presentation		
Emergency echocardiography is indicated in patients with cardiogenic shock and/or haemodynamic instability or suspected mechanical complications without delaying angiography.[295]	I	C
Emergency echocardiography before coronary angiography should be considered if the diagnosis is uncertain.[295]	IIa	C
Routine echocardiography that delays emergency angiography is not recommended.[295]	III	C
Coronary CT angiography is not recommended	III	C
During hospital stay (after primary PCI)		
Routine echocardiography to assess resting LV and RV function, detect early post-MI mechanical complications, and exclude LV thrombus is recommended in all patients.[296,297]	I	B
Emergency echocardiography is indicated in haemodynamically unstable patients.[295]	I	C
When echocardiography is suboptimal/inconclusive, an alternative imaging method (CMR preferably) should be considered.	IIa	C
Either stress echo, CMR, SPECT, or PET may be used to assess myocardial ischaemia and viability, including in multivessel CAD.[1,298–300]	IIb	C
After discharge		
In patients with pre-discharge LVEF ≤40%, repeat echocardiography 6–12 weeks after MI, and after complete revascularization and optimal medical therapy, is recommended to assess the potential need for primary prevention ICD implantation.[3,296]	I	C
When echo is suboptimal or inconclusive, alternative imaging methods (CMR preferably) should be considered to assess LV function.	IIa	C



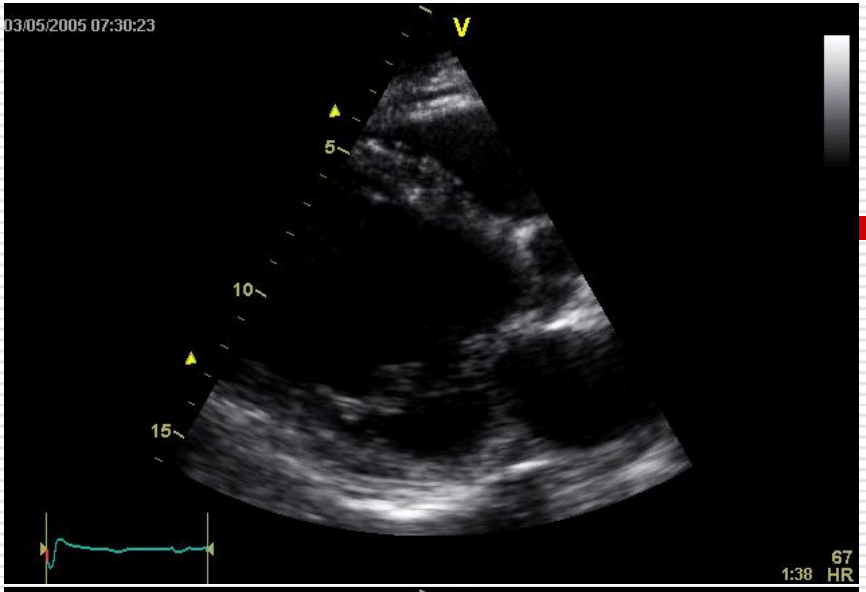
Recommendations	Class[a]	Level[b]
Beta-blockers		
Oral treatment with beta-blockers is indicated in patients with heart failure and/or LVEF ≤40% unless contraindicated.[357–361]	I	A
Intravenous beta-blockers should be considered at the time of presentation in patients undergoing primary PCI without contraindications, with no signs of acute heart failure, and with an SBP >120 mmHg.[346–348,350,403]	IIa	A
Routine oral treatment with beta-blockers should be considered during hospital stay and continued thereafter in all patients without contraindications.[344,354–356,404,405]	IIa	B
Intravenous beta-blockers must be avoided in patients with hypotension, acute heart failure or AV block, or severe bradycardia.[344]	III	B
Lipid lowering therapies		
It is recommended to start high-intensity statin therapy[c] as early as possible, unless contraindicated, and maintain it long-term.[364,366,368]	I	A
An LDL-C goal of < 1.8 mmol/L (70 mg/dL) or a reduction of at least 50% if the baseline LDL-C is between 1.8–3.5 mmol/L (70–135 mg/dL) is recommended.[367,369,376,382]	I	B
It is recommended to obtain a lipid profile in all STEMI patients as soon as possible after presentation.[369,406]	I	C
In patients with LDL-C ≥1.8 mmol/L (≥70 mg/dL) despite a maximally tolerated statin dose who remain at high risk, further therapy to reduce LDL-C should be considered.[376,382]	IIa	A
ACE inhibitors/ARBs		
ACE inhibitors are recommended, starting within the first 24 h of STEMI in patients with evidence of heart failure, LV systolic dysfunction, diabetes, or an anterior infarct.[383]	I	A
An ARB, preferably valsartan, is an alternative to ACE inhibitors in patients with heart failure and/or LV systolic dysfunction, particularly those who are intolerant of ACE inhibitors.[396,407]	I	B
ACE inhibitors should be considered in all patients in the absence of contraindications.[394,395]	IIa	A
MRAs		
MRAs are recommended in patients with an LVEF <40% and heart failure or diabetes, who are already receiving an ACE inhibitor and a beta-blocker, provided there is no renal failure or hyperkalaemia.[397]	I	B



Recommendations	Class[a]	Level[b]
ICD therapy is recommended to reduce sudden cardiac death in patients with symptomatic heart failure (NYHA class II–III) and LVEF ≤35% despite optimal medical therapy for >3 months and ≥6 weeks after MI, who are expected to survive for at least 1 year with good functional status.[3,466,467]	I	A
ICD implantation or temporary use of a wearable cardioverter defibrillator may be considered <40 days after MI in selected patients (incomplete revascularization, pre-existing LVEF dysfunction, occurrence of arrhythmias >48 h after STEMI onset, polymorphic VT or VF).	IIb	C



Kdy samotná echokardiografie nestačí?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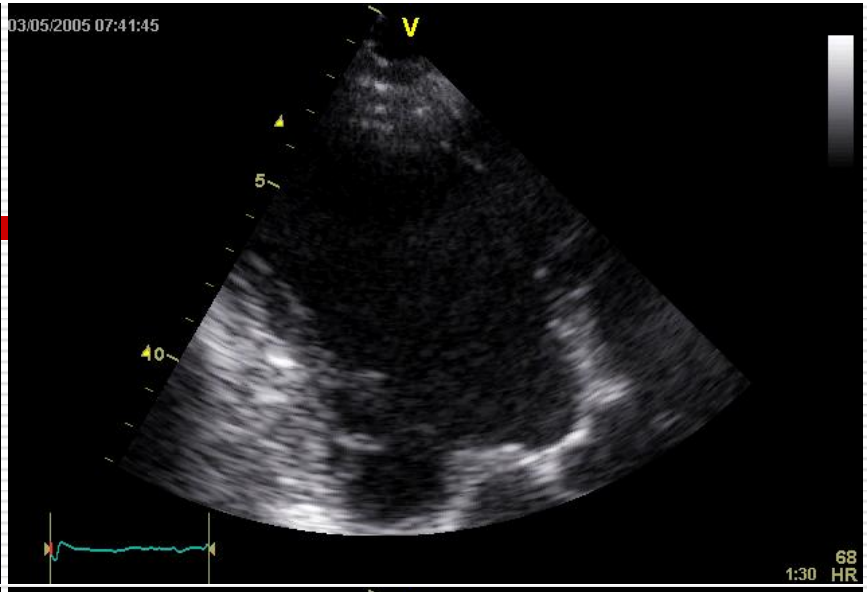
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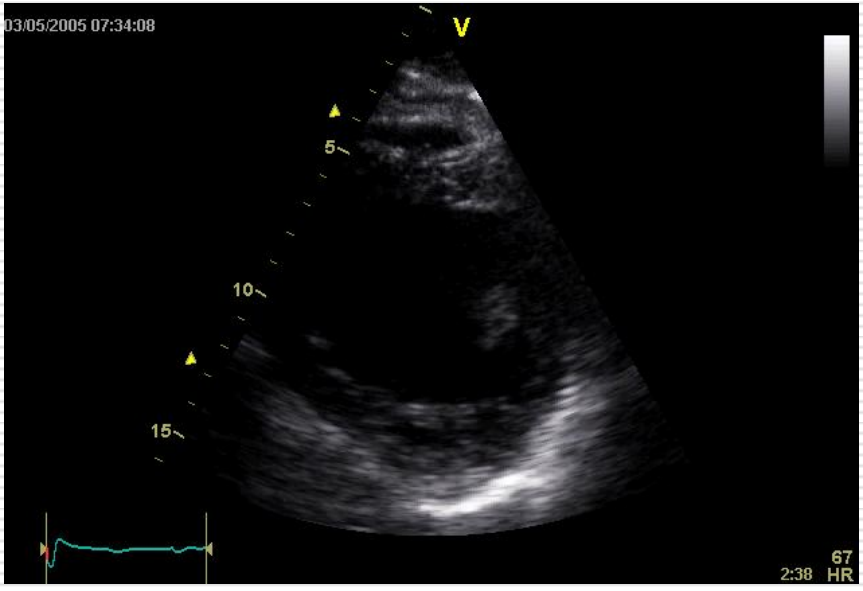
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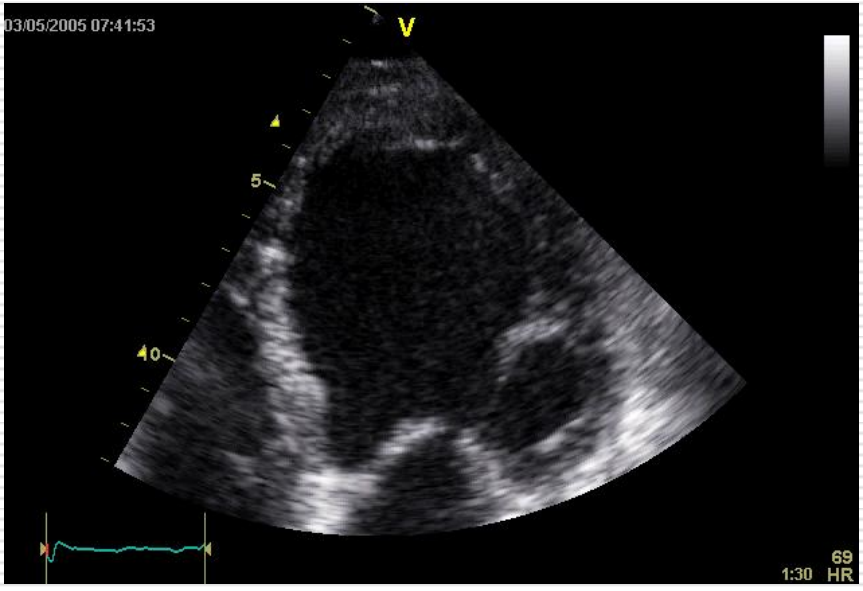
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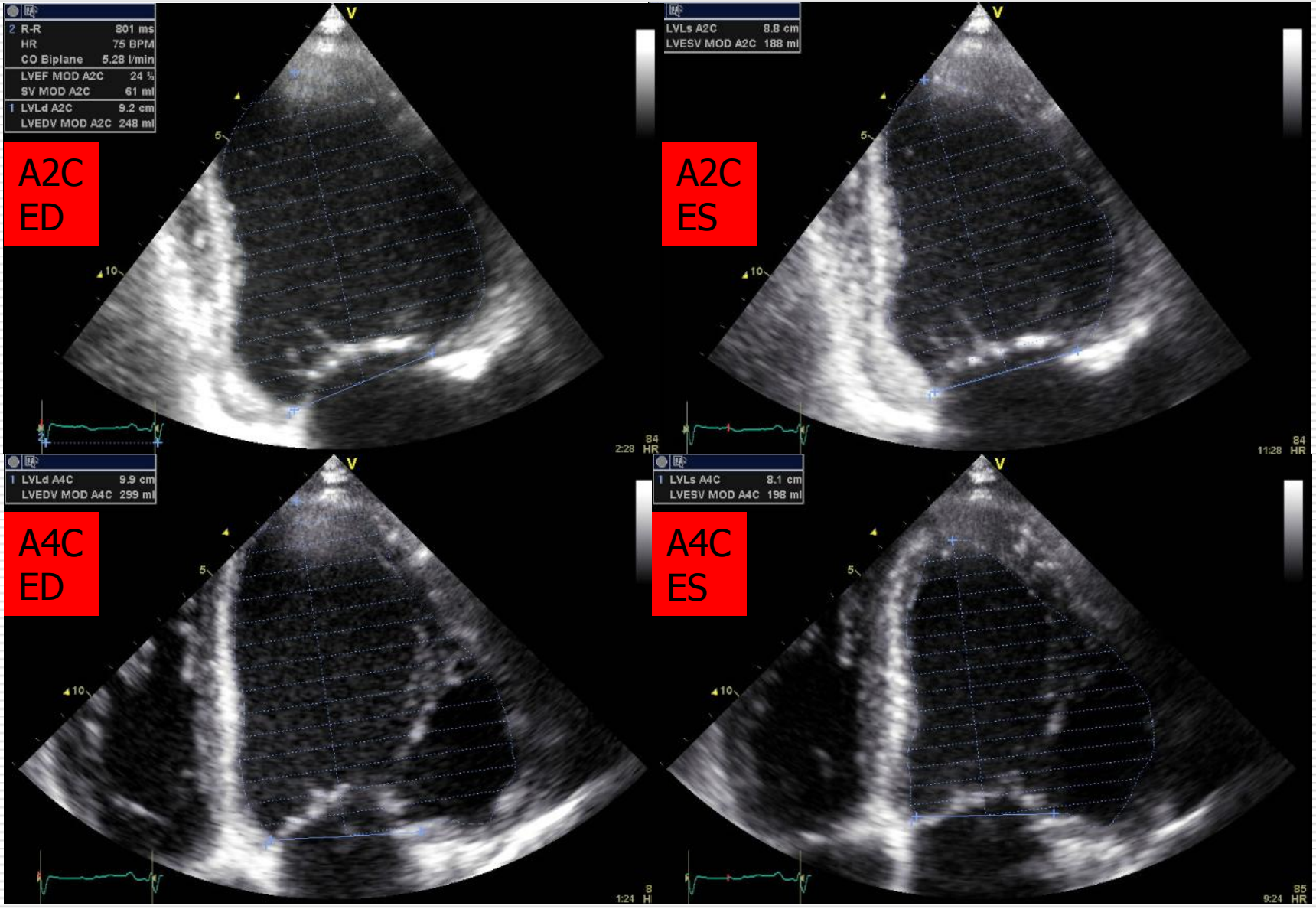


I. INTERNÍ KLINIKA
KARDIOLOGIE
FAKULTNÍ NEMOCNICE OLOMOUC

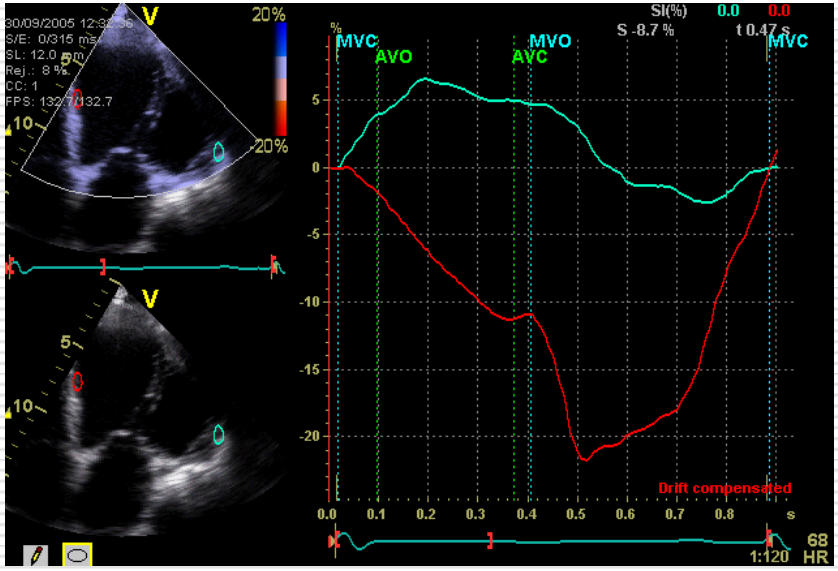
Otázky?

1. Nález systolické dysfunkce je dostatečný pro indikaci revaskularizace při SKG nálezu MVD.

2. Znalost evidence ne/viability myokardu je důležitá pro indikaci revaskularizace myokardu.

3. Pacient je indikován k endomyokardiální biopsii a srdeční transplantaci.

4. Dále není nutné indikovat žádnou zobrazovací metodu, stav není kauzálně řešitelný.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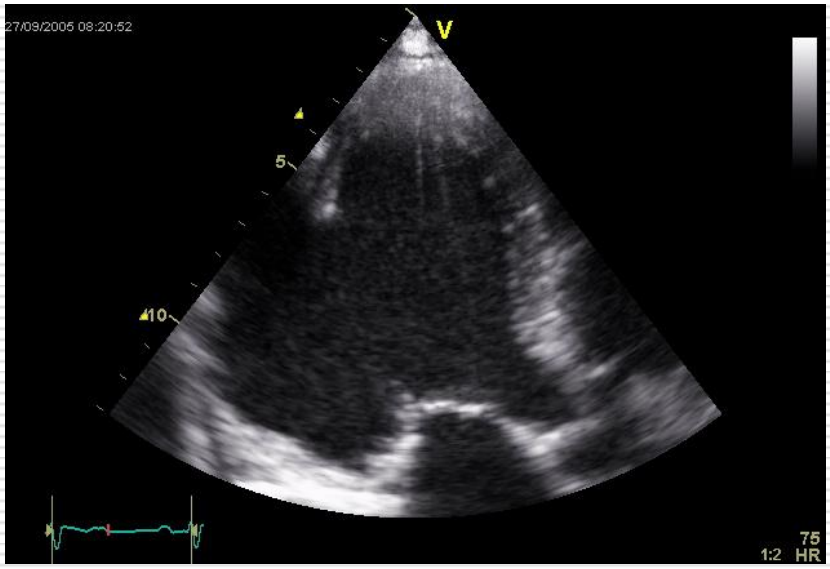
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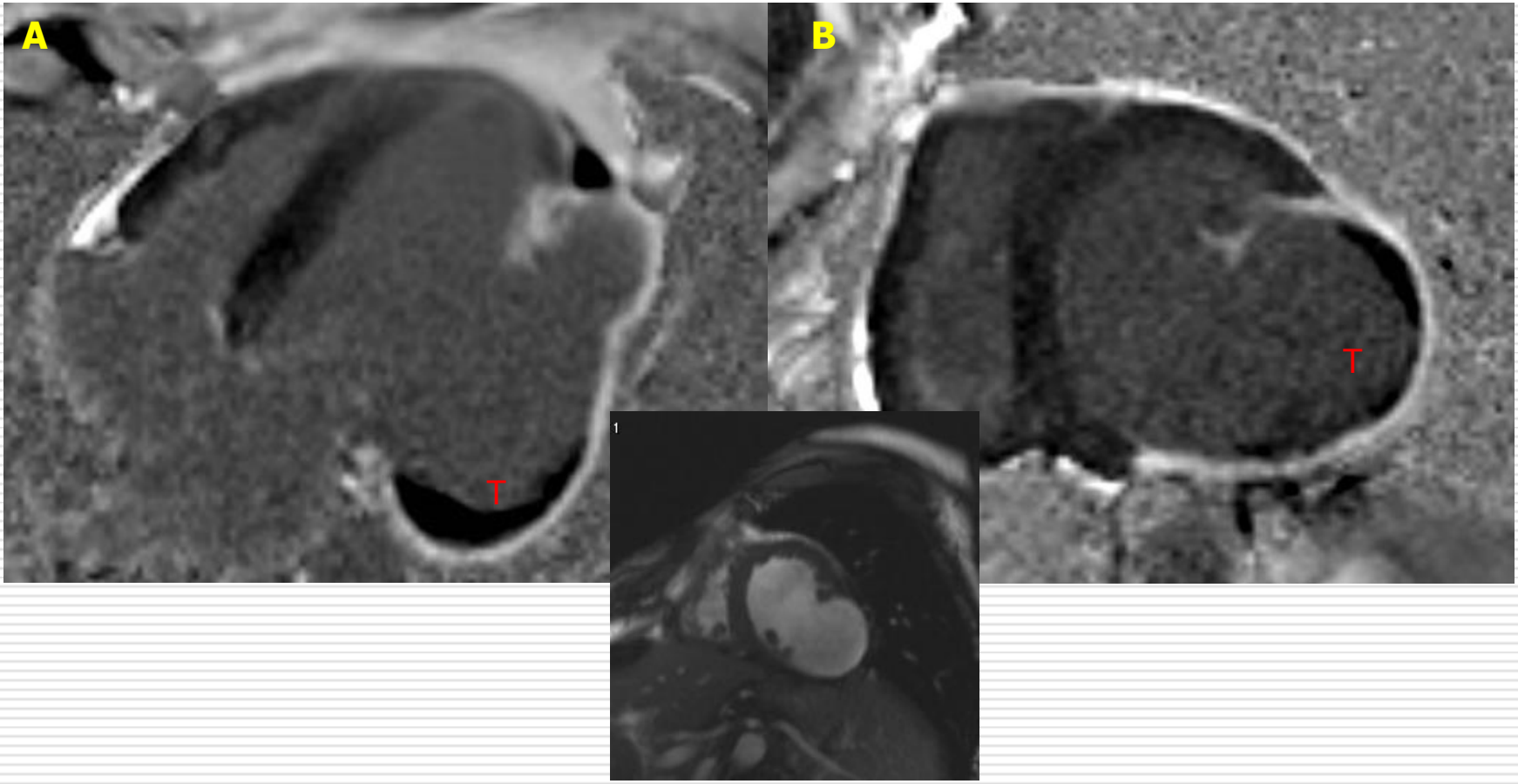
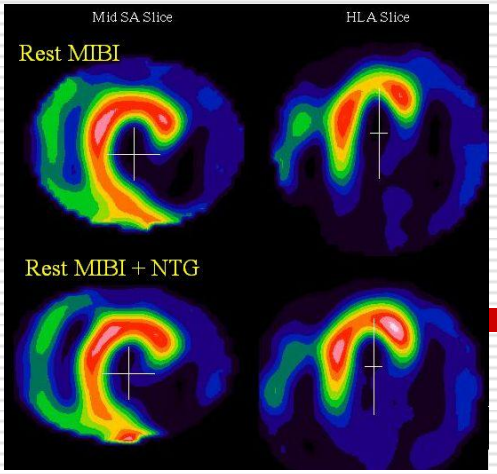
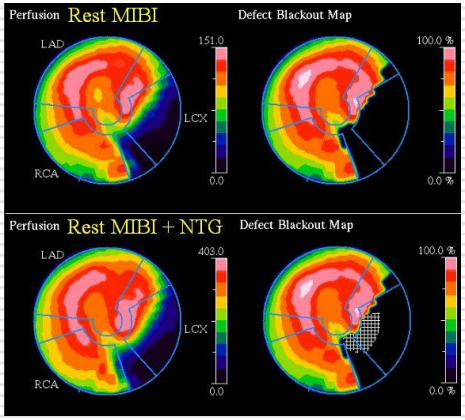


Magnetická rezonance srdce: V projekcích na horizontální dlouhou **(A)** a krátkou osu LK **(B)** v sekvenci PSIR-TrueFisp 2D s použitím kontrastní látky (Gadovist) je patrné aneuryzmatické vyklenutí 106x68x49 mm v oblasti posterolaterální stěny myokardu levé komory srdeční s patrnou dyskinézou ztenčené stěny aneuryzmatu. Dále je evidentní transmurální postkontrastní sycení (fenomén delayed enhancement) v celém rozsahu stěny aneuryzmatu a kraniobazálně na endokardiálním povrchu lokalizovaný nástěnný trombus (T).

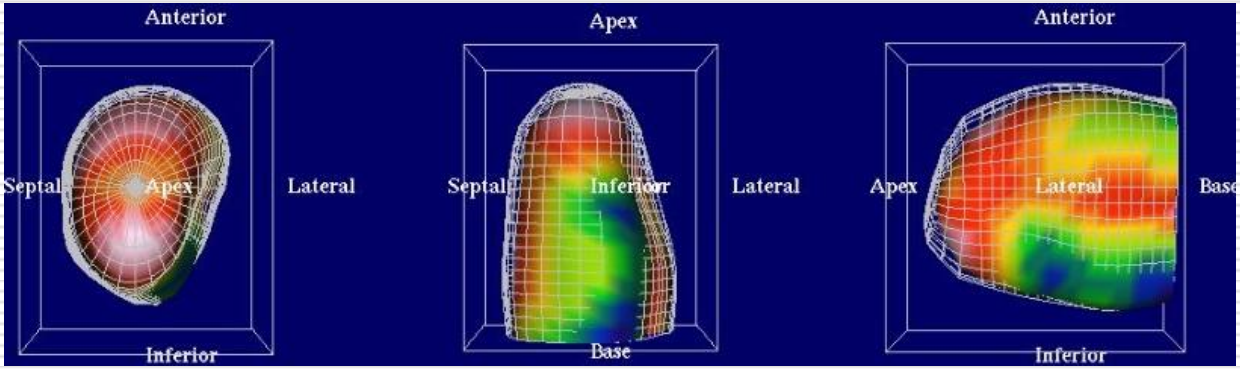


SPECT myokardu:

A. Na tomografických řezech v krátké (SA) a horizontální dlouhé ose (HLA) je zobrazen klidový perfuzní defekt laterálně a inferolaterálně na úrovni absence vychytávání radiofarmaka (horní řádek). Na opakované studii po podání NTG se nález prakticky nemění (dolní řádek).



B. Kvantifikace perfuze na polárních mapách, klidový perfuzní defekt zaujímá 22% z levé komory (horní řádek). Obdobný nález i na opakované studii po aplikaci nitroglycerinu (dole vlevo). Neviabilní myokard, tj. fixní perfuzní defekt s vychytáváním pod 50% maxima, zaujímá 15% z levé komory (dole uprostřed a vpravo).



C. Gated 3D SPECT, v kterém mřížka odpovídá siluetě endokardu zastavené na konci diastoly, barevně je znázorněna systolická hybnost endokardu v mm. Nález svědčí pro difuzní hypokinezu levé komory s akinézou až dyskinézou inferolaterálně.

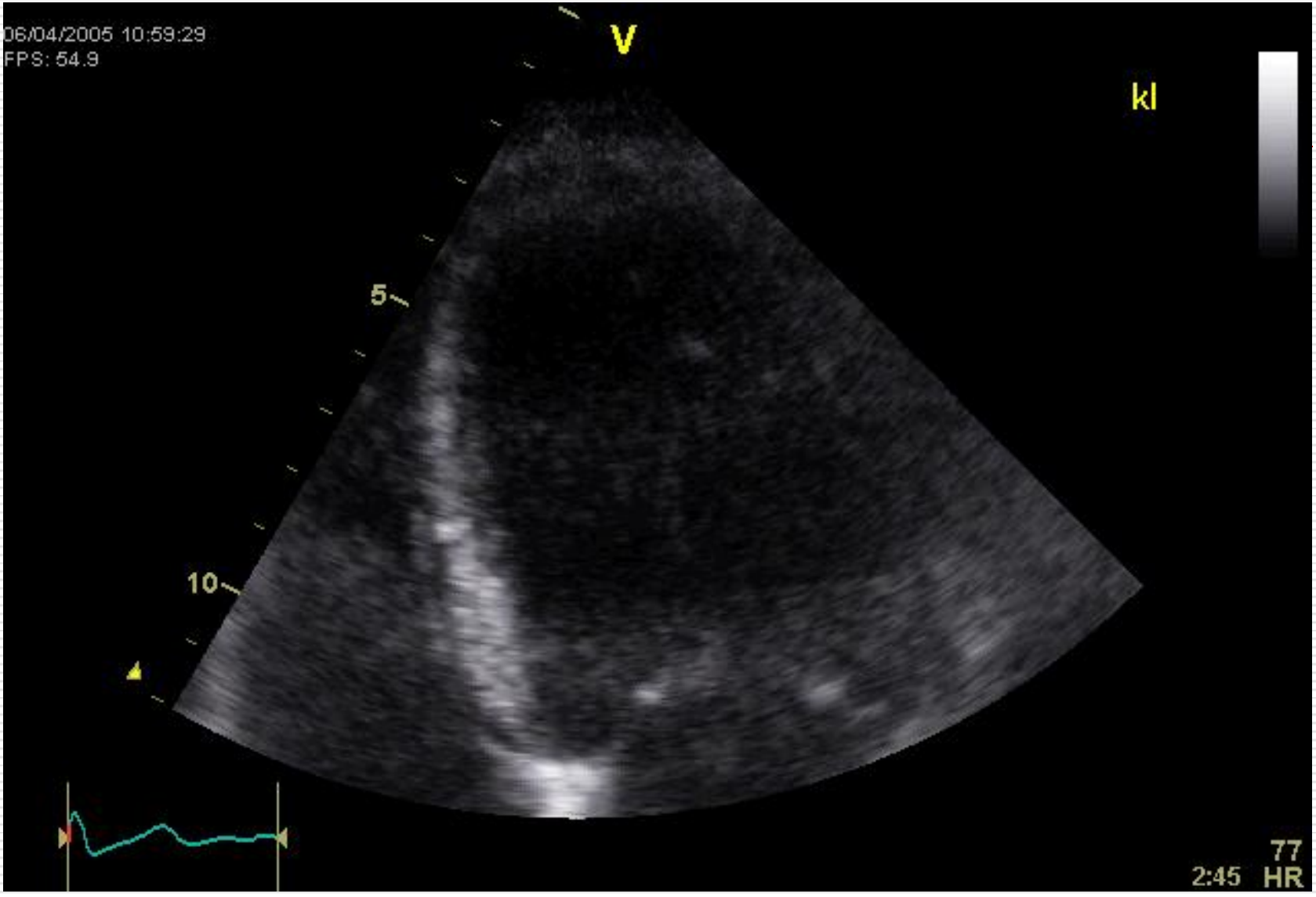
Odpověď…

1. Nález systolické dysfunkce je dostatečný pro indikaci revaskularizace při SKG nálezu MVD.

2. **Znalost evidence ne/viability myokardu je důležitá pro indikaci revaskularizace myokardu.**

3. Pacient je indikován k endomyokardiální biopsii a srdeční transplantaci.

4. Dále není nutné indikovat žádnou zobrazovací metodu, stav není kauzálně řešitelný.


06/04/2005 10:59:29
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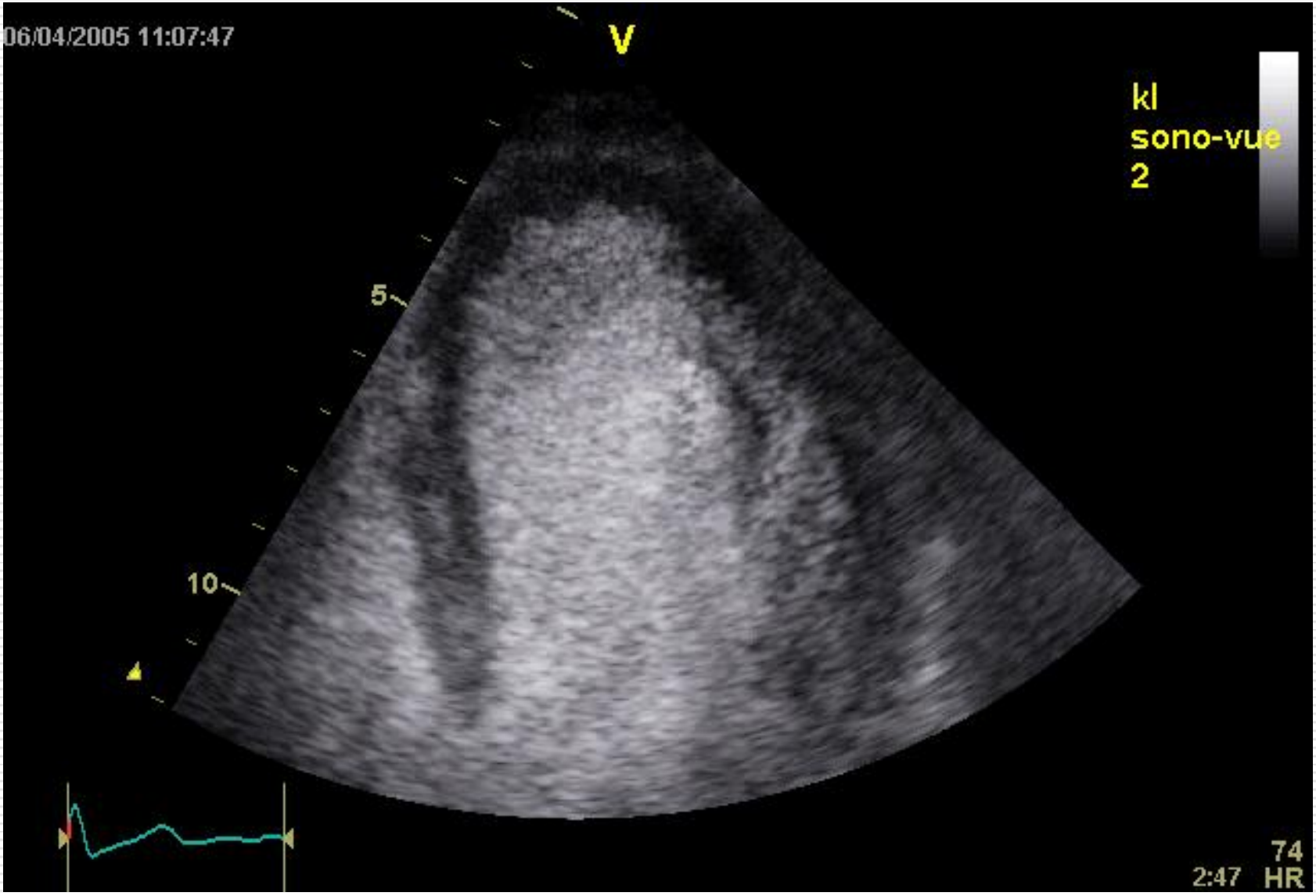
Otázky?

1. Vystačím si s echokardiografickým odhadem EF LK.

2. Použiju RT 3D TTE EF LK, která mě dá jasnou odpověď jak postupovat dále.

3. Indikuji CRT-D bez ohledu na výsledek EF LK.

4. Indikuji jinou alternativní metodu EF LK, aby primárně preventivní indikace ICD po předchozím infarktu myokardu byla důsledně dokumentovaná.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Otázky?

1. Vystačím si s echokardiografickým odhadem EF LK.

2. Použiju RT 3D TTE EF LK, která mě dá jasnou odpověď jak postupovat dále.

3. Indikuji CRT-D bez ohledu na výsledek EF LK.

4. **Indikuji jinou alternativní metodu EF LK, aby primárně preventivní indikace ICD po předchozím infarktu myokardu byla důsledně dokumentovaná.**


THE SATURDAY STAR

BEN'S PURE GOLD

Johnson blasts to world record in 9.79 seconds

THE GOLDEN MAN: Ben Johnson knows who is No.1 and teammate Desai Williams would surely agree


Drug scandal shatters Canada's Olympic glory

Stripped of gold medal Johnson banned for life

Big Ben's career in ruins

Závěry

Kdyby nebylo EF LK, museli bychom ji vytvořit…

- Ejekční frakce LK je **široce používaný**, ale velmi **problematický** parametr systolické funkce LK, se kterým je nutné *(i z historických důvodů)* pracovat…
- S echokardiografií si **nevystačím** pokud…
  1. Požaduji **další přídatnou informaci**, kterou je nutné získat jinou alternativní metodou (MR, CT, PET/SPECT) – viabilita myokardu, CCTA, CCT morfologie chlopně…
  2. Pacient je **špatně echokardiograficky vyšetřitelný** a z hlediska dalšího managementu je nutné přesné stanovení EF LK.

…byli jsme i před EF LK, budeme i po ní !!!


The BEATLES
All You Need Is EF ?
Samozřejmě, že ne !