MRI a ICHS

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MRI a ICHS

Chronická ICHS:

- MR koronarografie
- zátěžové testy
- detekce IM a jeho komplikací
- viabilita myokardu

Akutní ICHS:

- AIM
- MINOCA

Co obecně očekáváme

- přímé zobrazení koronárních tepen
- průkaz zátěžové ischemie myokardu
- průkaz proběhlé ischemie myokardu
- odlišení neischemického poškození myokardu

MR koronarografie

- malý diametr koronárních tepen (2-5 mm)
- tortuosita
- pohyb koronárních tepen
- rušivý signál okolního myokardu a tuku

Table 14.6. Characteristics of breath-hold and free-breathing coronary MR angiography versus coronary CT angiography

	MR		CT
	Free-Breathing	Breath-Hold	
Spatial resolution (mm)	0.7×1.0×3.0 0.5×0.5×1.5(reconstructed)	1.1×1.1×3.0	0.6×0.6×0.75 (16-slice) 0.4×0.4×0.6 (64-slice)
Acquisition window (ms)	70–100	120–150	83–165
Total scan time	Several minutes	Multiple breath-holds	±16 sec
Approach	Targeted–whole-heart	Targeted	Whole-heart
ECG trigger/gating	Prospective triggering	Prospective triggering	Retrospective gating
Contrast agent needed	No	Advisable	Yes
Impact CA calcifications	Minimal	Minimal	Large
Influence heart rate	Moderate	Minimal	Large
Irradiation	No	No	Yes
Operator (training)	Experience needed	Experience needed	Less experience needed
CA stenosis detection	Possible	Possible	Possible
CA stenosis quantification	Not possible	Not possible	Possible (?)
CA wall visualization	Difficult	Difficult	Possible
Comprehensive study, including:			
- cardiac function	Yes	Yes	Yes
- myocardial perfusion	Yes	Yes	Research
- late enhancement	Yes	Yes	Research

BOGAERT, J.; DYMARKOWSKI, S.; TAYLOR, A. M. *Clinical Cardiac MRI.* 549 p. ISBN 3-540-26217-2.

ESC Guidelines on myocardial revascularization

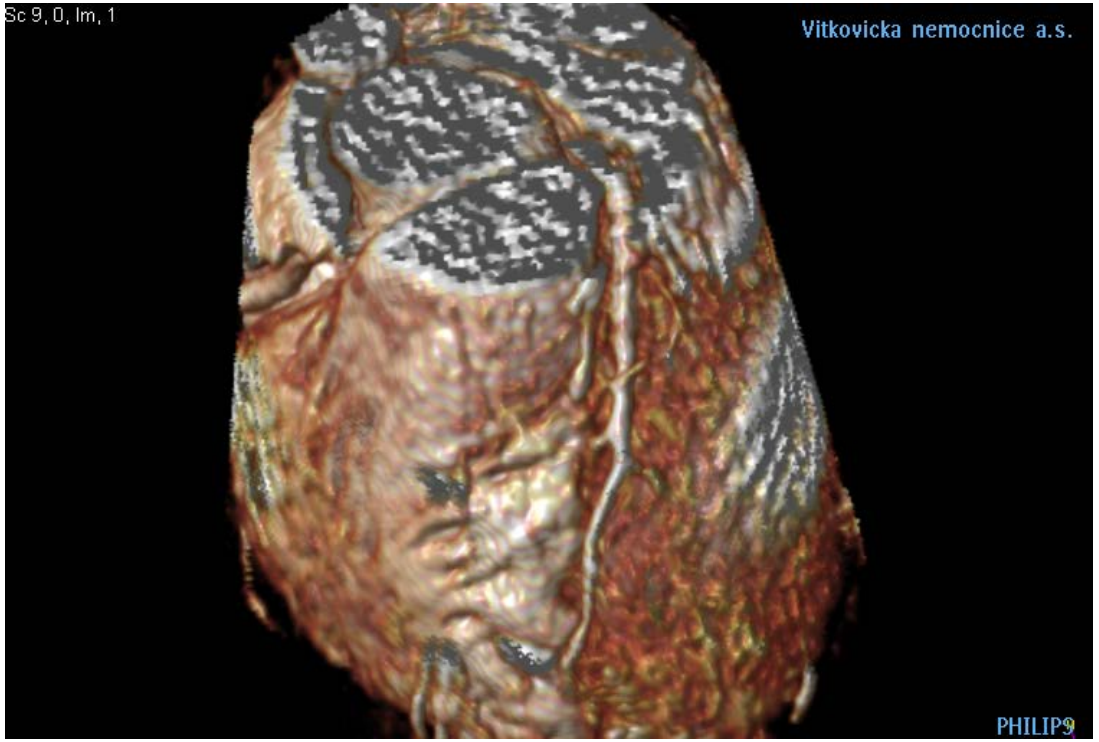
Indications for diagnostic testing in patients with suspected CAD and stable symptoms

	Asymptomatic[a]		Symptomatic						
			Probability of significant disease[b]						
			Low (<15%)		Intermediate (15–85%)		High (>85%)		
	Class[c]	Level[d]	Class[c]	Level[d]	Class[c]	Level[d]	Class[c]	Level[d]	Ref[e]
Anatomical detection of CAD									
Invasive angiography	III	A	III	A	IIb	A	I	A	50–52,54
CT angiography[f,g]	III	B	III	C	IIa	A	III	B	57–62
Functional test									
Stress echo	III	A	III	A	I	A	III	A	63–65
Nuclear imaging	III	A	III	A	I	A	III	A	60,66–70
Stress MRI	III	B	III	C	I	A	III	B	71–75
PET perfusion	III	B	III	C	I	A	III	B	67,69,70,76,77
Combined or hybrid imaging test									
	III	C	III	C	IIa	B	III	B	78–83

CAD = coronary artery disease; CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography.
[a]Screening for silent (asymptomatic) myocardial ischaemia may be considered in selected high-risk patients, such as those with diabetes mellitus.[84]
[b]Pre-test probability of CAD. Low 0—15%; intermediate 15—85%; high >85% as assessed using the criteria based on ESC Guidelines of SCAD.[47]
[c]Class of recommendation.
[d]Level of evidence.
[e]References.
[f]This refers to CT angiography, not calcium scoring.
[g]CT is considered to perform best in the lower range of pre-test probability (15—50%).[47]

2014ESC/EACTSGuidelinesonmyocardial revascularization. EuropeanHeart Journal. 2014;35,2541–2619.

MR koronarografie



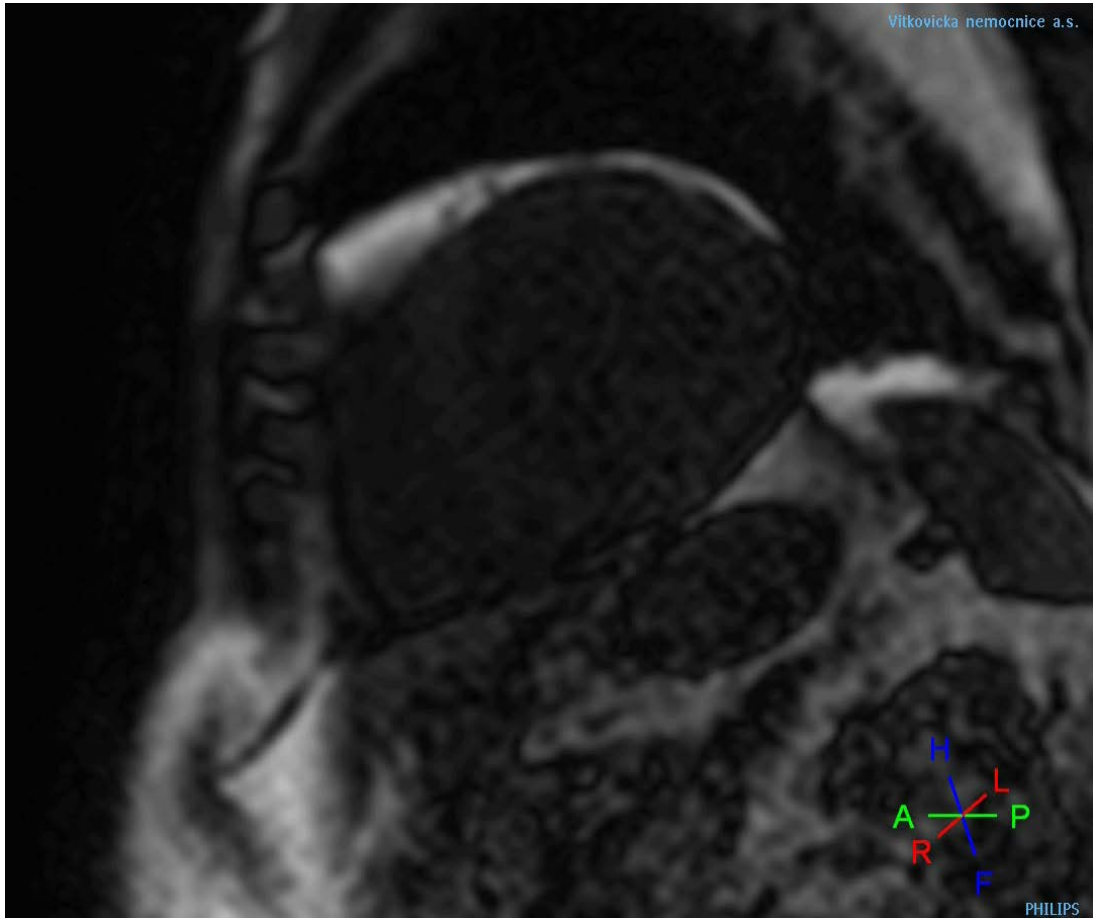
Zátěžové MRI srdce

- srovnatelná metoda se zátěžovým SPECT/DSE
- možná pouze farmakologická zátěž

- perfuze
- kinetika

- Adenosin (Dipyridamol/Regadenoson)
- Dobutamin (+ Atropin)

Perfuze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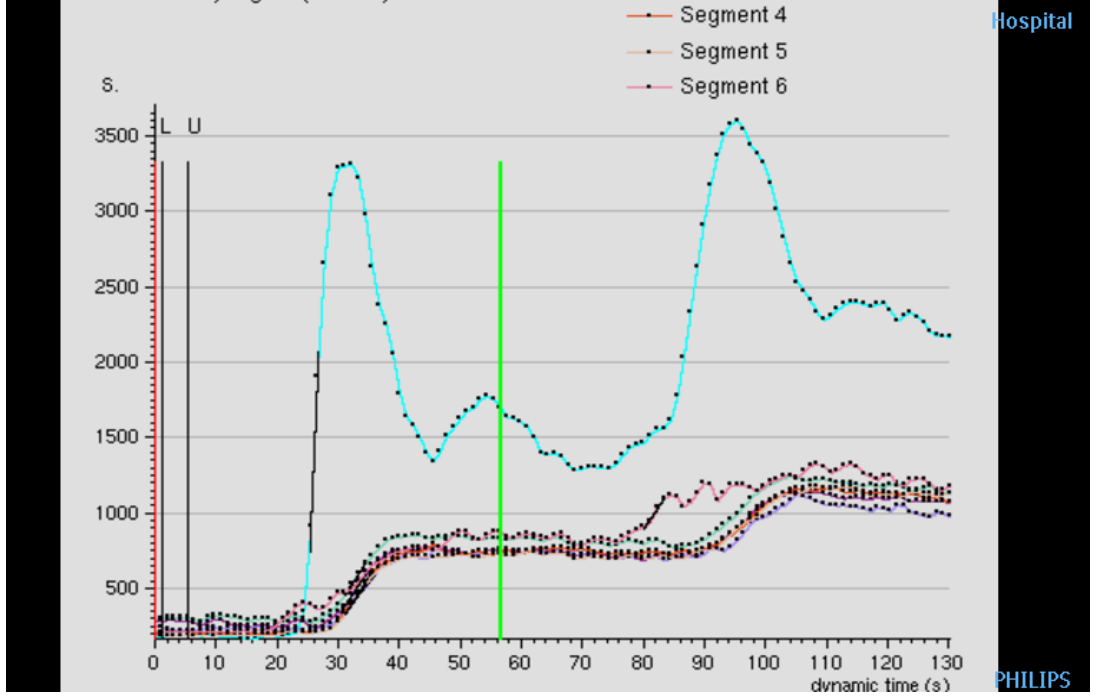
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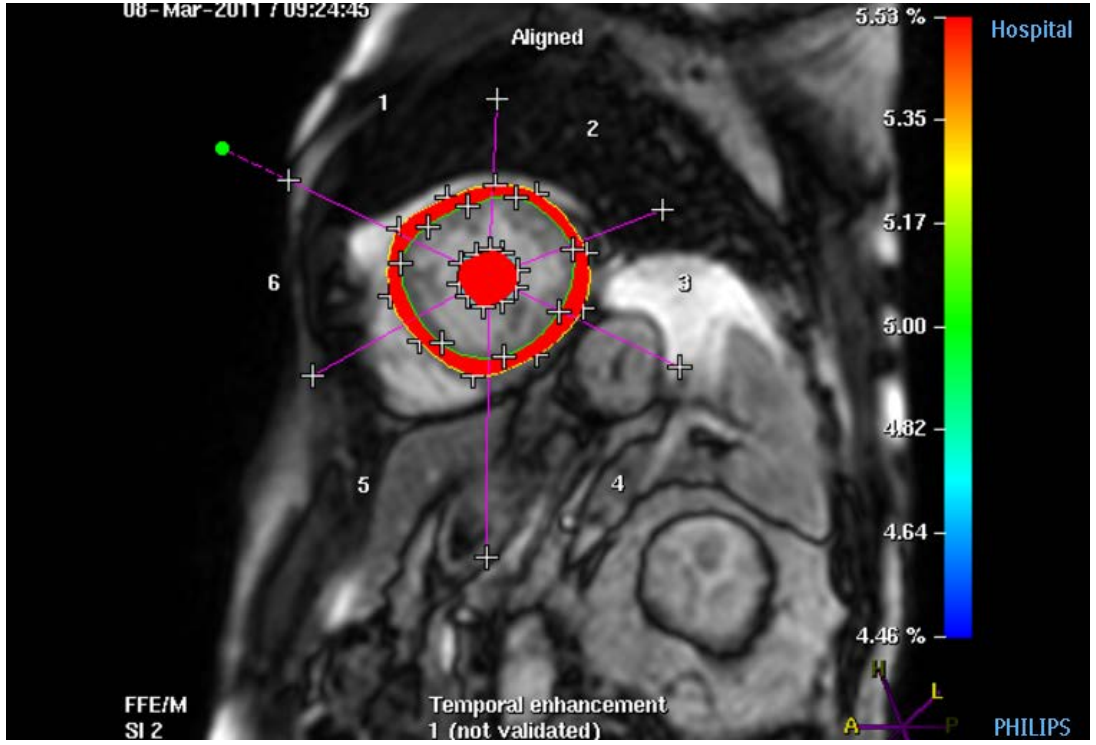
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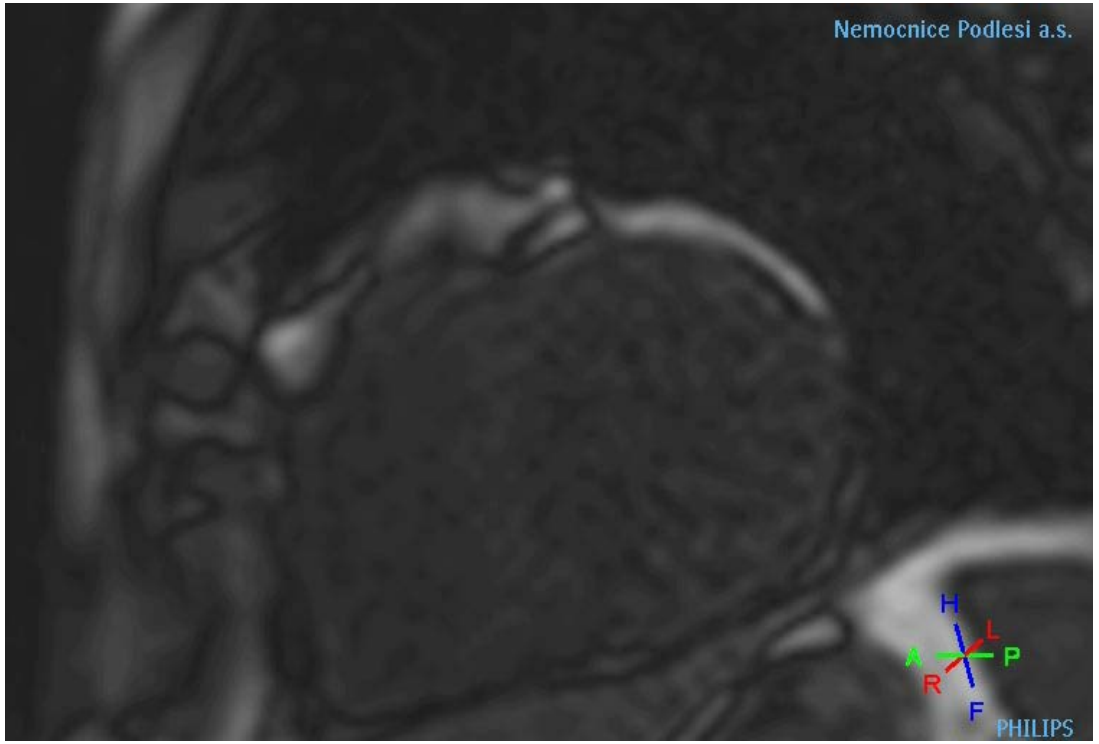
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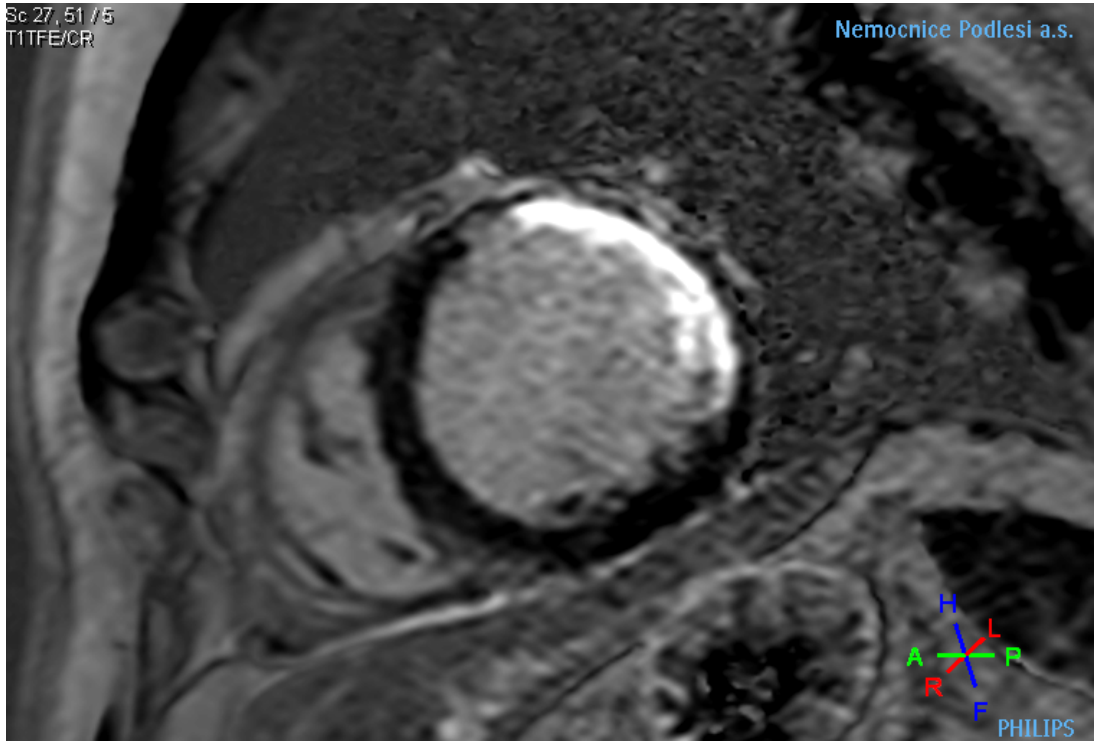
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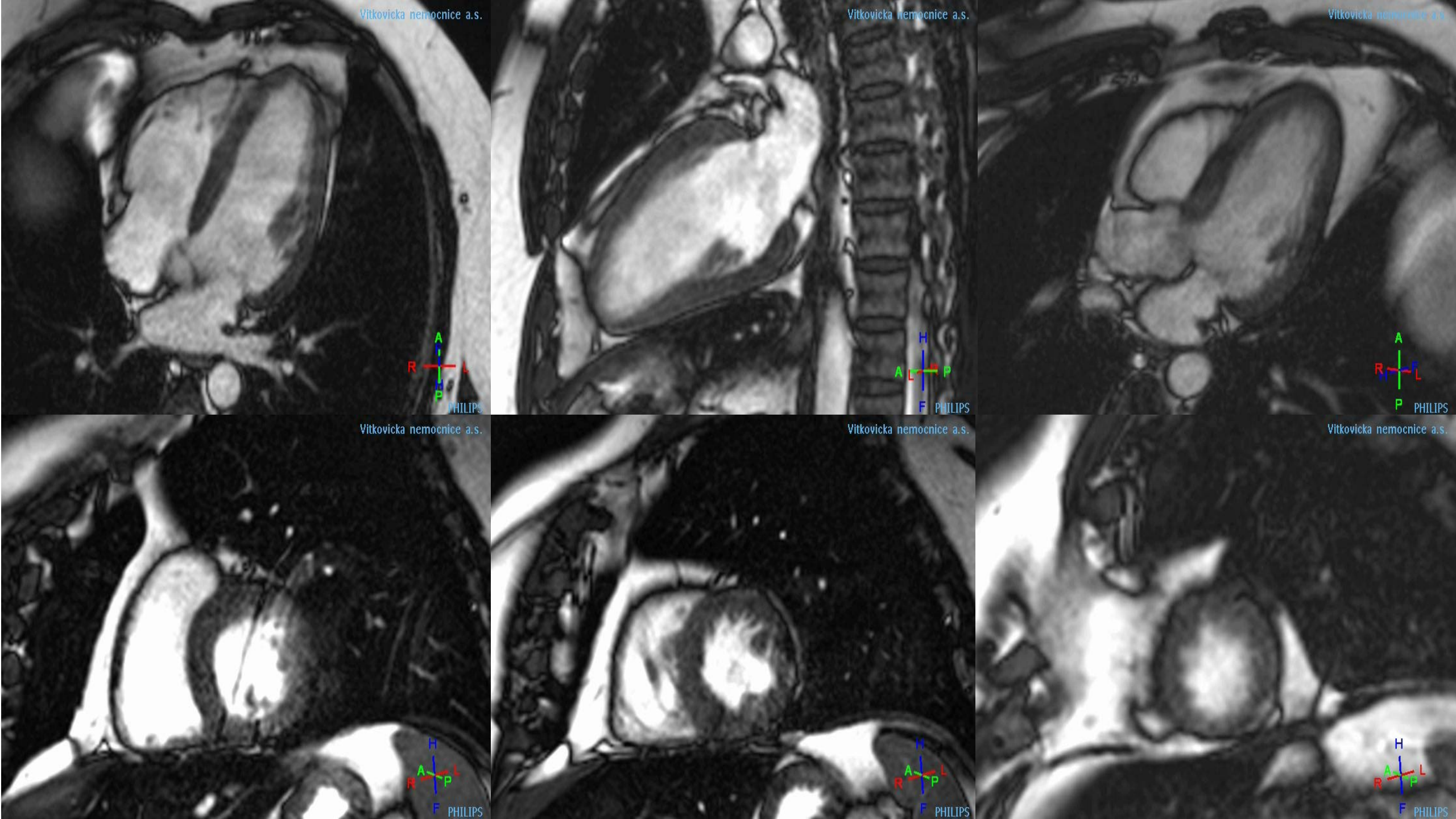
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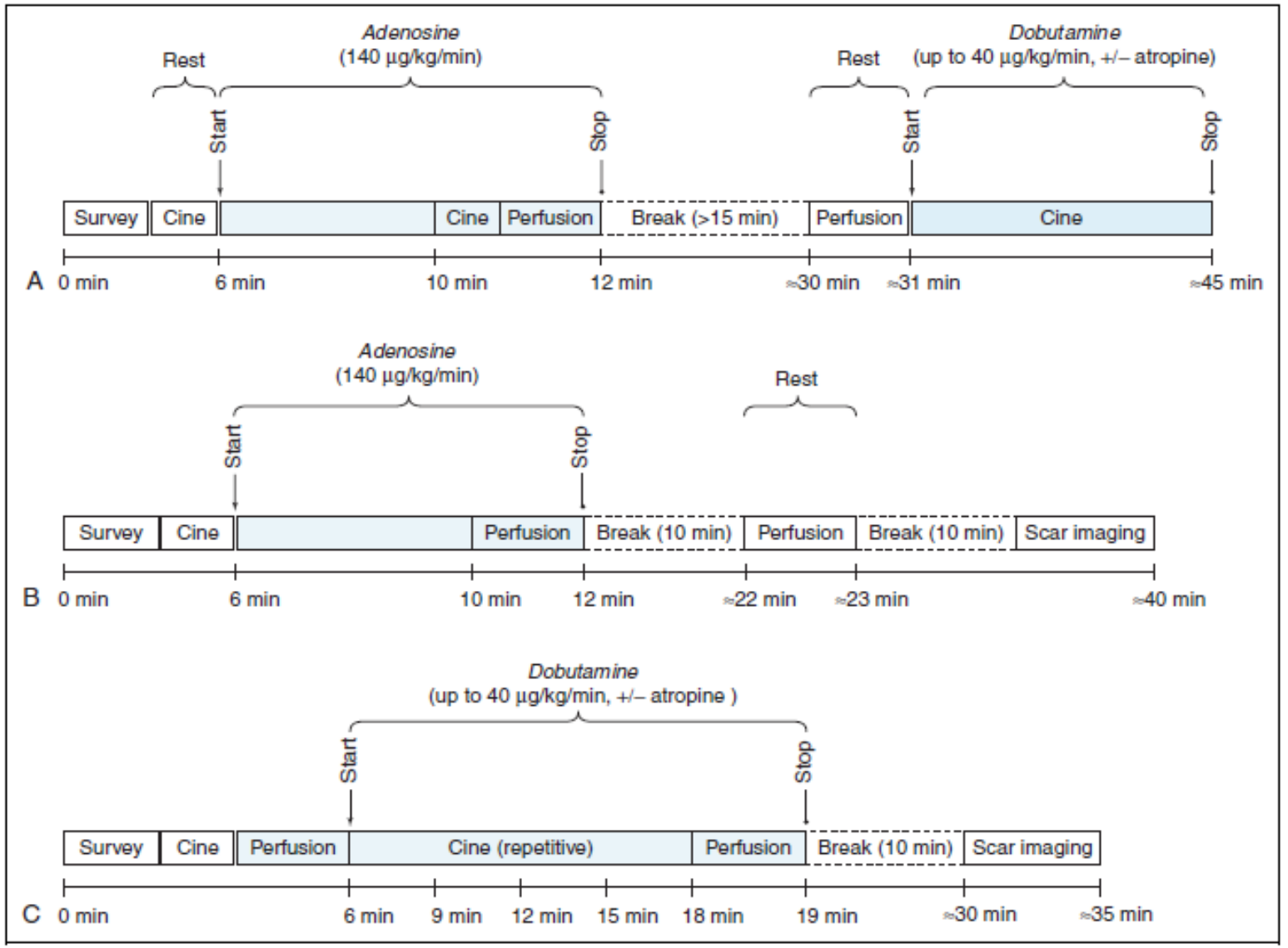


MANNING, W.J.; PENNELL, D.J. *Cardiovascular Magnetic Resonance.* 2nd ed., 2010. 643 p.

Perfuze

- bez ionizujícího záření
- dynamická
- výborná rozlišovací schopnost (2-3 mm)
- rychlost provedení vyšetření
- okolní orgány neovlivňují intenzitu signálu

DSMRI

- stejné indikace a stejný vyšetřovací protokol jako u DSE
- nepřítomnost limitace akustickým oknem
- lepší rozlišení kontury endokardu a epikardu
- možnost provést současně zátěžovou perfuzi

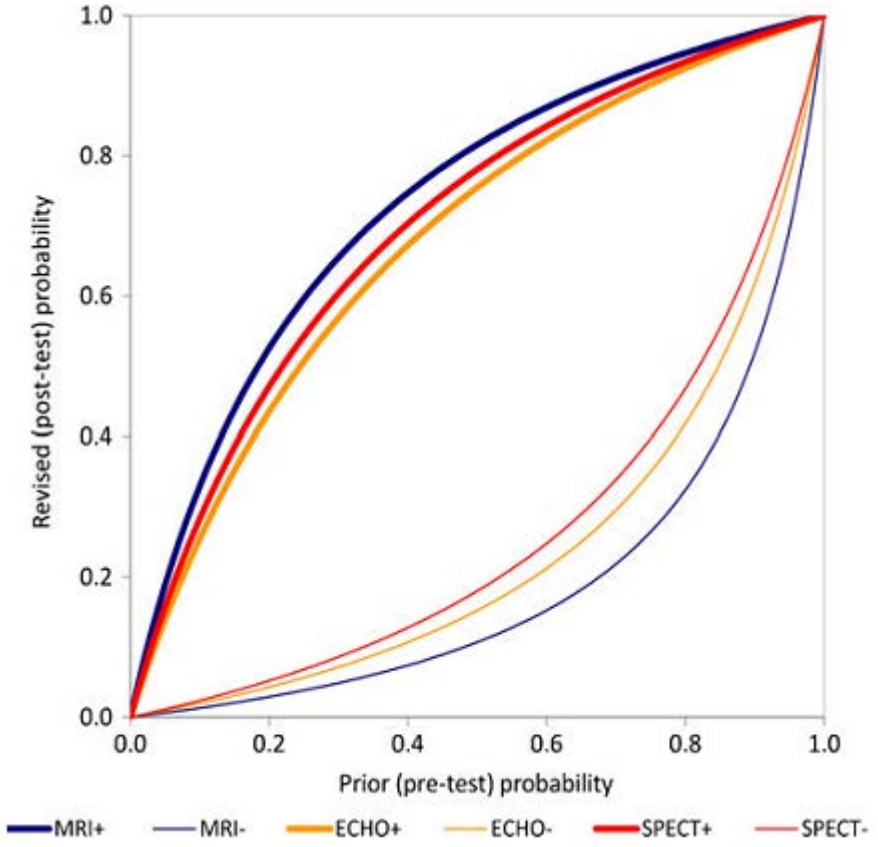
Přesnost MR perfuze

Table 3 Measures of diagnostic performance for MRI, ECHO and SPECT, estimated using the bivariate random effects model

		Sensitivity	Specificity	LR+	LR-	DOR	lnDOR	CAD prevalence*
MRI	**Overall**	**0.91 (0.88 – 0.93)**	**0.80 (0.76 – 0.83)**	**4.43 (3.64 – 5.23)**	**0.12 (0.08 – 0.15)**	**37.69 (26.00 – 54.63)**	**3.63 (3.26 – 4.00)**	**54% (1603/2970)**
	Suspected	0.90 (0.78 – 0.96)	0.86 (0.74 – 0.93)	6.61 (2.23 – 10.99)	0.12 (0.03 – 0.22)	54.70 (20.07 – 149.07)	4.00 (3.00 – 5.00)	49% (118/242)
	CAD 50	0.89 (0.86 – 0.92)	0.79 (0.73 – 0.84)	4.25 (3.15 – 5.35)	0.13 (0.09 – 0.17)	31.84 (20.96 – 48.37)	3.46 (3.04 – 3.88)	66% (882/1338)
	CAD 70	0.91 (0.87 – 0.94)	0.82 (0.75 – 0.87)	4.97 (3.47 – 6.47)	0.11 (0.07 – 0.15)	46.40 (28.90 – 74.49)	3.84 (3.36 – 4.31)	48% (937/1952)
ECHO	**Overall**	**0.87 (0.81 – 0.91)**	**0.72 (0.56 – 0.83)**	**3.08 (1.65 – 4.50)**	**0.18 (0.13 – 0.24)**	**16.94 (9.84 – 29.15)**	**2.83 (2.29 – 3.37)**	**66% (525/795)**
	Suspected	0.88 (0.60 – 0.97)	0.89 (0.58 – 0.98)	8.35 (6.67 – 21.76)	0.13 (-0.05 – 0.32)	62.76 (7.37 – 534.54)	4.14 (2.00 – 6.28)	64% (32/50)
	CAD 50	0.86 (0.79 – 0.92)	0.74 (0.63 – 0.82)	3.28 (2.09 – 4.47)	0.19 (0.10 – 0.27)	17.59 (9.48 – 32.66)	2.87 (2.25 – 3.49)	63% (339/534)
	CAD 70	0.90 (0.80 – 0.96)	0.65 (0.46 – 0.80)	2.58 (1.32 – 3.84)	0.15 (0.04 – 0.26)	17.04 (6.60 – 44.04)	2.84 (1.89 – 3.79)	71% (186/261)
SPECT	**Overall**	**0.83 (0.73 – 0.89)**	**0.77 (0.64 – 0.86)**	**3.56 (2.07 – 5.04)**	**0.22 (0.14 – 0.31)**	**15.84 (9.74 – 25.77)**	**2.76 (2.28 – 3.25)**	**50% (666/1323)**
	Suspected	0.83 (0.70 – 0.91)	0.79 (0.66 – 0.87)	3.88 (2.03 – 5.73)	0.21 (0.09 – 0.34)	18.15 (8.34 – 39.52)	2.90 (2.12 – 3.68)	41% (221/535)
	CAD 50	0.81 (0.72 – 0.87)	0.81 (0.72 – 0.87)	4.15 (2.55 – 5.75)	0.24 (0.15 – 0.33)	17.24 (9.67 – 30.73)	2.85 (2.27 – 3.43)	53% (452/848)
	CAD 70	0.85 (0.76 – 0.91)	0.66 (0.54 – 0.77)	2.53 (1.69 – 3.37)	0.22 (0.12 – 0.33)	11.42 (6.04 – 21.59)	2.44 (1.80 – 3.07)	53% (331/620)

De Jong MC et al. Diagnostic performance of stress myocardial perfusion imaging for coronary artery disease: a systematic review and meta-analysiEur Radiol (2012) 22:1881–1895s.

Přesnost MR perfuze



De Jong MC et al. Diagnostic performance of stress myocardial perfusion imaging for coronary artery disease: a systematic review and meta-analysiEur Radiol (2012) 22:1881–1895s.

DSMRI

TABLE 5. Results of Dobutamine Stress Echocardiography and Dobutamine Stress Magnetic Resonance Compared With Angiography

	DSE	DSMR	*P*
Sensitivity	74.3%	86.2%	<0.05
Specificity	69.8%	85.7%	<0.05
Positive predicting value	81.0%	91.3%	<0.05
Negative predicting value	61.1%	78.3%	<0.05
Accuracy	72.7%	86.0%	<0.005

Nagel E et al. Noninvasive diagnosis of ischemia-induced wall motion abnormalities with the use of high-dose dobutamine stress MRI. Circulation. 1999;99:763-770.

ESC Guidelines on myocardial revascularization

Indications for diagnostic testing in patients with suspected CAD and stable symptoms

	Asymptomatic[a]		Symptomatic						
			Probability of significant disease[b]						
			Low (<15%)		Intermediate (15–85%)		High (>85%)		
	Class[c]	Level[d]	Class[c]	Level[d]	Class[c]	Level[d]	Class[c]	Level[d]	Ref[e]
Anatomical detection of CAD									
Invasive angiography	III	A	III	A	IIb	A	I	A	50–52,54
CT angiography[f,g]	III	B	III	C	IIa	A	III	B	57–62
Functional test									
Stress echo	III	A	III	A	I	A	III	A	63–65
Nuclear imaging	III	A	III	A	I	A	III	A	60,66–70
Stress MRI	III	B	III	C	I	A	III	B	71–75
PET perfusion	III	B	III	C	I	A	III	B	67,69,70,76,77
Combined or hybrid imaging test									
	III	C	III	C	IIa	B	III	B	78–83

CAD = coronary artery disease; CT = computed tomography; MRI = magnetic resonance imaging; PET = positron emission tomography.
[a]Screening for silent (asymptomatic) myocardial ischaemia may be considered in selected high-risk patients, such as those with diabetes mellitus.[84]
[b]Pre-test probability of CAD. Low 0—15%; intermediate 15—85%; high >85% as assessed using the criteria based on ESC Guidelines of SCAD.[47]
[c]Class of recommendation.
[d]Level of evidence.
[e]References.
[f]This refers to CT angiography, not calcium scoring.
[g]CT is considered to perform best in the lower range of pre-test probability (15—50%).[47]

2014ESC/EACTSGuidelinesonmyocardial revascularization. EuropeanHeart Journal. 2014;35,2541–2619.

Results—Nineteen studies (14 vasodilator, 4 dobutamine, and 1 that used both) involved a total of 11,636 patients with a mean follow-up of 32 months. Patients had a mean age of 63 ± 12 years, 63% were male, and 26% had previous MI; mean left ventricular ejection fraction was 61 ± 12%; and late gadolinium enhancement was present in 29% and ischemia in 32%. Patients with ischemia had a higher incidence of MI (odds ratio [OR]: 7.7; $p < 0.0001$), cardiovascular death (OR: 7.0; $p < 0.0001$), and the combined endpoint (OR: 6.5; $p < 0.0001$) compared with those with a negative study. The combined outcome annualized events rates were 4.9% for a positive versus 0.8% for a negative stress CMR ($p < 0.0001$), 2.8% versus 0.3% for cardiovascular death ($p < 0.0001$), and 2.6% versus 0.4% for MI ($p < 0.0005$). The presence of late gadolinium enhancement was also significantly associated with a worse prognosis.

Conclusions—A negative stress CMR study is associated with very low risk of cardiovascular death and MI. Stress CMR has excellent prognostic characteristics and may help guide risk stratification of patients with known or suspected CAD.

Lipinski MJ et al. Prognostic value of stress cardiac magnetic resonance imaging in patients with or suspected artery disease: A systematic review and meta-analysis. J Am Coll Cardiol. 2013 August 27; 62(9).

ESC Guidelines on the management of stable coronary artery disease

Table 17 Definitions of risk for various test modalities[a]

Exercise stress ECG[b]	High risk Intermediate risk Low risk	CV mortality >3%/year. CV mortality between 1 and 3%/year. CV mortality <1%/year.
Ischaemia imaging	High risk Intermediate risk Low risk	Area of ischaemia >10% (>10% for SPECT; limited quantitative data for CMR – probably ≥2/16 segments with new perfusion defects or ≥3 dobutamine-induced dysfunctional segments; ≥ 3 segments of LV by stress echo). Area of ischaemia between 1 to 10% or any ischaemia less than high risk by CMR or stress echo. No ischaemia.
Coronary CTA[c]	High risk Intermediate rick Low risk	Significant lesions of high risk category (three-vessel disease with proximal stenoses, LM, and proximal anterior descending CAD). Significant lesion(s) in large and proximal coronary artery(ies) but not high risk category. Normal coronary artery or plaques only.

CAD = coronary artery disease; CMR = cardiac magnetic resonance; CTA = computed tomography angiography; CV = cardiovascular; ECG = electrocardiogram; ICA = invasive coronary angiography; LM = left main; PTP = pre-test probability; SPECT = single photon emission computed tomography.

[a] For detailed explanation on rationale for risk stratification scheme see web addenda.

[b] From nomogram (see web addenda, Figure W1) or http://www.cardiology.org/tools/medcalc/duke/

[c] See Fig 2 consider possible overestimation of presence of significant multivessel disease by coronary CTA in patients with high intermediate PTP (≥50%) and/or severe diffuse or focal coronary calcifications and consider performing additional stress testing in patients without severe symptoms before ICA.

The Task Force on the management of stable coronary artery disease of the European Society of Cardiology. 2013 ESC guidelines on the management of stable coronary artery disease. European Heart Journal. 2013;34:2949–3003.

Zátěžové MR testy

Nevýhody:

- přítomnost KI (kardiostimulátor, klaustrofobie atd.)
- dostupnost a cena
- artefakty
- nemožnost kontroly ekg křivky během zátěže (pouze VCG monitoring)
- hlasový kontakt s pacientem
- horší kvalita MR obrazů u arytmie

Zátěžové testy

- senzitivita/specificita testů podobná

  ale

- další schopnosti rozdílné

Table 2 Comparison of different functional imaging modalities in the assessment of IHD (CMR vs Echo vs SPECT)

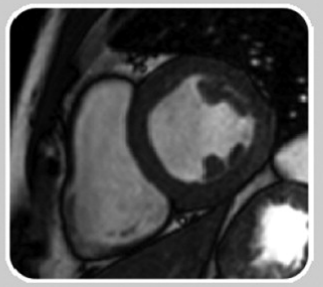
	CMR	Echo	SPECT
Ejection fraction	+++	++	+
RWMA	+++	++	–
Wall thinning	++	+	–
Myocardial oedema	++	–	–
Viability	+++	++	+++
MVO	+++	–	–
Thrombus	++	+	–
Valve assessment	+	+++	–
RV	+++	++	+
Ischaemia assessment			
Increased BMI	++	+	++
Female	++	++	+
Adenosine	++	+	++
Dobutamine	++	++	++
Exercise	(+)	+++	++

BMI, body mass index; CMR, cardiac MRI; IHD, ischaemic heart disease; MVO, microvascular obstruction; RV, right ventricle; RWMA, regional wall motion abnormality; SPECT, single-photon emission computed tomography.

Dastidar AG et al. MRI in the assessment of ischaemic heart disease. Heart. 2016; 102:239-252.

Diagnostika IM

A



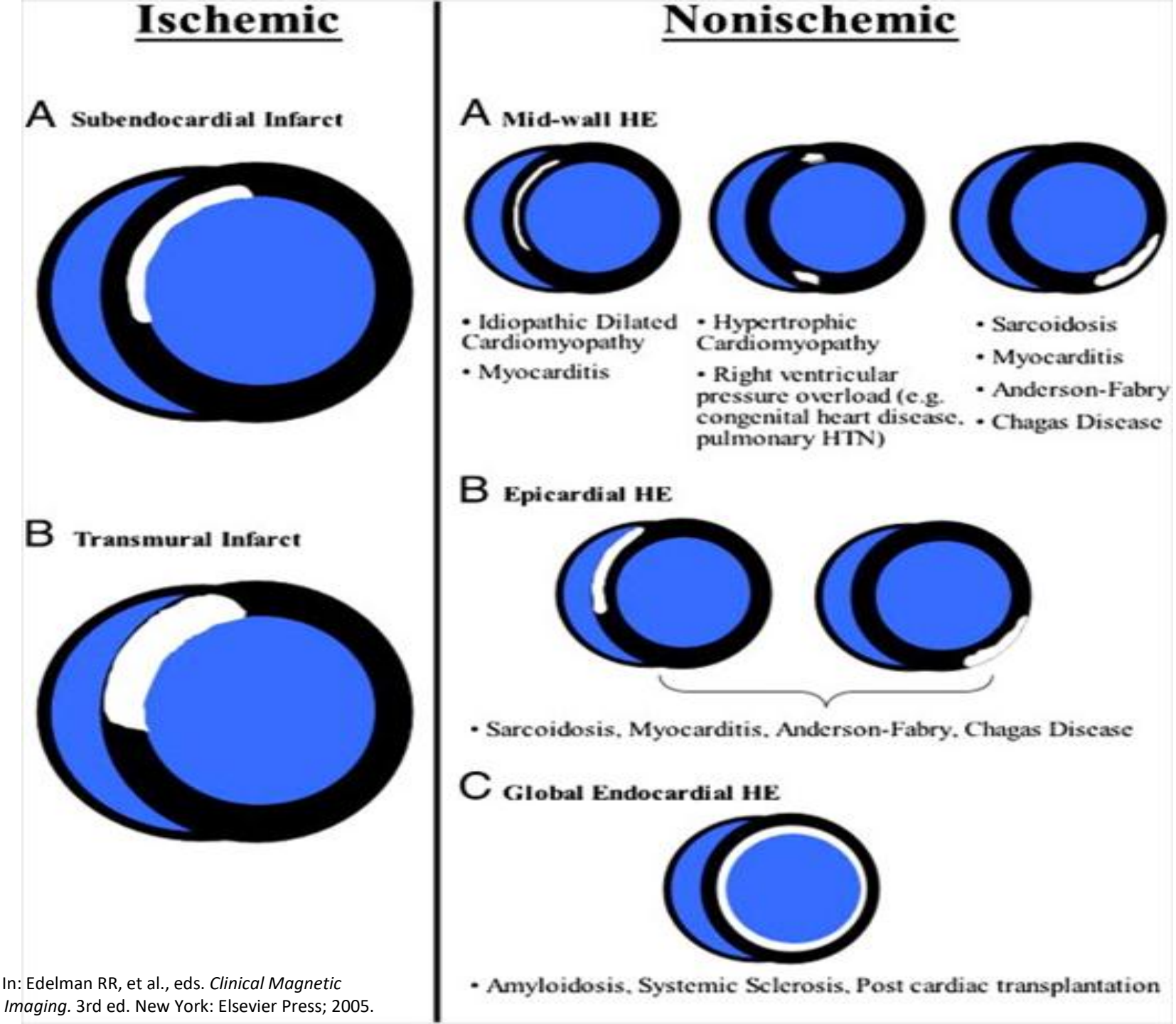
Cine Imaging (rest/stress)	T2-Weighted Imaging	First Pass Perfusion (rest/stress)	Early Gadolinium Enhancement	Late Gadolinium Enhancement
Contractile function	Tissue edema	Regional myocardial blood flow	Microvascular integrity	Myocardial necrosis/fibrosis
LV function/ ischemia/viability	Infarct age/ myocardial salvage	MVO/ischemia	No reflow/ MVO	Infarct size/viability

B

Lockie T et al. Use of Cardiovascular Magnetic Resonance Imaging in Acute Coronary Syndromes. Circulation. 2009;119:1671-1681.

Pozdní sycení (LGE)

- MR kontrast (chelát gadolinia) má rozdílnou kinetiku ve viabilním myokardu a v jizvě
- zpomalený wash-in a wash-out
- nespecifický jev (fibrosa, nekrosa, amyloid)
- pozdní scany s „vynulováním“ signálu zdravého myokardu



Shah et al. In: Edelman RR, et al., eds. *Clinical Magnetic Resonance Imaging.* 3rd ed. New York: Elsevier Press; 2005.

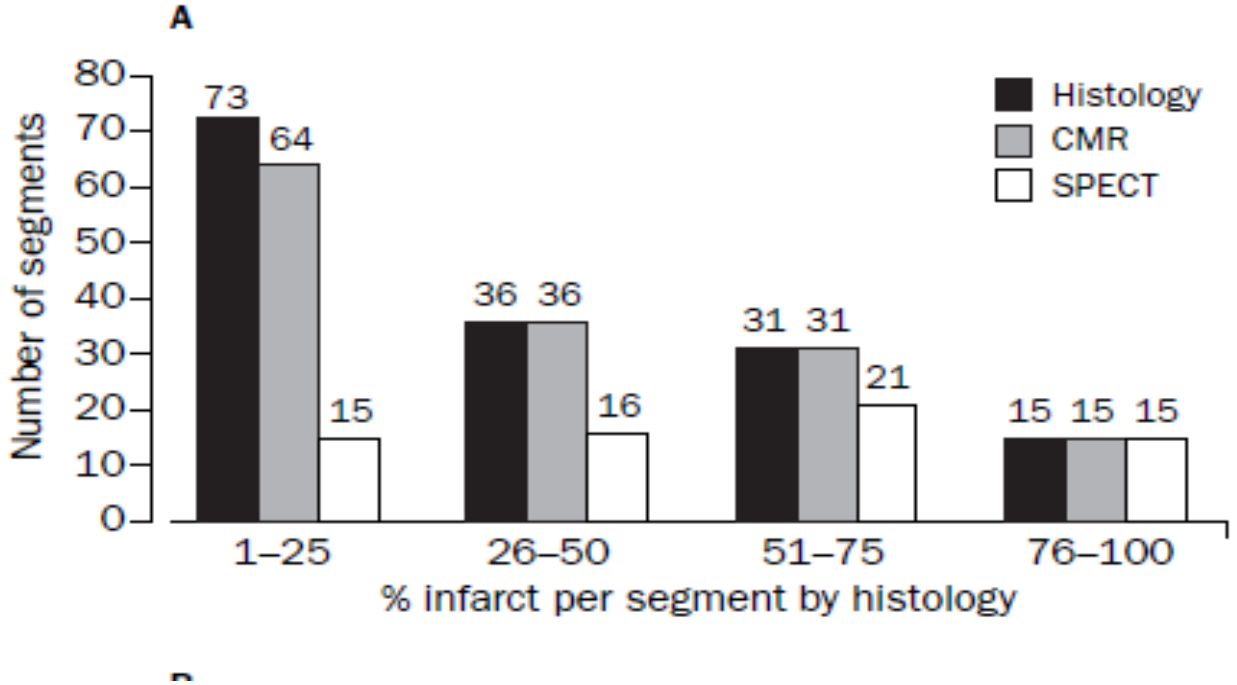
Pozdní sycení (LGE)

TABLE 3. Accuracy of MRI Hyperenhancement in Assessing Transmural or Both Transmural and Subendocardial Defects as Defined by PET in Relation to the Degree of Dysfunction

	Transmural		Transmural and Subendocardial	
Segments	Sensitivity	Specificity	Sensitivity	Specificity
All	0.86	0.94	0.83	0.88
Akinetic	0.89	0.84	0.89	0.79
Severe hypokinetic	0.86	0.90	0.95	0.82
Moderate hypokinetic	1.00	0.98	1.00	0.94

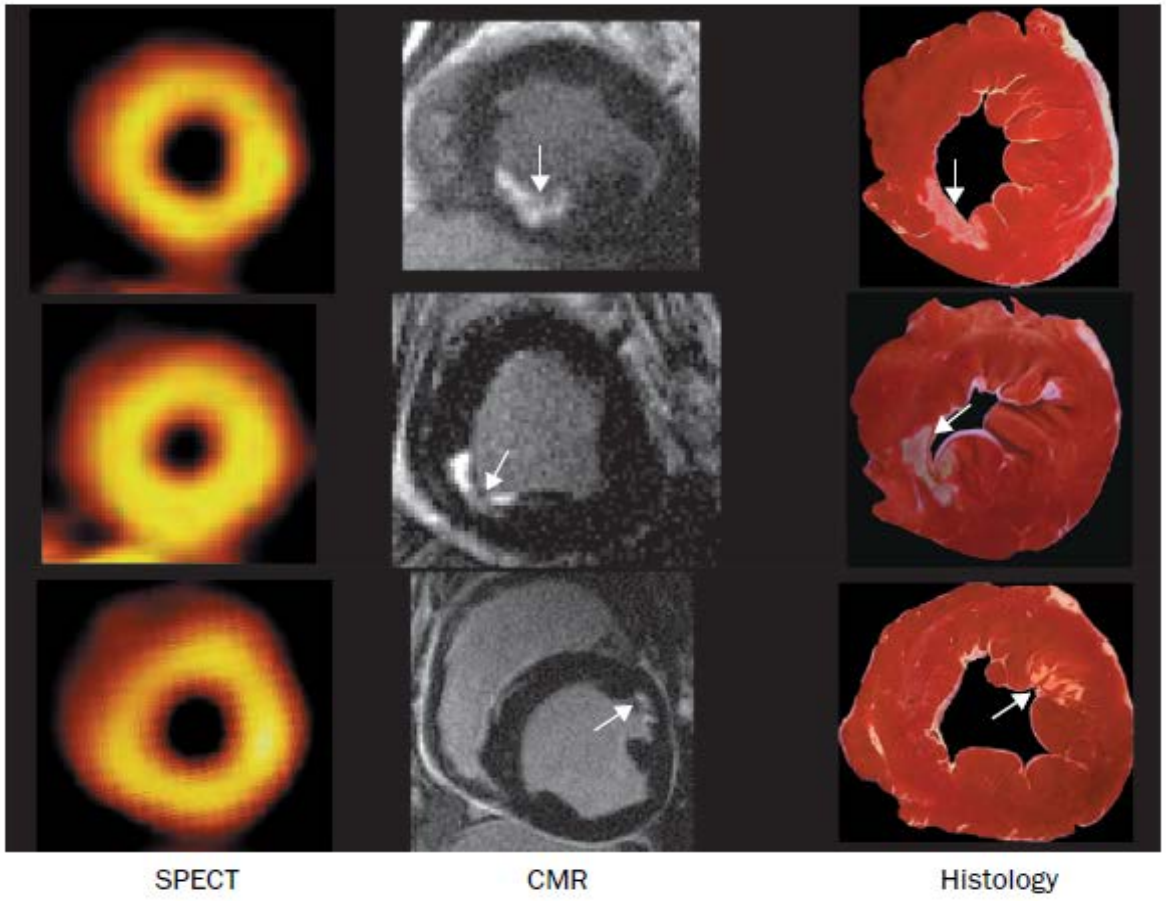
KLEIN, C. et al. Assessment of myocardial viability with contrast enhanced magnetic resonance imaging: comparison with positron emission tomography. *Circulation.* 2002;105(2):162 167.

Detekce infarktu – MRI x SPECT



WAGNER, A.; MAHRHOLD, H.; HOLLY, T.A. et al. *Contrast-enhanced MRI and routine single photon emission computed tomography (SPECT) perfusion imaging for detection of subendocardial myocardial infarcts: an imaging study.*

Detekce infarktu



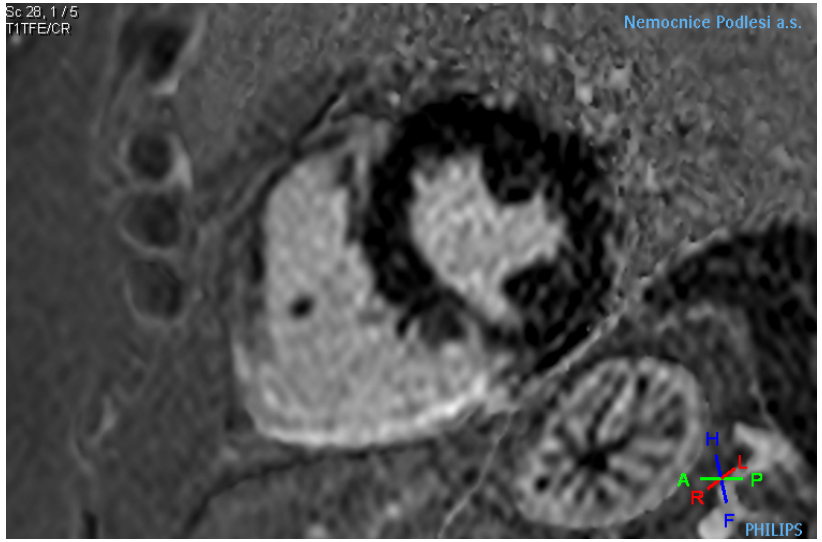
WAGNER, A.; MAHRHOLD, H.; HOLLY, T.A. et al. *Contrast-enhanced MRI and routine single photon emission computed tomography (SPECT) perfusion imaging for detection of subendocardial myocardial infarcts: an imaging study.*

Detekce infarktu

- MRI má mnohem lepší rozlišovací schopnost (1-2 mm) než SPECT/PET
- nejpřesnější „in vivo“ zobrazení IM

✓ AIM – senzitivita 99 %, chron. IM – senzitivita 94 % - ale vyšší dávky k.l. a CK MB ≥ 3x normy (Kim et al., 2008)

- LGE umožňuje přesně stanovit diametr jizvy a diametr viabilního okraje daného segmentu



Kim et al. Performance of Delayed-Enhancement Magnetic Resonance Imaging With Gadoversetamide Contrast for the Detection and Assessment of Myocardial Infarction. Circulation. 2008;117:629-637.

Impact of Unrecognized Myocardial Scar Detected by Cardiac Magnetic Resonance Imaging on Event-Free Survival in Patients Presenting With Signs or Symptoms of Coronary Artery Disease

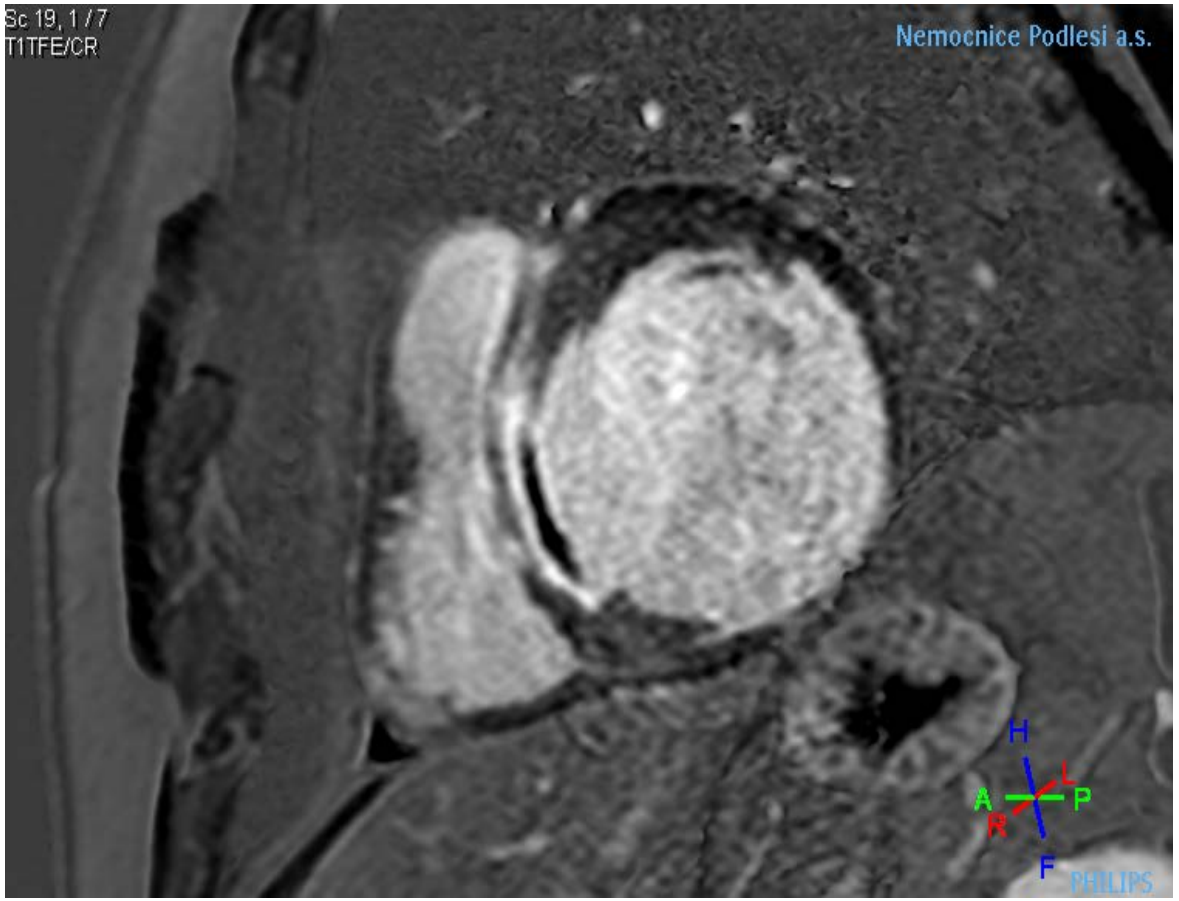
Raymond Y. Kwong, MD, MPH; Anna K. Chan, MBBS; Kenneth A. Brown, MD; Carmen W. Chan, MBBS; H. Glenn Reynolds, MSc; Sui Tsang, BS; Roger B. Davis, ScD

Background—Contrast-enhanced cardiac magnetic resonance imaging (CMR) can determine the extent of myocardial scar from infarction (MI). However, the prognostic significance of unrecognized myocardial scar by CMR in patients without a history of MI is unknown.

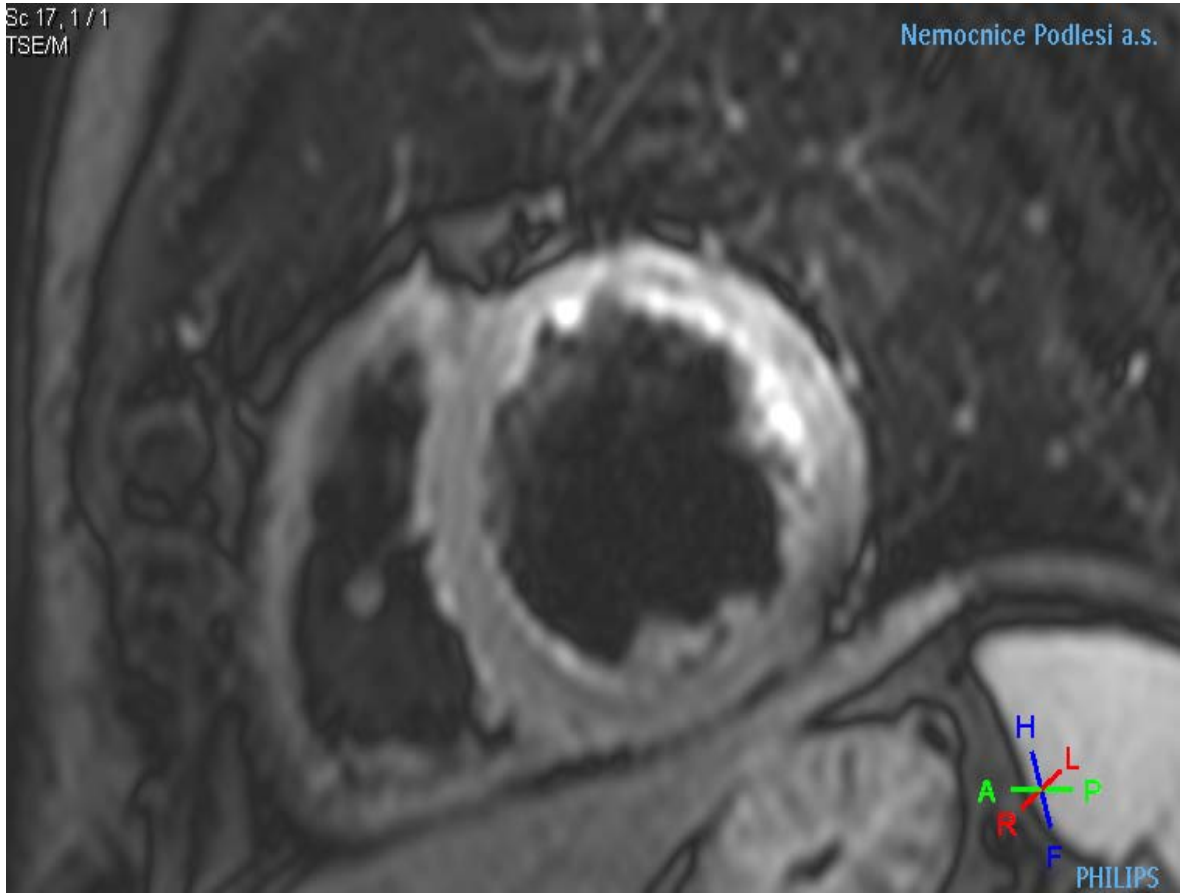
Methods and Results—One hundred ninety-five patients without a known prior MI underwent CMR for assessment of left ventricular (LV) function and late gadolinium enhancement (LGE). We assessed the prognostic value of LGE and other CMR variables beyond the strongest clinical predictors and built the best overall models for major adverse cardiac events (MACE) and cardiac mortality. During a median follow-up of 16 months, 31 patients (18%) experienced MACE, including 17 deaths. LGE demonstrated the strongest unadjusted associations with MACE and cardiac mortality (hazard ratios of 8.29 and 10.9, respectively; both $P<0.0001$). Patients in the lowest tertile of LGE-involved myocardium (mean LV mass, 1.4%) experienced a >7-fold increased risk for MACE. By multivariable analyses, LGE was independently associated with MACE beyond the clinical model ($P<0.0001$) or the clinical model combined with angiographically significant coronary stenosis ($P=0.0007$), LV ejection fraction ($P=0.001$), LV end-systolic volume index ($P=0.0006$), or segmental WMA ($P=0.002$). LGE remained the strongest predictor selected in the best overall models for MACE and cardiac mortality.

Conclusions—Among patients with a clinical suspicion of coronary artery disease but without a history of MI, LGE involving a small amount of myocardium carries a high cardiac risk. In addition, LGE provides incremental prognostic value to MACE and cardiac mortality beyond common clinical, angiographic, and functional predictors. (***Circulation.*** **2006;113:2733-2743.**)

Odhad stáří IM



mikrovaskulární obstrukce < 4 týdnů



edém myokardu < 3 měsíce (6 měsíců?)

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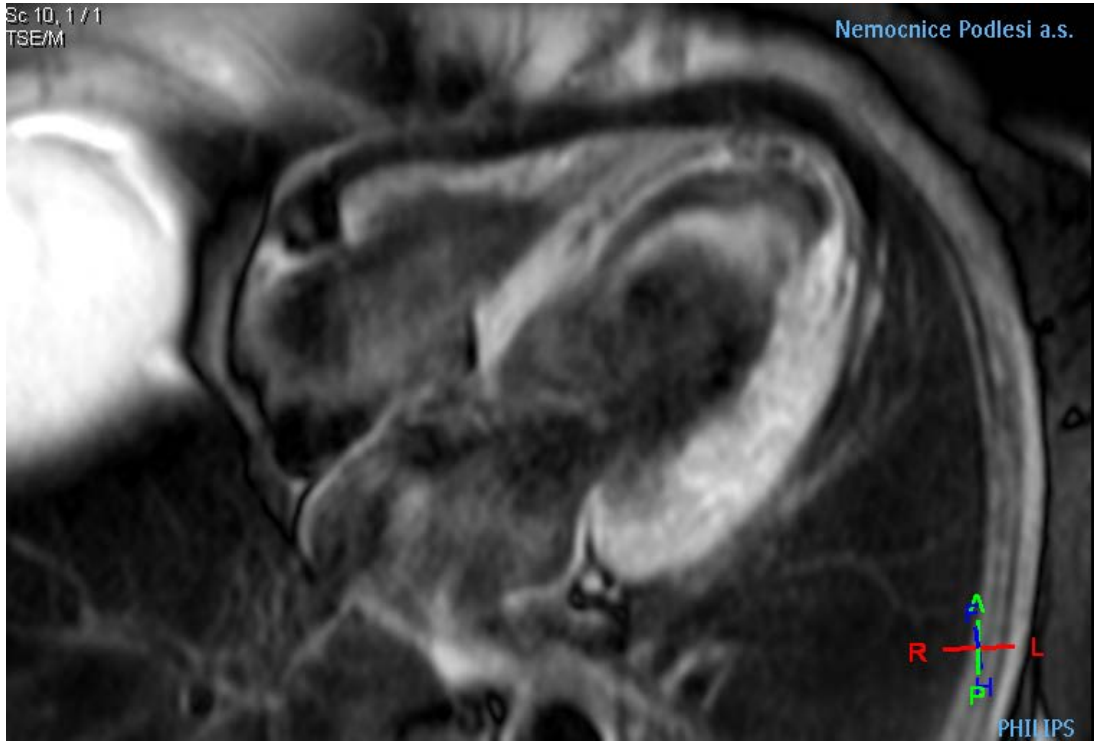


Tuková metaplázie IM > 6 měsíců

Komplikace IM - trombus

MRI:

- senzitivita: 88 %, specificita: 99 %

TEE:

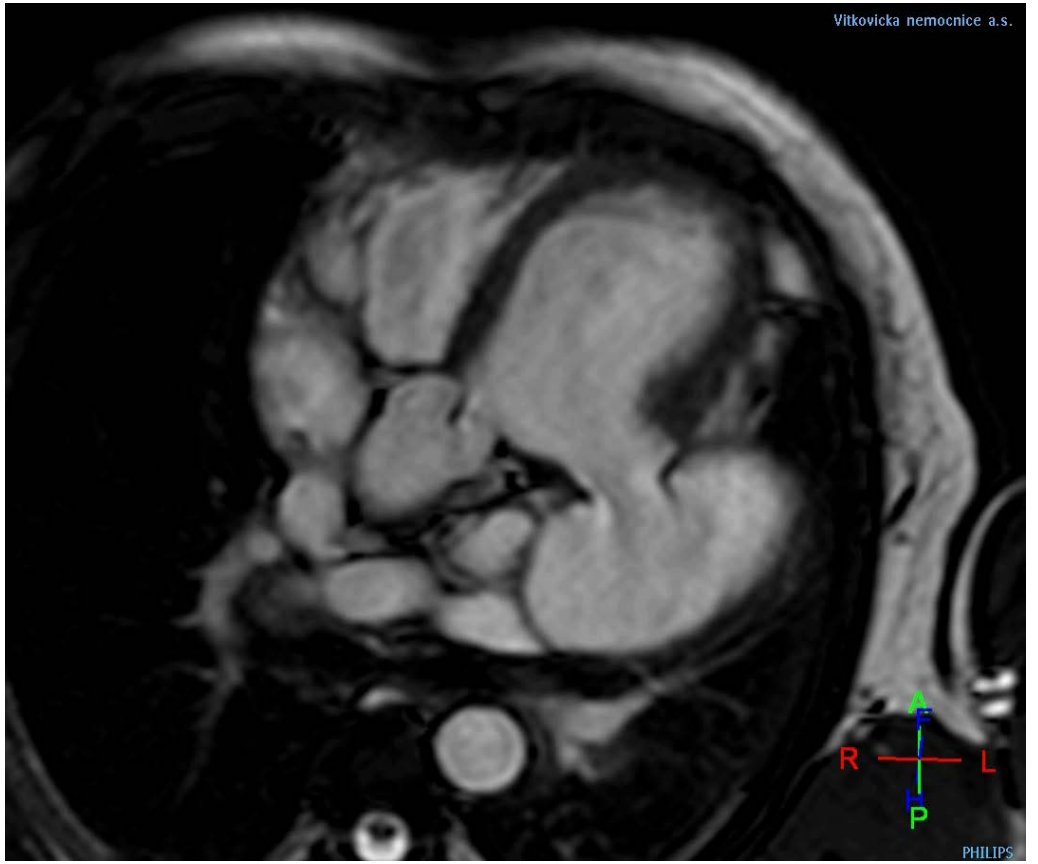
- senzitivita: 40 %, specificita 96 %

TTE:

- senzitivita: 23 %, specificita 96 %

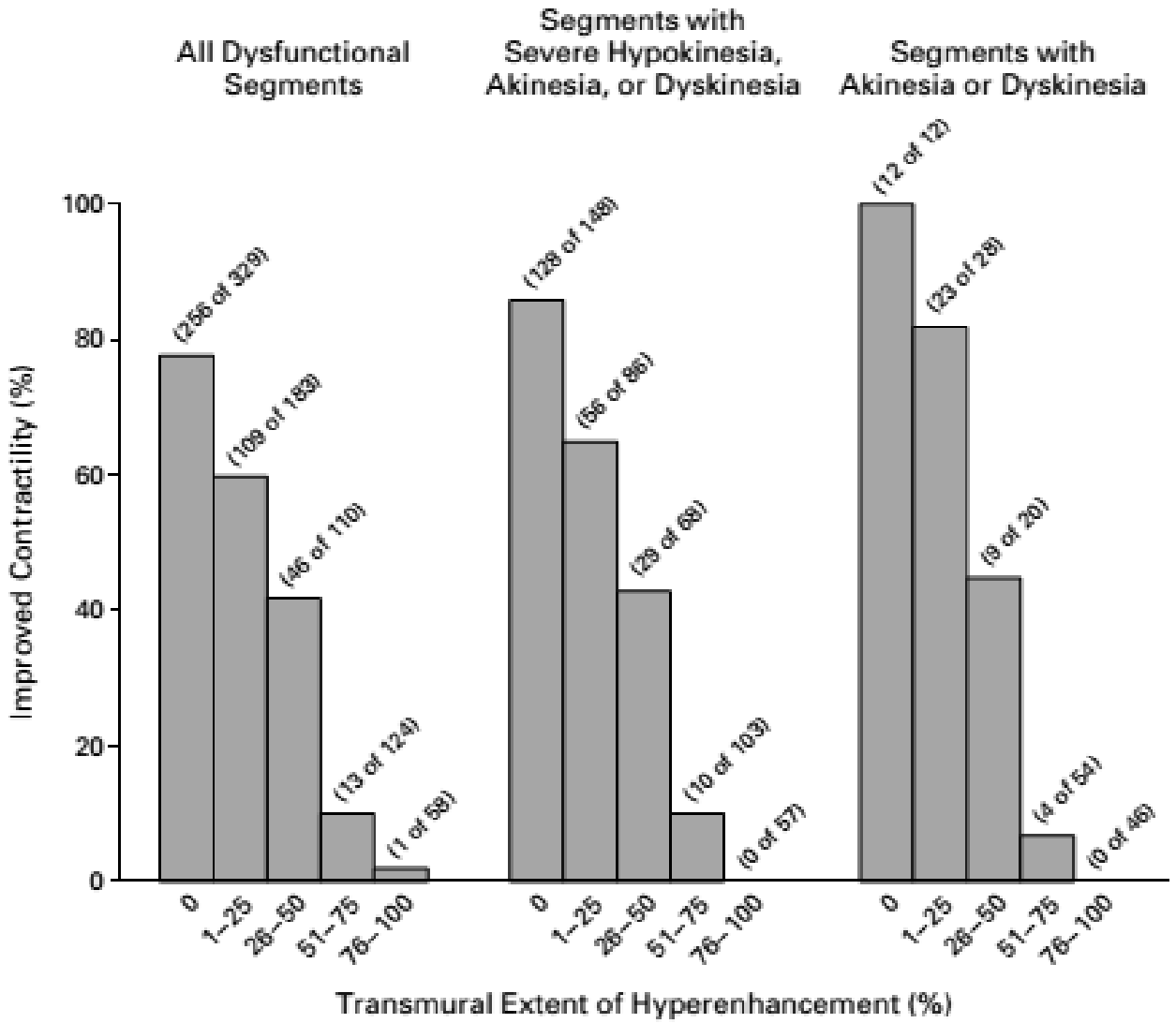
Srichai MB et al. **Clinical, imaging, and pathological characteristics of left ventricular thrombus: a comparison of contrast-enhanced magnetic resonance imaging, transthoracic echocardiography, and transesophageal echocardiography with surgical or pathological validation.** Am Heart J. 2006 Jul;152(1):75-84.

Komplikace IM



Viabilita myokardu

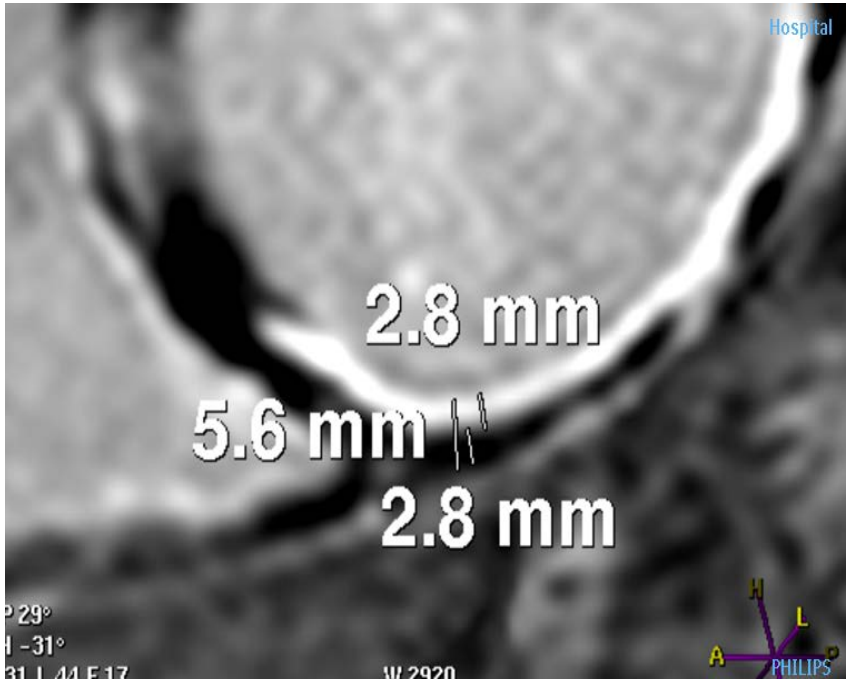
- klidová kinetika (ztlušťování)
- endiastolický diametr segmentu (objem LK)
- **pozdní sycení (LGE)**
- **farmakologická podpora kinetiky nízkými dávkami dobutaminu (low- dose DSMRI)**

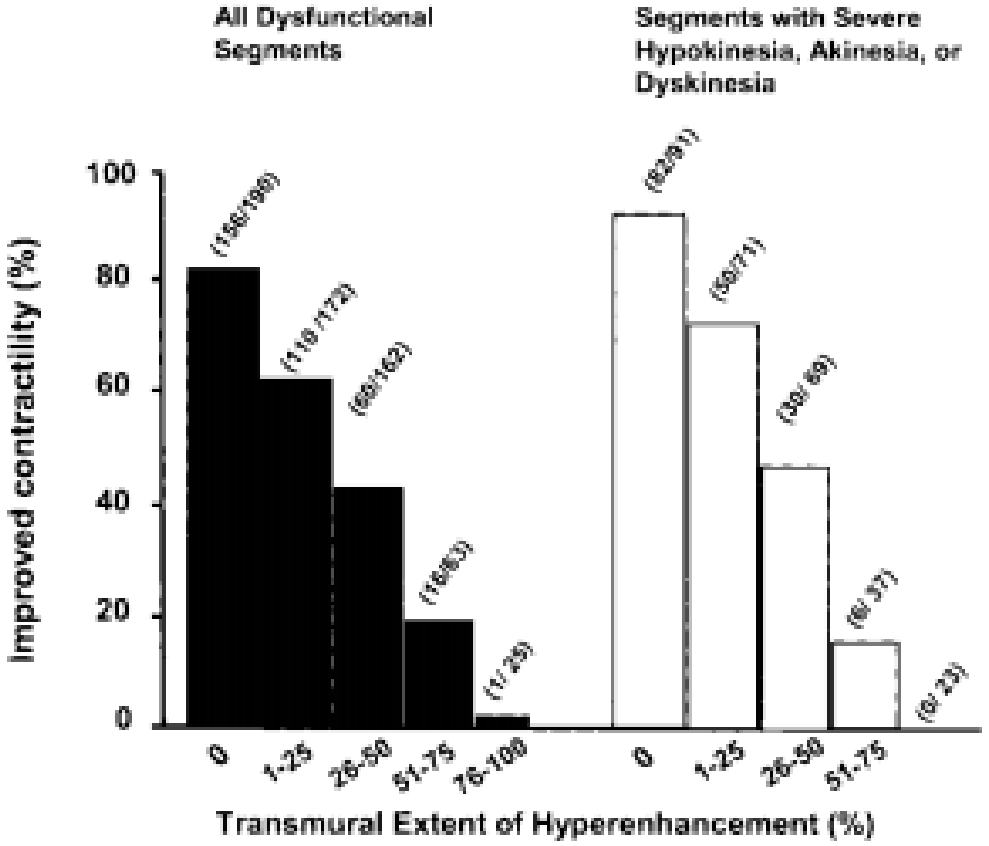


Kim RJ et al. The use of contrast-enhanced magnetic resonance imaging to identify reversible myocardial dysfunction. N Engl J Med 2000;343: 1445-53.

LGE – Index transmurality (IT)

- Cutt-off hodnota IT = 50 %





Selvanayagam JB et al. Value of delayed-enhancement cardiovascular magnetic resonance imaging in predicting myocardial viability after surgical revascularization. Circulation. 2004;110:1535-1541.

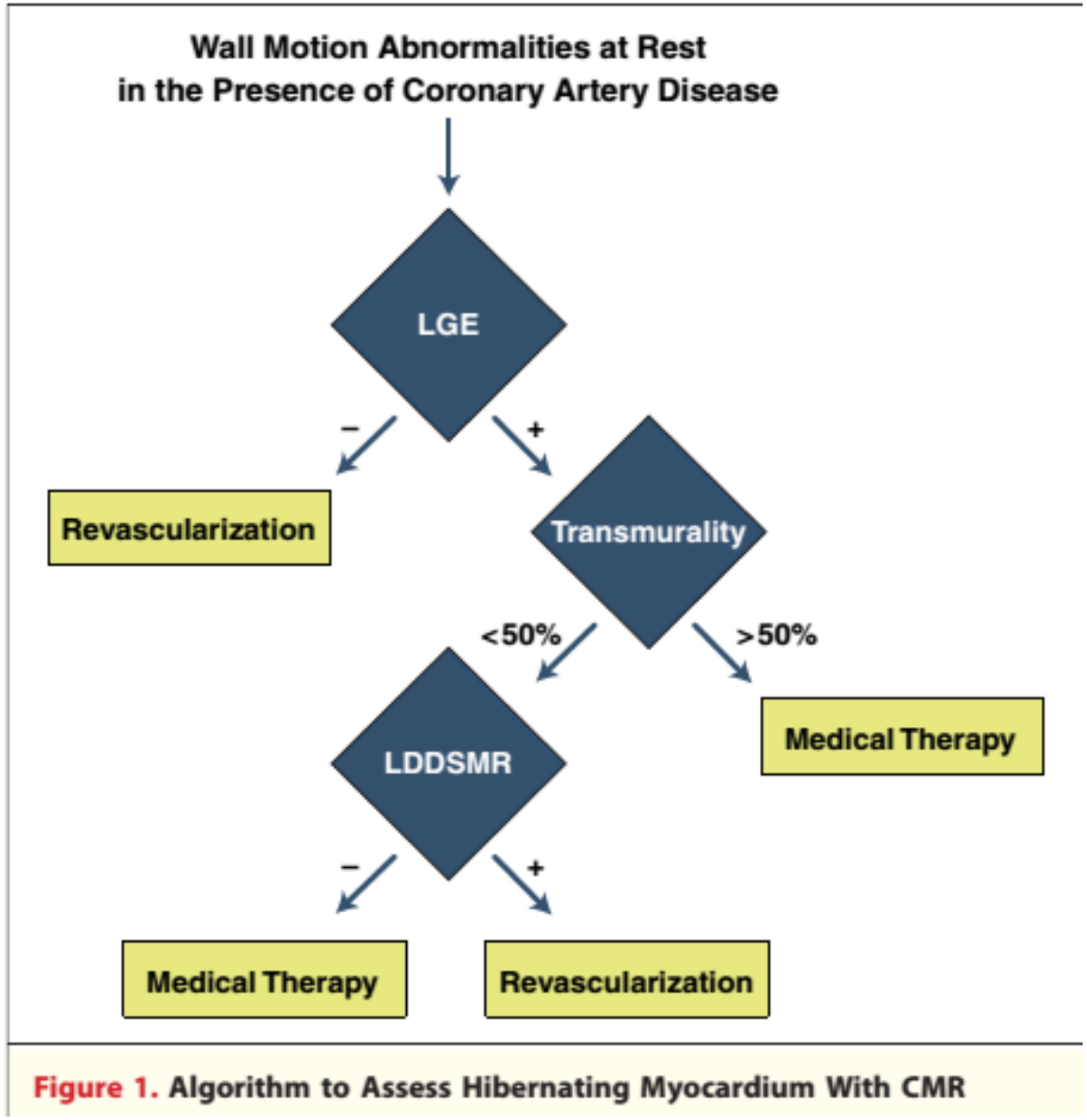
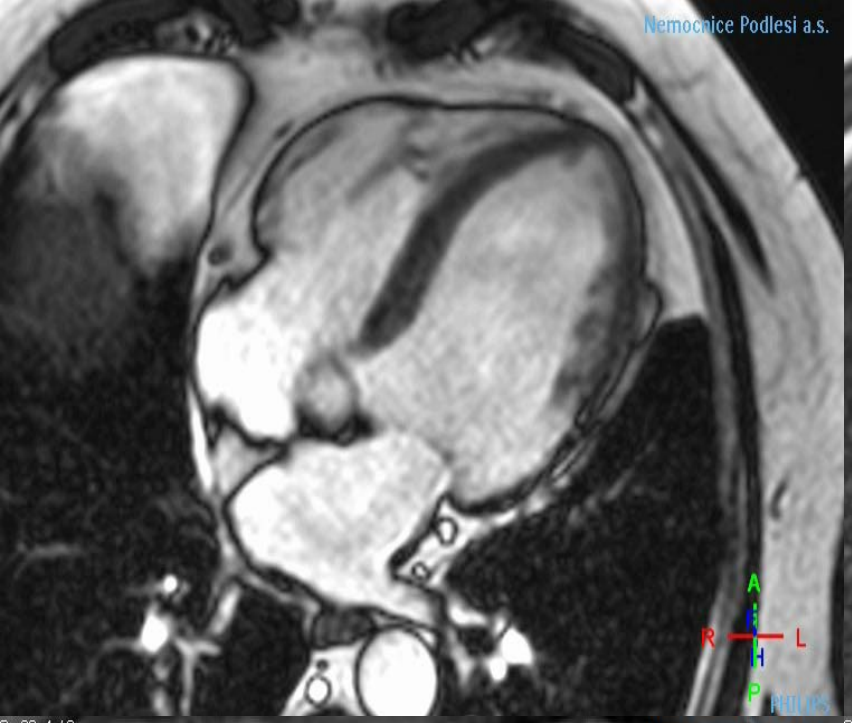


Figure 1. Algorithm to Assess Hibernating Myocardium With CMR

Nagel E, Schuster A. Myocardial viability. Dead or alive is not the question! JACC: Cardiovascular imaging. 2012;5(5).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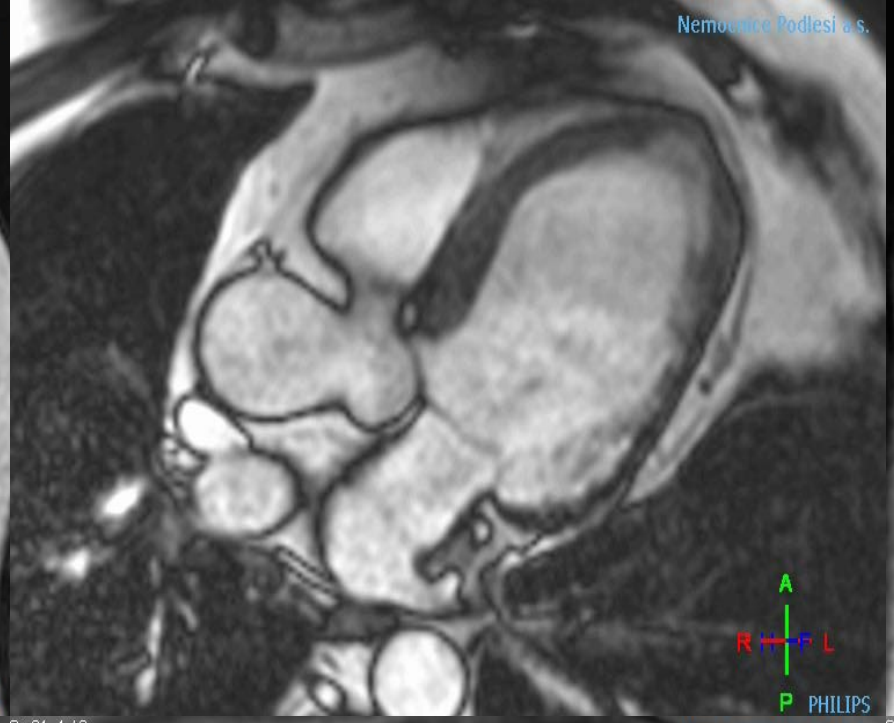
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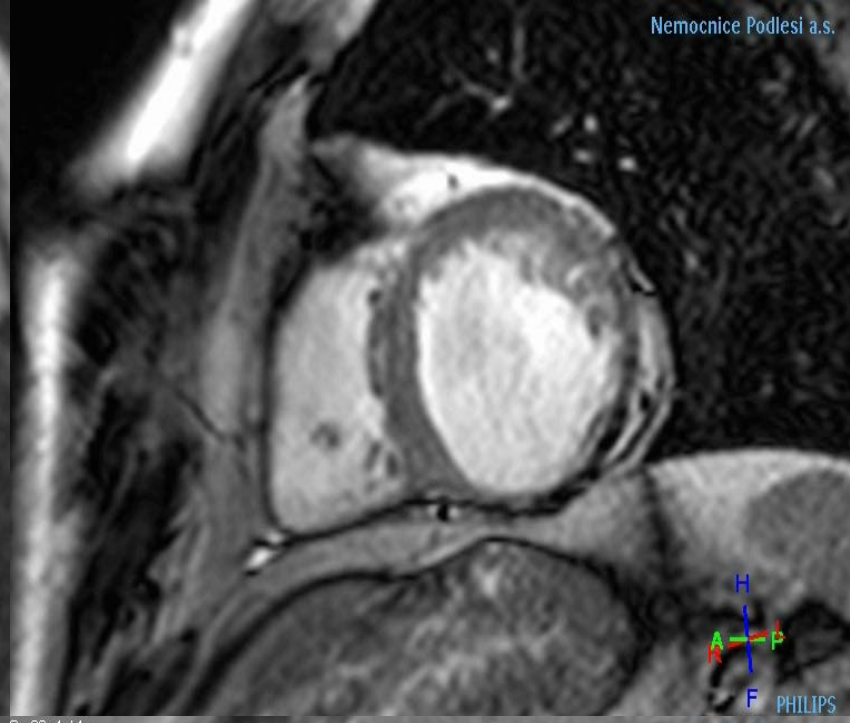
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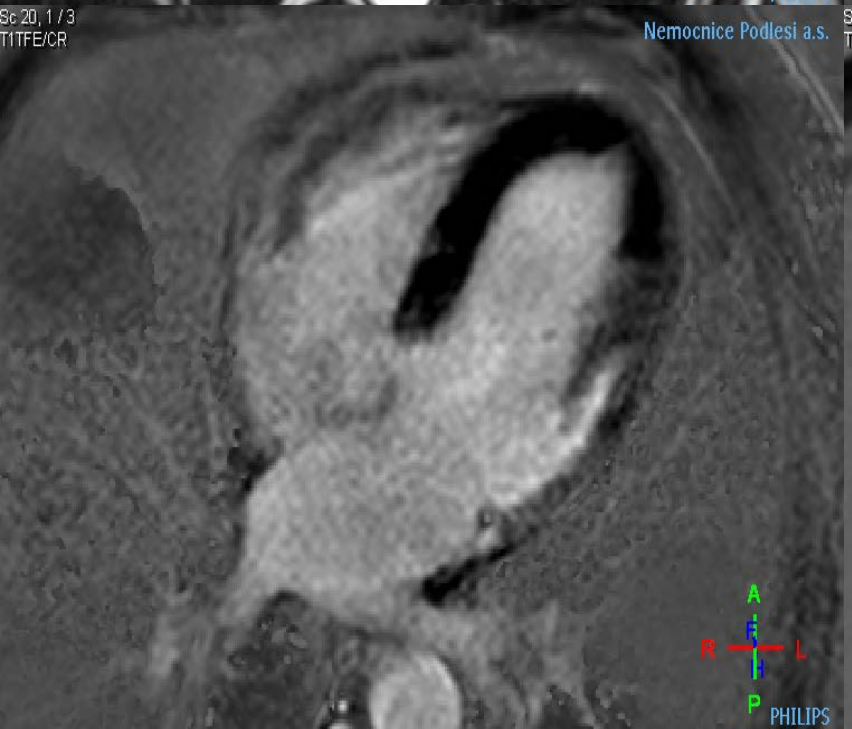
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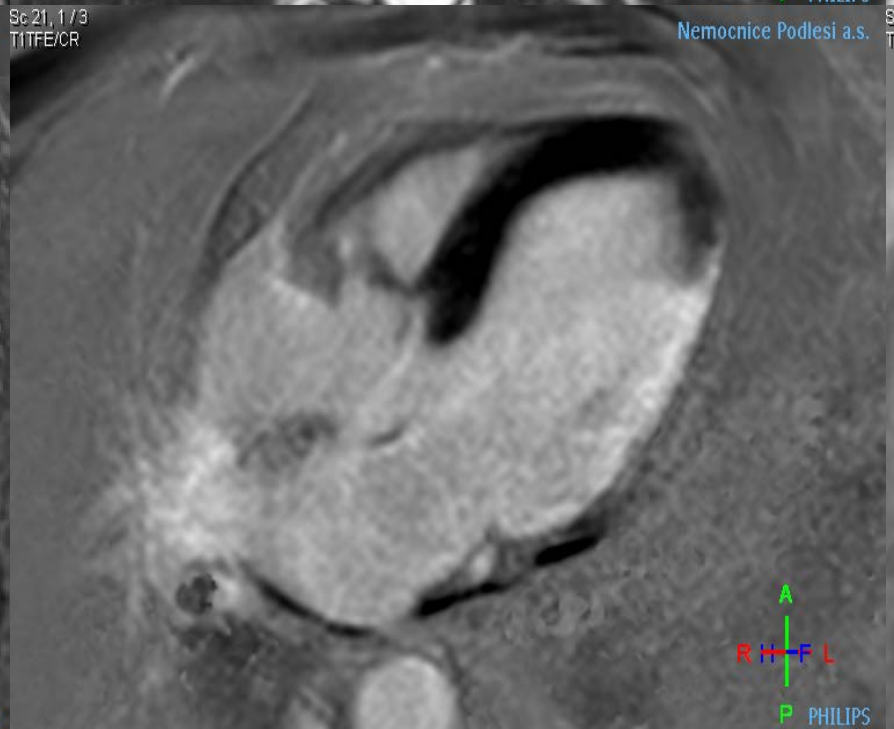
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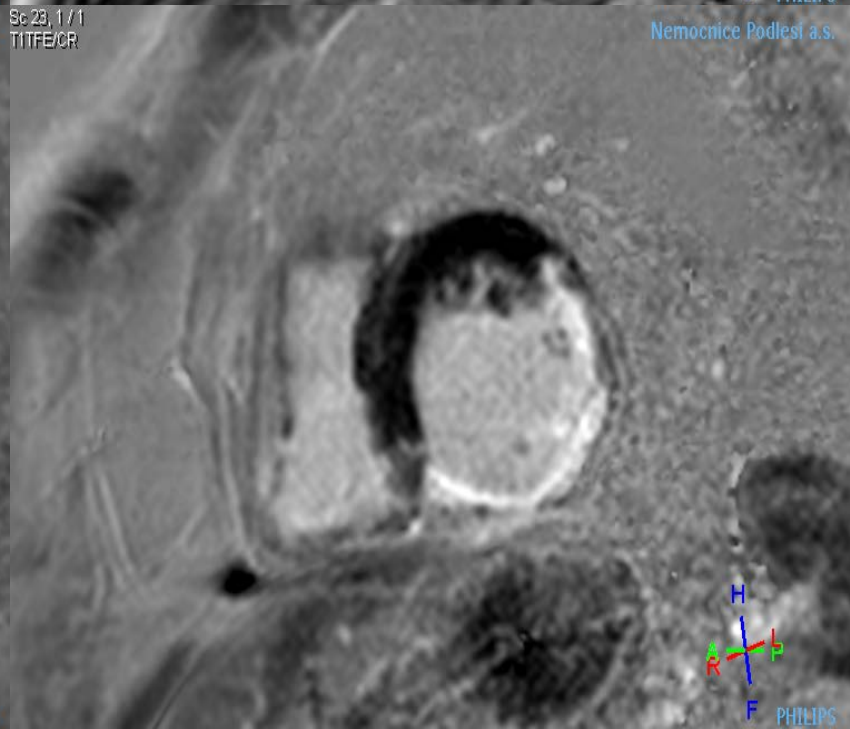
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Viabilita myokardu – LGE<50 %

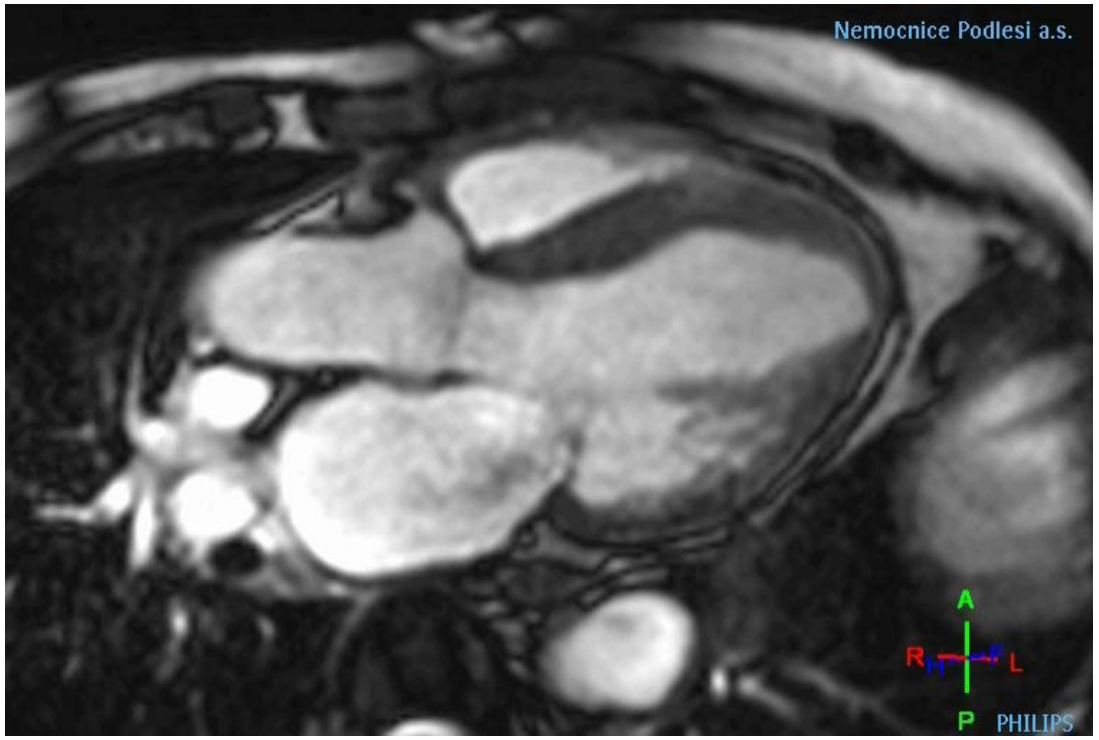
Table 3. Infarct Region–Based Predictive Accuracy of Magnetic Resonance Imaging–Assessed Dobutamine-Induced Systolic Wall Thickening and Preserved End-Diastolic Wall Thickness for Recovery of Regional Left Ventricular Function After Successful Revascularization

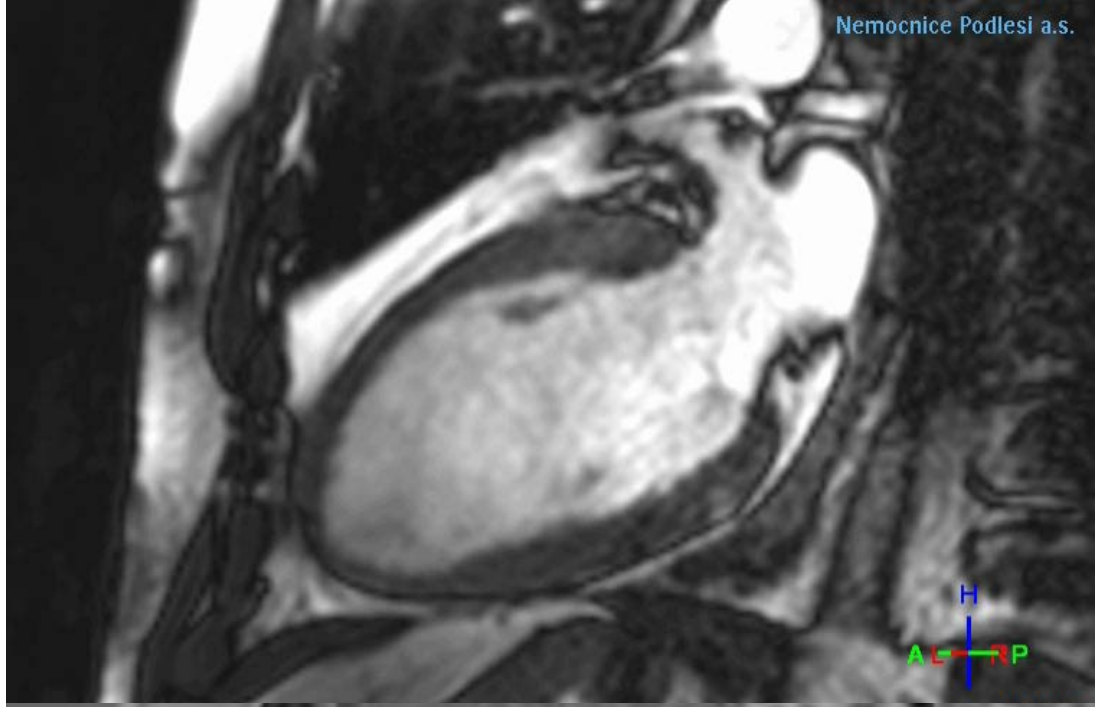
	Dob-SWT (≥2 mm)	Preserved DWT (≥5.5 mm)
Sensitivity	89% (24/27)	92% (25/27)
Specificity	94% (15/16)	56% (9/16)
Pos predictive accuracy	96% (24/25)	78% (25/32)
Neg predictive accuracy	83% (15/18)	82% (9/11)
Diagnostic accuracy	91% (39/43)	79% (34/43)

Neg = negative; Pos = positive; other abbreviations as in Table 1.

BAER, F.M.; THEISSEN, P.; SCHNEIDER, C.A. et al. Dobutamine magnetic resonance imaging predicts contractile recovery of chronically dysfunctional myocardium after successful revascularization. *J Am Coll Cardiol*. 1998;31:1040-1048

DSMRI (low-dose)

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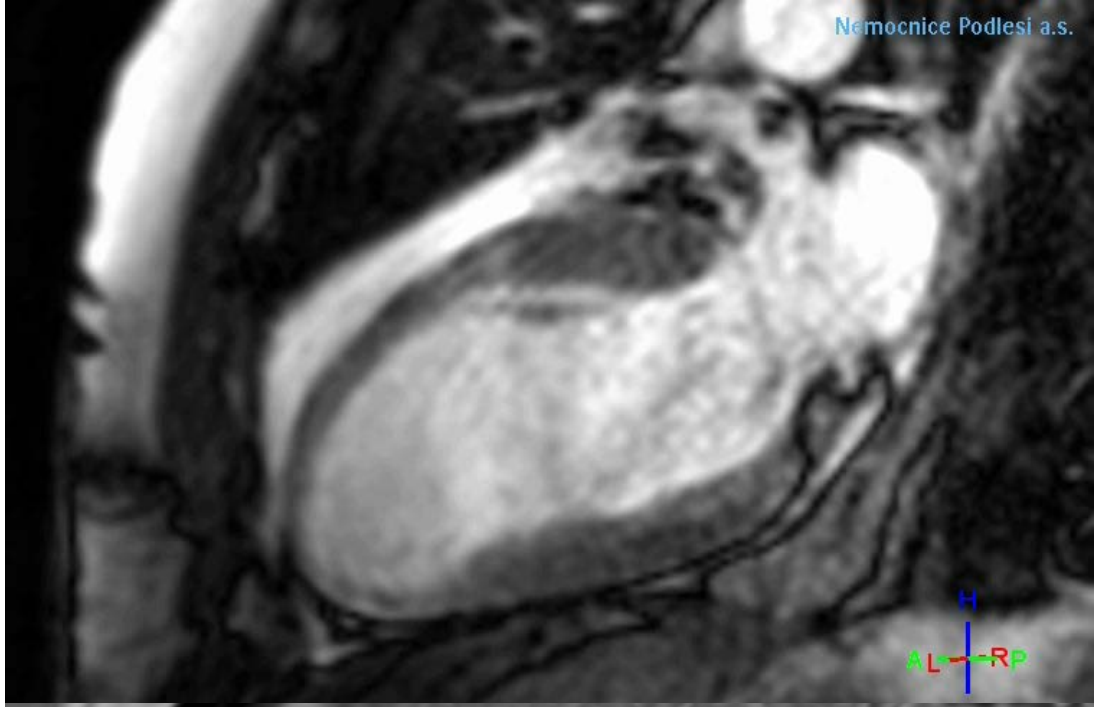
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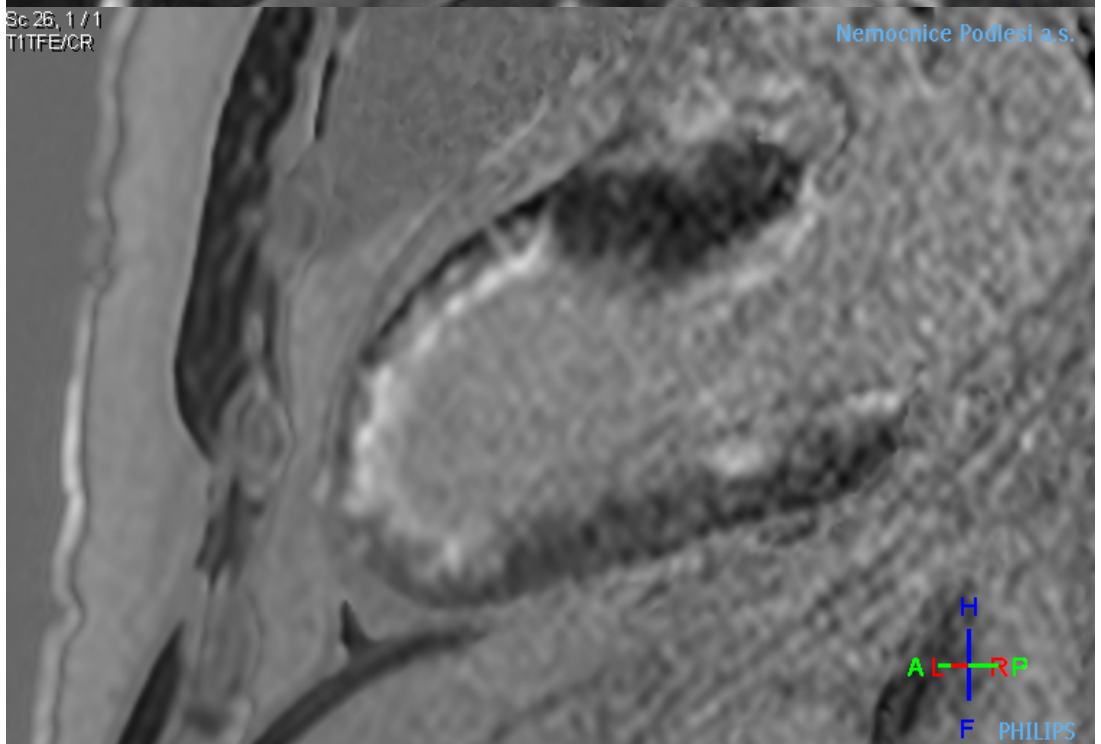
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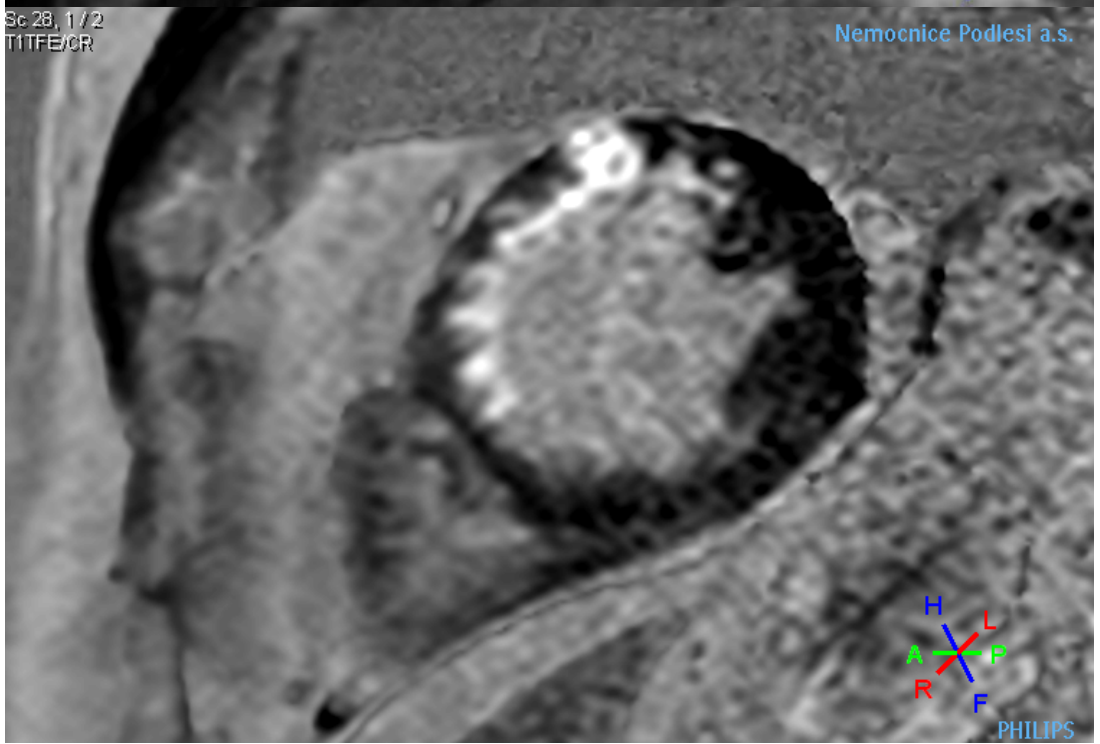
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DSMRI (low-dose)

Příčiny chybějící kontraktilní rezervy:

- nepřítomnost dostatečného množství viabilního myokardu

X

- vratné změny v buněčném metabolismu (včetně omráčeného myokardu v rámci akutní fáze IM)
- prohloubení ischemie již při nízkých dávkách dobutaminu
- nepřítomnost radiální kontrakce, ale přítomnost longitudinální a cirkulární kontrakce

Viabilita

Table 3. Viability cascade

Levels of damage	DOB	Thallium, FDG	Chance of recovery	% Viable myocytes
Mild	+	+	High	>75%
Moderate	–	+	Moderate	25%–75%
Severe	–	–	Low	<25%

DOB, dobutamine; *FDG*, fluorodeoxyglucose.

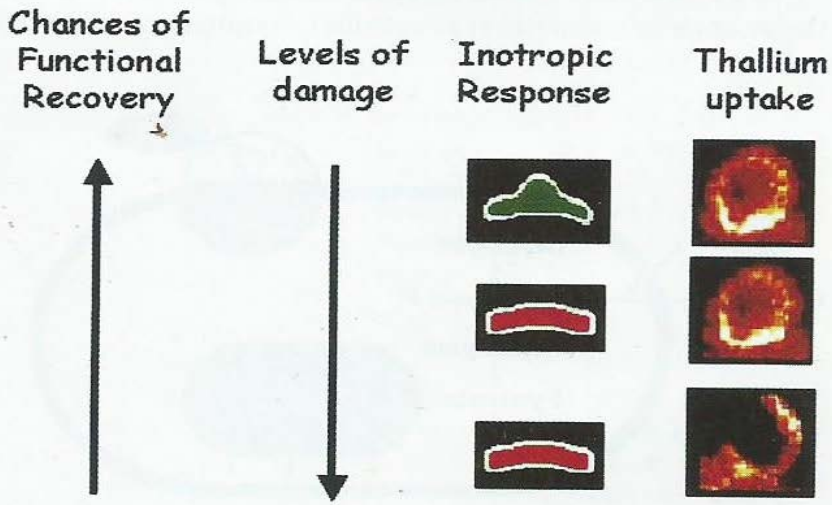


Fig. 1. The viability cascade. Higher degrees of cellular damage correspond to progressive loss of cellular functions. Mild damage is associated with preserved inotropic response and thallium uptake. Moderate damage can be identified as a loss of contractile response with preserved thallium uptake. Severe preterminal damage is expressed by loss of contractile response and no thallium uptake

Stress echocardiography, Eugenio Picano, 4th edition, 2003

Viabilita

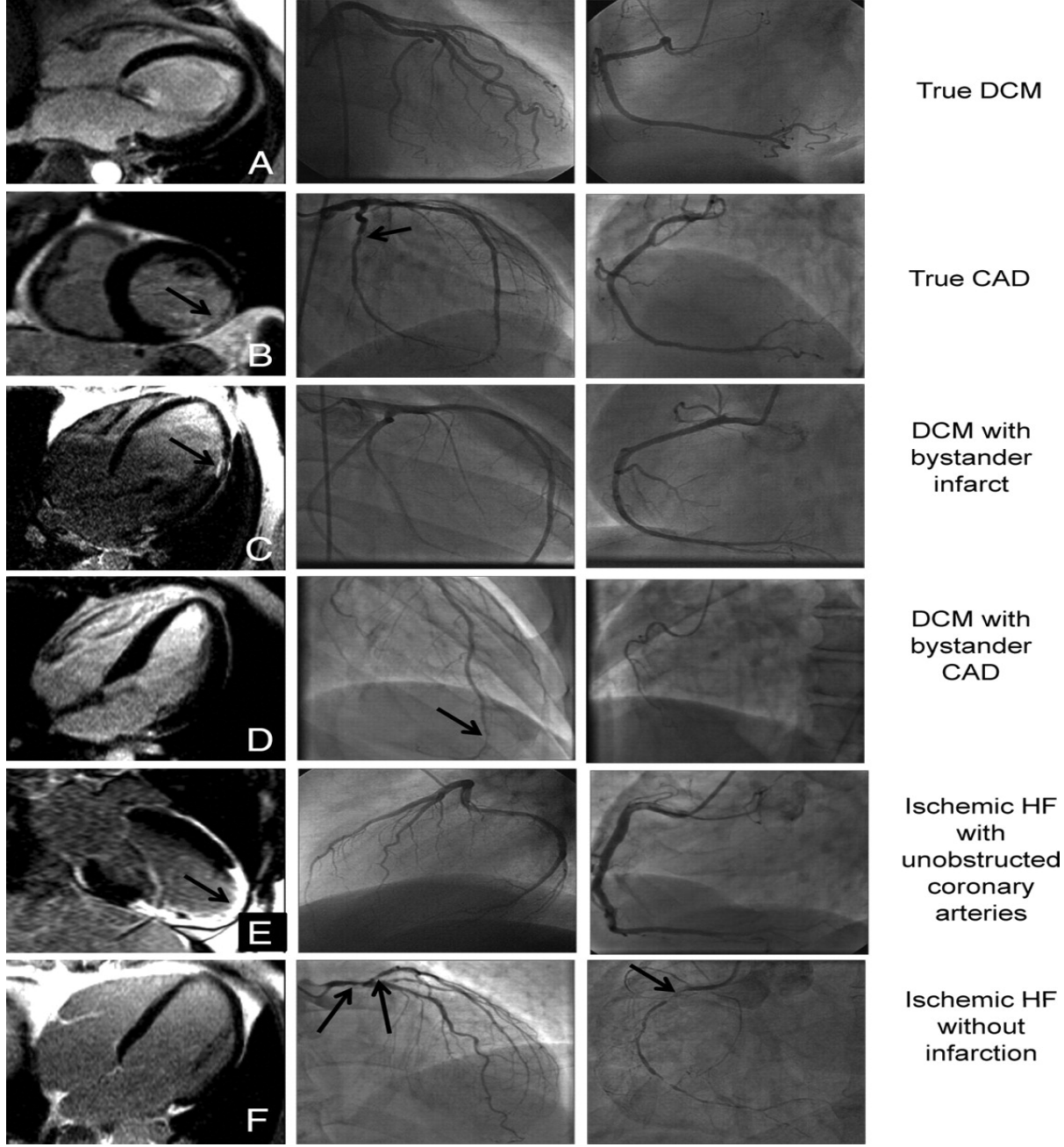
LGE < 50 %, DSMRI (low-dose) – : nutné komplexní posouzení

- věk
- komorbidity
- koronarografický nález
- typ revaskularizace
- přidružený výkon
- preference pacienta

Etiologie systolické dysfunkce LK

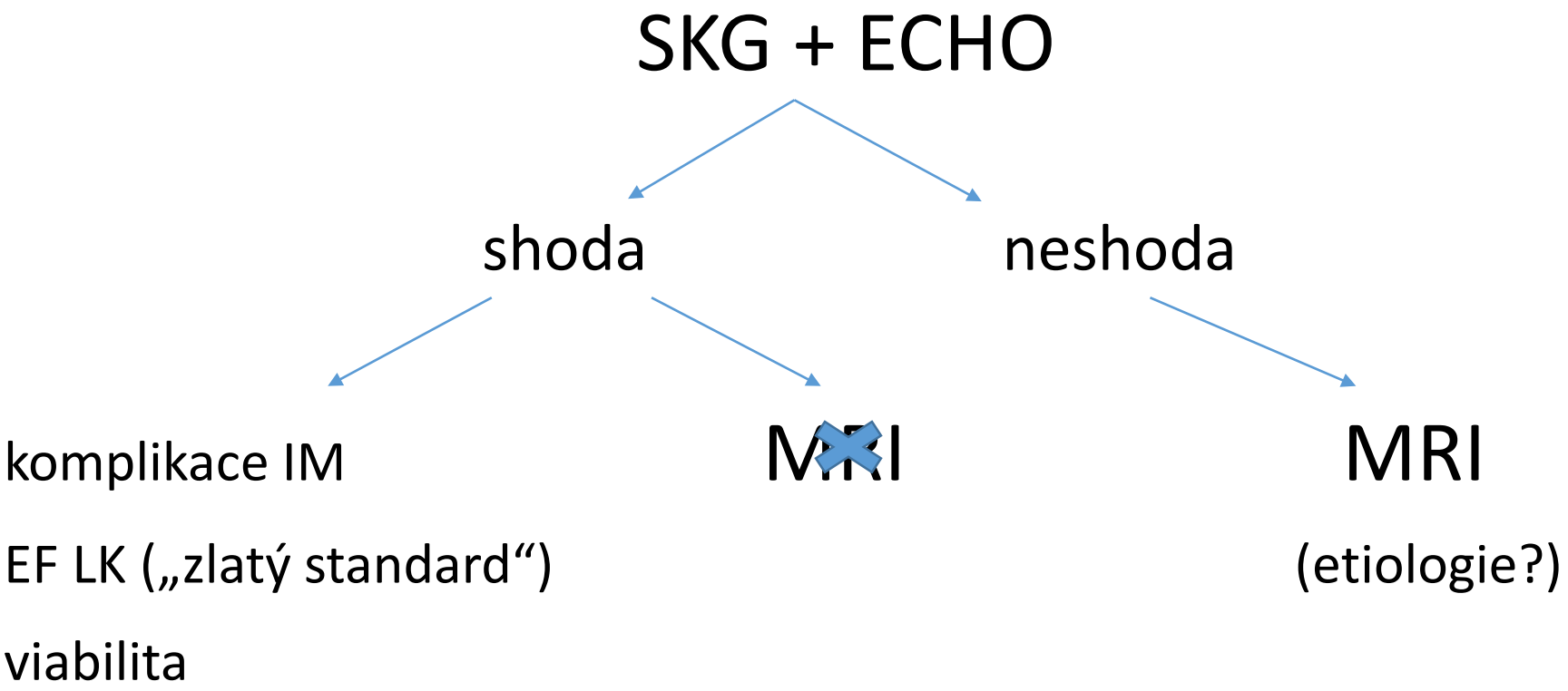
Kombinace KG a MRI = rozlišení ischemické a neischemické etiologie

- normální koronarogram nevylučuje ischemickou etiologii
- obstruktivní ateroskleróza nepotvrzuje ischemickou etiologii
- nepřítomnost pozdního sycení myokardu nevylučuje ischemickou etiologii regionální dysfunkce LK (hibernace)

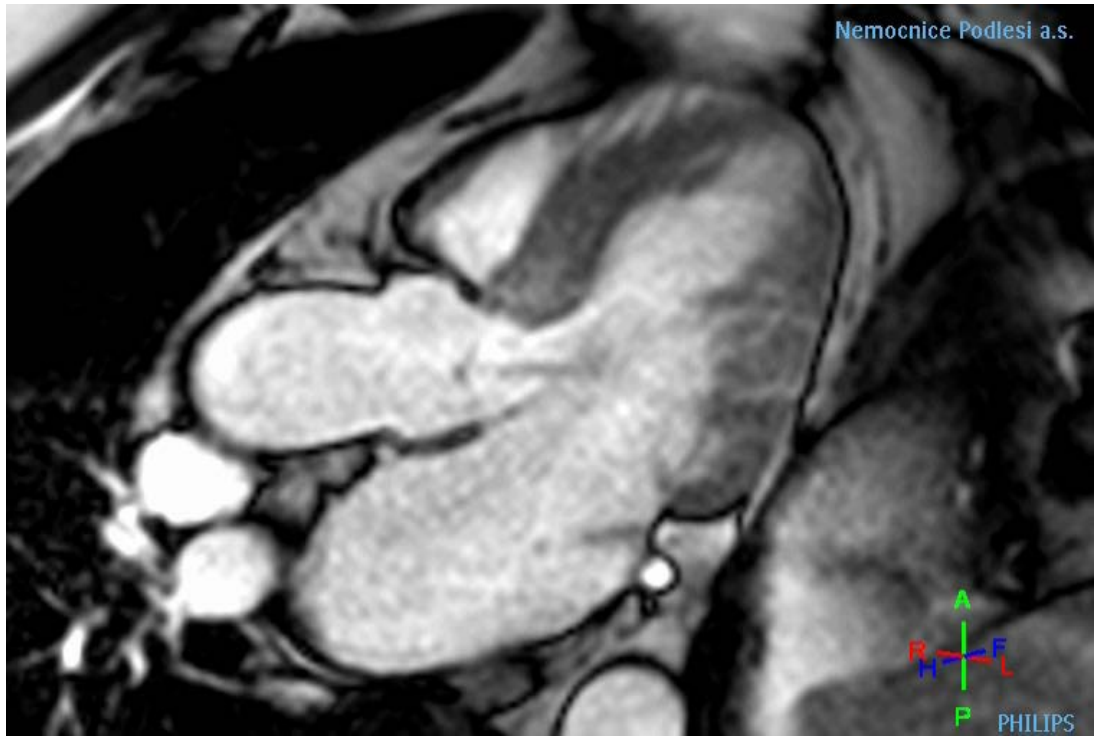


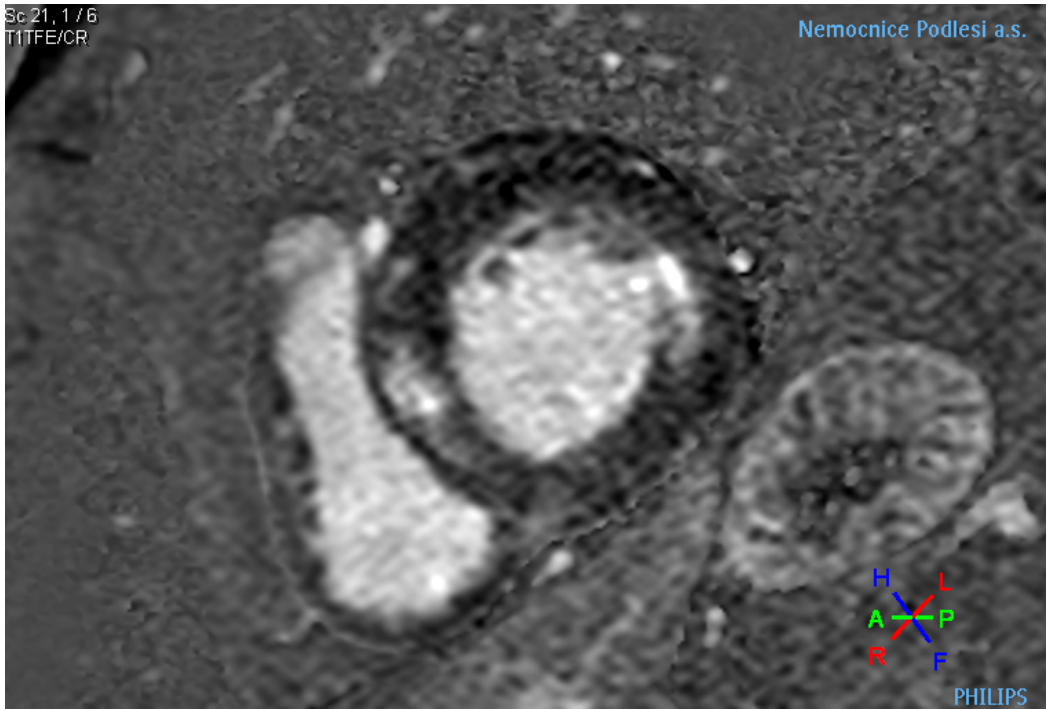
Assomull RG et al.Role of Cardiovascular Magnetic Resonance as a Gatekeeper to Invasive Coronary Angiography in Patients Presenting With Heart Failure of Unknown Etiology, (Circulation. 2011;124:1351-1360..

Systolická dysfunkce LK a ICHS



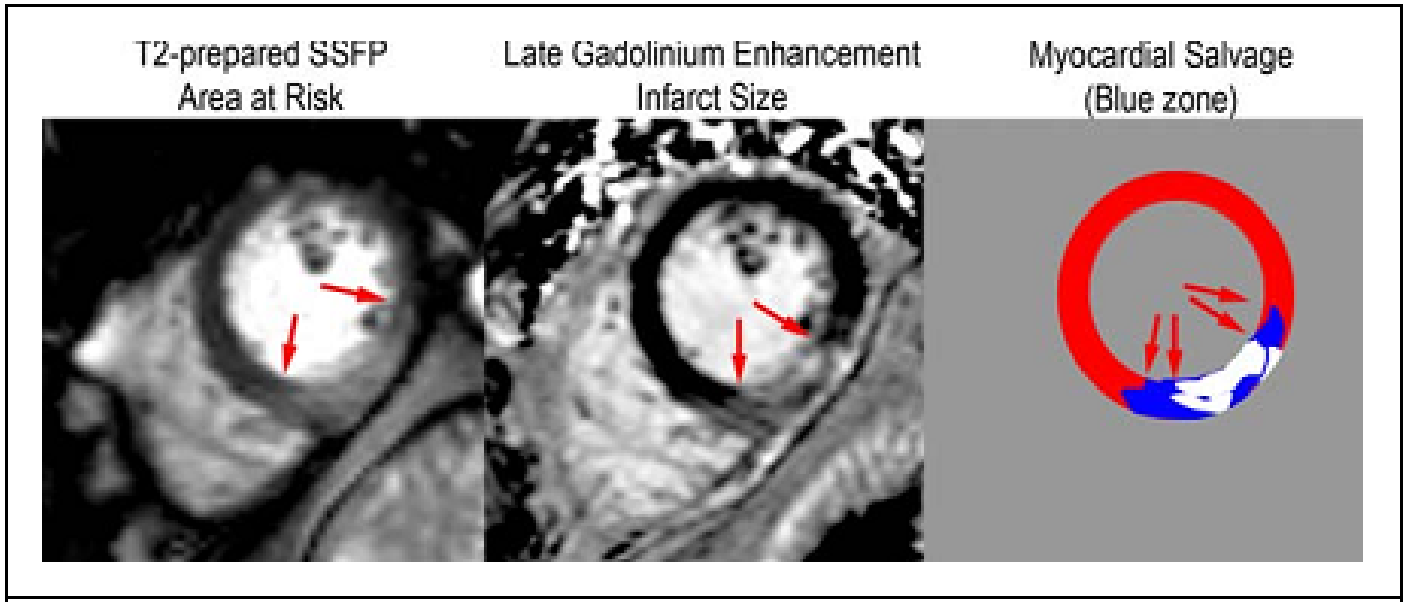
Systolická dysfunkce LK





AIM

- detekce a lokalizace
- odhad prognózy (rozsah sycení, mikrovaskulární obstrukce)
- komplikace
- „area at risk“



Arai AE. Magnetic resonance imaging for area at risk, myocardial infarction, and myocardial salvage. Journal of Cardiovascular Pharmacology and Therapeutics 16(3-4) 313-320.

MINOCA

Table I Diagnostic criteria for myocardial infarction with non-obstructive coronary arteries

The diagnosis of MINOCA is made immediately upon coronary angiography in a patient presenting with features consistent with an acute myocardial infarct, as detailed by the following criteria:

(1) AMI criteria.[1]
   (a) Positive cardiac biomarker (preferably cardiac troponin) defined as a rise and/or fall in serial levels, with at least one value above the 99th percentile upper reference limit.
   and
   (b) Corroborative clinical evidence of infarction evidenced by at least one of the following:
      (i) Symptoms of ischaemia
      (ii) New or presumed new significant ST-T changes or new LBBB
      (iii) Development of pathological Q waves
      (iv) Imaging evidence of new loss of viable myocardium or new RWMA
      (v) Intracoronary thrombus evident on angiography or at autopsy

(2) Non-obstructive coronary arteries on angiography:
   - Defined as the absence of obstructive CAD on angiography, (i.e. no coronary artery stenosis ≥50%), in any potential infarct-related artery.
   - This includes both patients with:
     o normal coronary arteries (no stenosis >30%)
     o mild coronary atheromatosis (stenosis >30% but <50%).

(3) No clinically overt specific cause for the acute presentation:
   - At the time of angiography, the cause and thus a specific diagnosis for the clinical presentation is not apparent.
   - Accordingly, there is a necessity to further evaluate the patient for the underlying cause of the MINOCA presentation.

LBBB, left bundle branch block. RWMA, regional wall motion abnormality.

Agewall S, Beltrame JF, Reynolds HR, Niessner A, Rosano G, Caforio AL, De Caterina R, Zimarino M, Roffi M, Kjeldsen K, Atar D, Kaski JC, Sechtem U, Tornwall P; WG on Cardiovascular Pharmacotherapy. ESC working group position paper on myocardial infarction with non-obstructive coronary arteries. *Eur Heart J.* 2016 Apr 28. pii: ehw149. [Epub ahead of print].

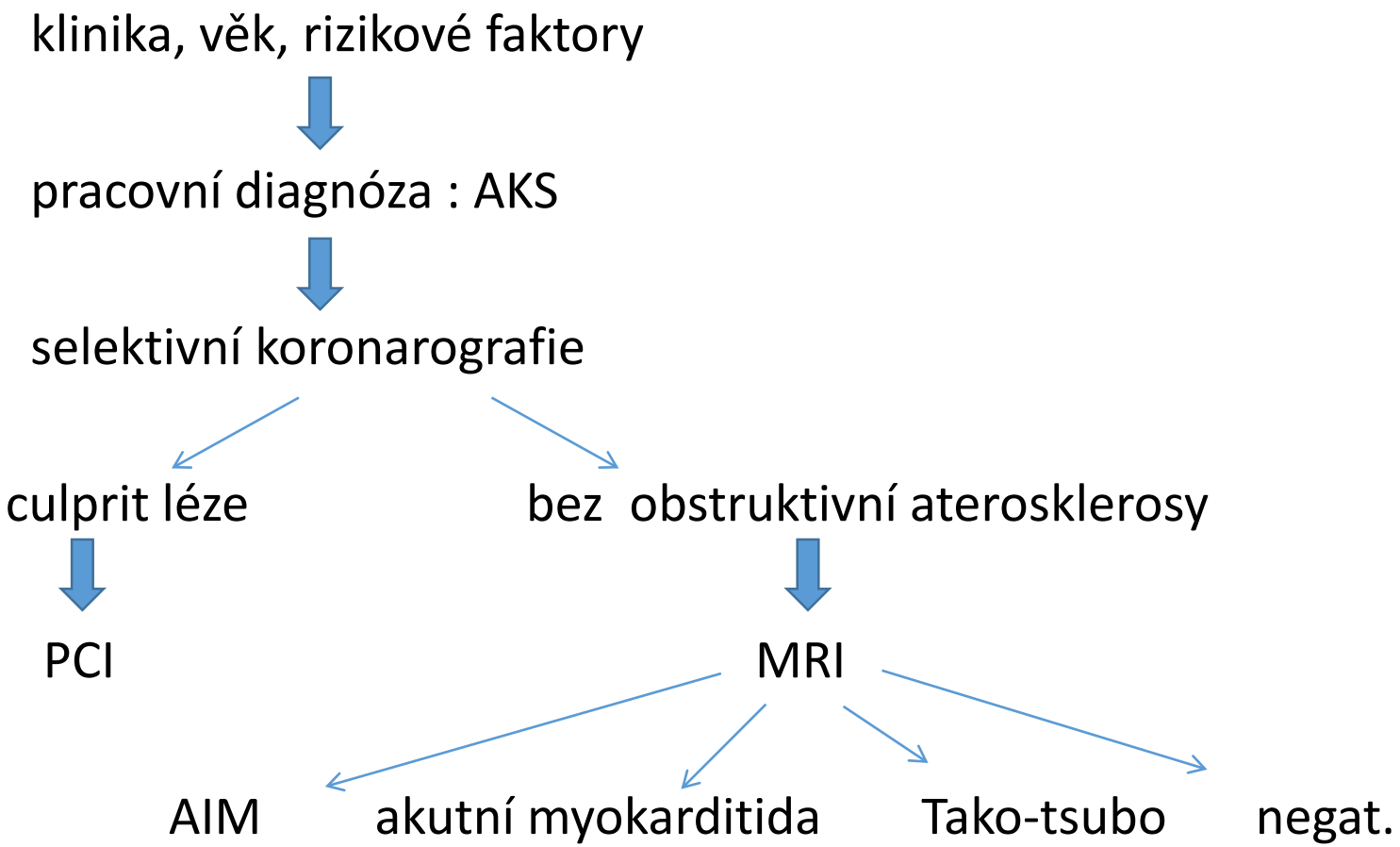
MINOCA

- syndrom zahrnující jak ischemické, tak neischemické postižení myokardu
- prevalence 6-8,8 %
- jednoroční (celková) mortalita 4,5 % (vs. 6,7 % u obstruktivní koronární AS)

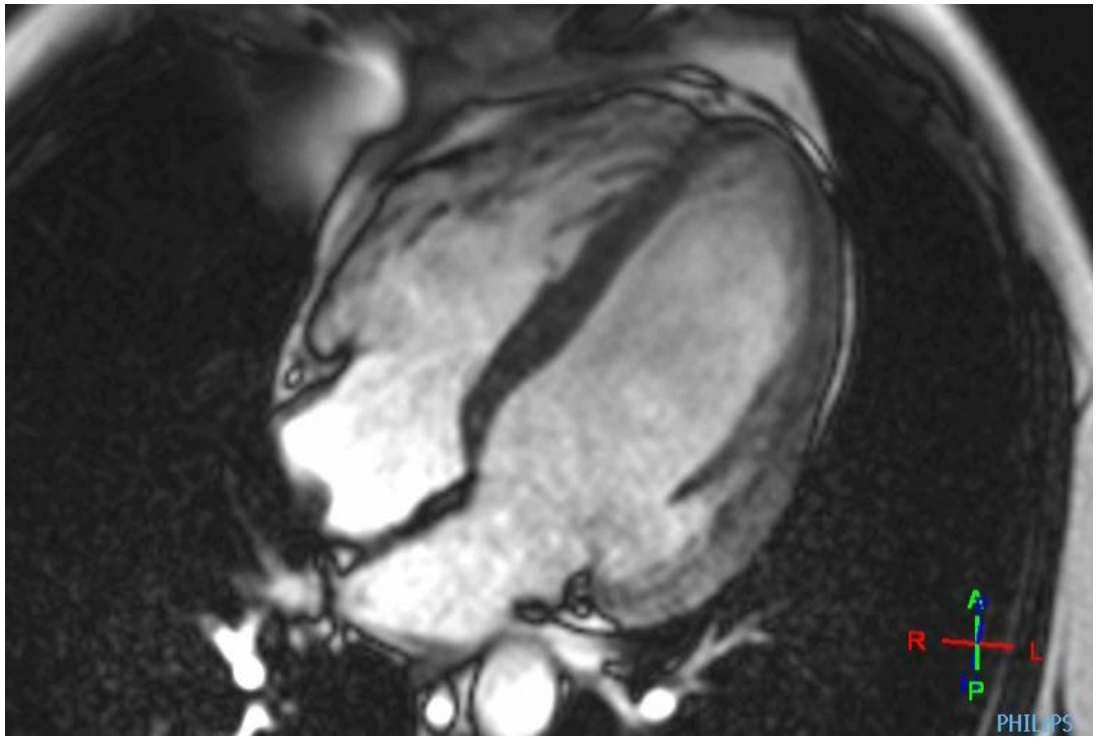
Etiologie:

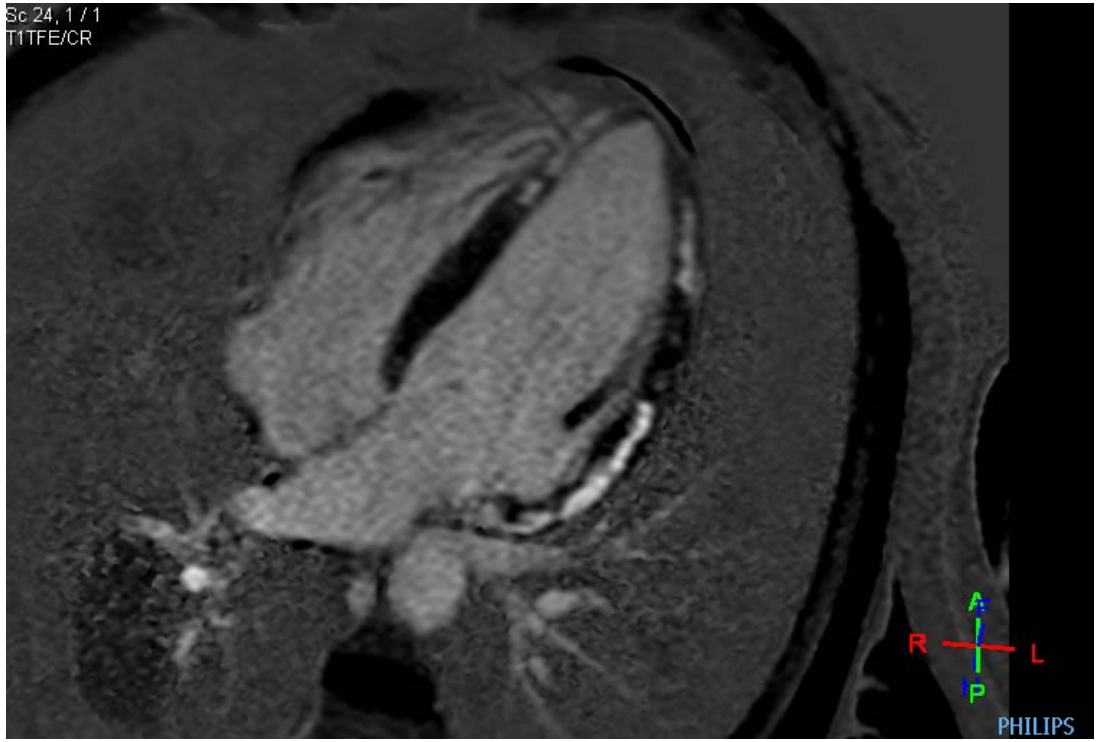
- AIM (ruptura plátu, spasmus, disekce, embolizace)
- akutní myokarditida
- stresová KMP

Bolest na hrudi + dynamika v troponinu



Myokarditida





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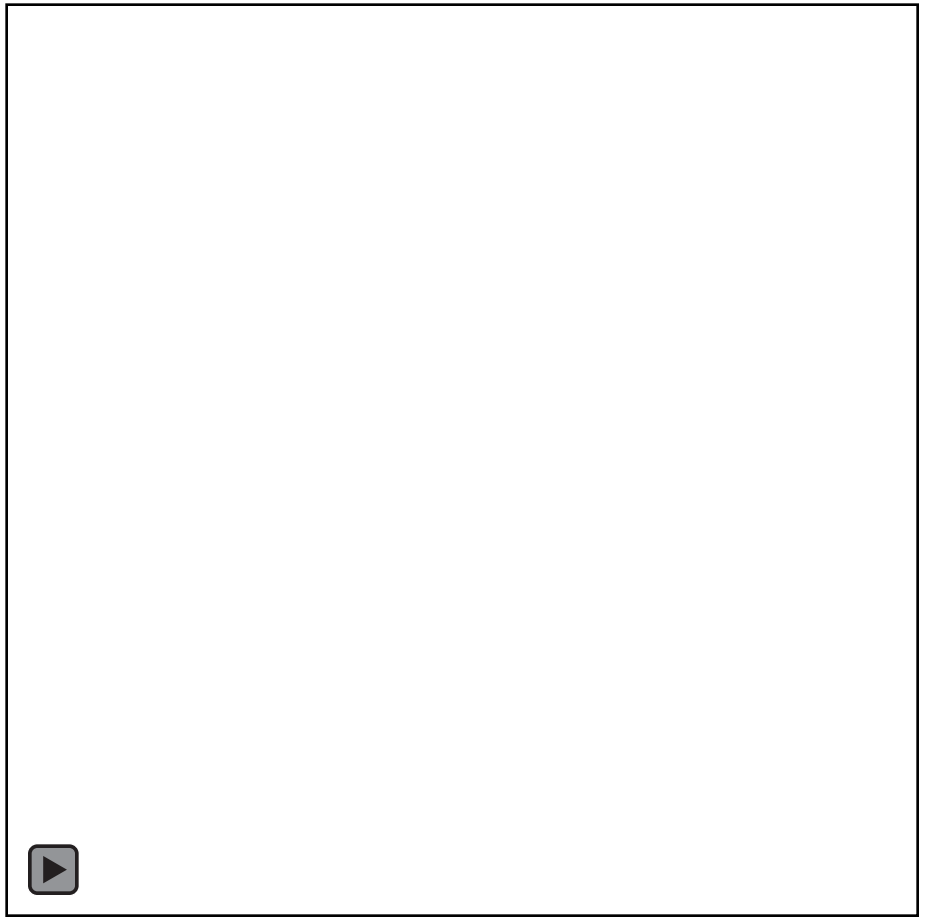

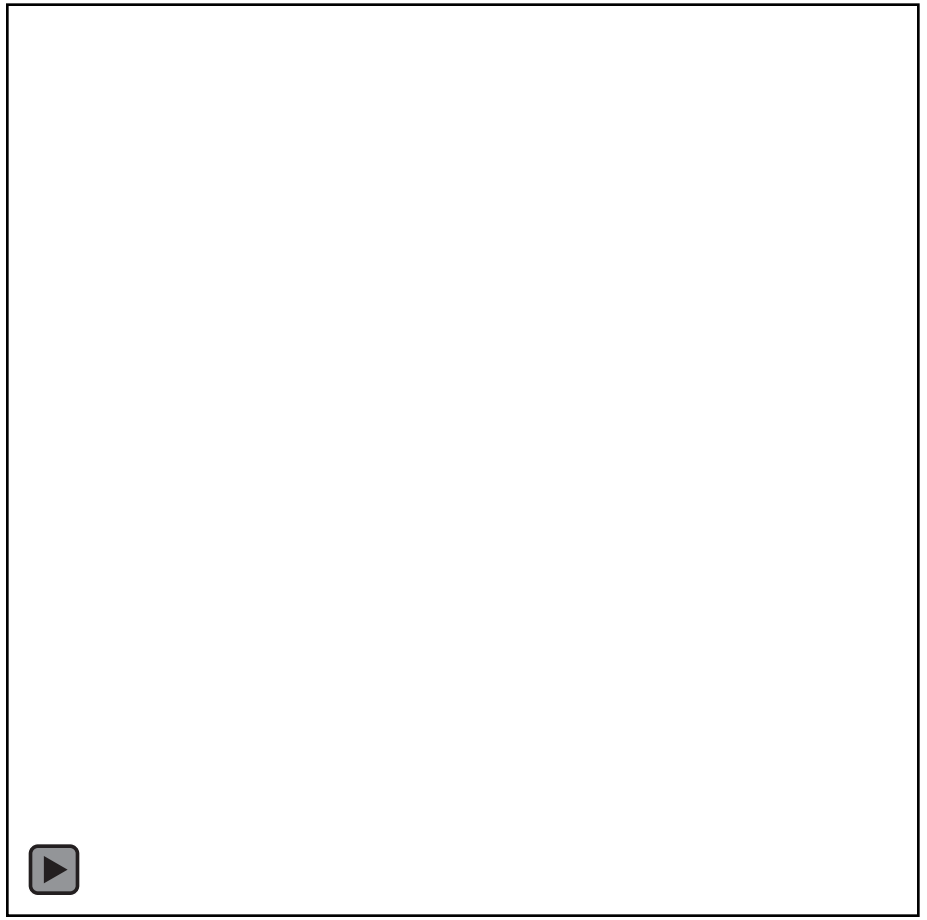

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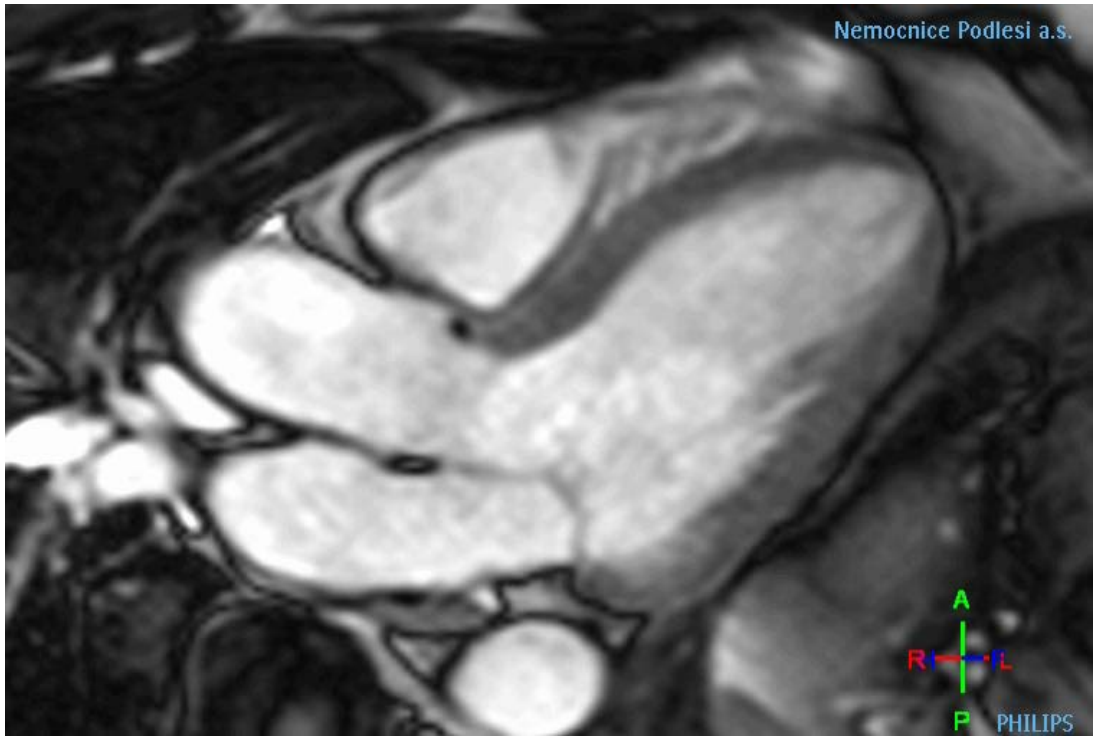
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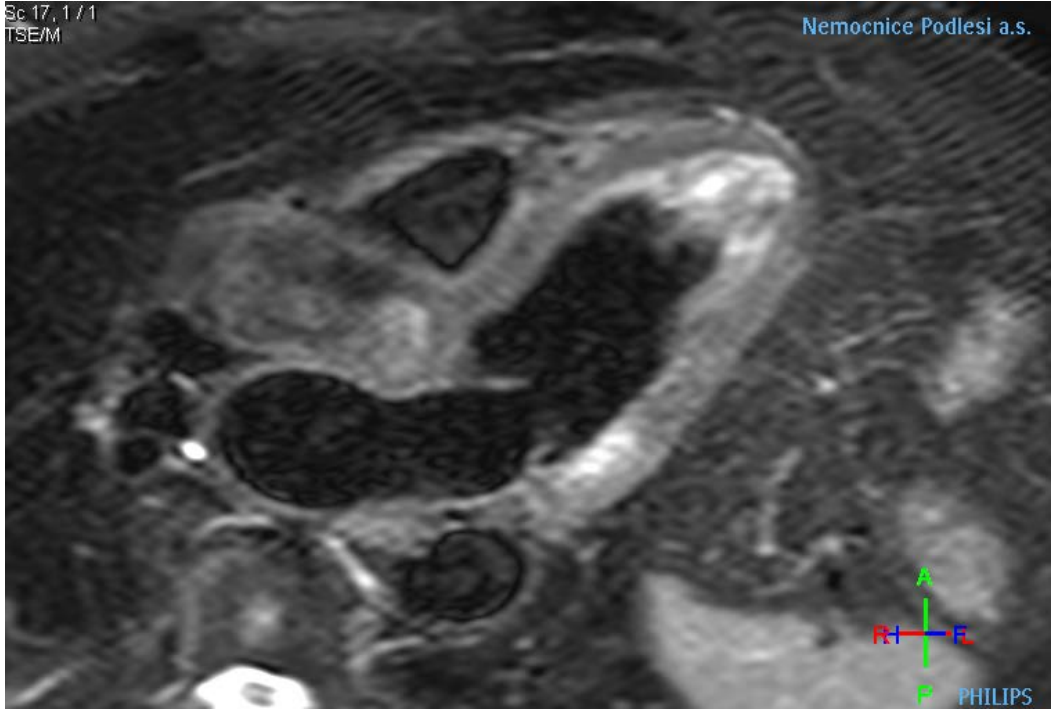
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The unique value of cardiovascular magnetic resonance in patients with suspected acute coronary syndrome and culprit-free coronary angiograms

Roman Panovsky, M.D., Ph.D.; Julia Borova; Martin Pleva; Vera Feitova; Petr Novotny; Vladimir Kincl, Ph.D.; Tomas Holecek; Jaroslav Meluzin, Prof., Ph.D.; Ondrej Sochor; Radka Stepanova

Summary:

Background and objective: Making a diagnosis in patients with chest pain and absence of a significant coronary artery stenosis may be difficult. The purpose of this study was to investigate the incremental diagnostic value of cardiovascular magnetic resonance (CMR) in cohort of patients with suspected acute coronary syndrome (ACS) and unobstructed coronary arteries.

Methods: Data files of patients meeting the inclusion criteria in two cardiology centres were searched out and analysed. Special attention was paid to the benefits of CMR in determining the final diagnosis.

Results: In total, 136 patients who underwent coronary angiography for chest pain were analysed. The most frequent underlying causes were myocarditis (38%) and perimyocarditis (18%), followed my angiographically unrecognised acute myocardial infarction (18%), and takotsubo cardiomyopathy (15%). Final diagnosis remained unclear in 6% patients. The contribution of CMR for the final diagnosis determination was crucial in 57% patients. In another 35% patients CMR confirmed the suspicion and, only 8% CMR examinations did not help at all and had no influence on diagnosis and treatment.

Conclusion: CMR provides powerful incremental diagnostic value in the cohort of patients with ACS and unobstructed coronary arteries. CMR should be strongly advised to be an inalienable part of diagnostic algorithms in these patients.

Závěr

- MR koronarografie je metodou experimentální
- zátěžové MRI testy mají srovnatelnou senzitivitu a specificitu jako zátěžový SPECT/DSE
- MRI je metodou volby pro detekci IM a stanovení viability myokardu
- nejpřesnější metoda pro detekci nitrokomorového trombu
- diferenciální diagnostika systolické dysfunkce LK
- diferenciální diagnostika MINOCA syndromu

ESC CMR Level 1

*** Special Track****

(free, included in conference registration fees)

CMR level 1
is considered the basic knowledge
for European Cardiologists

SAVE THE DATE

European's main clinical CMR meeting

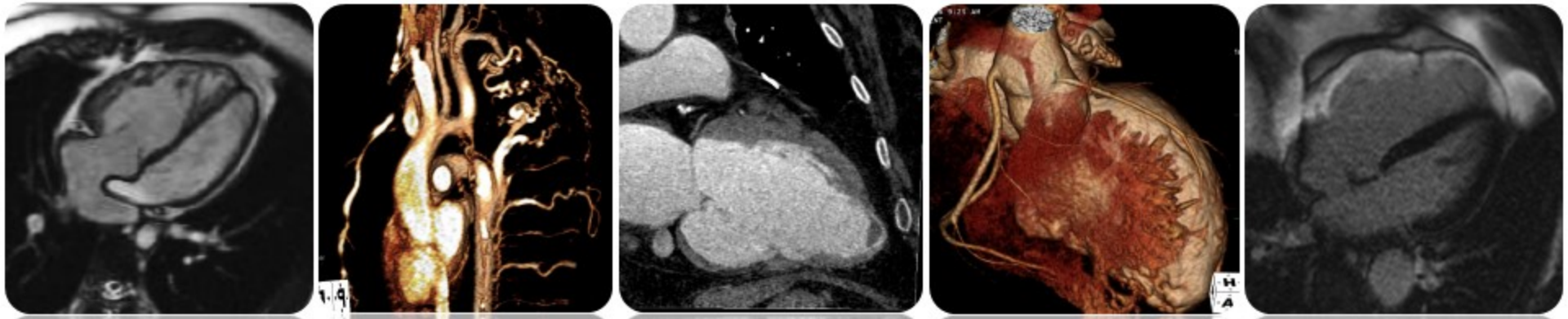
- 2.5 days of science and clinical training
- 800+ delegates from 40+ countries
- 300+ abstract submitters
- 35+ scientific sessions
- 90+ international speakers
- Abstract, posters and cases sessions
- The opportunity to get CMR level 1 certified

MOST

Mezi-Oborové sympozium
o Srdeční Tomografii

Sympozium věnované výpočetní tomografii a magnetické rezonanci srdce

8. 4. 2017 - FN Motol, Praha



První oznámení

Děkuji Vám za pozornost