

Zobrazovací metody u srdečního selhání a nová ESC doporučení z roku 2026: role echokardiografie

Hana Línková

Kardiologická klinika FNMH a 2. lékařská fakulta UK

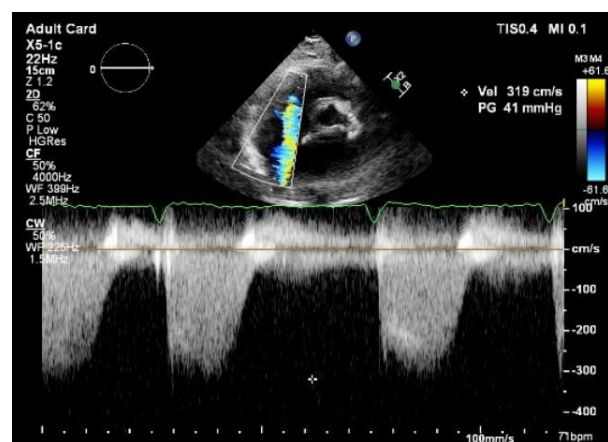
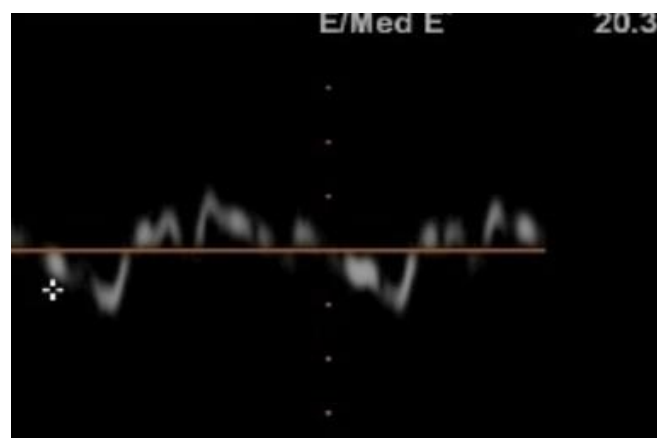
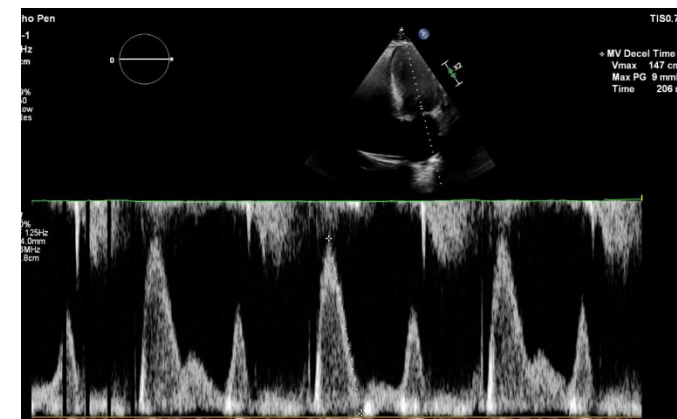
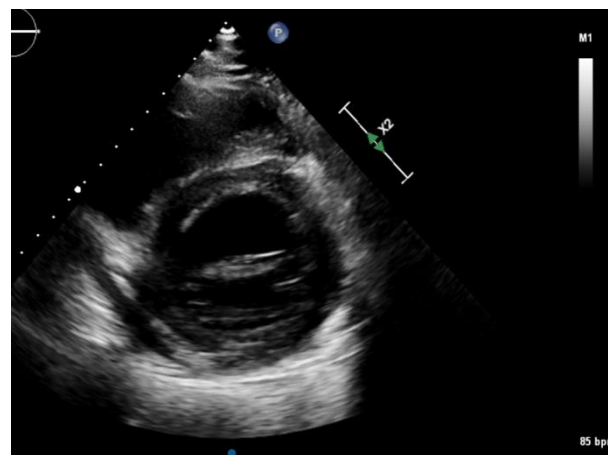
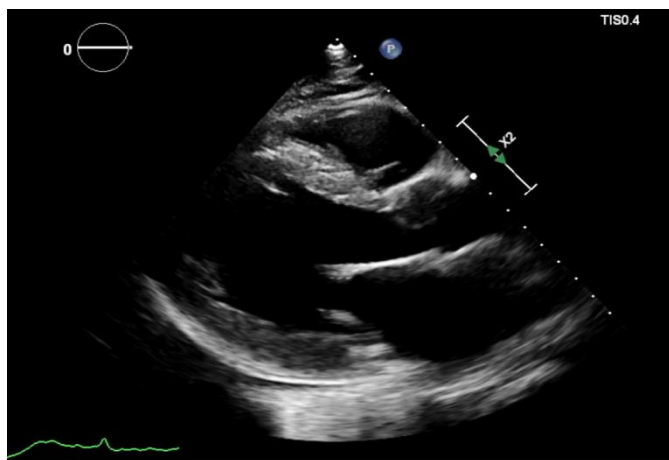
Praha

Srdeční selhání – současný pohled

HF je **klinický syndrom** charakterizovaný:

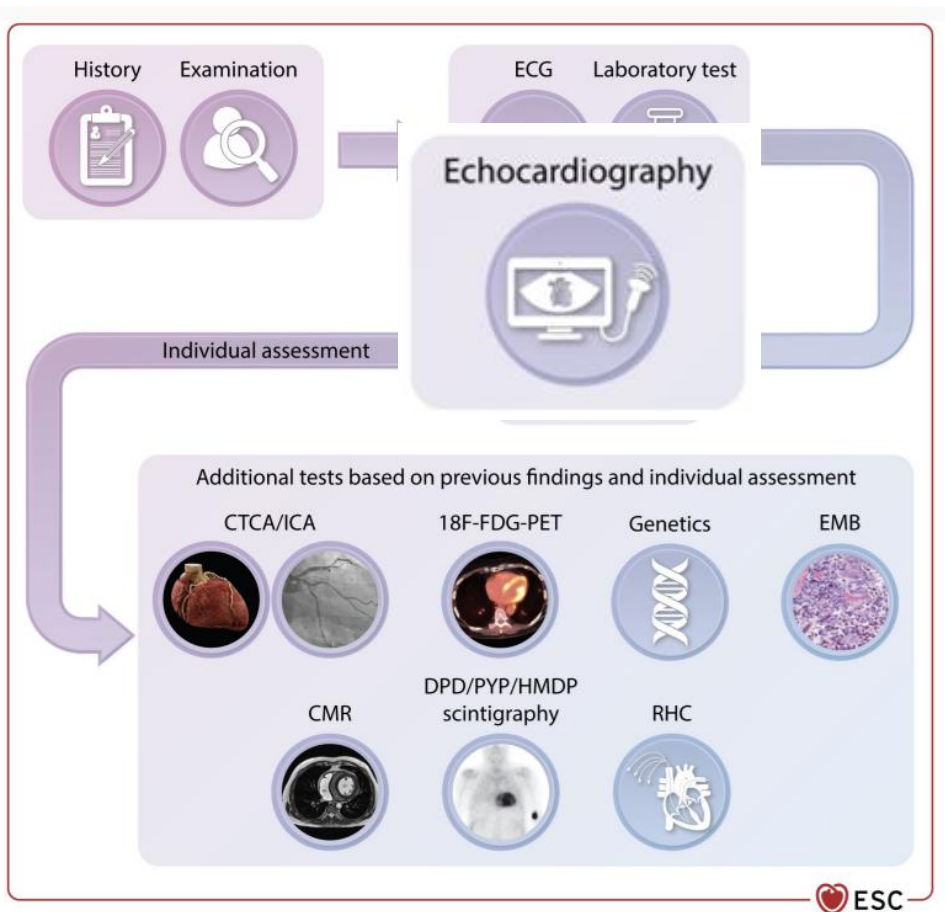
- symptomy
- známkami městnání
- strukturální nebo funkční abnormalitou srdce
- zvýšenými plicími tlaky nebo sníženým srdečním výdejem
- **echokardiografie je spolu s natriuretickými peptidy základním diagnostickým nástrojem.**

Echokardiografické vyšetření



Muž 65 let, dušnost NYHA III, NT pro BNP 6000 ng/l

Diagnostika srdečního selhání – doporučené postupy pro pacienty s podezřením na srdeční selhání



Recommendations	Class ^a	Level ^b
In patients with suspected HF, the following laboratory tests are recommended when screening for comorbidities: full blood count, kidney function (eGFR and UACR), electrolytes, liver function, thyroid function, HbA1c, lipids, and iron status (TSAT and ferritin). ¹⁶⁸	I	C
Natriuretic peptide measurement is recommended in patients with suspected HF (interpreted in relation to patient age, obesity, and other factors known to affect natriuretic peptide level ^c). ^{146-148,151-153,169}	I	C
A 12-lead ECG is recommended in patients with suspected HF.	I	C
Chest radiography (X-ray) is recommended in patients with suspected HF.	I	C
Transthoracic echocardiogram is recommended in patients with suspected HF to confirm the diagnosis, differentiate between HF phenotypes and aid in identifying the underlying aetiology of HF.	I	C

Nový koncept a echokardiografie v diagnostickém algoritmu

New concepts

HFrEF has been expanded to include LVEF up to 50%

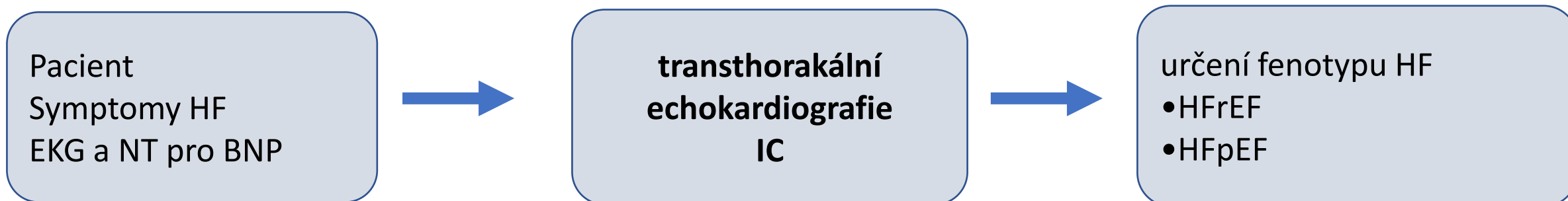
HFmrEF has been removed

HFpEF includes LVEF from 50% and above

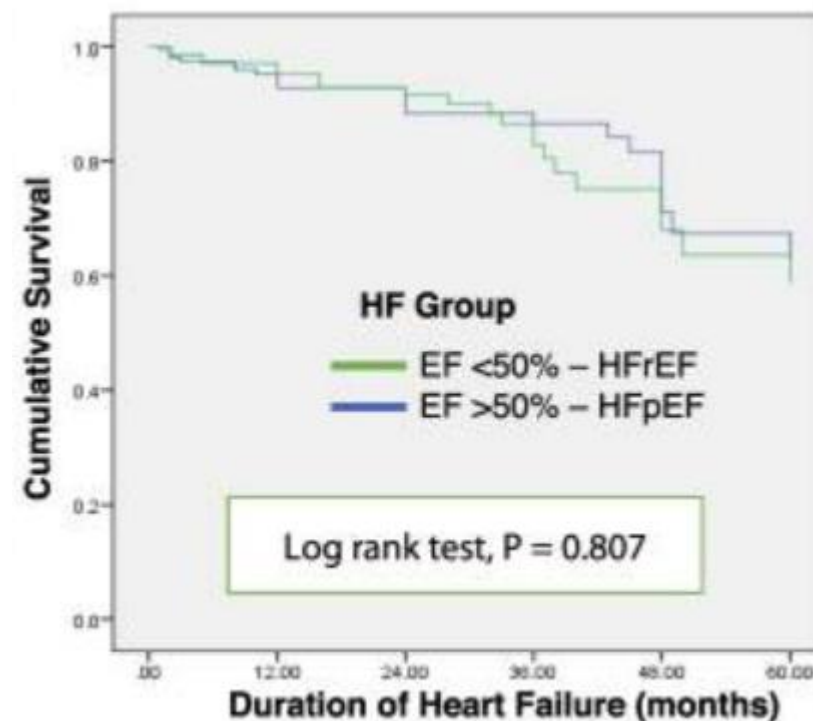
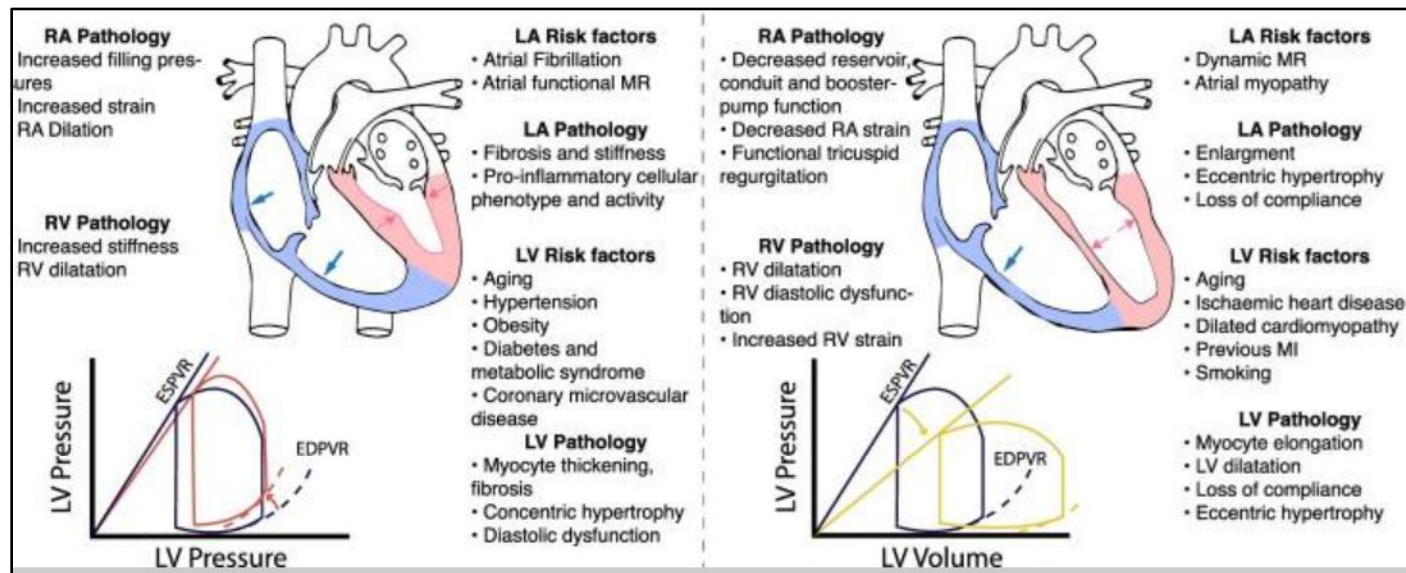
Decompensated HF replaces acute HF

Stages of HF (A–D) ranging from risk factors to advanced HF have been adopted

New classifications for medical and interventional therapy have been introduced



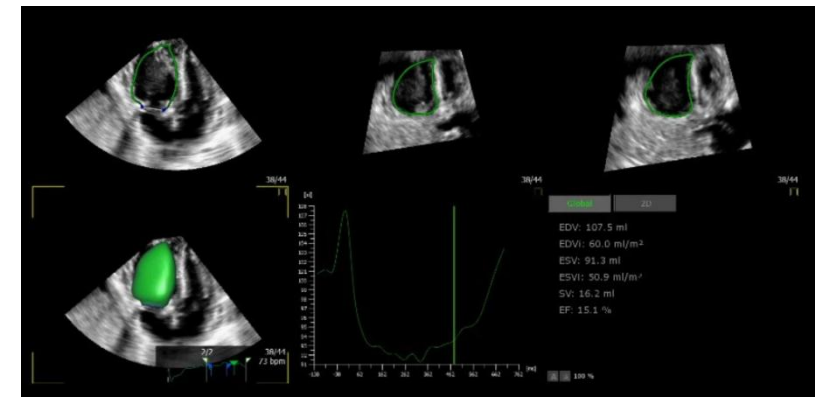
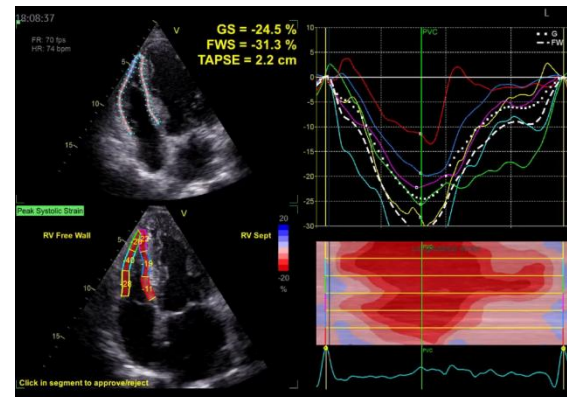
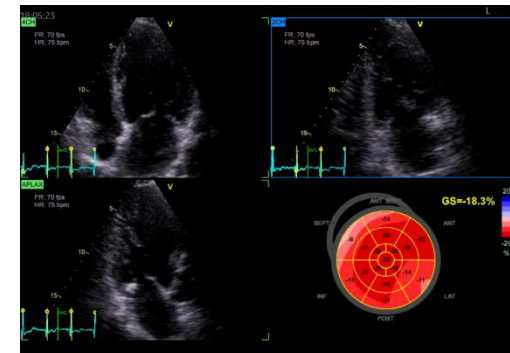
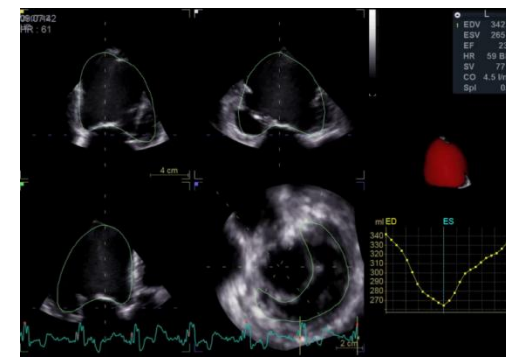
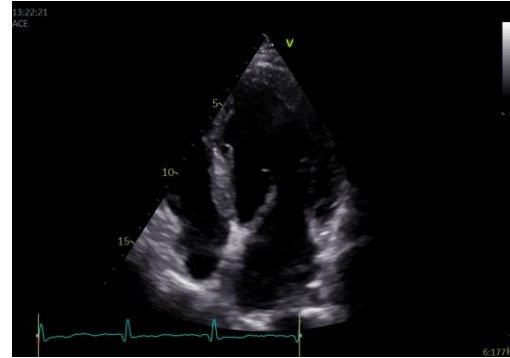
HFpEF x HFrEF



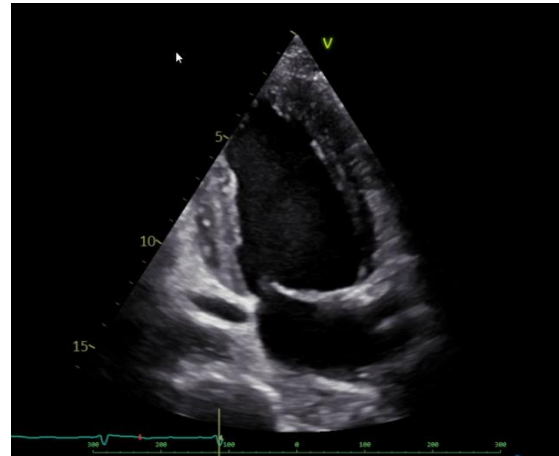
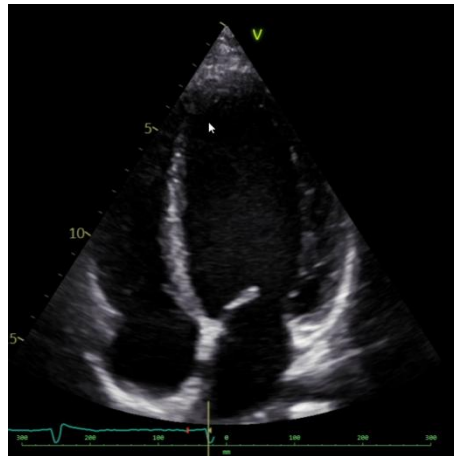
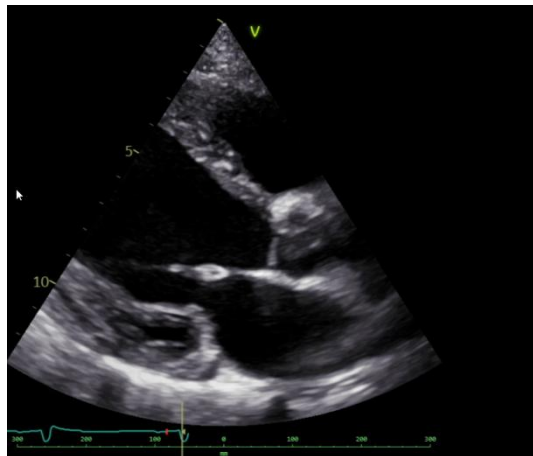
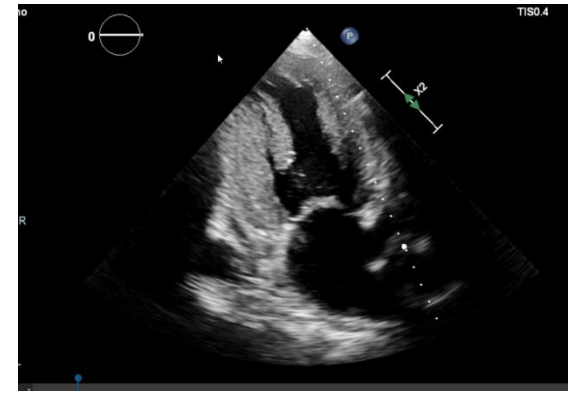
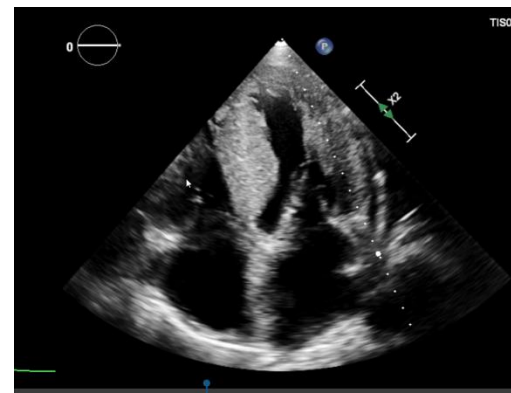
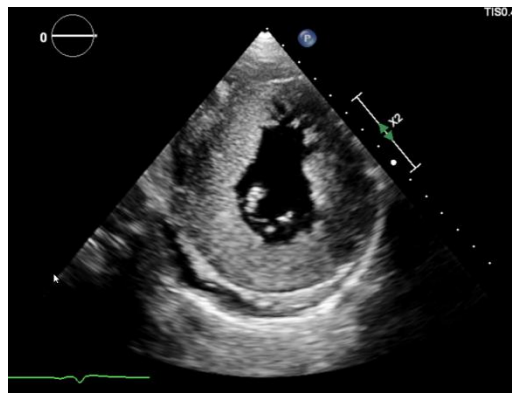
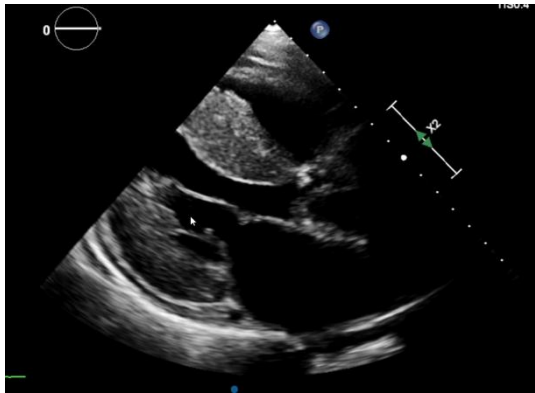
Proč právě echokardiografie?

Echo umožňuje současně hodnotit:

- anatomii
- systolickou funkci
- diastolickou funkci
- chlopenní vady
- pravou komoru
- plicní hypertenzi
- perikard
- hemodynamiku



Systolická funkce levé komory



Hlavní parametry systolické funkce levé komory- EF

- **Definice:**

Ejekční frakce je procento objemu krve vypuzené s systole v porovnání s objemem na konci diastoly

$$EF = (EDV - ESV) / EDV \times 100$$

- **Výhody:**

Jednoduchá, široce používaná metoda.

Poskytuje rychlý přehled o systolické funkci.

- **Omezení:**

Nezohledňuje tvar komory a změny v geometrii.

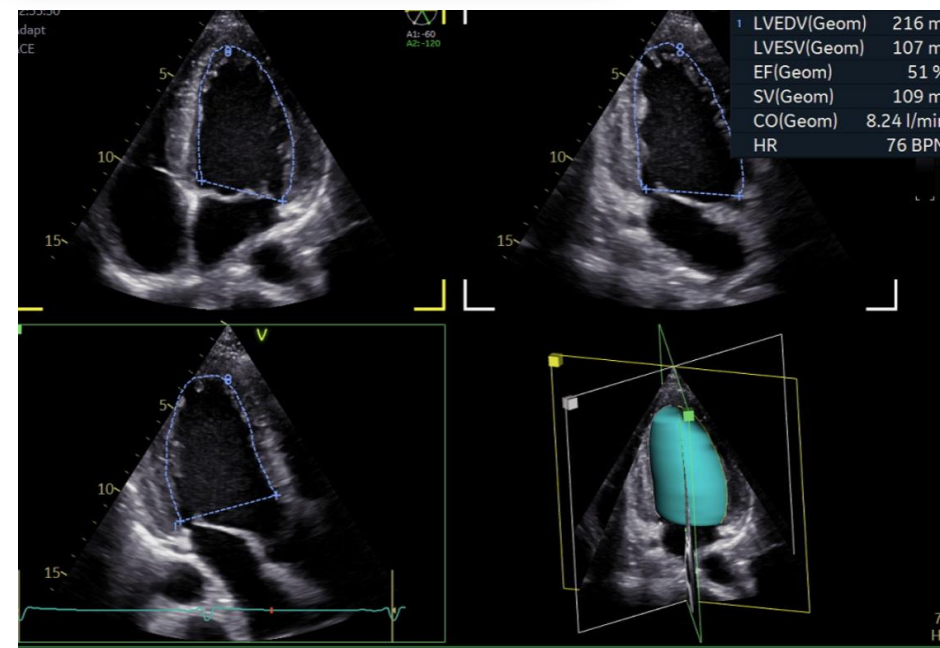
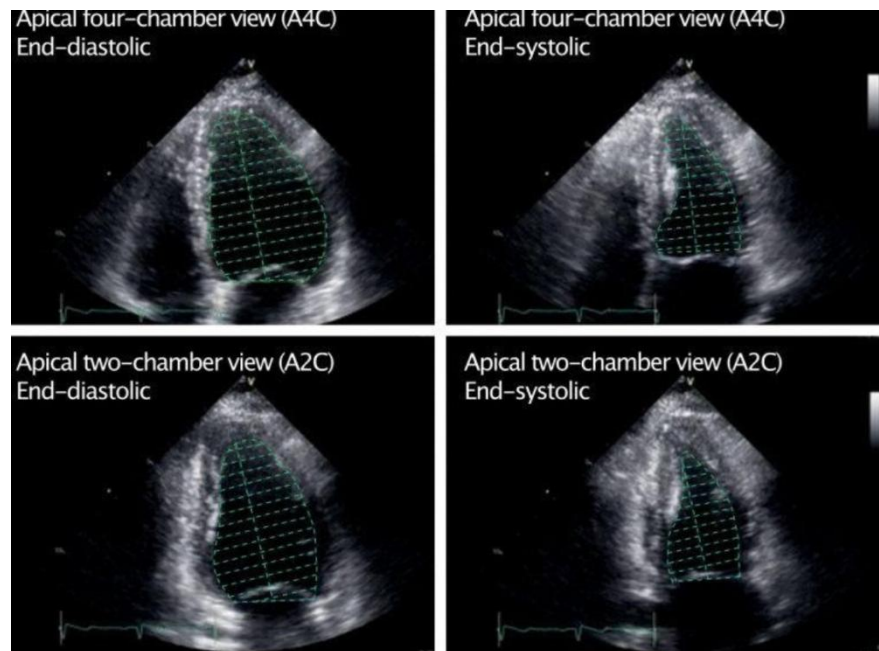
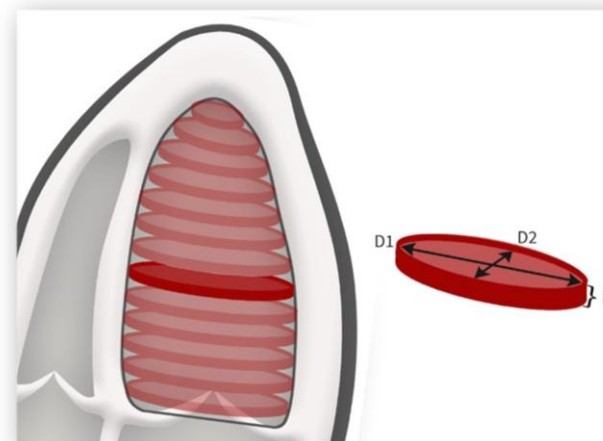
Normal ranges and severity partition cutoff values for 2DE-derived LV EF and LA volume

	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

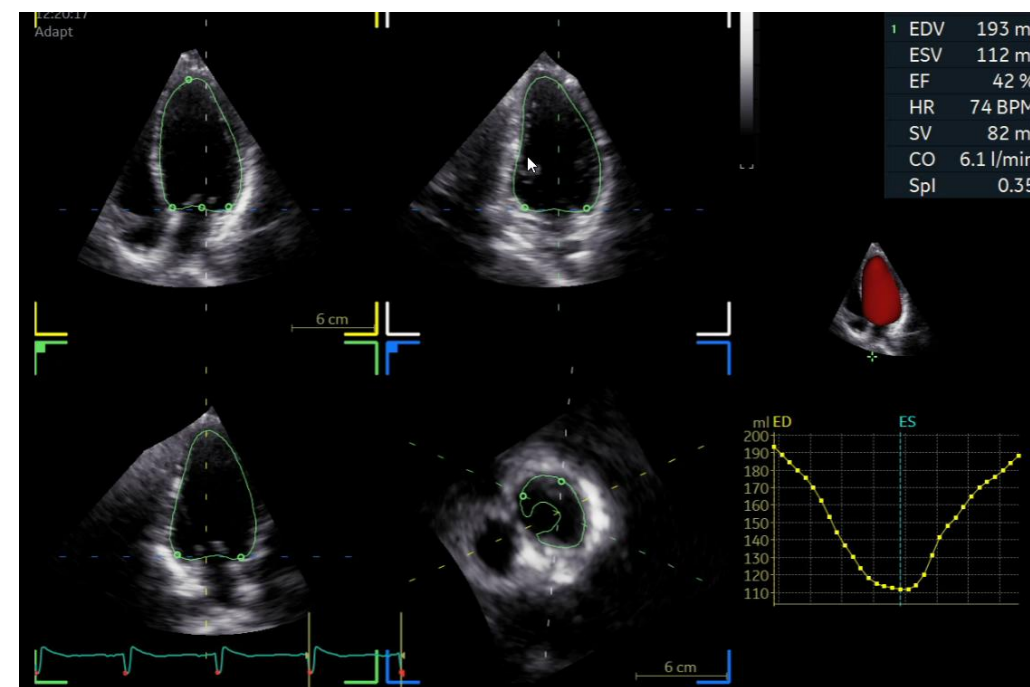
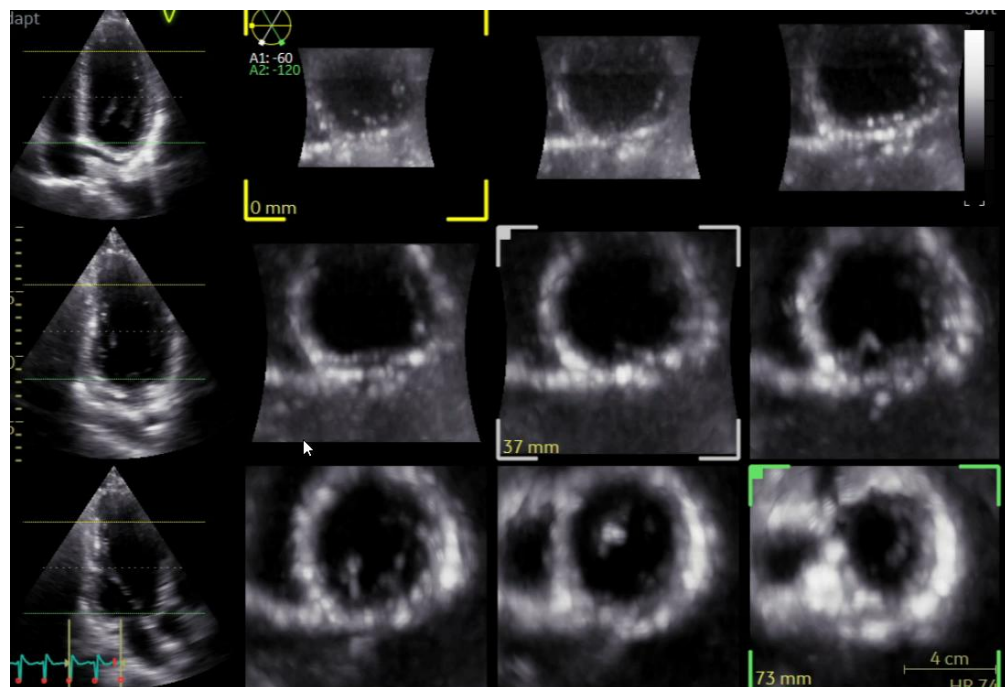
Hodnocení systolické funkce levé komory 2D

Simpsonova metoda

$$EF = (LVEDV - LVESV) / LVEDV \times 100$$



Pokročilé hodnocení systolické funkce levé komory



Strain a strain rate imaging

- **Definice:**

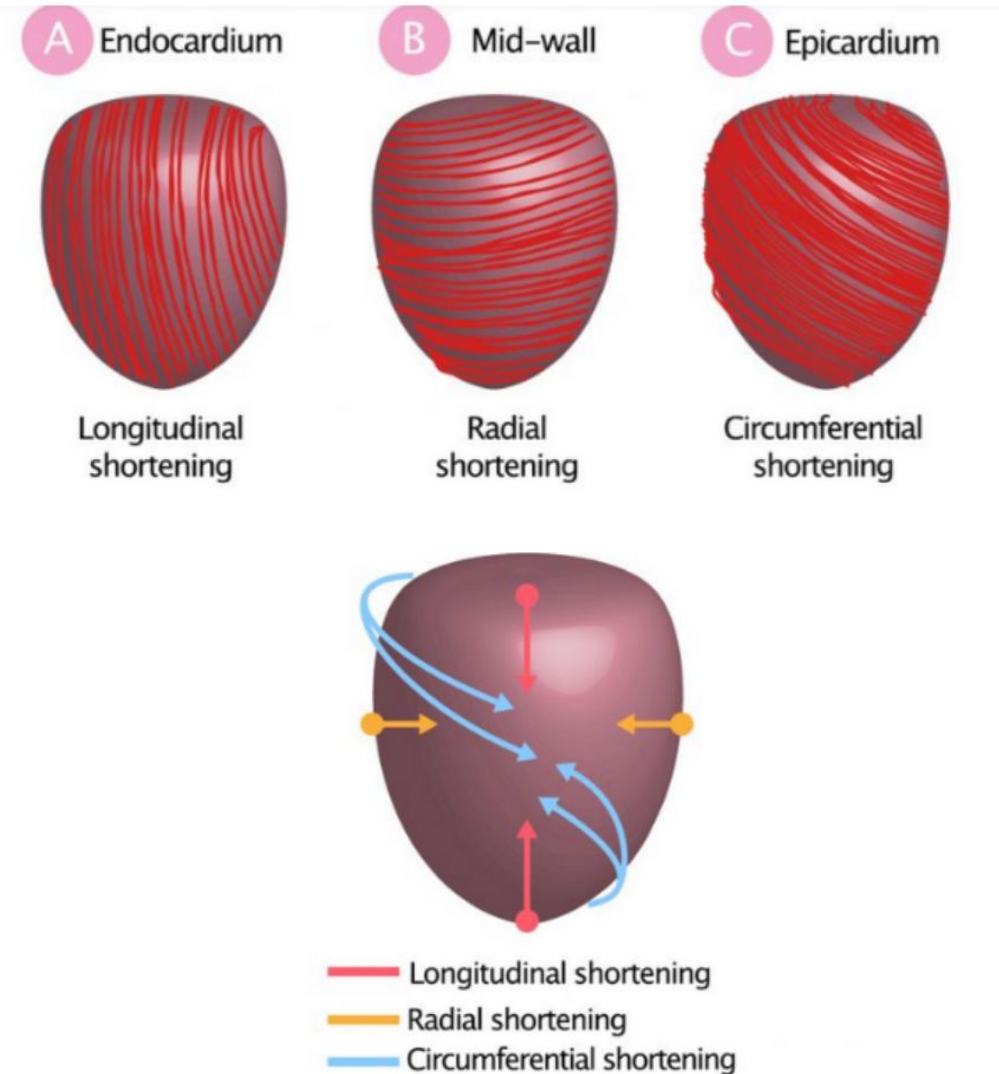
Měření deformace myokardu během kontrakce (radialní, cirkumferenciální, longitudinální strain).

- **Výhody:**

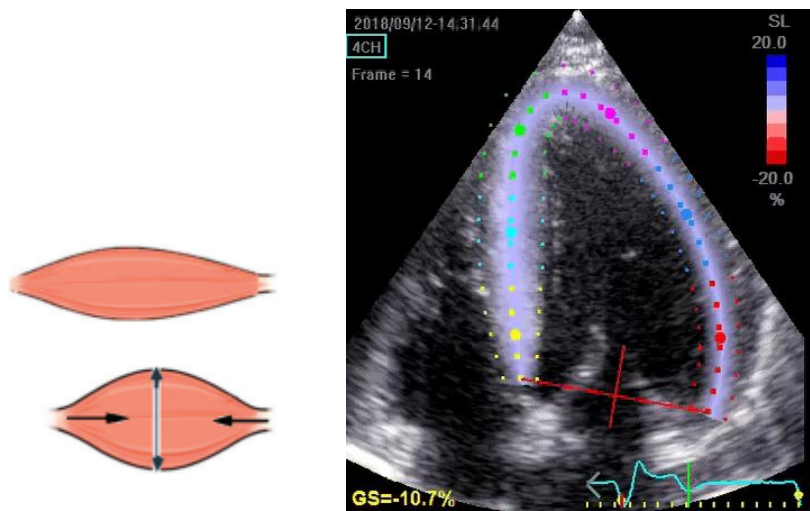
Vysoká citlivost na změny funkce LK dříve, než se projeví snížení EF. Hodnocení lokální funkce.

- **Klinická aplikace:**

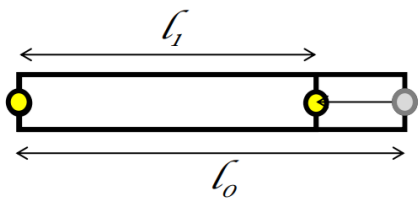
Diagnóza subklinického srdečního selhání, monitorování pacientů s chemoterapií, ICHS, chlopenními vadami atd



Strain levé komory

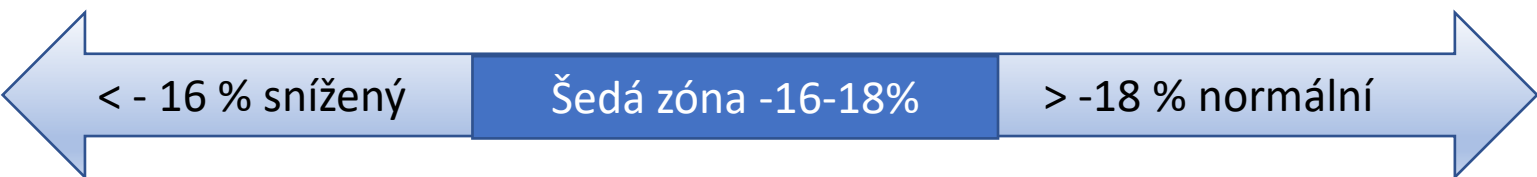


Vendor	Software	n	Mean	SD	LLN	Reference from list below
Varying	Meta-analysis	2597	-19.7%		NA	1
GE	EchoPAC BT 12	247	-21.5%	2.0%	-18%	2
	EchoPAC BT 12	207	-21.2%	1.6%	-18%	3
	EchoPAC BT 12	131	-21.2%	2.4%	-17%	4
	EchoPAC 110.1.3	333	-21.3%	2.1%	-17%	5
Philips	QLAB 7.1	330	-18.9%	2.5%	-14%	5
Toshiba	Ultra Extend	337	-19.9%	2.4%	-15%	5
Siemens	VVI 1.0	116	-19.8%	4.6%	-11%	6
	VVI 1.0	82	-17.3%	2.3%	-13%	7
Esaote	Mylab 50	30	-19.5%	3.1%	-13%	8



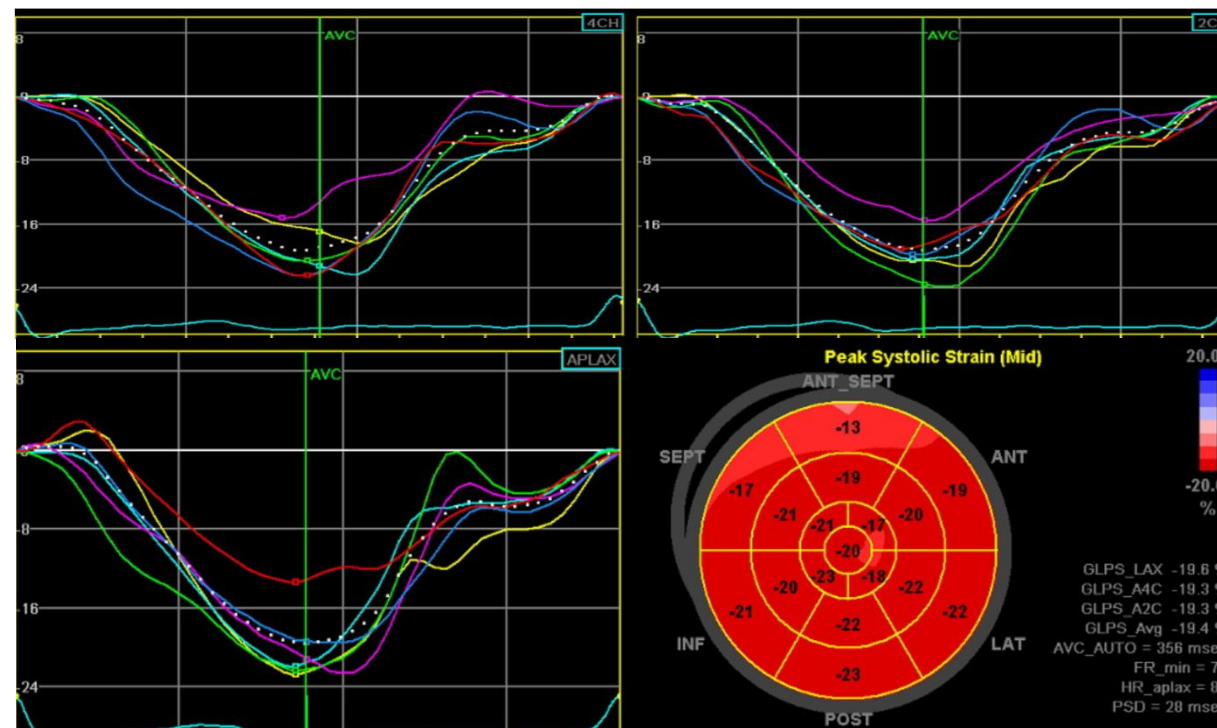
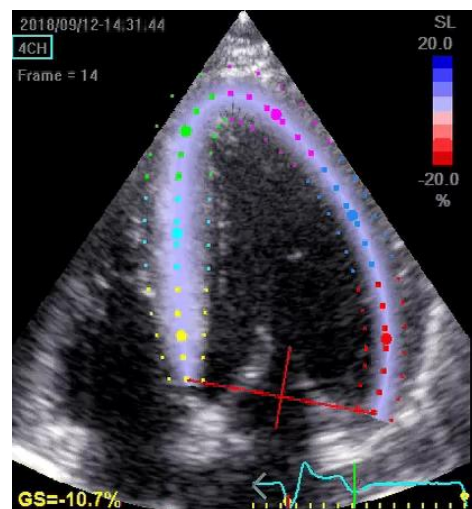
$$s(\varepsilon) = \frac{l_1 - l_0}{l_0}$$

strain
(deformace)

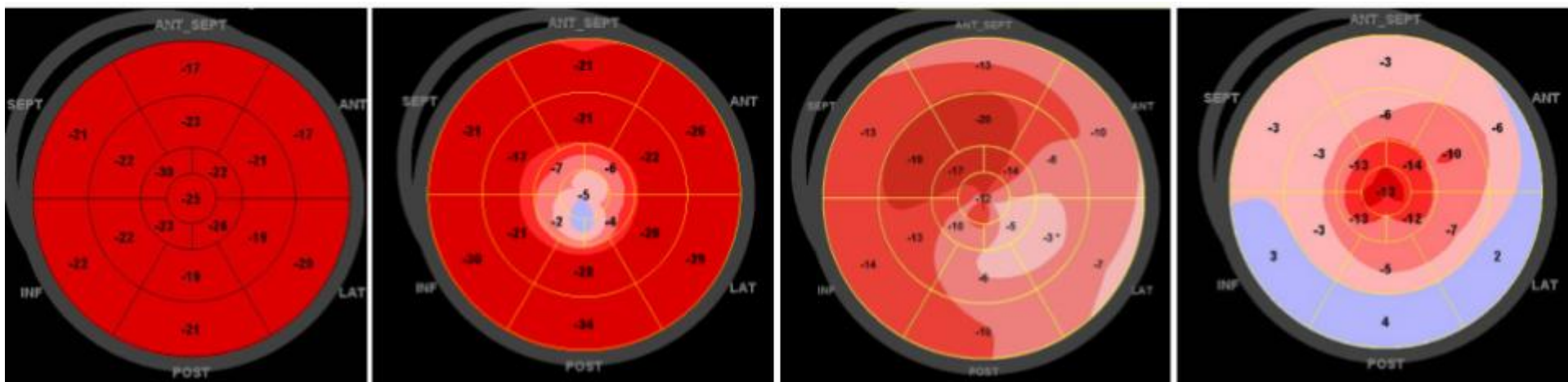


V praxi longitudinální strain, zkracování v podélné ose
Metoda speckle tracking- software analýza rutinních 2 D obrázků

Strain levé komory normální nález



Strain LK - fenotypizace



Normální nález

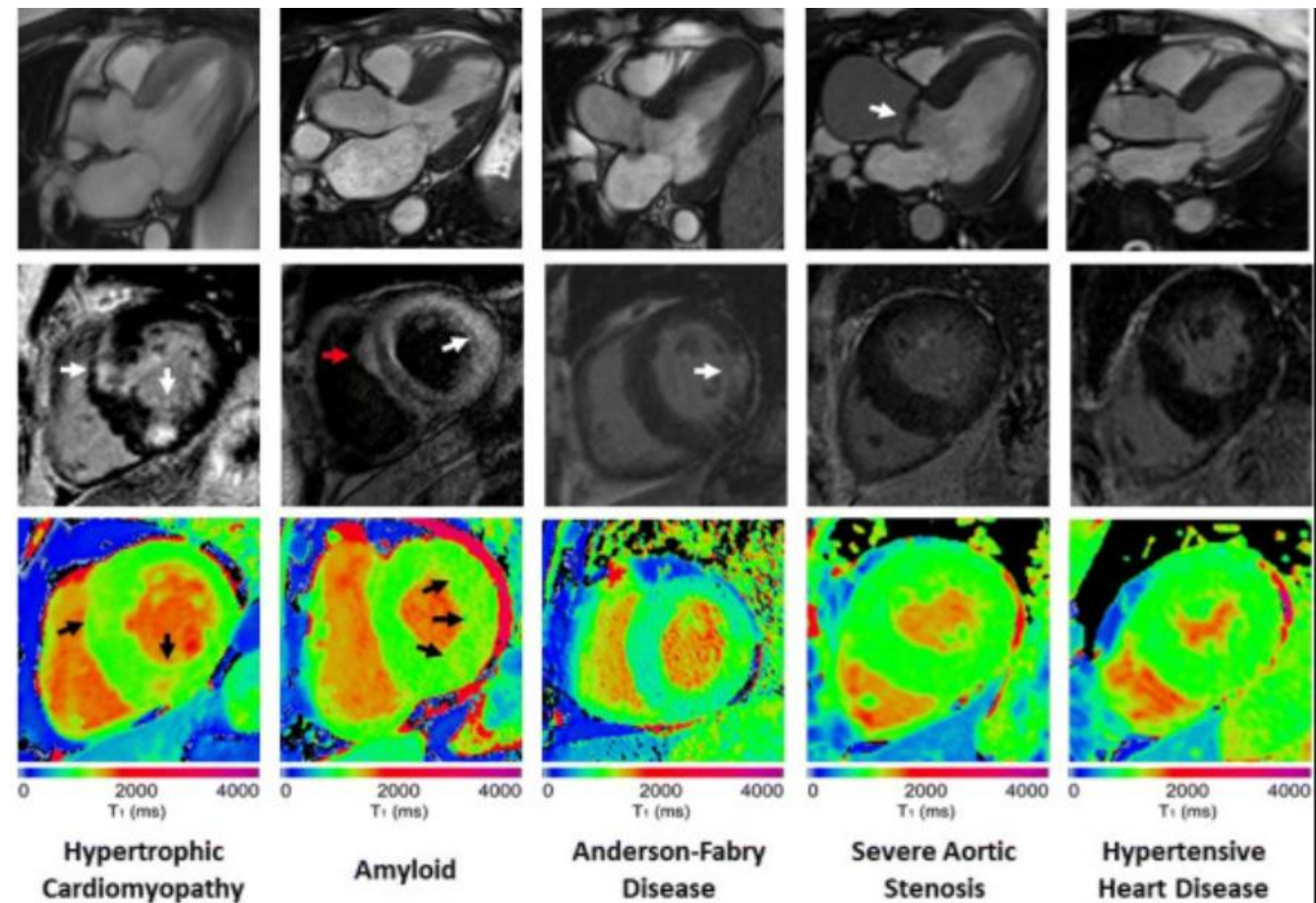
Apikální HKMP

Fabryho nemoc

Amyloidóza

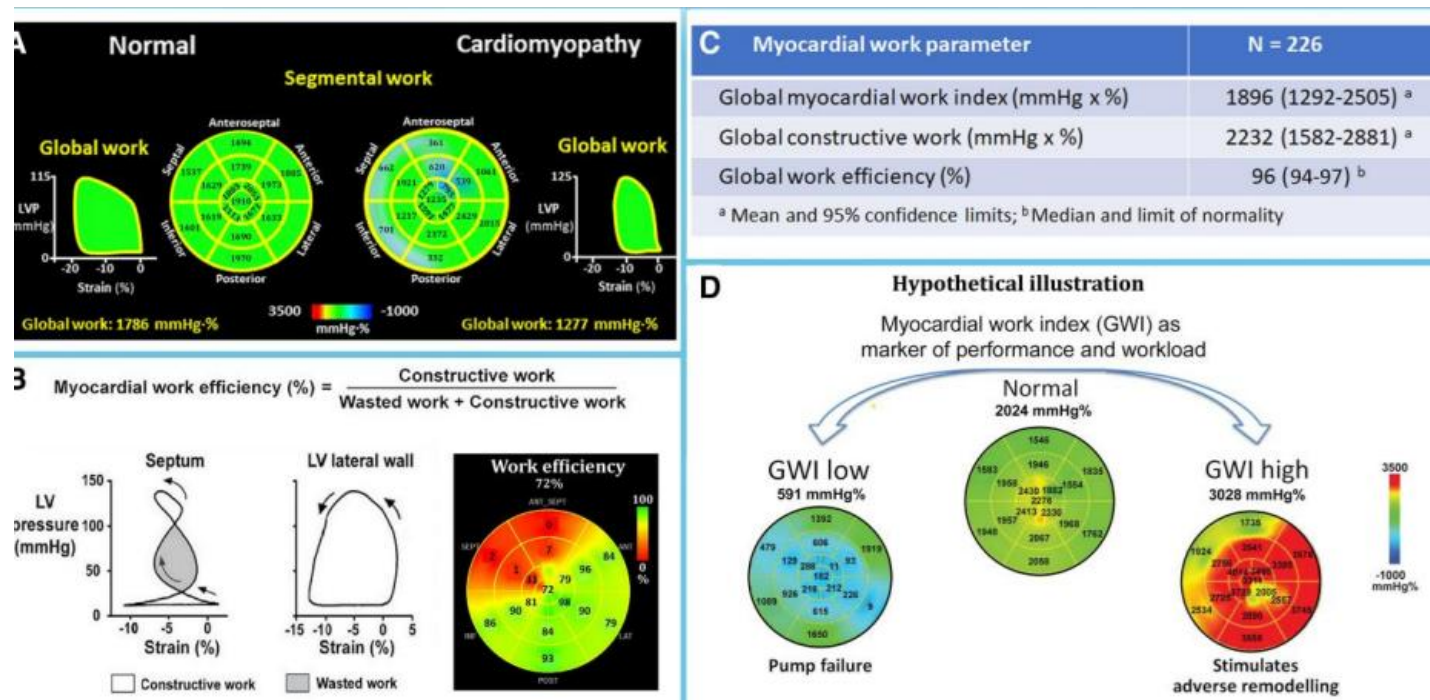
- Snížený strain (< 16%) u 50-60% pacientů s HFpEF
- GLS by měl být zahrnut rutinně do vyšetření při suspekci na HFpEF
- Poskytuje prognostické informace a diagnostické indicie k určení etiologie

MRI v diferenciální diagnostice hypertrofie LK

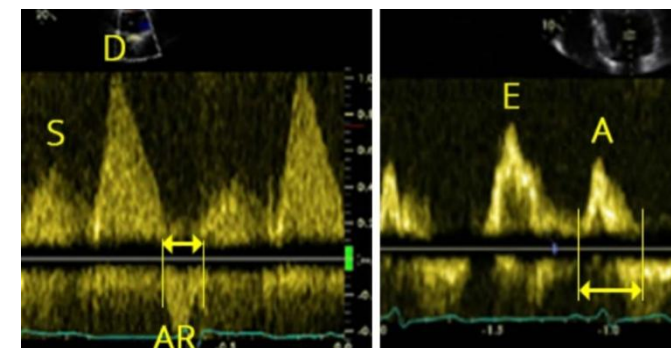
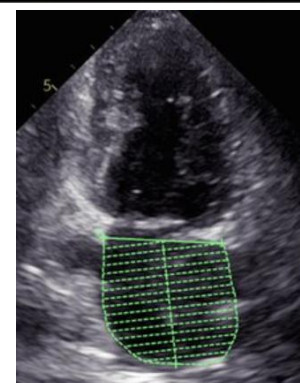
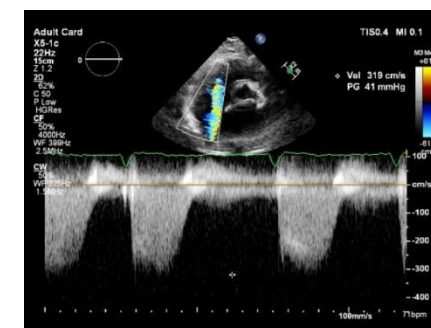
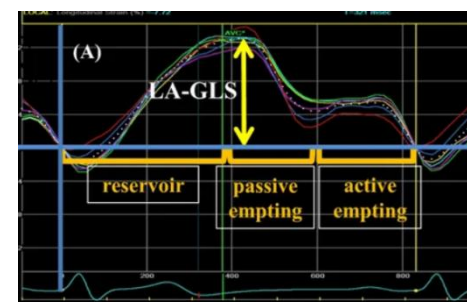
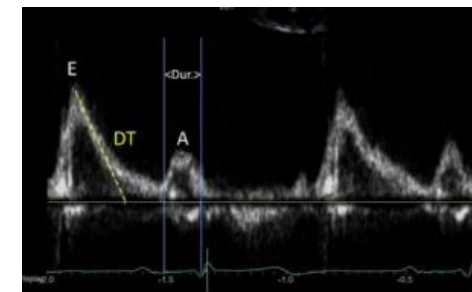
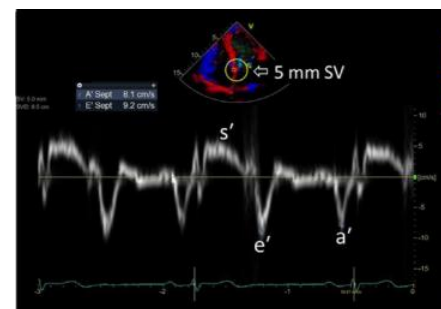
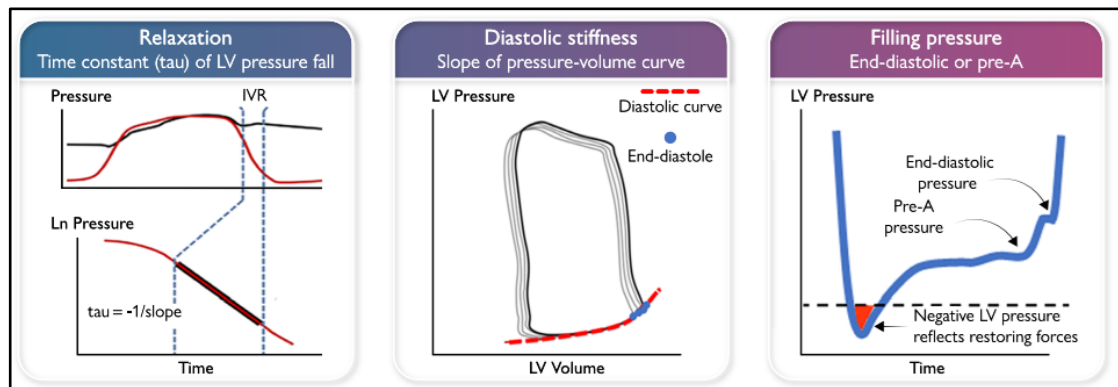
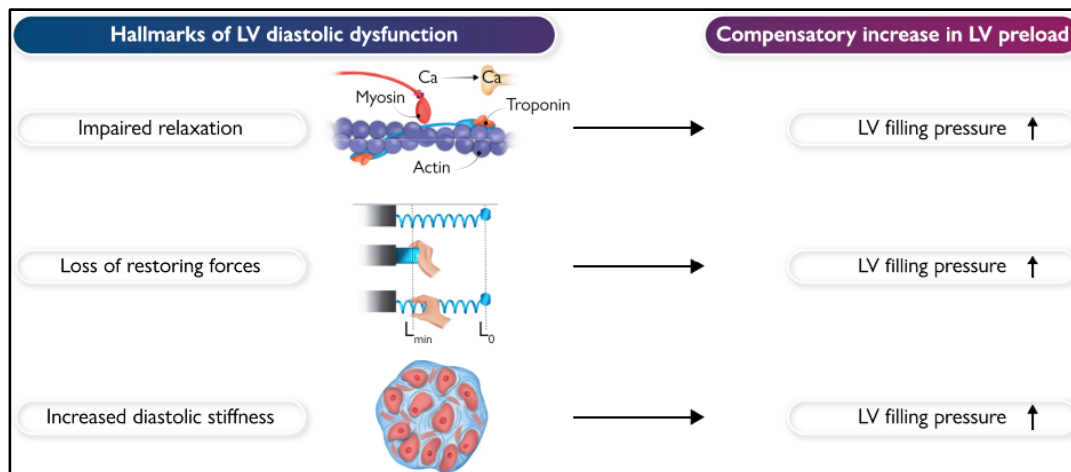


Myokardiální práce

- hodnotí kolik práce musí srdeční sval vykonat při kontrakci.
- oproti EF nehodnotí jen výsledek kontrakce, ale zohledňuje také tlak, proti kterému levá komora pracuje.
- Kombinace deformace myokardu (strain) s odhadem tlaku v levé komoře.



Hodnocení diastolické dysfunkce levé komory



Hodnocení diastolické dysfunkce levé komory

Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography An Update from the American Society of Echocardiography

Sherif F. Naguch, Chair, MD, FASE,¹
Benjamin F. Byrd, III, MD, FASE,
Frank A. Flachskampf, MD, PhD, FES
Patrizio Lancellotti, MD,
Bogdan Alexandru Popescu, MD, PhD,
*Oslo, Norway; Phoenix, Arizona; Nashville,
Tennessee; Liège, Belgium; Cleveland, Ohio; Novato, California*

J Am Soc Echocardiogr 2016;29:27

In patients with normal LV EF

GUIDELINES AND STANDARDS

Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography and for Heart Failure With Preserved Ejection Fraction Diagnosis: An Update From the American Society of Echocardiography

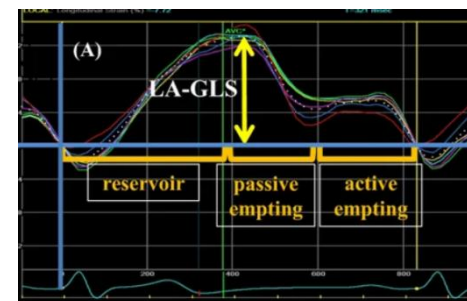
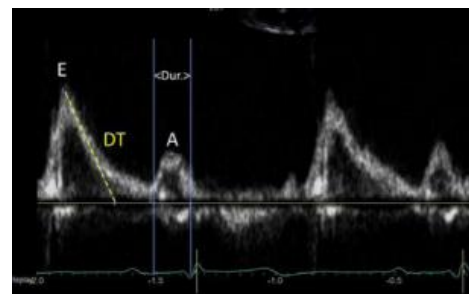
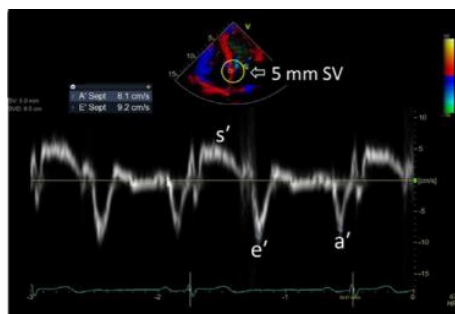
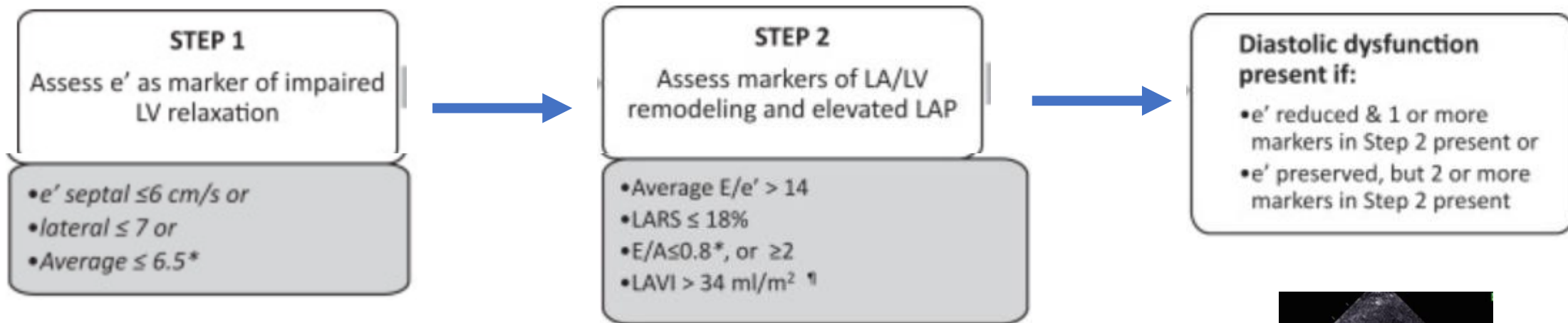
 Check for updates

>50%
positive

Diastolic
Dysfunction

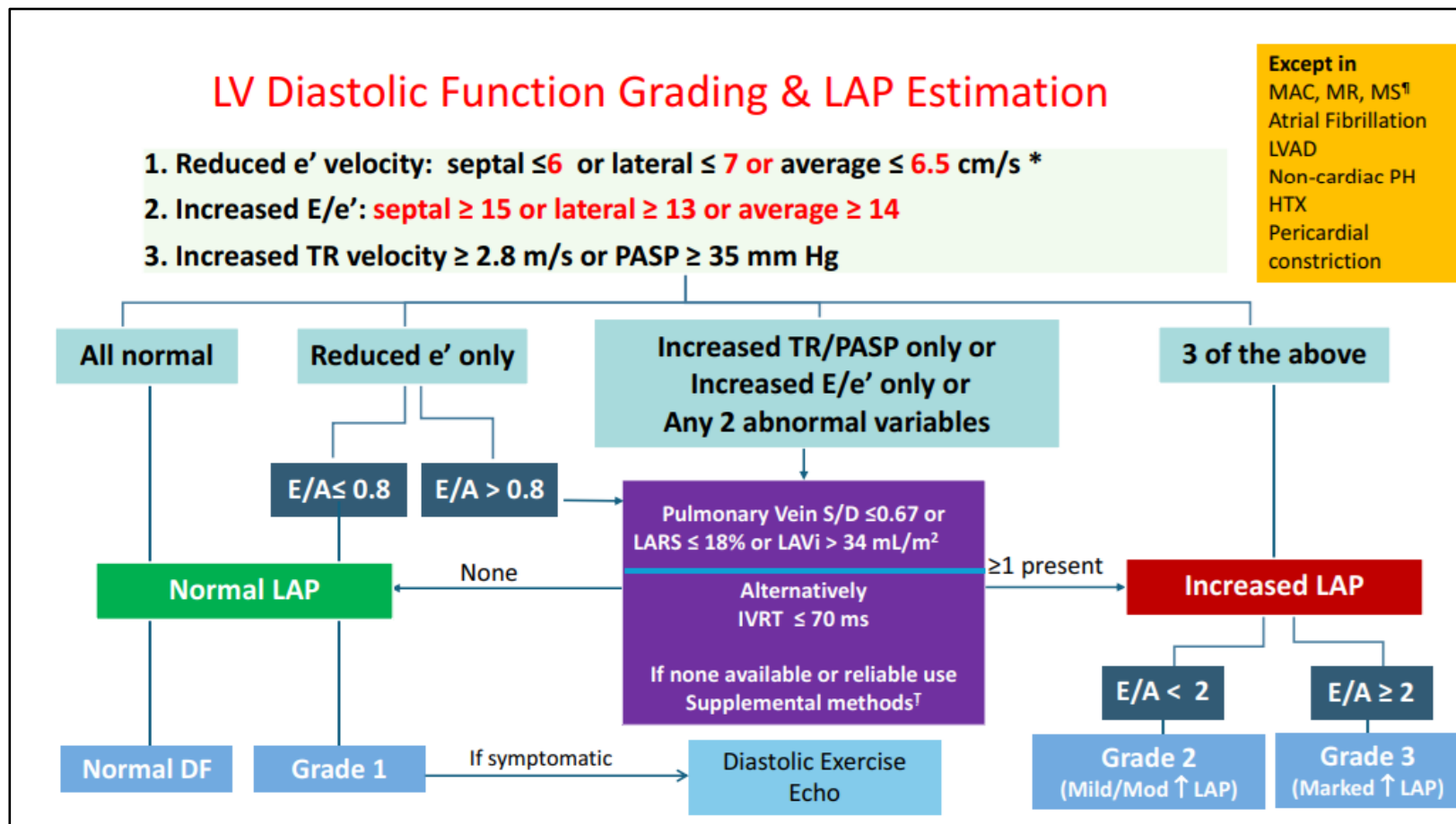
Sherif F. Naguch, MD, FASE (Chair), Danita Y. Sanborn, MD, FASE (Co-Chair), Jae K. Oh, MD, FASE, Bonita Anderson, MAppSc, DMU, ACS, FASE, FASA, Kristen Billick, BS, ACS, RCS, RDCS, FASE, Genevieve Derumeaux, MD, PhD, Allan Klein, MD, FASE, Konstantinos Koulogiannis, MD, FASE, Carol Mitchell, PhD, ACS, RDMS, RDCS, RVT, RT(R), FASE, Amil Shah, MD, Kavita Sharma, MD, Otto A. Smiseth, MD, PhD, Honorary FASE, and Teresa S. M. Tsang, MD, FASE, *Houston and Dallas, Texas; Boston, Massachusetts; Rochester, Minnesota; Brisbane, Australia; San Diego, California; Creteil, France; Cleveland, Ohio; Morristown, New Jersey; Madison, Wisconsin; Baltimore, Maryland; Oslo, Norway; and Vancouver, British Columbia, Canada*

Algoritmus hodnocení diastolické dysfunkce LKS –ASE 2025

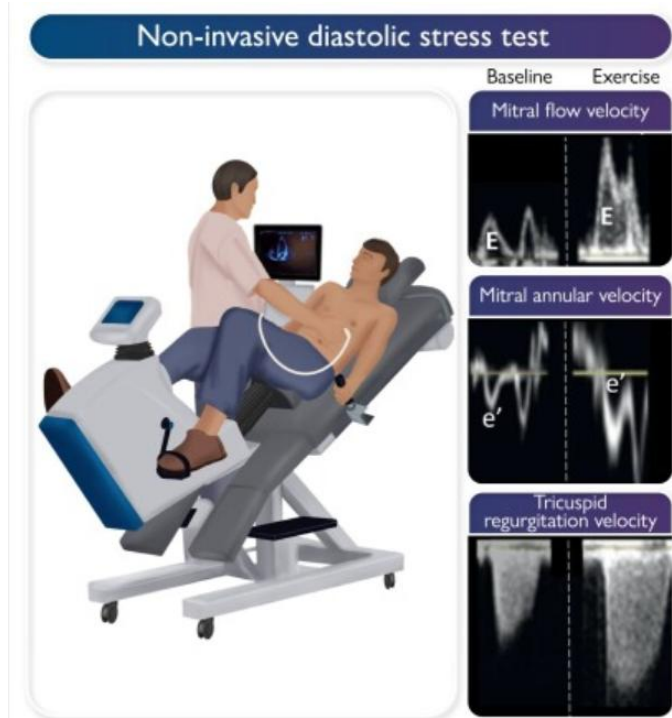


	20-39 y	40-65 y	>65 y
1. Septal e' , cm/s	<7	<6	<6
2. Lateral e' , cm/s	<10	<8	<7
3. Average e' , cm/s	<9	<7	<6.5

Algoritmus hodnocení diastolické dysfunkce LKS –ASE 2025

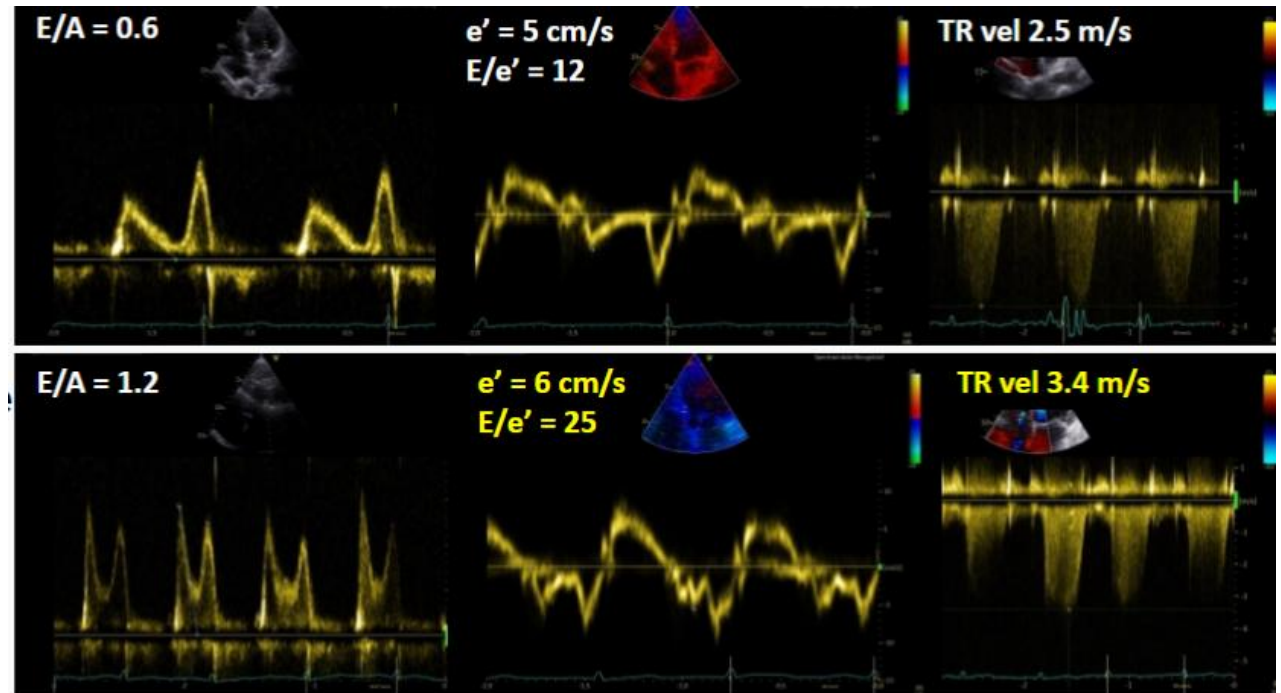


Diastolický zátěžový test



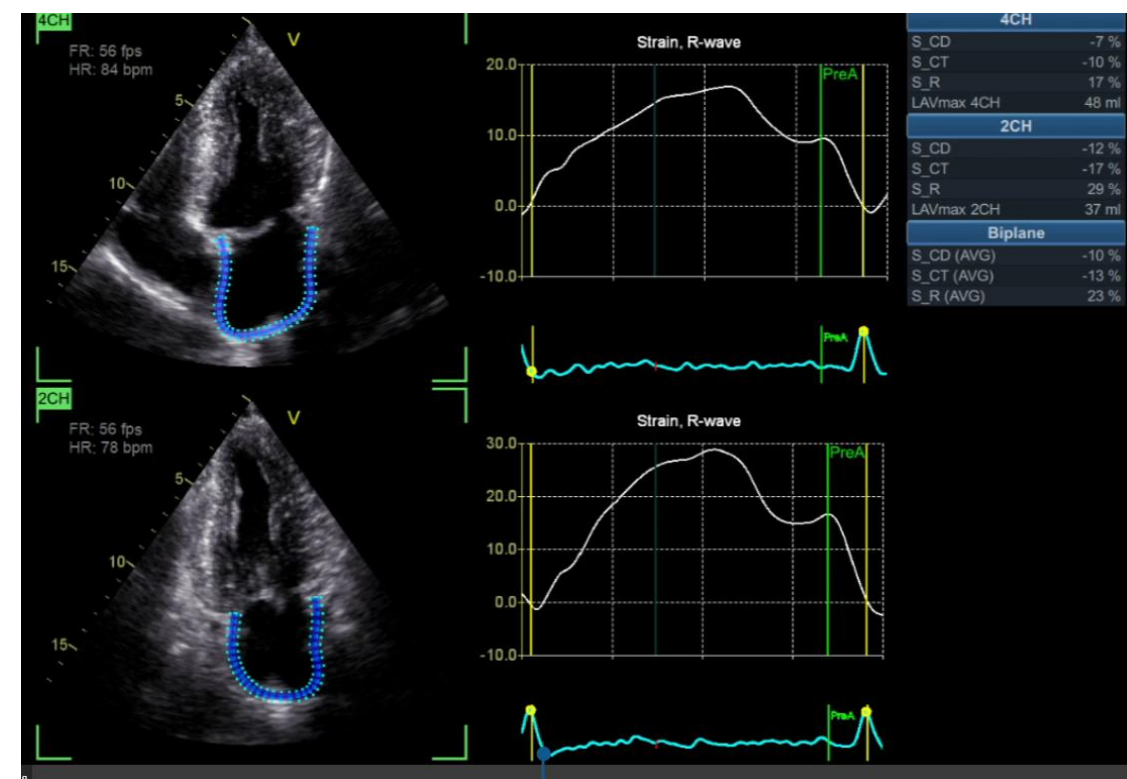
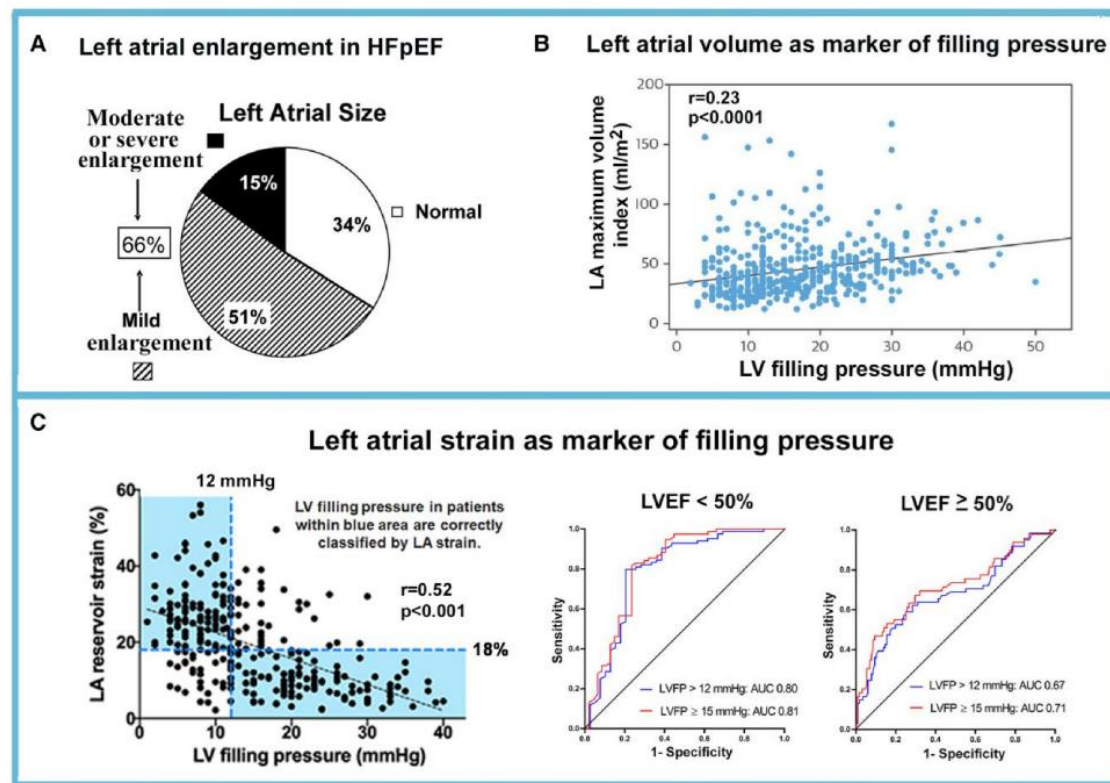
A diastolic stress test is positive when all three criteria are met:

1. Septal $e' < 7$ cm/s at baseline
2. Septal $E/e' > 15$ with exercise (or average $E/e' > 14$)
3. TR velocity > 2.8 m/s with exercise



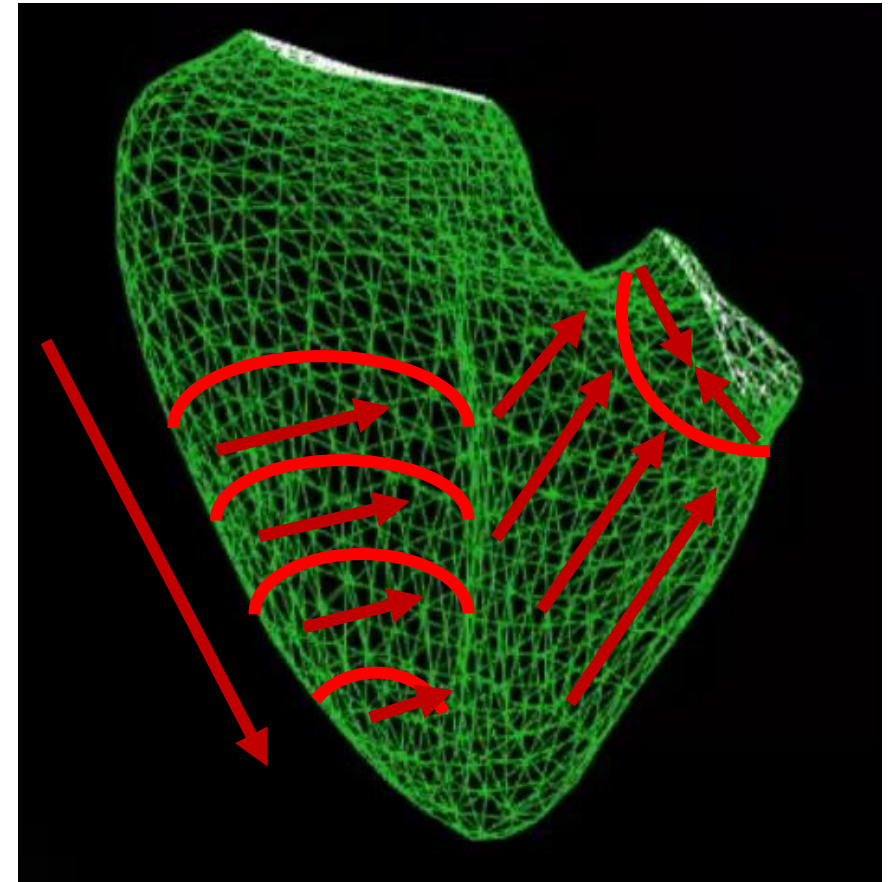
U suspekce na HFpEF při normálním klidovém plnicím tlaku levé komory, tj. u pacientů s diastolickou dysfunkcí I. stupně a a zpožděnou relaxací (septální $e' < 7$ nebo laterální $e' < 10$ cm/s)

Levá síň- strain

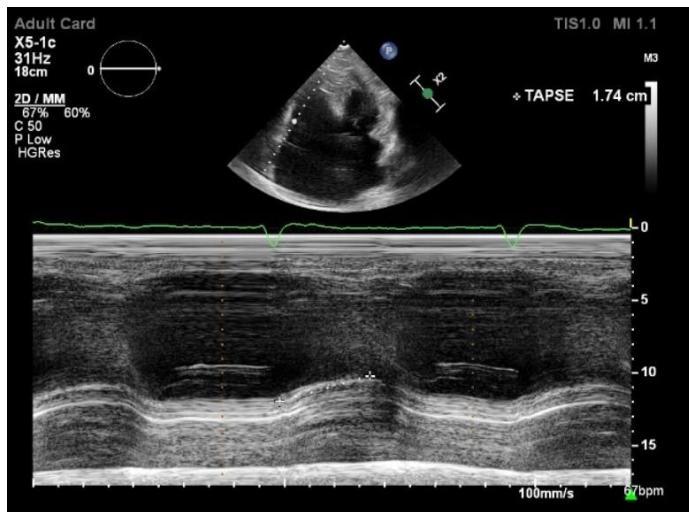


Zhodnocení funkce pravé komory

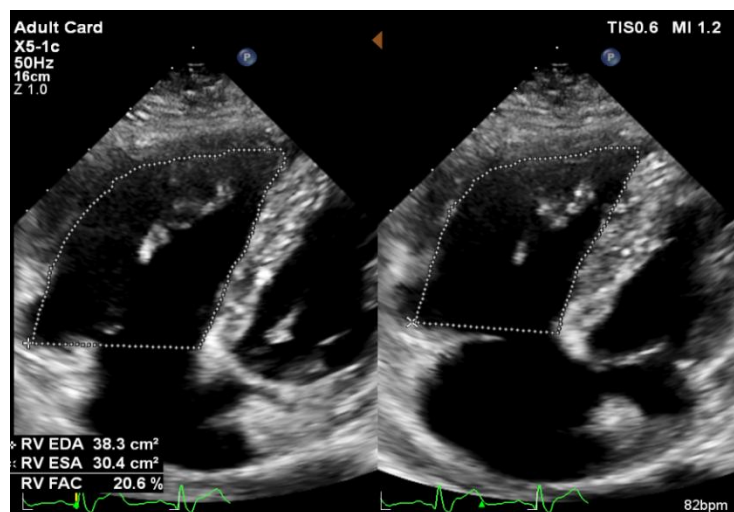
- Funkce PK má zásadní klinický význam napříč téměř všemi kardiovaskulárními onemocněními.
- Její selhání významně zhoršuje prognózu –
- Kvantifikace funkce by tedy měla být standardní součástí echokardiografického vyšetření, podobně jako hodnocení levé komory.
- RV ale není jen „menší sestra“ levé komory. Její anatomie, funkce i způsob adaptace se od LV zásadně liší.
- Tyto rozdíly znemožňují jednoduchý přenos našich znalostí z LV na RV.



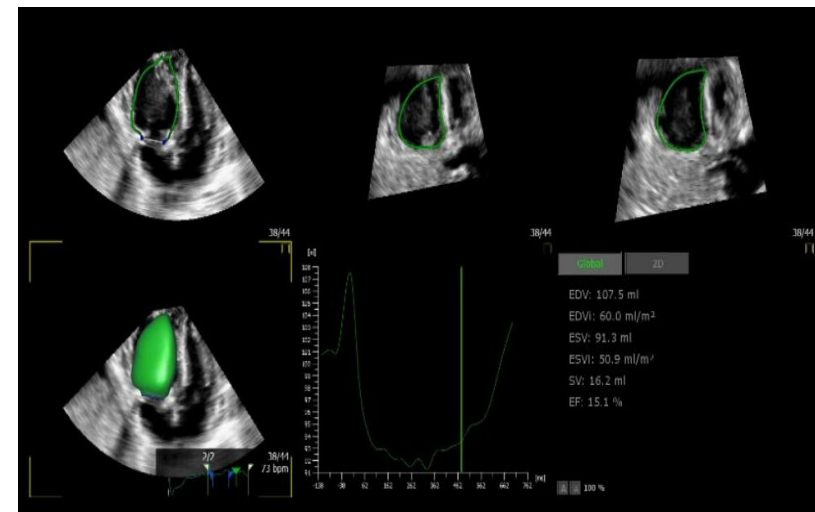
Zhodnocení funkce pravé komory



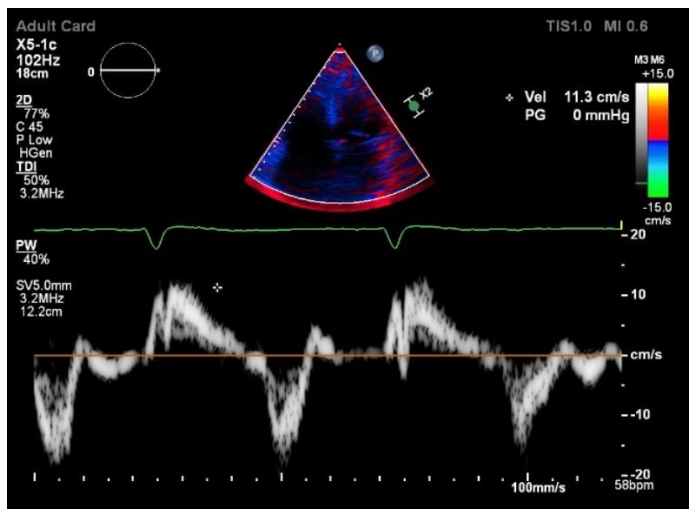
TAPSE < 17mm



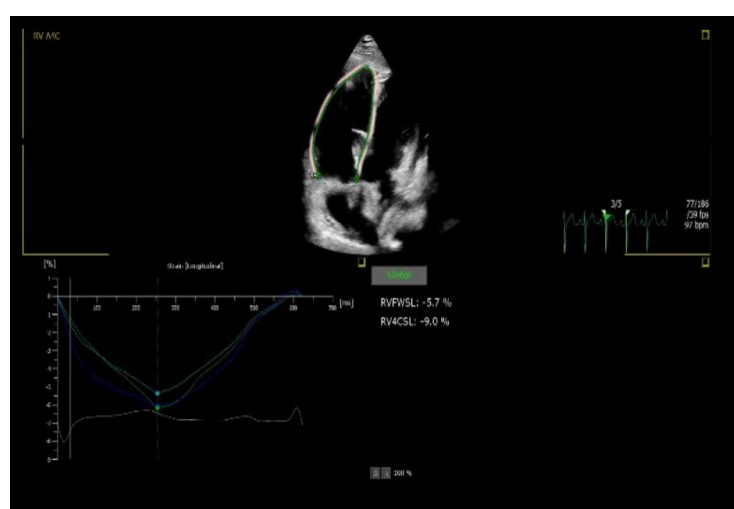
FAC < 35%



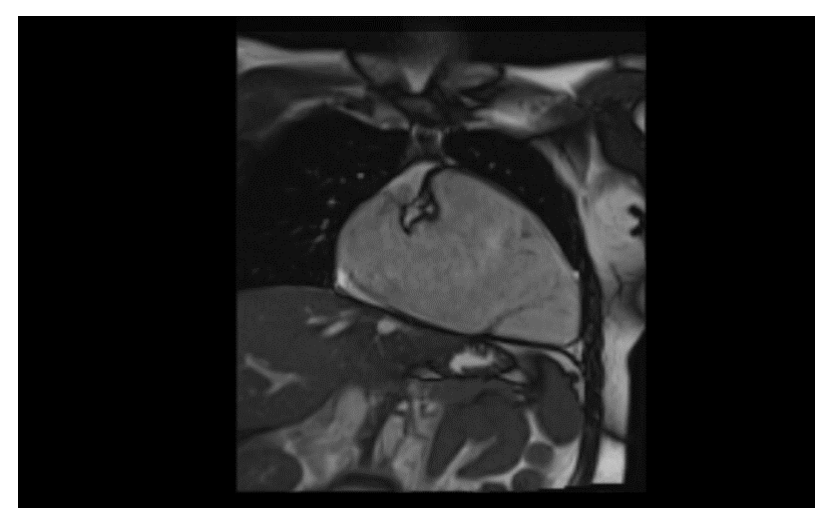
EF < 44%



Sm < 9,5cm/s



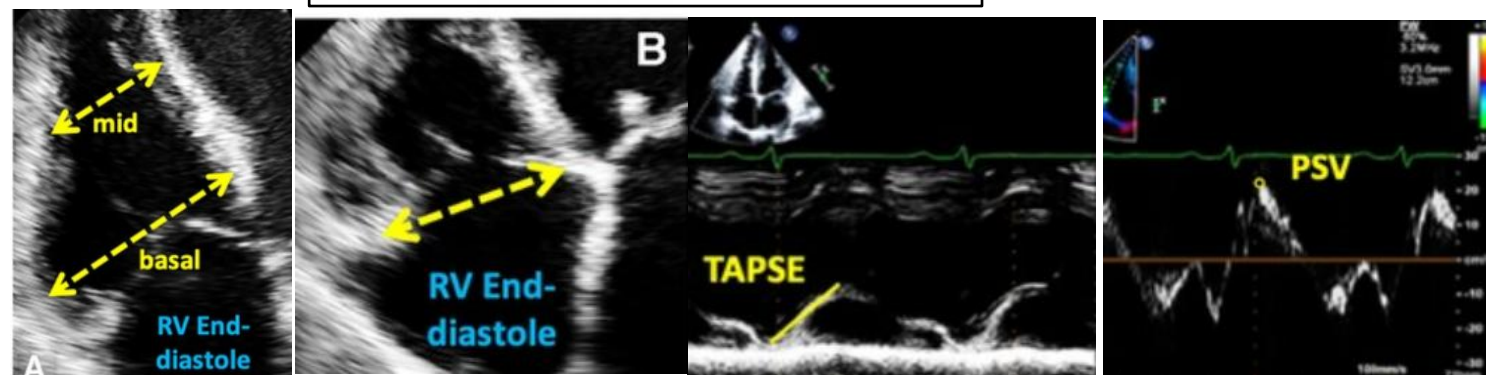
GLS > -17%, Free wall strain > -19%



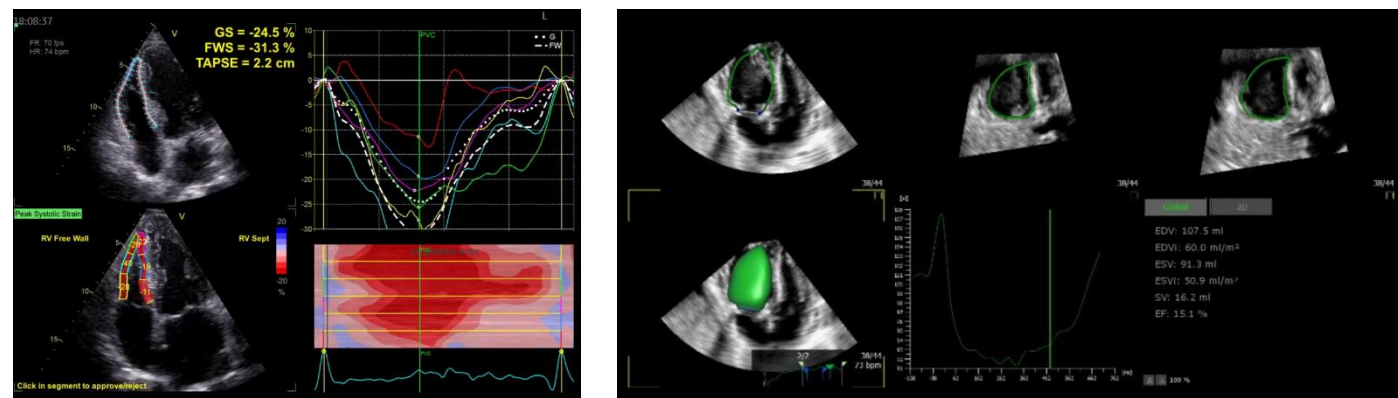
MR srdce

Echokardiografické a invazivní zhodnocení funkce PK a PH

standardní echo



pokročilé echo a event. MRI , PSK



Převzato a upraveno dle Eur Heart J, ehaf194
R.Hahn et al., Europ Heart J 2023

RV dilatation^a

RV basal diameter index:
>24 mm/m²

RV mid-diameter index:
>21 mm/m²

Tricuspid annulus index:
>21 mm/m²

RV end-diastolic
volume index:
>95 mL/m²

RV end-systolic
volume index:
>37 mL/m²

RV dysfunction:

TAPSE <17 mm
RV TDI s' <10 cm/s
RV FWS <23%
RV GLS <21%
3D RV EF <50%
FAC ≤35%

Severe RV dysfunction:

TAPSE <10 mm
RV TDI s' <6 cm/s
RV FWS <11%
RV GLS <9%
3D RV EF <35%
FAC ≤22%

monary pressures

Pre-capillary PH:

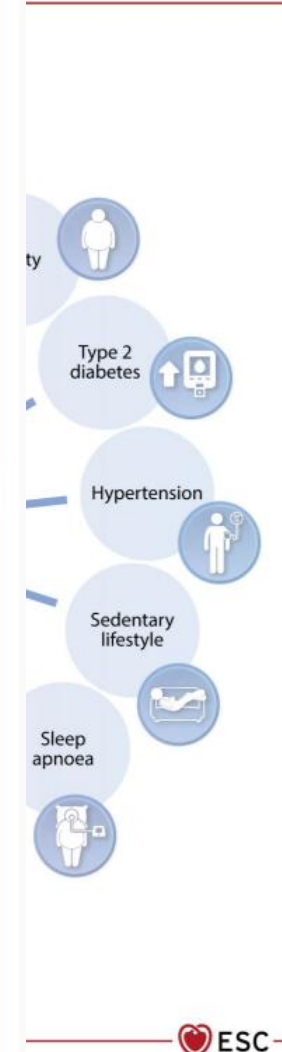
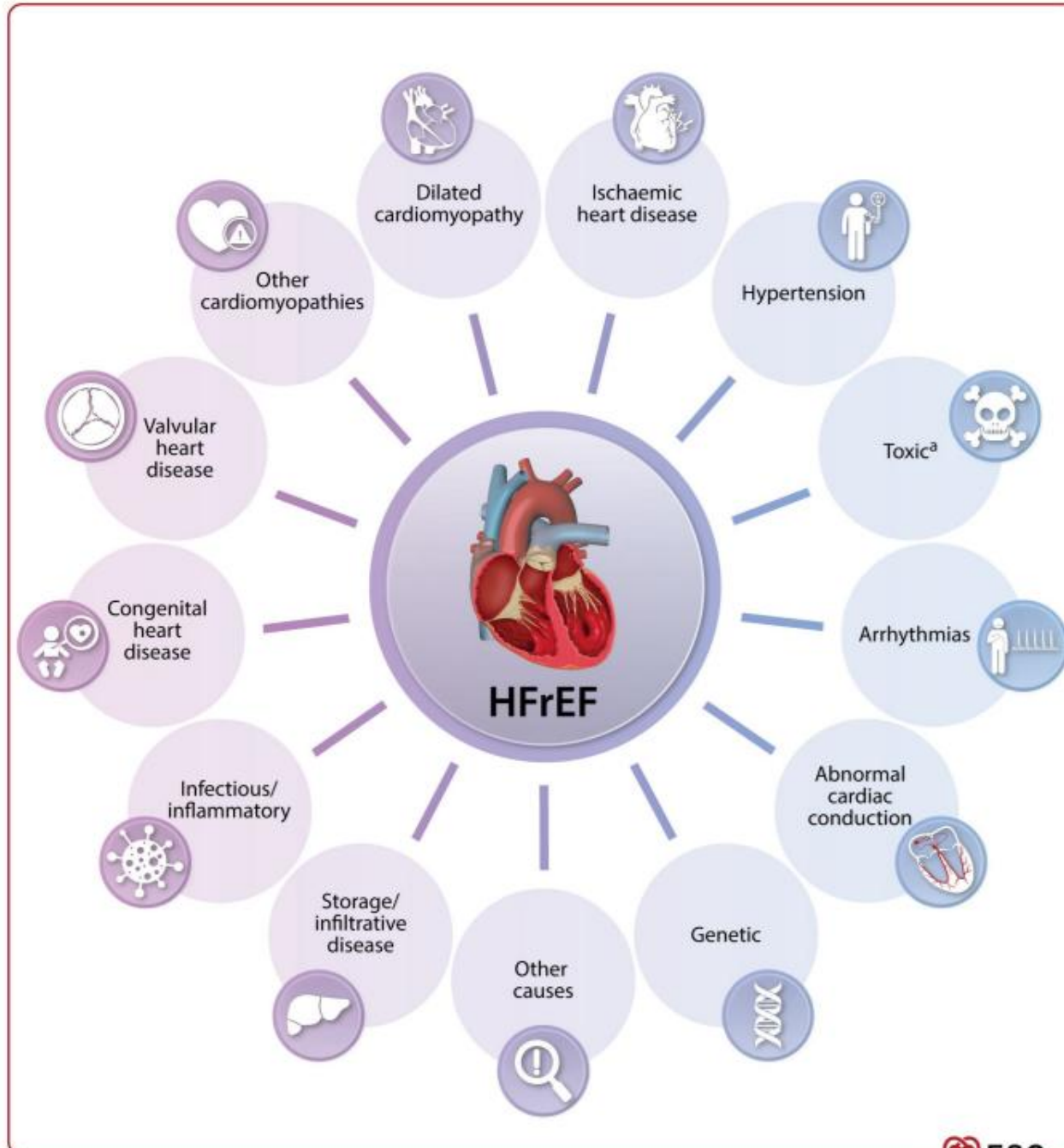
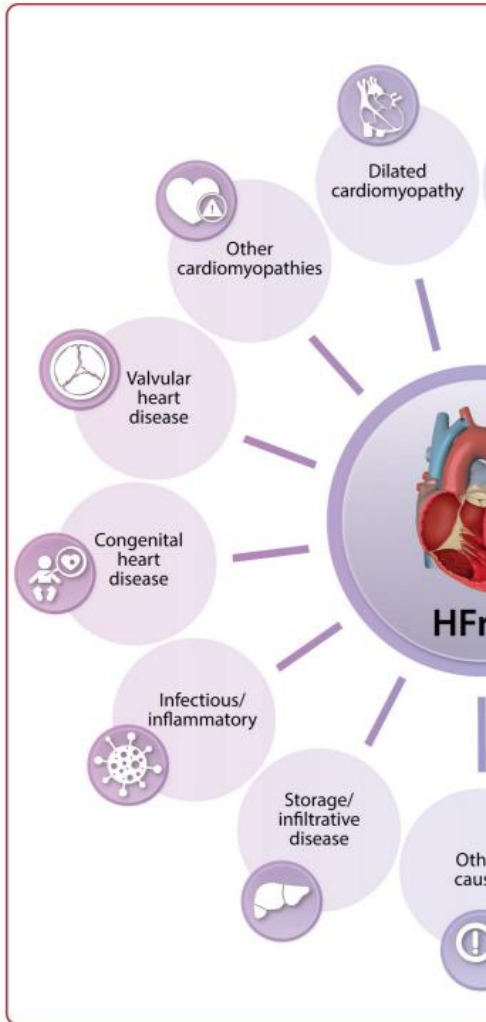
AP >20 mmHg
MP ≤15 mmHg
>2 WU

Post-capillary PH:

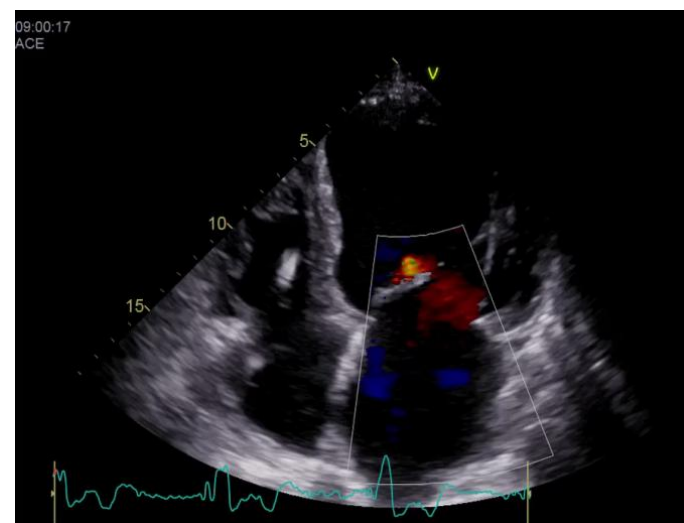
AP >20 mmHg
PAWP >15 mmHg
≤2 WU

Severe PH:

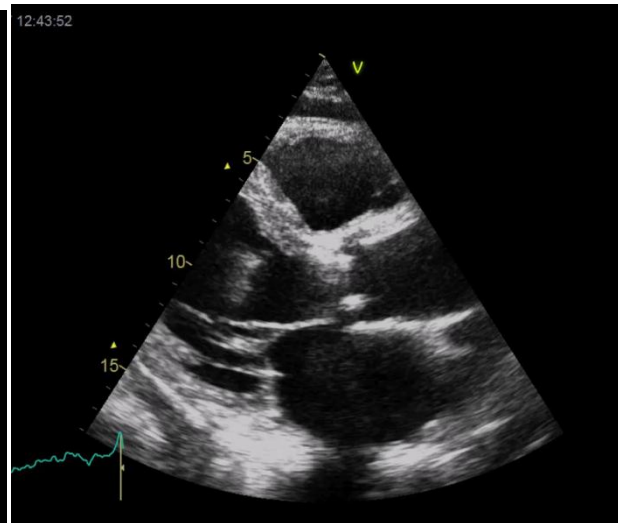
>5 WU
AP >35 mmHg



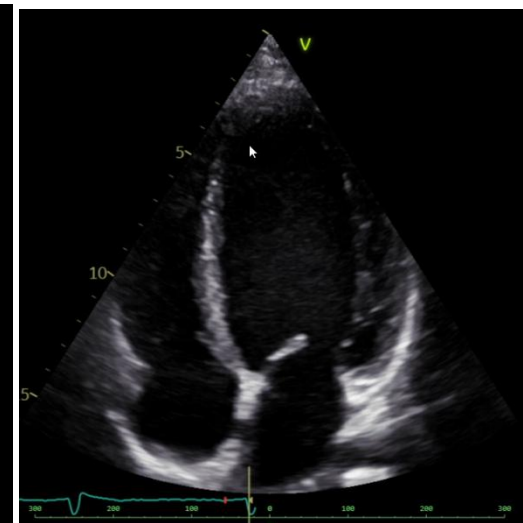
HFrEF



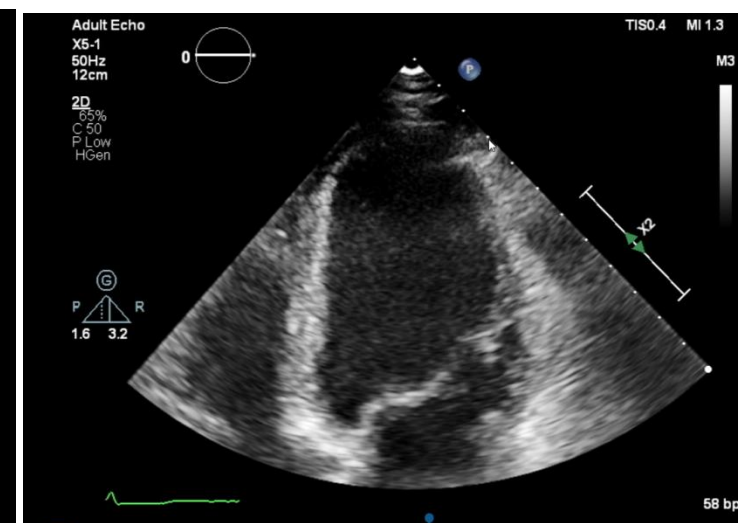
Dysfunkce u MR



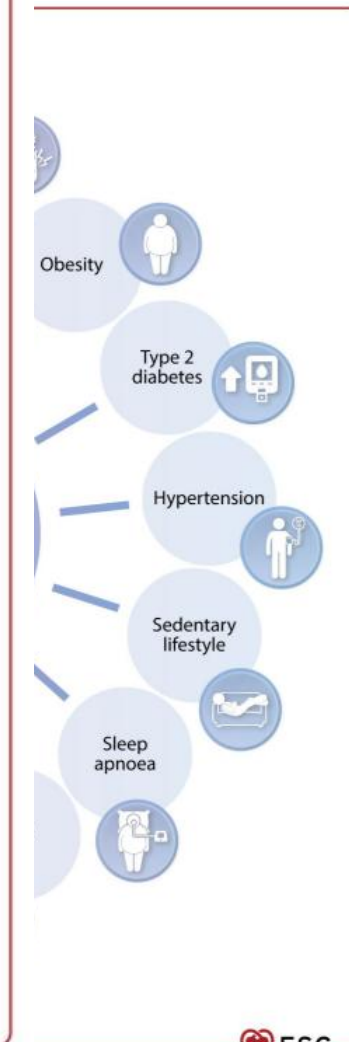
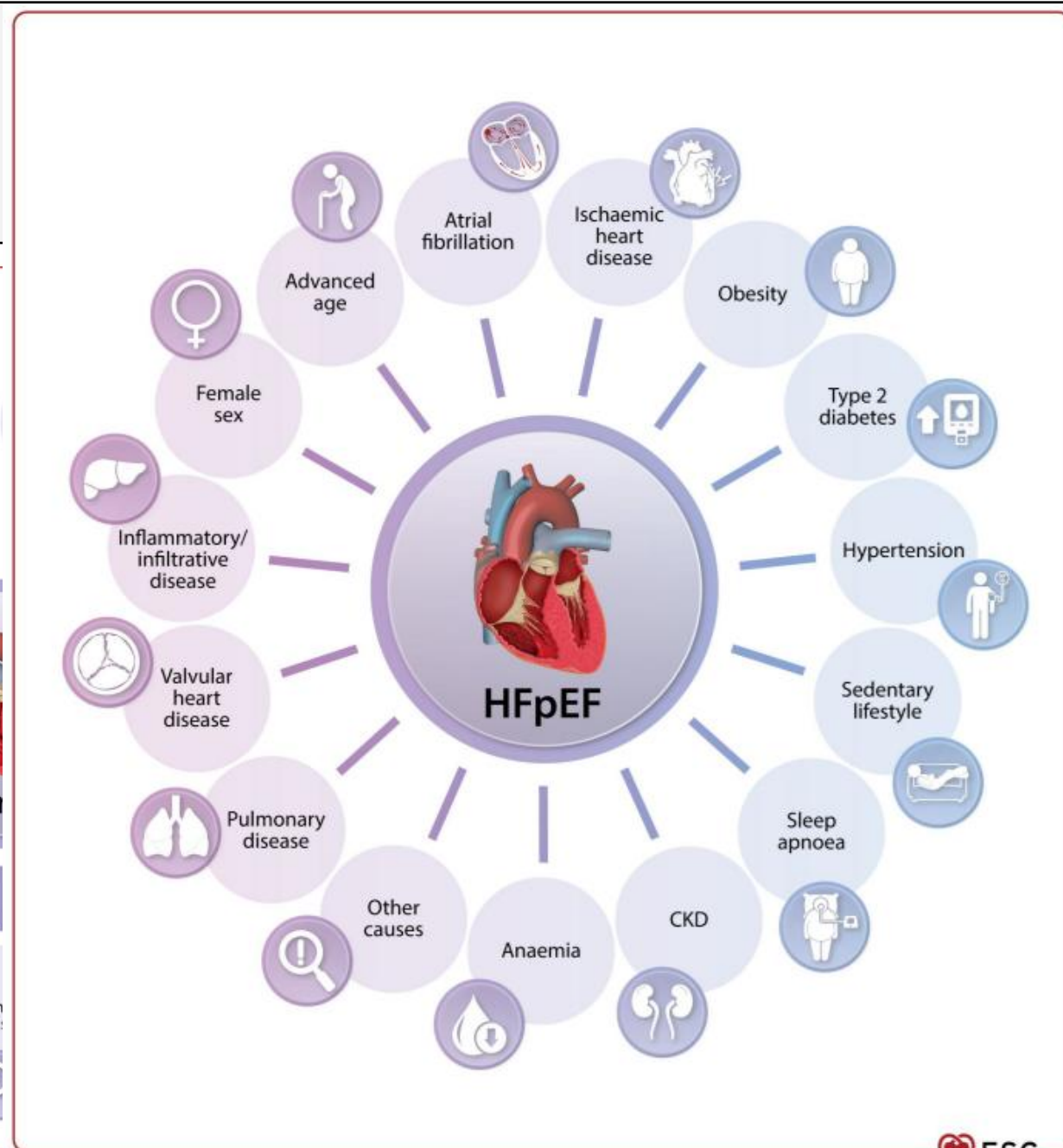
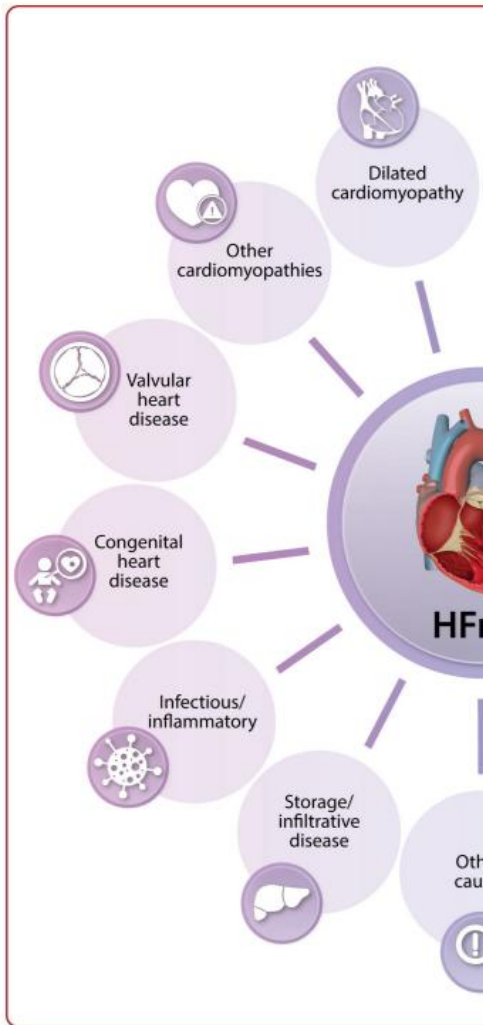
Dysfunkce u AS



DKMP



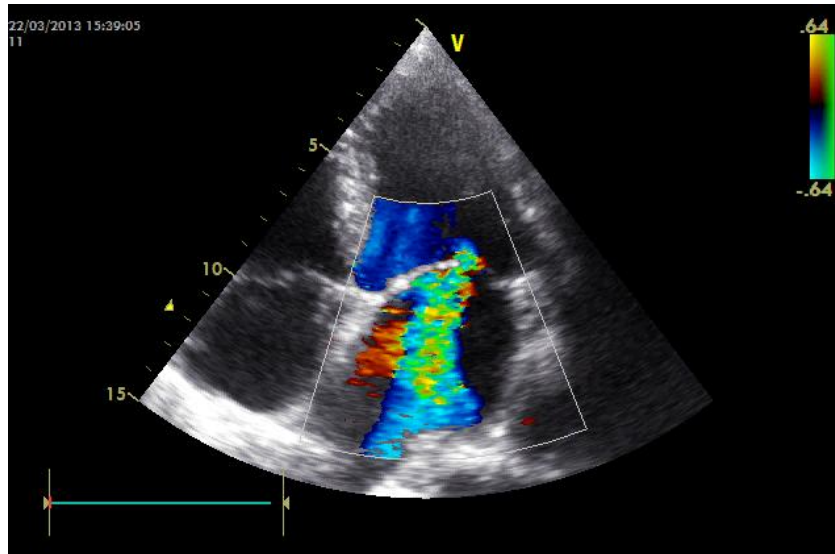
ICHS



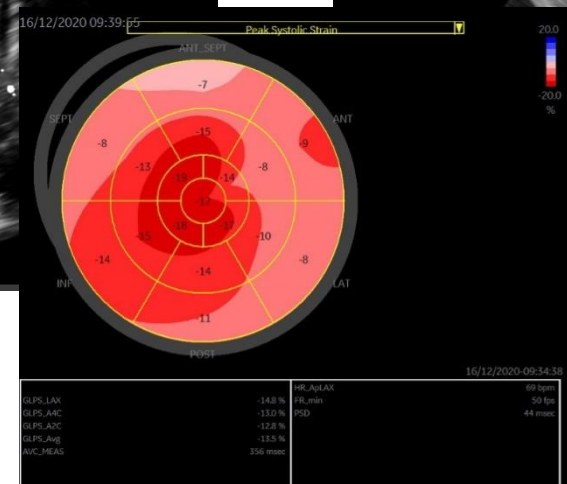
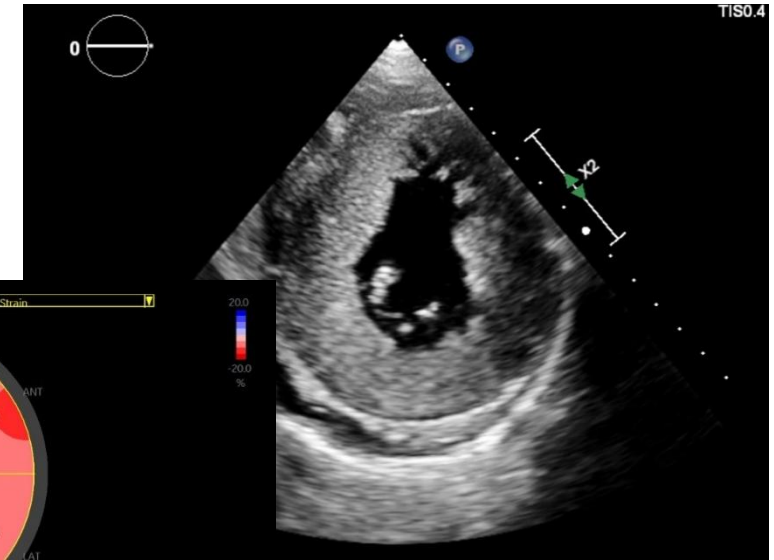
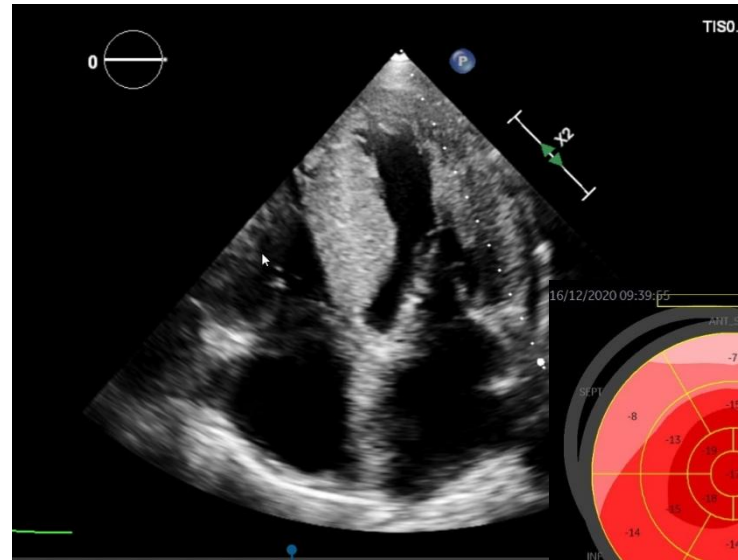
Zjednodušená echokardiografická kritéria pro podporu diagnóz HFpEF

Criteria	Echocardiographic threshold
LV hypertrophy	LV mass index ≥95 g/m ² (female) ≥115 g/m ² (male) OR Relative wall thickness >0.42
LA dilatation (volume indexed by BSA)	>34 mL/m ² (sinus rhythm) >40 mL/m ² (AF)
Increased likelihood of elevated LV filling pressure	E/e' >9 at rest
Raised estimated systolic PA pressure	>35 mmHg OR TR velocity at rest >2.8 m/s

HFrEF

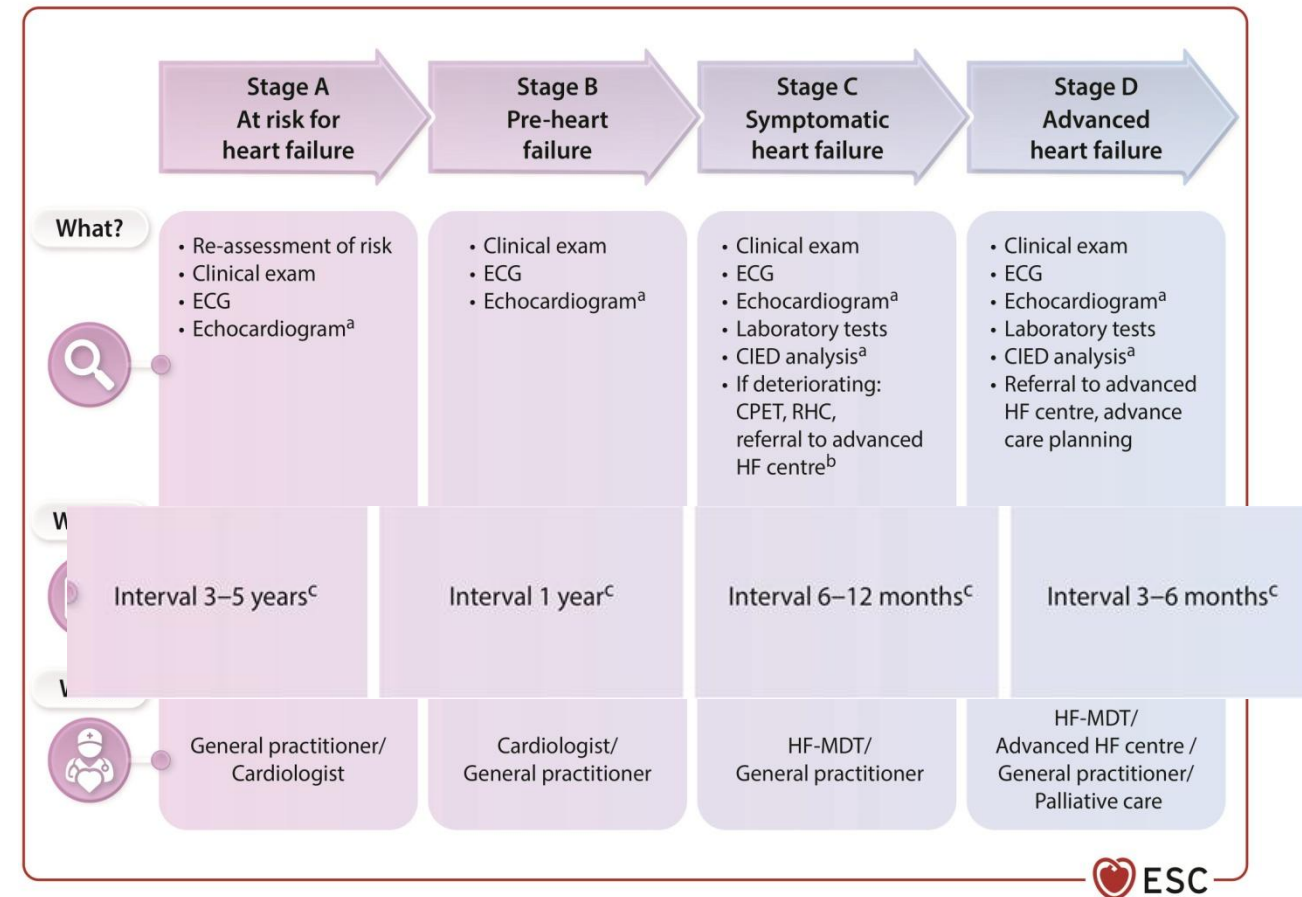
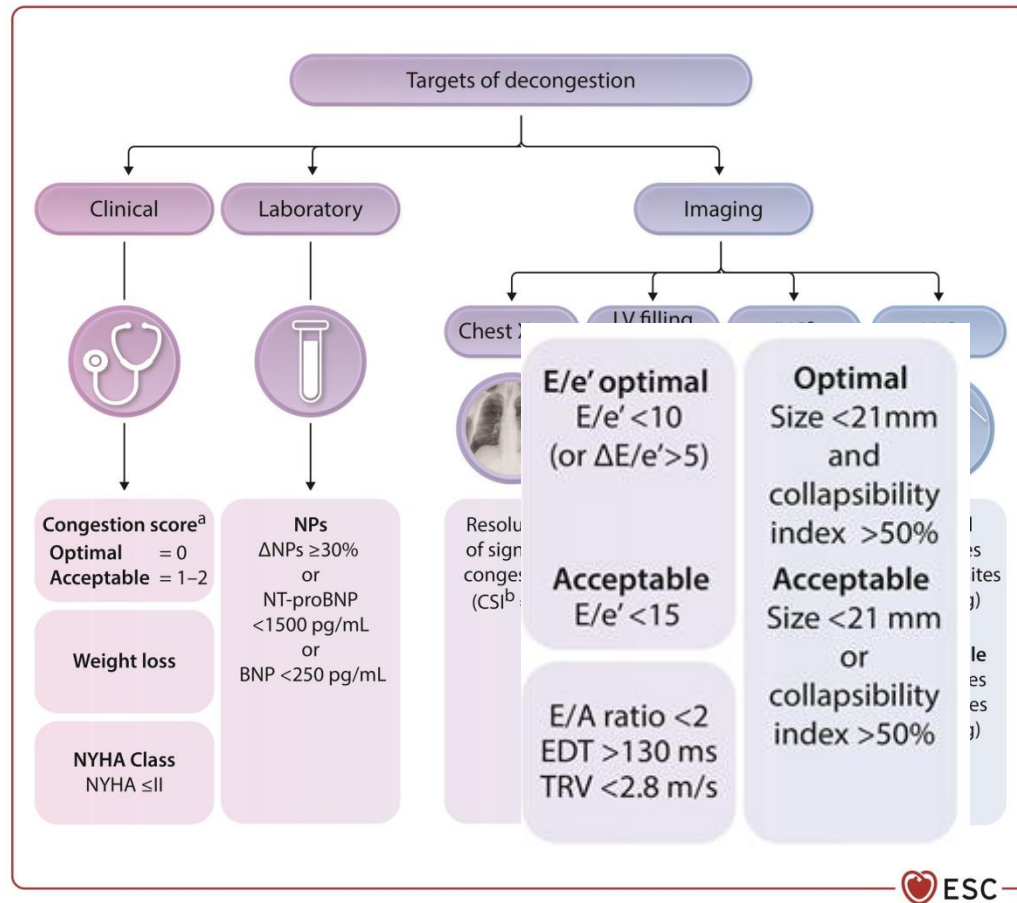


Mitrální regurgitace



Amyloidóza

Follow-up HF a echokardiografie

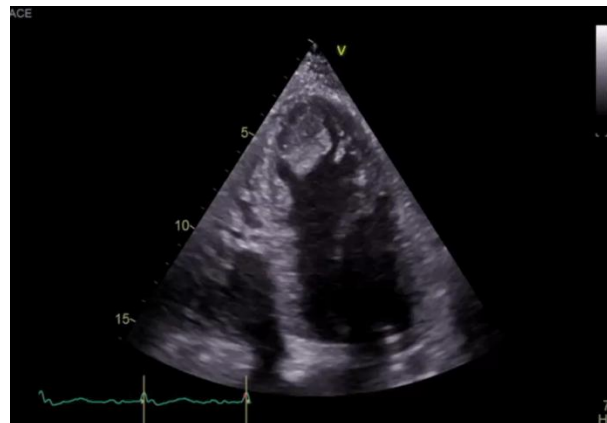
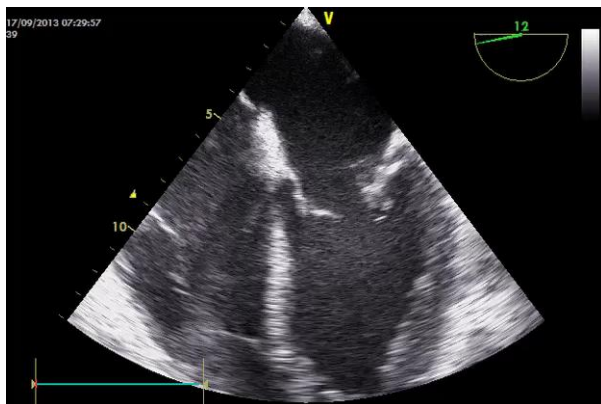


Akutní srdeční selhání

Bedside ECHO

- Jaká je EF?
- Tamponáda?
- Akutní MR?
- Infarkt?
- RV selhání?
- Plicní embolie?

Rychlé rozhodnutí



Take-home messages

- Echokardiografie je základní zobrazovací metoda u všech pacientů se srdečním selháním.
- EF sama nestačí.
- GLS a parametry diastolické funkce významně zpřesňují diagnostiku i prognózu.
- Hodnocení pravé komory je nezbytnou součástí vyšetření.
- Echo zásadně ovlivňuje terapeutická rozhodnutí včetně farmakoterapie, CRT, ICD, TEER, TAVI i transplantace.

Take home messages II

Nové trendy

- 3D echokardiografie
- automatické měření EF
- AI analýza
- strain všech srdečních oddílů
- kontrastní echo
- integrace s MRI

Děkuji za pozornost

