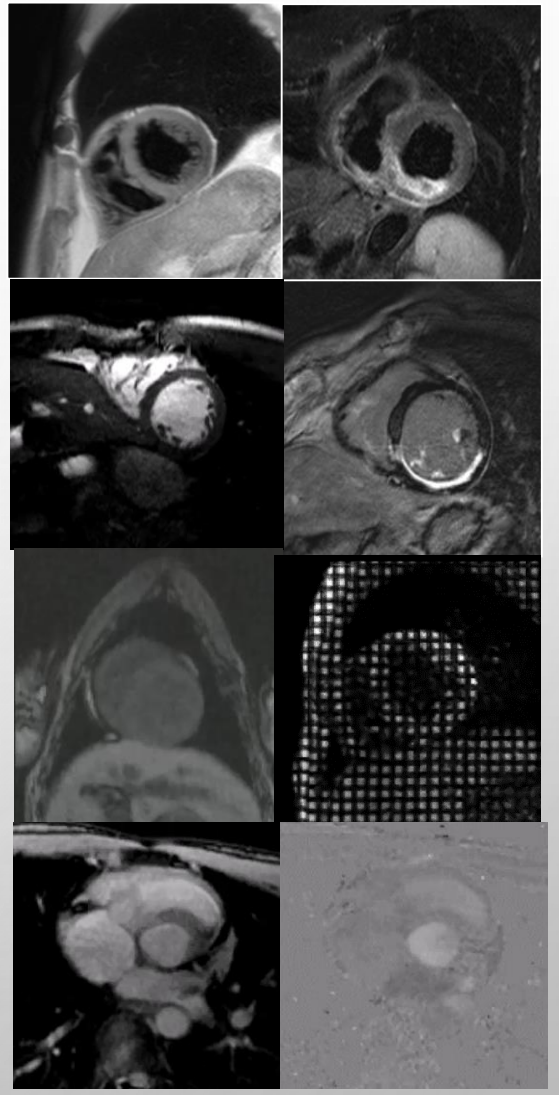
Возможности МРТ в оценке миокарда желудочков у пациентов с хронической сердечной недостаточностью

Рудь С.Д.

МРТ ОСНОВНЫЕ ПОСЛЕДОВАТЕЛЬНОСТИ

- МОРФОЛОГИЯ (T1- T2- TSE / КИНО SSFP)
- ВЫЯВЛЕНИЕ ОТЕКА, ГИПЕРЕМИИ ОЦЕНКИ ИЗМЕНЕНИЙ МОРФОЛОГИИ МИОКАРДА (T1- T2- TSE И STIR-SE)
- ОЦЕНКА ФУНКЦИИ:
  - СИСТОЛИЧЕСКОЙ (КИНО SSFP / TAGGING)
  - ДИАСТОЛИЧЕСКОЙ: ФАЗОВО-КОНТРАСТНЫЕ ИЗОБРАЖЕНИЯ
- ОЦЕНКА ПЕРФУЗИИ (T1-FLASH –SSFP, EPI)
- ХАРАКТЕРИСТИКА МИОКАРДА
  - ОТСРОЧЕННОЕ КОНТРАСТИРОВАНИЕ (IR-GRE)
  - ОЦЕНКА СОДЕРЖАНИЯ ЖЕЛЕЗА (T2*-GRASE)
- ПАТОЛОГИЯ КЛАПАНОВ (КИНО-TFISP, ФАЗОВО-КОНТРАСТНЫЕ ИЗОБРАЖЕНИЯ)



ПОКАЗАНИЯ К МРТ СЕРДЦА

Table 7 Possible applications of various imaging techniques in the diagnosis of HF

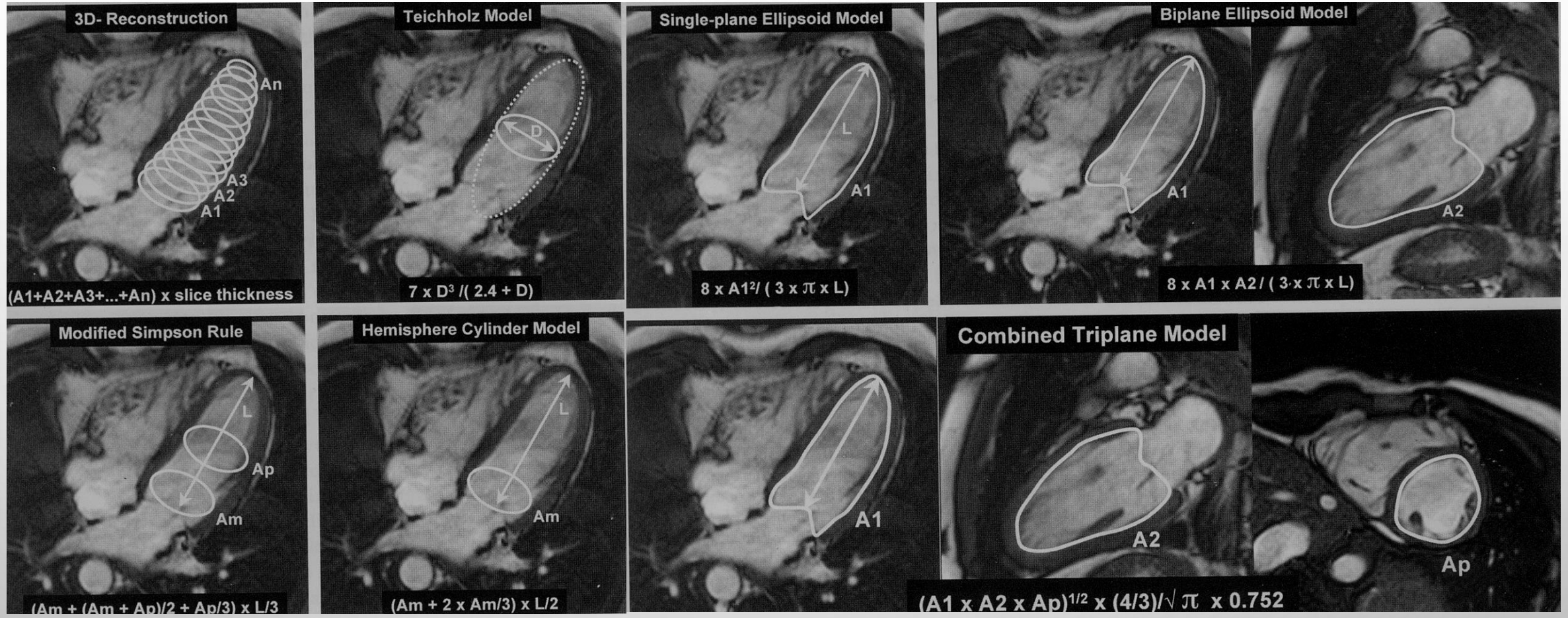
		Echo	CMR	Cath	SPECT	MDCT	PET
Remodelling/dysfunction							
LV:	EDV	++	+++	++	++	++	++
	ESV	++	+++	++	++	++	++
	EF	++	+++	++	++	++	++
	Mass	++	+++	-	-	++	-
RV:	EDV	++	+++	+	-	++	-
	ESV	++	+++	+	-	++	-
	EF	++	+++	+	-	++	-
	Mass	++	+++	-	-	++	-
LV diastolic dysfunction		+++	+	+++	-	-	-
Dyssynchrony		++	+	-	+	-	-
Aetiology							
CAD:	Ischaemia	+++[a]	+++	+++[b]	+++	-	+++
	Hibernation	+++[a]	+++[a]	-	+++	-	+++
	Scar	++	+++	-	++	-	++
	Coronary anatomy	-	-	+++	-	+++	-
Valvular:	Stenosis	+++	+	+++	-	++[c]	-
	Regurgitation	+++	++	++	-	-	-
Myocarditis		+	+++	+++[d]	-	-	-
Sarcoidosis		+	+++	++[d]	-	-	++
Hypertrophic CMP:	HCM	+++	++	++	-	-	-
	Amyloidosis	++	+++	+++[d]	-	-	-
Dilated CMP:	Myocarditis	+	+++	+++[d]	-	-	-
	Eosinophilic syndromes	+	+++	+++[d]	-	-	-
	Iron: haemochromatosis	+	+++	-	-	-	-
	Iron: thalassaemia	+	+++	-	-	-	-
ARVC		++	+++	+++[d]	-	+	-
Restrictive CMP:	Pericarditis	++[e]	++[f]	++[e]	-	++[g]	-
	Amyloidosis	++	+++	+++[d]	-	-	-
	Endomyocardial fibrosis	+	+++	+++[d]	-	-	-
	Anderson–Fabry	+	+	-	-	-	-
Unclassified CMP	Takotsubo-CMP	++	++	+++	-	-	-
Main advantages							
		Wide availability Portability No radiation Relatively low cost	Good quality images[h] No radiation	Good availability	Good availability	Reasonable availability High quality images	Limited availability Good quality images[i]
Main disadvantages							
		Echo window needed	Limited availability Contraindications[k] Functional analysis Image quality limited if arrhythmia	Radiation Invasive	Radiation	Radiation Image quality limited if arrhythmia	Radiation Limited availability

ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure 2012

ПОКАЗАНИЯ К МРТ СЕРДЦА

- ПРИ ПОГРАНИЧНЫХ ИЛИ НЕОДНОЗНАЧНЫХ РЕЗУЛЬТАТАХ ДРУГИХ МЕТОДОВ ИССЛЕДОВАНИЯ (УЗИ, ЭКГ)
- НЕВОЗМОЖНОСТИ КАЧЕСТВЕННОГО УЗИ СЕРДЦА
- ДИФФЕРЕНЦИРОВКЕ ФИЗИОЛОГИЧЕСКИХ И ПАТОЛОГИЧЕСКИХ ИЗМЕНЕНИЙ МИОКАРДА ЖЕЛУДОЧКОВ
- «ЗОЛОТОЙ СТАНДАРТ» ДЛЯ ОЦЕНКИ МАССЫ МИОКАРДА ЛЕВОГО ЖЕЛУДОЧКА, ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО И ПРАВОГО ЖЕЛУДОЧКОВ
- ОЦЕНКА «МАЛЫХ» ЛОКАЛЬНЫХ НАРУШЕНИЙ СОКРАТИМОСТИ ЖЕЛУДОЧКОВ
- ОЦЕНКА ДИССИНХРОНИИ СОКРАЩЕНИЙ ЖЕЛУДОЧКОВ
- ВЫЯВЛЕНИЕ НЕКОМПАКТНОГО МИОКАРДА
- ПРИ ТОЧЕННОЙ ГРАДАЦИИ ТЕЧЕНИЯ ЗАБОЛЕВАНИЯ (ТОЧНАЯ ОЦЕНКА ФВ)

ОЦЕНКА СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА



Различные подходы к расчету объёма левого желудочка

ОЦЕНКА ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА

Cardiac Radiology

Matthias C. Dulce, MD • Gerhard H. Mostbeck, MD • Kerstin K. Friese, BS
Gary R. Caputo, MD • Charles B. Higgins, MD

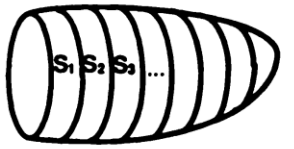
Quantification of the Left Ventricular Volumes and Function with Cine MR Imaging: Comparison of Geometric Models with Three-dimensional Data[1]

Table 2
Correlation of Global LV Volumes and Function in Both Groups

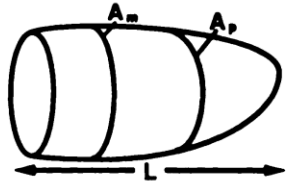
Group and Method	EDV (mL)		ESV (mL)		SV (mL)		EF
	r	SEE	*r*	SEE	*r*	SEE	Student *t* test
Healthy volunteers (n = 10)							
3D vs SR	.99	3.9	.94	5.1	.97	4.2	NS
3D vs BP	.97	6.2	.93	4.5	.88	7.7	NS
3D vs HC	.97	9.0*	.89	9.0*	.95	5.8*	*
3D vs SP	.95	10.6	.83	6.6	.78	15.1	NS
3D vs TF	.86	14.6	.82	11.2	.73	11.2	NS
Patients with LV hypertrophy (n = 10)							
3D vs SR	.97	3.7	.94	2.1	.94	4.1	NS
3D vs BP	.90	5.9	.76	3.1	.87	5.5	NS
3D vs HC	.96	6.2*	.95	2.9*	.94	7.2*	NS
3D vs SP	.61	7.8	.37	8.4*	.26	13.7	*
3D vs TF	.78	15.0*	.35	7.2*	.84	12.7	*

Note.—Values were obtained with geometric models versus a three-dimensional data set of cine MR images. NS = not significant, *r* = linear regression coefficient, SEE = standard error of the estimate. See Table 1 for other abbreviations.
* Significant differences compared with a three-dimensional data set were $P < .05$.

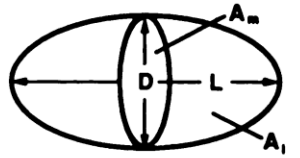
- **3-dimensional reconstruction:**
  LVV = S1 + S2 + S3 + ...



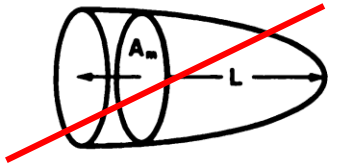
- **modified Simpson's Rule:**
  LVV = Am x L/3 + (Am + Ap)/2 x L/3 + 1/3 x Ap x L/3



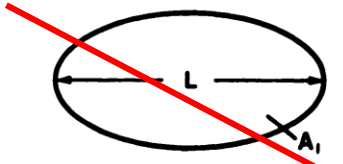
- **biplane ellipsoid:**
  LVV = π/6 x L x (4/π x Am/D) x (4/π x Al/L)



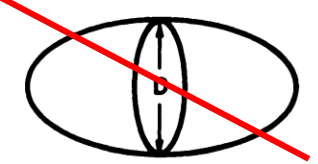
- **hemisphere cylinder:**
  LVV = Am x L/2 + 2/3 x Am x L/2 = 5/6 x Am x L



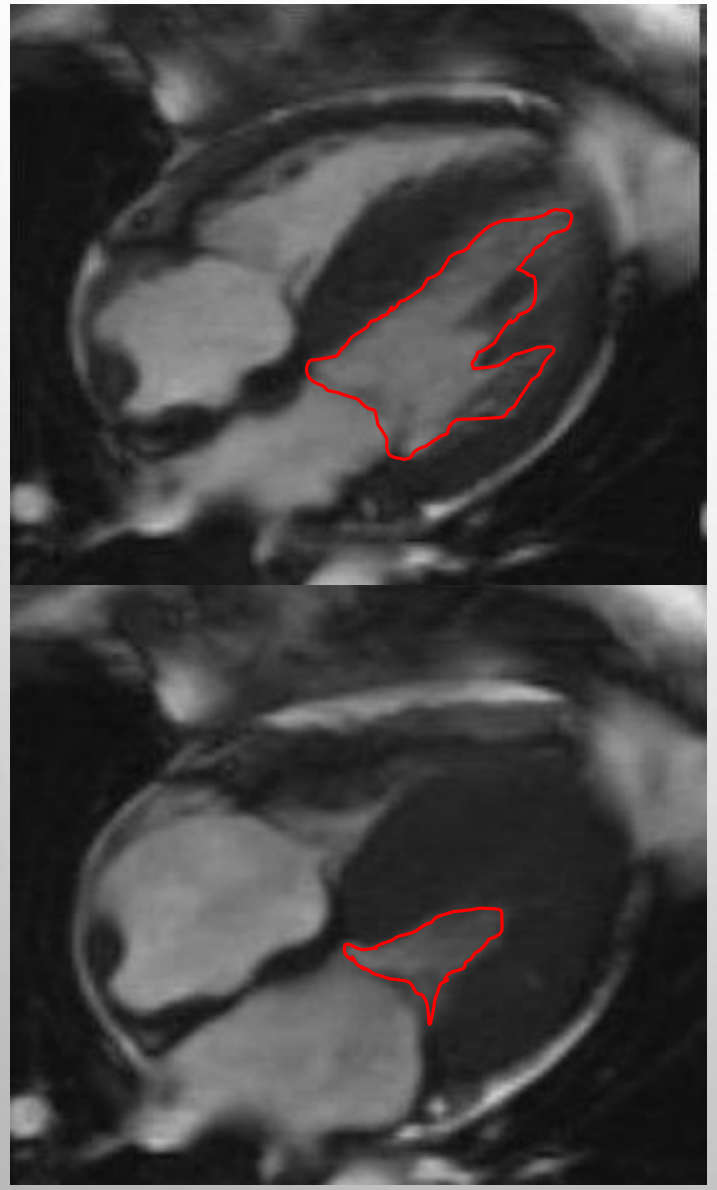
- **single-plane ellipsoid:**
  LVV = (8 x Al x Al) / (3π x L) = 0.85 x (Al x Al) / L



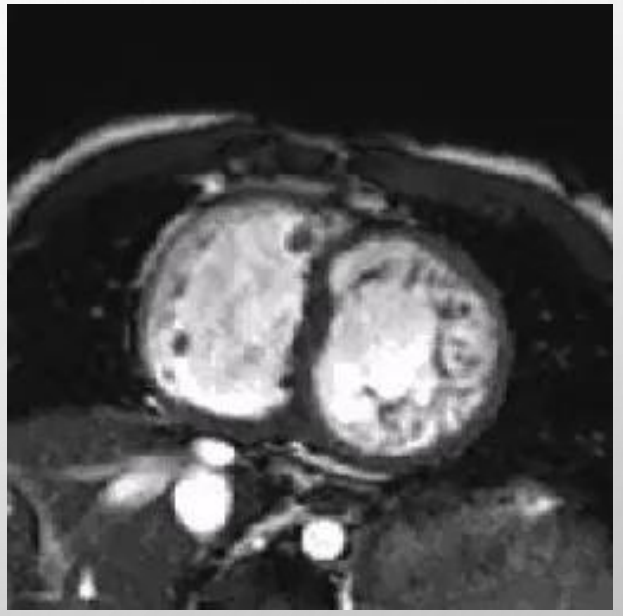
- **mod. Teichholz formula:**
  LVV = [7 / (2.4 + D)] x D x D x D



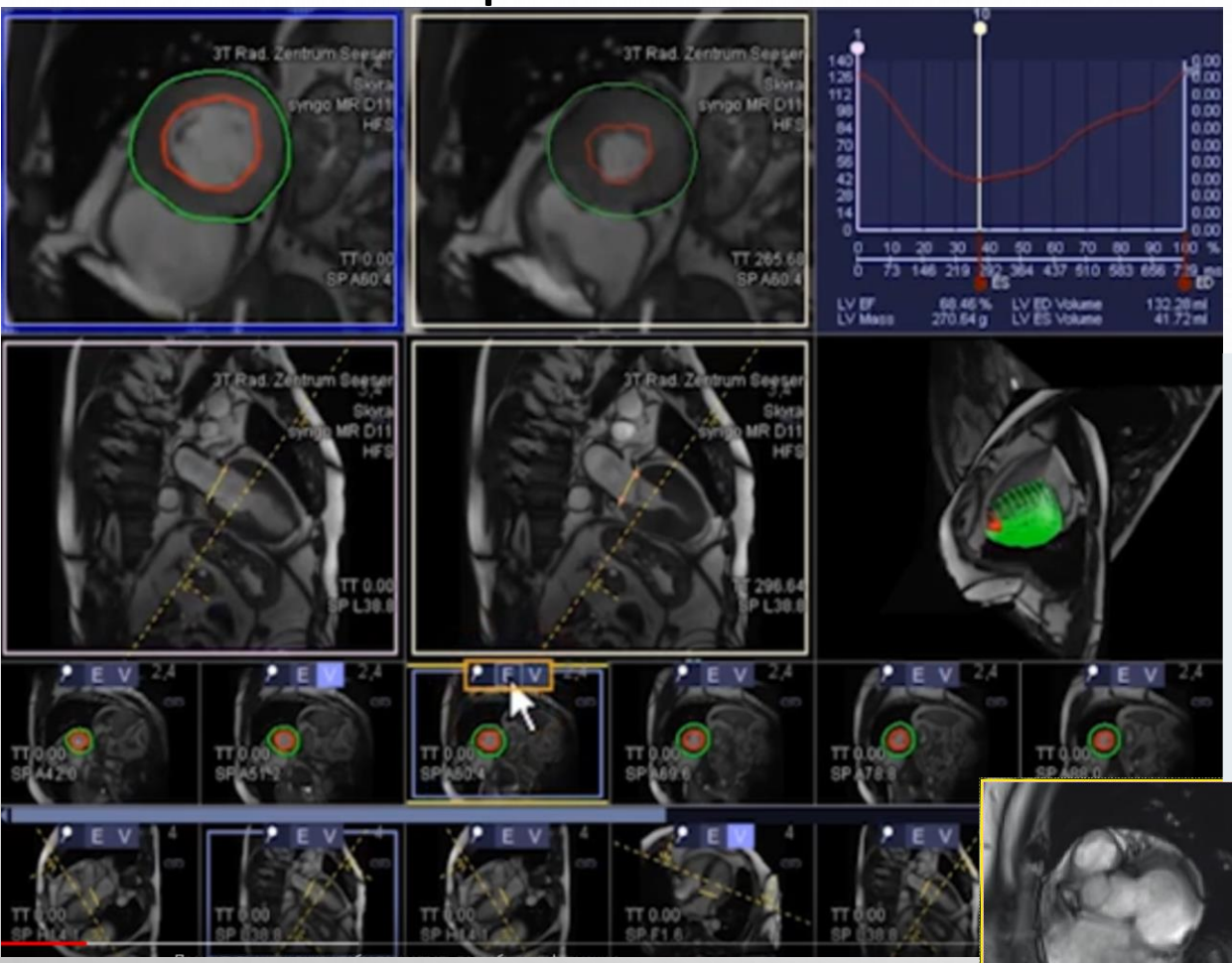
Оценка глобальной систолической функции левого желудочка

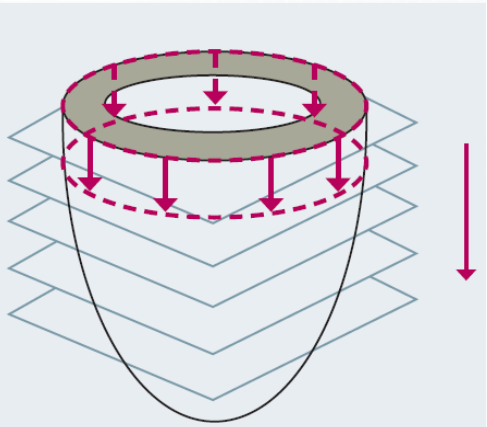


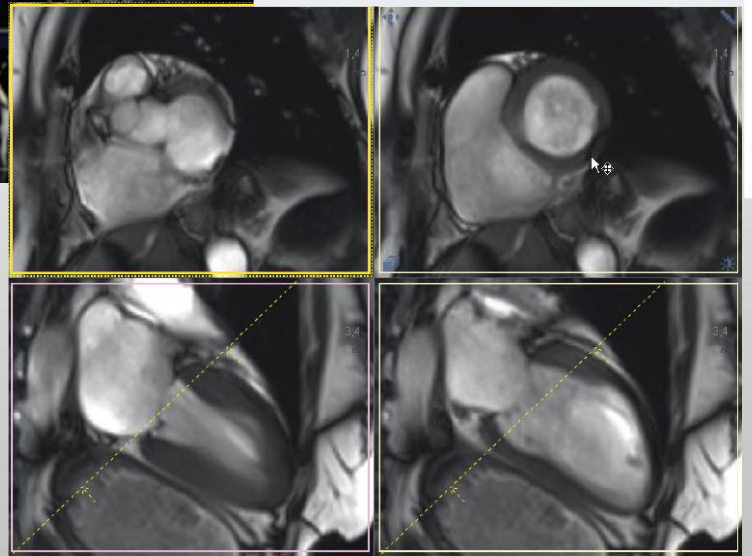
Варианты формы полости левого желудочка

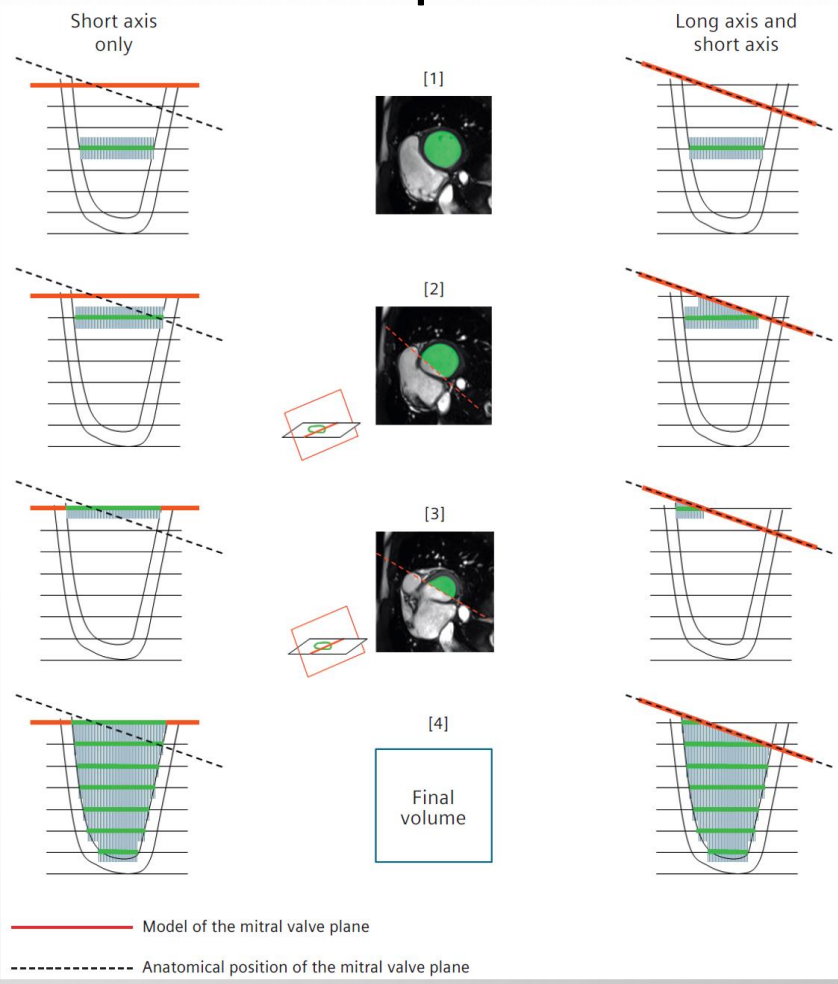


ОЦЕНКА ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА









Оценка с учетом продольного уменьшения размера полости левого желудочка

НОРМАЛЬНЫЕ ЗНАЧЕНИЯ ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА

	20-29 (years)	30-39 (years)	40-49 (years)
EDV (ml)	139 (99, 179)	135 (94, 175)	130 (90, 171)
ESV (ml)	48 (29, 66)	45 (27, 64)	43 (25, 62)
SV (ml)	91 (63, 119)	89 (61, 117)	87 (59, 115)
EF (%)	66 (56, 75)	66 (57, 75)	67 (58, 76)
Mass (g)	110 (74, 146)	106 (70, 142)	107 (71, 143)
Indexed to BSA			
EDV/BSA (ml/m²)	82 (65, 99)	79 (62, 96)	76 (59, 93)
ESV/BSA (ml/m²)	28 (19, 37)	27 (17, 36)	25 (16, 34)
SV/BSA (ml/m²)	54 (42, 66)	53 (40, 65)	51 (39, 63)
Mass/BSA (g/m²)	62 (47, 77)	62 (47, 77)	63 (48, 77)

	50-59 (years)	60-69 (years)	70-79 (years)
EDV (ml)	126 (86, 166)	122 (82, 162)	118 (77, 158)
ESV (ml)	41 (22, 59)	39 (20, 57)	36 (18, 55)
SV (ml)	85 (57, 113)	83 (56, 111)	81 (54, 109)
EF (%)	68 (59, 77)	69 (60, 78)	69 (60, 78)
Mass (g)	108 (72, 144)	109 (73, 145)	110 (74, 146)
Indexed to BSA			
EDV/BSA (ml/m²)	73 (56, 90)	70 (53, 87)	67 (50, 84)
ESV/BSA (ml/m²)	24 (14, 33)	22 (13, 31)	21 (12, 30)
SV/BSA (ml/m²)	50 (37, 62)	48 (36, 60)	47 (34, 59)
Mass/BSA (g/m²)	63 (48, 78)	63 (48, 78)	63 (49, 78)

женщины

EACVI EUROPEAN ASSOCIATION OF CARDIOVASCULAR IMAGING
A Registered Branch of the ESC

EUROPEAN SOCIETY OF CARDIOLOGY®

	20-29 (years)	30-39 (years)	40-49 (years)
EDV (ml)	167 (126, 208)	163 (121, 204)	159 (117, 200)
ESV (ml)	58 (35, 80)	56 (33, 78)	54 (31, 76)
SV (ml)	109 (81, 137)	107 (79, 135)	105 (77, 133)
EF (%)	65 (57, 74)	66 (57, 75)	66 (58, 75)
Mass (g)	148 (109, 186)	147 (109, 185)	146 (108, 185)
Indexed to BSA			
EDV/BSA (ml/m²)	86 (68, 103)	83 (66, 101)	81 (64, 99)
ESV/BSA (ml/m²)	30 (19, 41)	29 (18, 39)	27 (17, 38)
SV/BSA (ml/m²)	56 (44, 68)	55 (43, 67)	54 (42, 66)
Mass/BSA (g/m²)	76 (59, 93)	75 (59, 92)	75 (58, 91)

	50-59 (years)	60-69 (years)	70-79 (years)
EDV (ml)	154 (113, 196)	150 (109, 191)	146 (105, 187)
ESV (ml)	51 (29, 74)	49 (27, 72)	47 (25, 70)
SV (ml)	103 (75, 131)	101 (73, 129)	99 (71, 127)
EF (%)	67 (58, 76)	67 (58, 76)	68 (59, 77)
Mass (g)	146 (107, 184)	145 (107, 183)	144 (106, 183)
Indexed to BSA			
EDV/BSA (ml/m²)	79 (62, 97)	77 (60, 95)	75 (58, 93)
ESV/BSA (ml/m²)	26 (15, 37)	25 (14, 36)	24 (13, 35)
SV/BSA (ml/m²)	53 (41, 65)	52 (40, 64)	51 (39, 63)
Mass/BSA (g/m²)	74 (57, 91)	73 (57, 90)	73 (56, 89)

мужчины

Cardiovascular Magnetic Resonance

Pocket Guide

ОЦЕНКА СИСТОЛИЧЕСКОЙ ФУНКЦИИ ЛЕВОГО ЖЕЛУДОЧКА

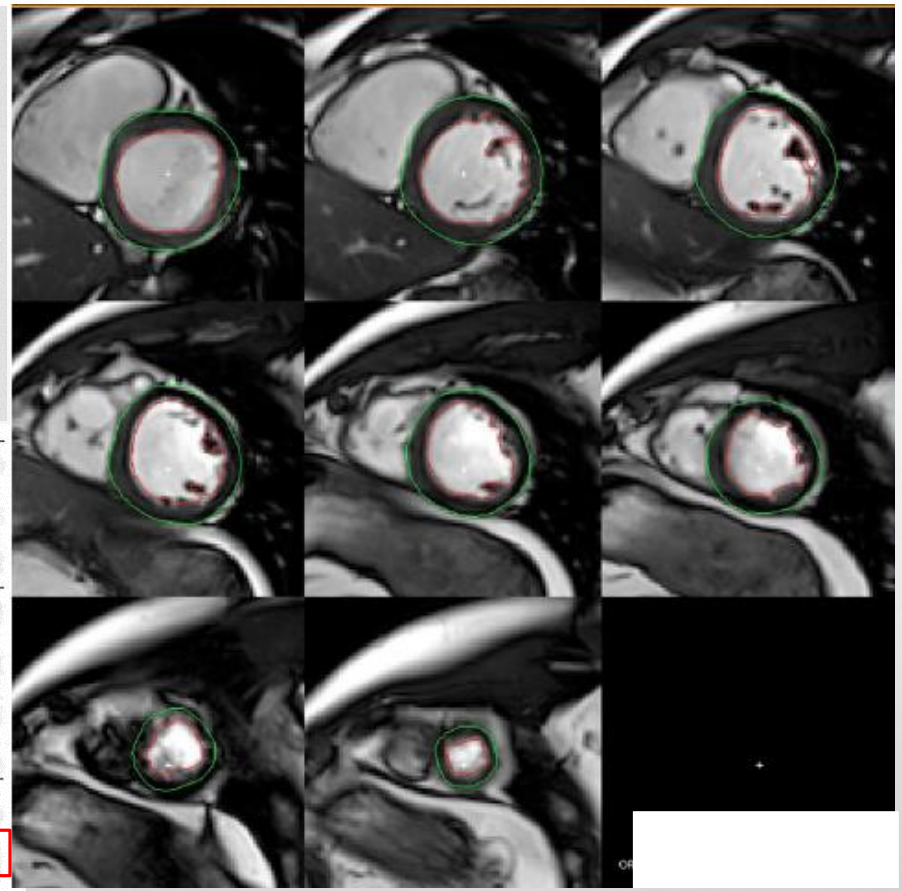
Clinical change	Echocardiography SD	N	MRI SD	N	Reduction in sample size(%)
EDV, 10 ml	23.8	121	7.4	12	90
ESV, 10 ml	15.8	53	6.5	10	81
EF, 3% (abs)	6.6	102	2.5	15	85
mass, 10 g	36.4	273	6.4	9	97

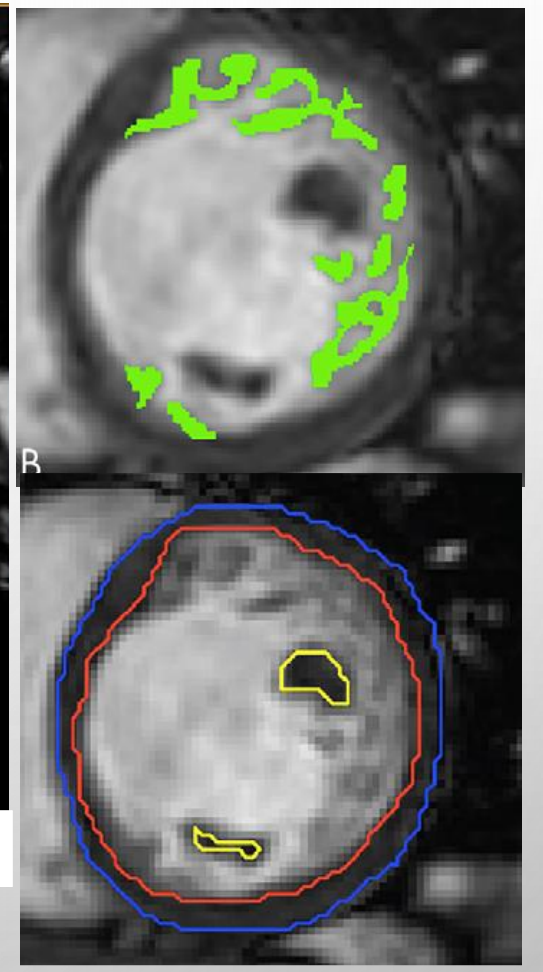
EDV, end-diastolic volume; EF, ejection fraction; ESV, end-systolic volume; LV, left ventricle

	Papillary muscles and trabeculae included	Papillary muscles excluded	Trabeculae excluded
EDV (ml)	130.8 ± 33.4	120.8 ± 31.7	101.1 ± 27.8*
ESV (ml)	51.2 ± 15.5	42.4 ± 14.3	32.6 ± 11.1*
EF (%)	60.9 ± 3.7	65.2 ± 4.4	68.2 ± 4.8*
Mass (g)	110.6 ± 23.1	118.7 ± 23.0	129.7 ± 25.1*

*($p<0.001$)

Ibrahim et al. 1999





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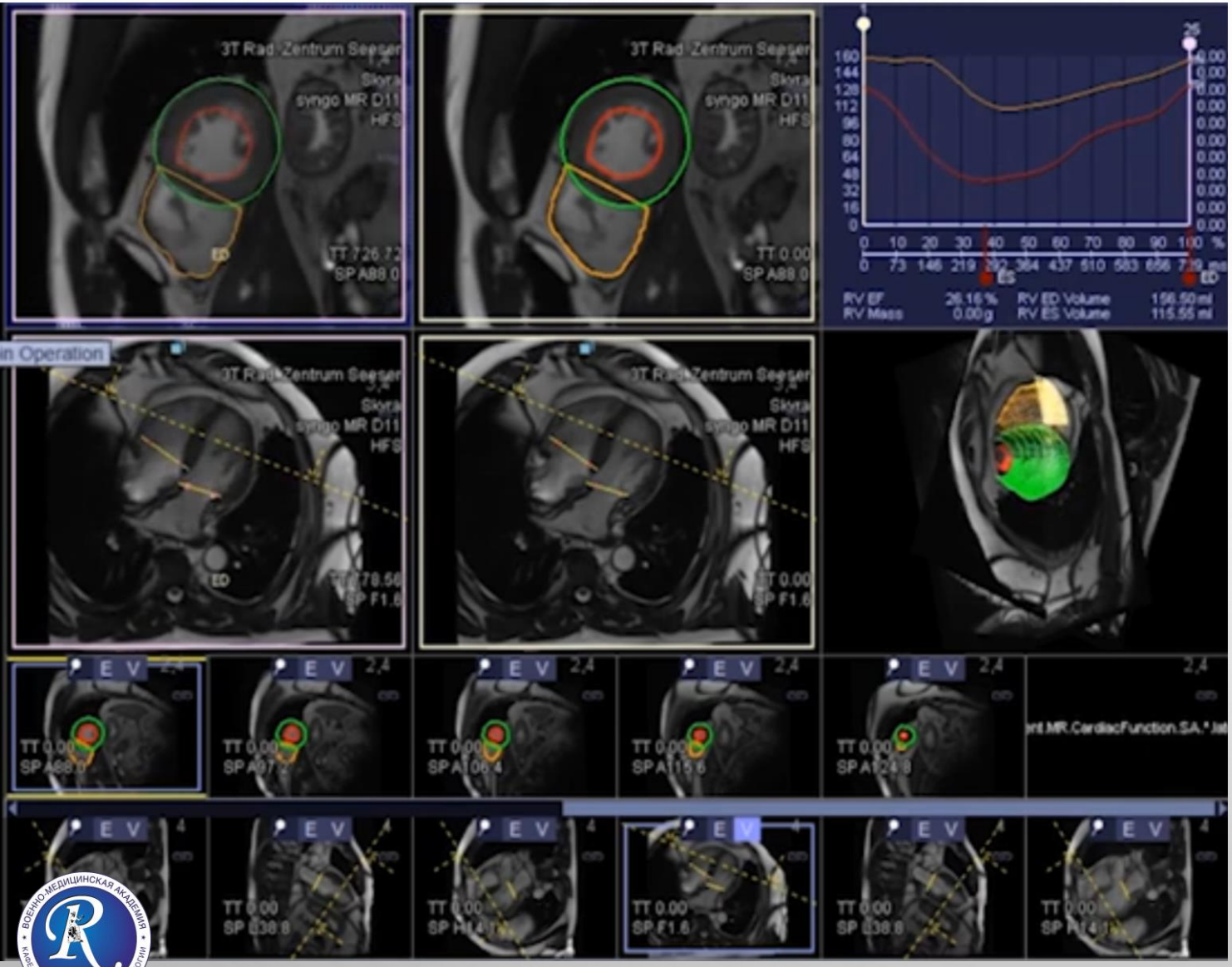
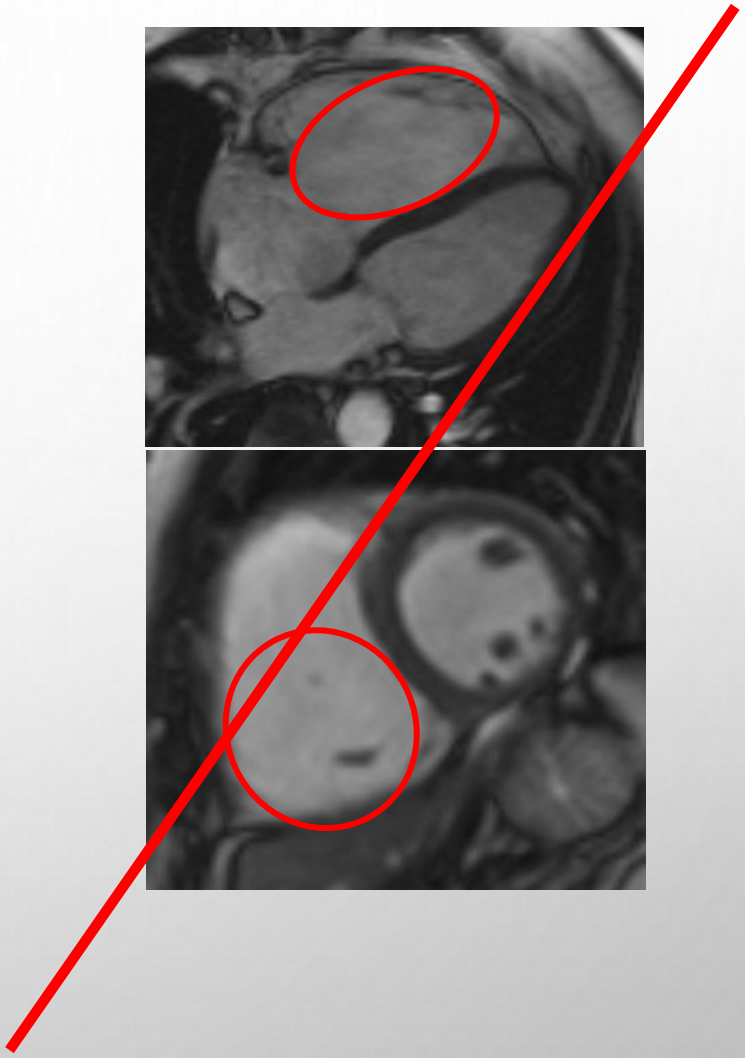
ПОКАЗАНИЯ К МРТ СЕРДЦА (ПРАВЫЕ КАМЕРЫ)

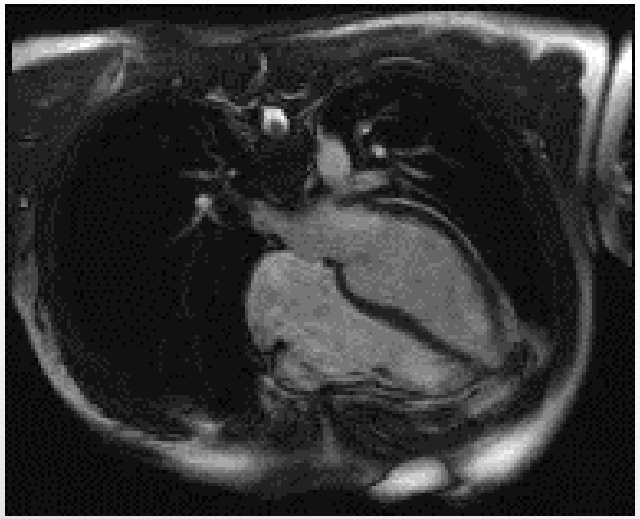
- ИСКЛЮЧЕНИЕ АРИТМОГЕННОЙ ДИСПЛАЗИИ ПРАВОГО ЖЕЛУДОЧКА
- ОЦЕНКА ПРАВЫХ КАМЕР ПРИ ЛЕГОЧНОЙ ГИПЕРТЕНЗИИ
- ОЦЕНКА ПРАВЫХ КАМЕР ПРИ НЕКОТОРЫХ ПОРОКАХ С ФОРМИРОВАНИЕМ ШУНТИРУЮЩИХ ТОКОВ КРОВИ.

ОЦЕНКА ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА

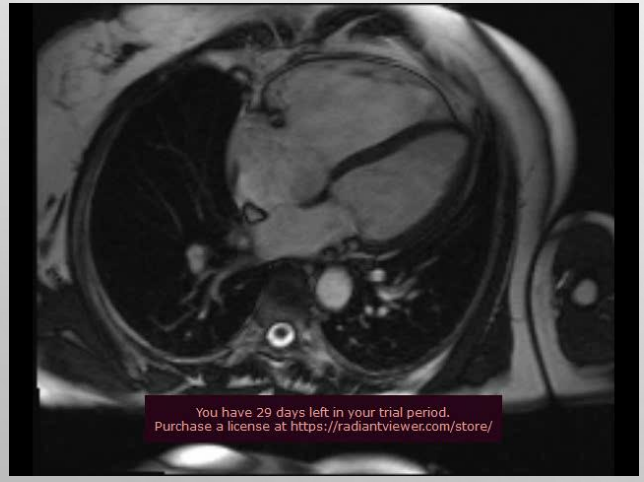




Оценка глобальной систолической функции правого желудочка



АДПЖ



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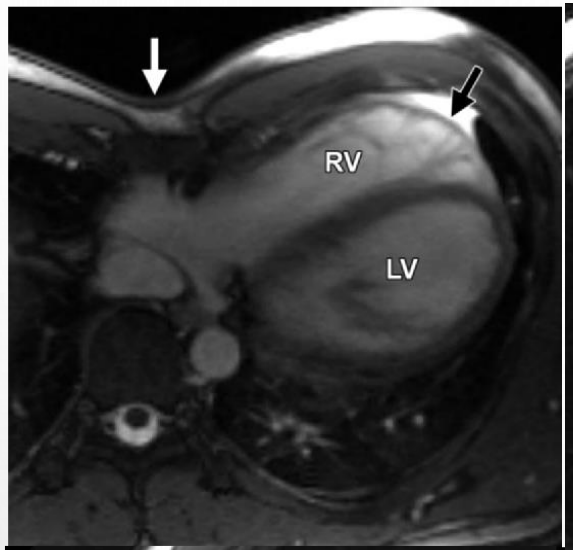
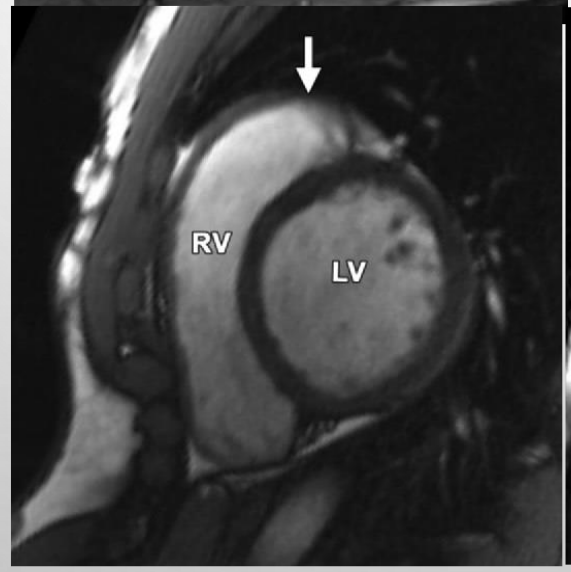
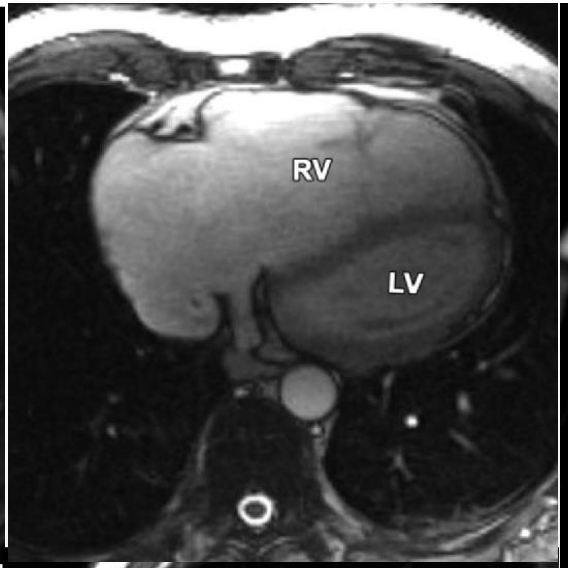
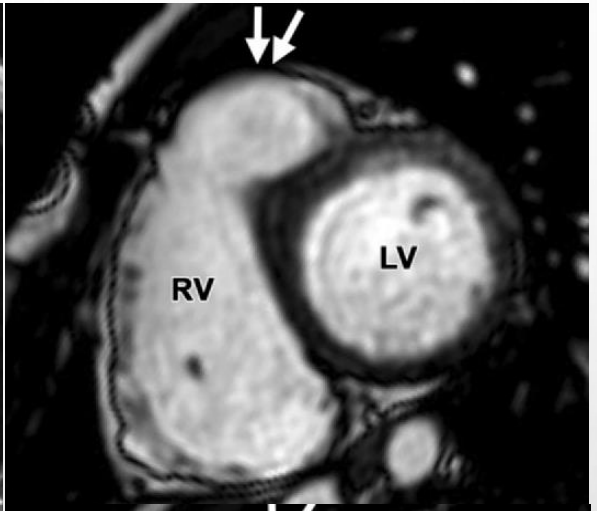


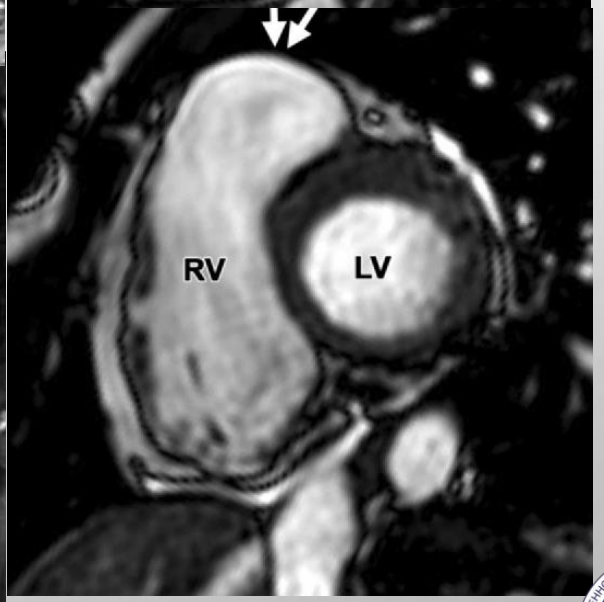


Воронкообразная грудная клетка



АДПЖ





АДПЖ

ОЦЕНКА ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА

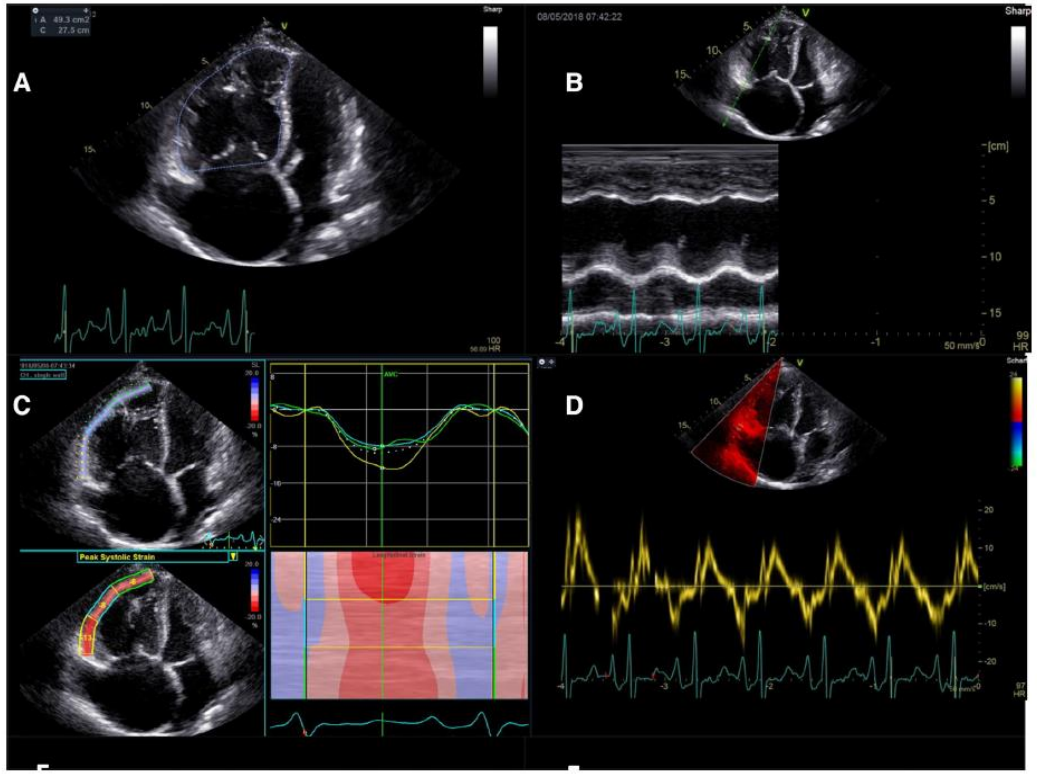
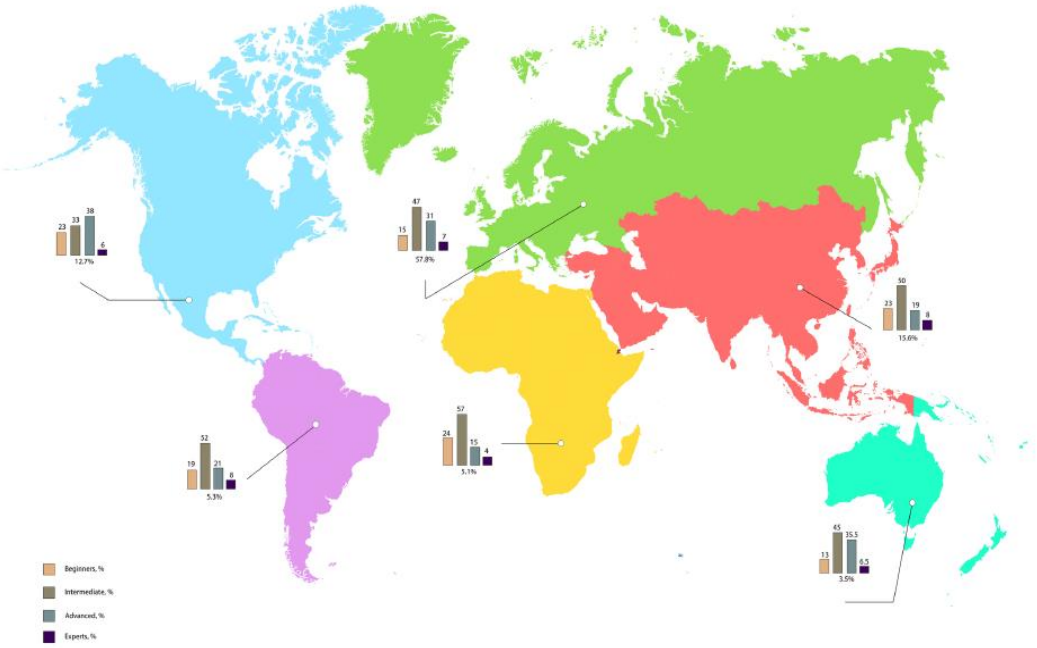


Fig. 1 Evaluation of right ventricular function: RV end-diastolic for calculation of right ventricular fractional area change (**a**, RVF reduced if < 35%), TAPSE (**b**, RVF reduced if < 17 mm), longitudinal strain of the free lateral wall of the right ventricle (**c**, RVF reduced if > −20%), and S' (**d**, RVF reduced if < 0.095 m/s) (1)



The International Journal of Cardiovascular Imaging (2019) 35:2001–2008
https://doi.org/10.1007/s10554-019-01653-2

ORIGINAL PAPER

Check for updates

Visual assessment of right ventricular function by echocardiography: how good are we?

Matthias Schneider[1] · Hong Ran[2] · Stefan Aschauer[1] · Christina Binder[1] · Julia Mascherbauer[1] · Irene Lang[1] · Christian Hengstenberg[1] · Georg Goliasch[1] · Thomas Binder[1]

Received: 30 April 2019 / Accepted: 17 June 2019 / Published online: 24 June 2019

ОЦЕНКА ГЛОБАЛЬНОЙ СИСТОЛИЧЕСКОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА

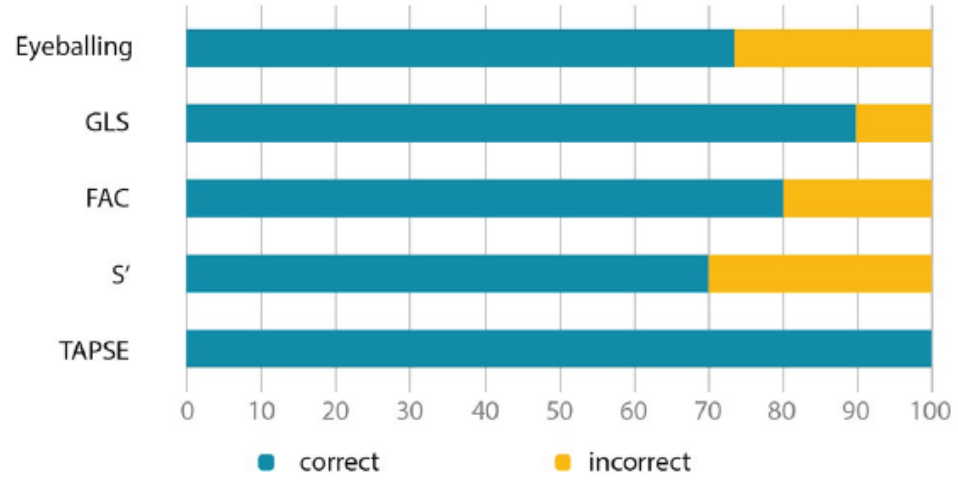


Fig. 3 Correct identification of reduced right ventricular function (RVF, defined as cardiac magnetic resonance imaging derived right ventricular ejection fraction <50%) of the different methods of RVF gradation. *GLS* global longitudinal strain, *FAC* fractional area change, *S'* tissue Doppler imaging basal free lateral wall of the right ventricle, *TAPSE* tricuspid annular plane systolic excursion

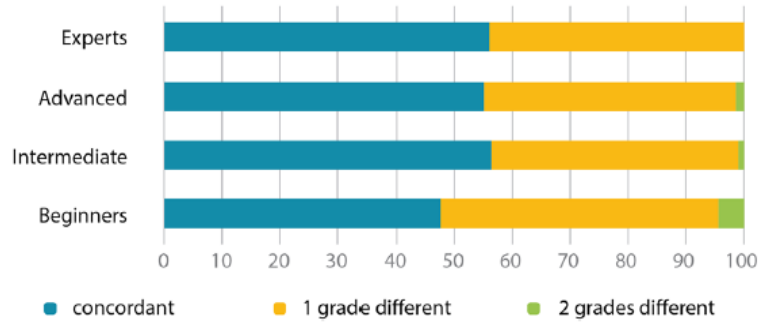


Fig. 5 Concordance with cardiac magnet resonance imaging derived right ventricular ejection fraction of the different levels of expertise

Conclusion

To our knowledge, the present study is the first international investigation to demonstrate that "eyeballing" alone differentiates between normal and abnormal RVF with excellent sensitivity but poor specificity, and that accurate classification of the degree of RV systolic dysfunction via "eyeballing" alone is imprecise, even among expert echocardiographers. Better concordance with the gold standard was found for the three advanced groups as compared with beginners. However, overall assessment quality was unsatisfactory. In accordance with current guidelines, the present data suggest that "eyeballing" should be combined with measurement of other parameters of RVF.

ПОЛУКОЛИЧЕСТВЕННАЯ ОЦЕНКА СОКРАТИТЕЛЬНОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА

Eur Radiol (2011) 21:2111–2120
DOI 10.1007/s00330-011-2152-0

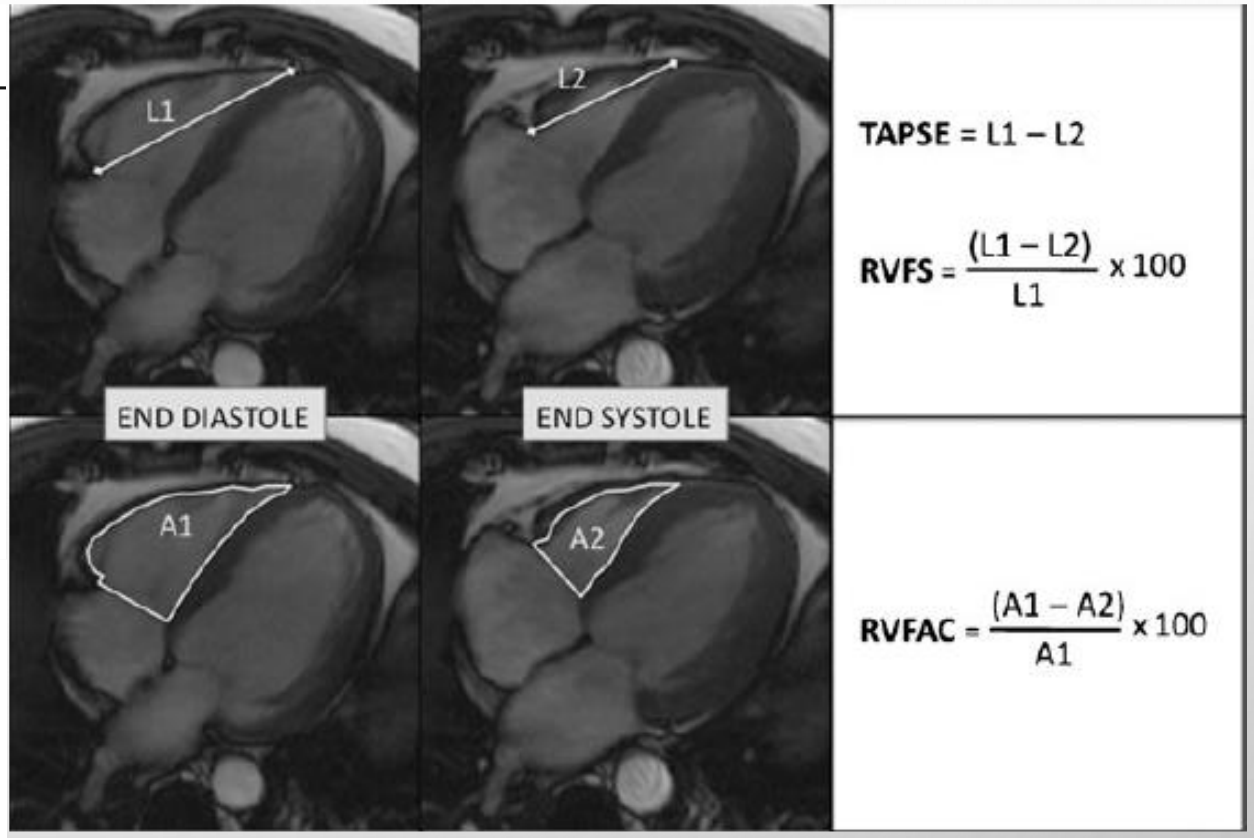
CARDIAC

Diagnostic accuracy and variability of three semi-quantitative methods for assessing right ventricular systolic function from cardiac MRI in patients with acquired heart disease

Jérôme Caudron · Jeannette Fares · Pierre-Hugues Vivier · Valentin Lefebvre · Caroline Petitjean · Jean-Nicolas Dacher

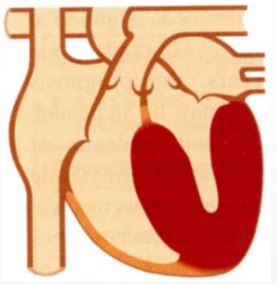
Conclusion

Despite its important prognostic value, RV function often remains disregarded in patients referred for cardiac MRI examination. We demonstrated that right ventricular fractional area change was a feasible, fast, accurate and reproducible semi-quantitative method for evaluating RVEF in daily practice, even in non-experienced observers. Thus, the time-consuming quantitative method could be reserved for patients with abnormal right ventricular fractional area change.

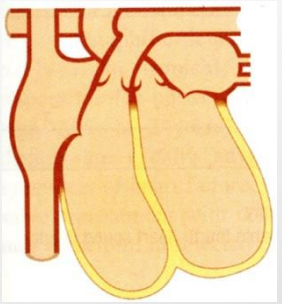


ОСНОВНЫЕ ПРОЯВЛЕНИЯ

- ПРОЯВЛЯЮЩИЕСЯ УТОЛЩЕНИЕМ СТЕНКИ МИОКАРДА



- ПРОЯВЛЯЮЩИЕСЯ ДИЛАТАЦИЕЙ ОДНОГО ИЛИ ДВУХ ЖЕЛУДОЧКОВ



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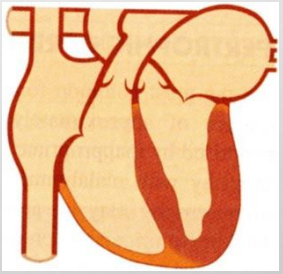
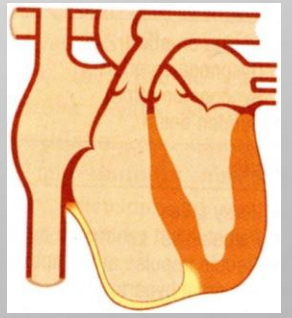


- ПРЕИМУЩЕСТВЕННЫМ ПОРАЖЕНИЕМ ПРАВОГО ЖЕЛУДОЧКА

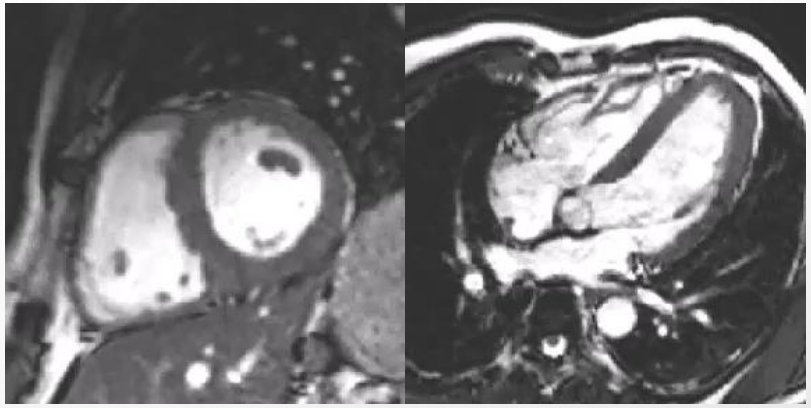


ПОКАЗАНИЯ К МРТ СЕРДЦА (ХАРАКТЕРИСТИКА МИОКАРДА)

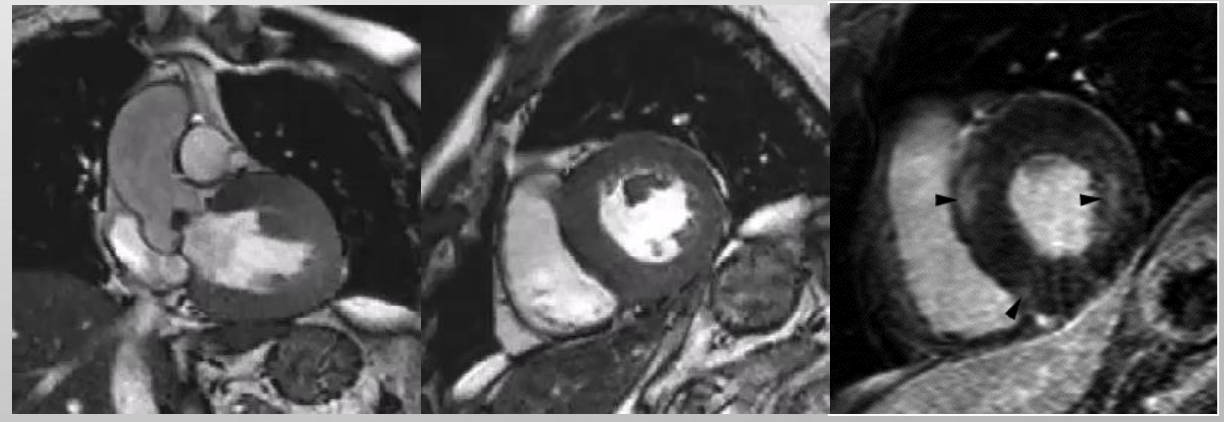
- ВЫЯВЛЕНИЕ И ОЦЕНКА КОЛИЧЕСТВА ФИБРОЗНЫХ И РУБЦОВЫХ ИЗМЕНЕНИЙ В МИОКАРДЕ
- ВЫЯВЛЕНИЕ ЖИЗНЕСПОСОБНОГО МИОКАРДА
- ДИАГНОСТИКА ВОСПАЛИТЕЛЬНЫХ ИЗМЕНЕНИЙ МИОКАРДА (МИОКАРДИТ)
- ВЫЯВЛЕНИЕ СПЕЦИФИЧЕСКОГО ПОРАЖЕНИЯ МИОКАРДА ПРИ НЕКОТОРЫХ КАРДИОМИОПАТИЯХ (ГЕМОХРОМАТОЗ, АМИЛОИДОЗ, БОЛЕЗНЬ ФАБРИ, ТАКОТСУБО)
- ДИФФЕРЕНЦИАЛЬНАЯ ДИАГНОСТИКА ОБРАЗОВАНИЙ ОБЛАСТИ СЕРДЦА
- ОЦЕНКА ПЕРФУЗИИ (НАГРУЗКА, ПОКОЙ)

УТОЛЩЕНИЕ СТЕНОК ЖЕЛУДОЧКОВ

- ГИПЕРТРОФИЯ
  - ФИЗИОЛОГИЧЕСКАЯ (ФИЗИЧЕСКИМИ НАГРУЗКА)
  - ПЕРЕГРУЗКА ДАВЛЕНИЕМ (АРТЕРИАЛЬНАЯ ГИПЕРТОНИЯ, АОРТАЛЬНЫЙ СТЕНОЗ)
- ГИПЕРТРОФИЧЕСКАЯ КАРДИОМИОПАТИЯ
- ВТОРИЧНЫЕ КАРДИОМИОПАТИИ
  - АМИЛОИДОЗ
  - САРКОИДОЗ
- НЕКОТОРЫЕ ОПУХОЛИ И МЕТАСТАЗЫ

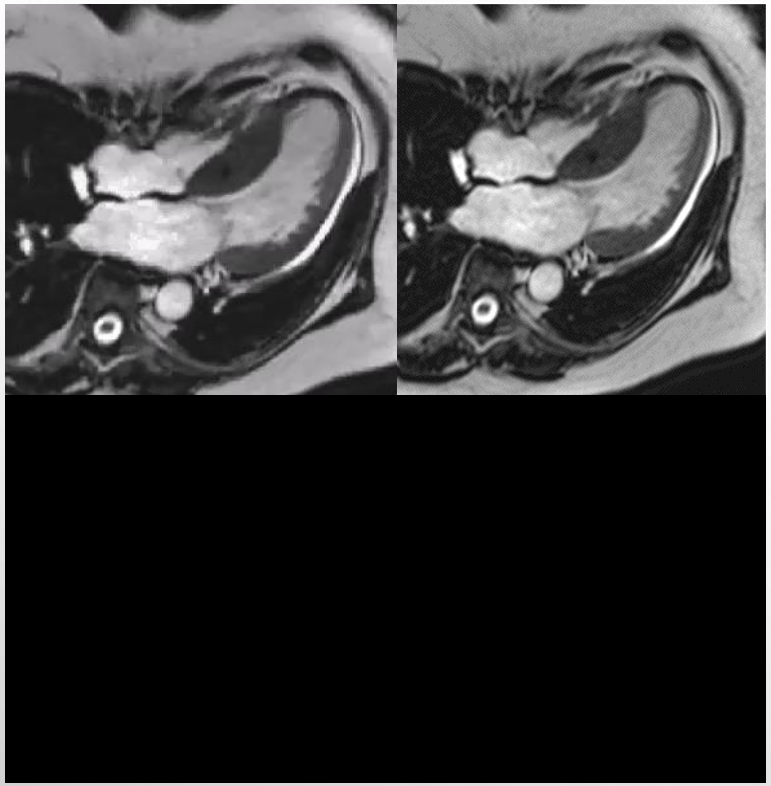


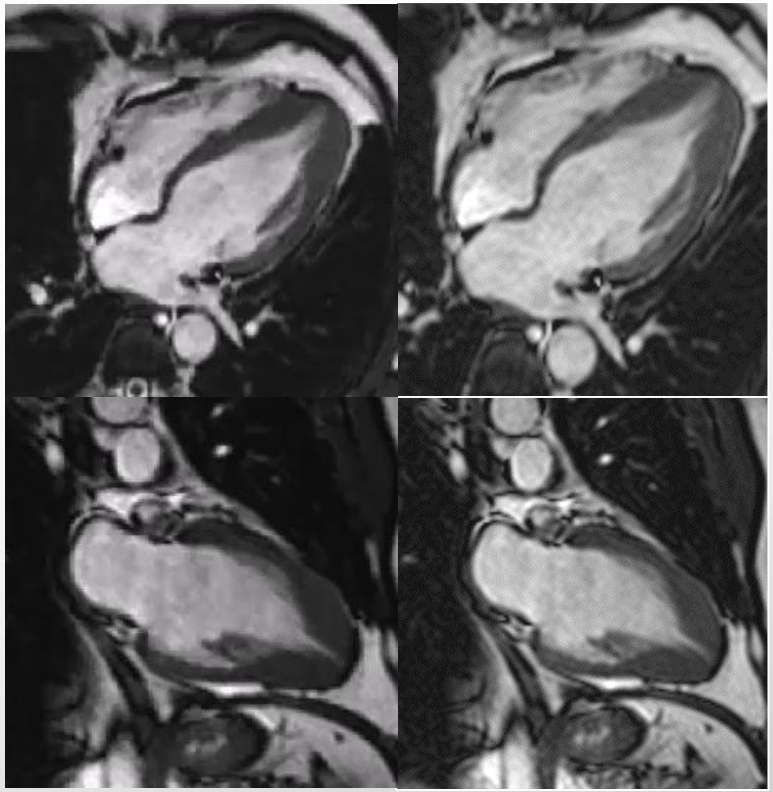
У большинства спортсменов диастолическая толщина стенки левого желудочка <12 мм. У некоторых может наблюдаться утолщение до 16-17 мм, которое всегда сопровождается дилатацией полости до 55 – 60 мм



Толщина стенки левого желудочка от 13 до 17 мм требует уточняющей диагностики

ГИПЕРТРОФИЧЕСКАЯ КАРДИОМИОПАТИЯ

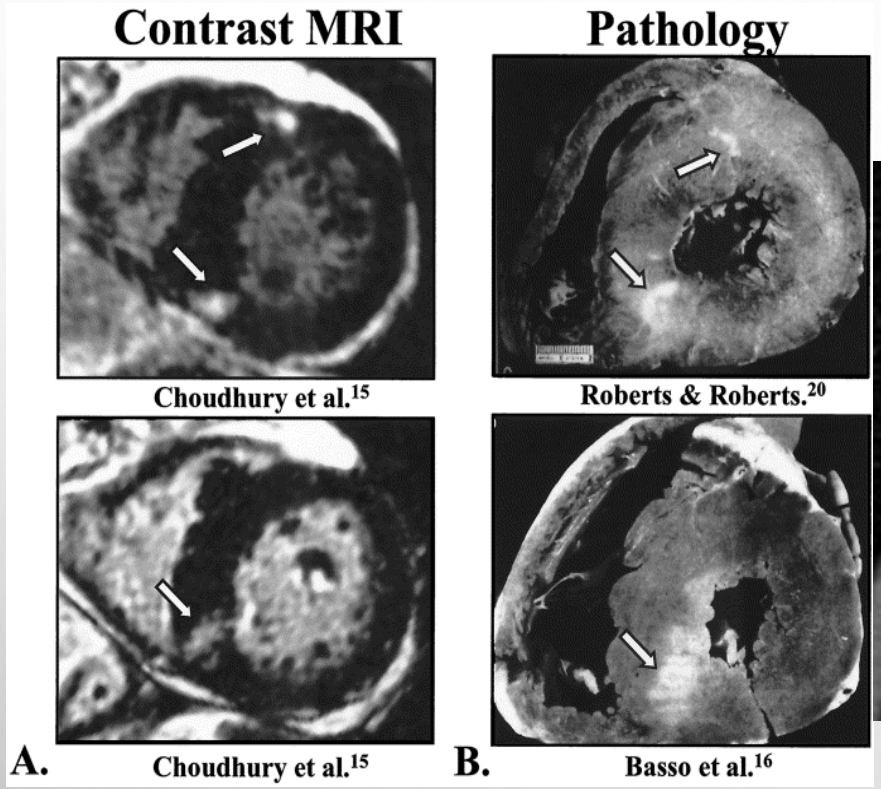


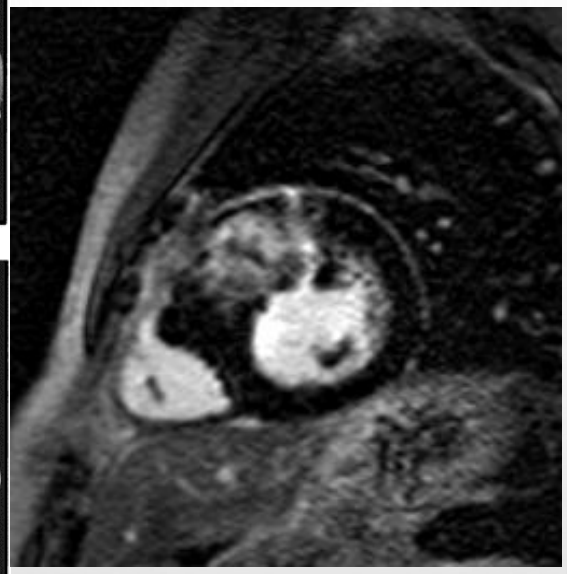


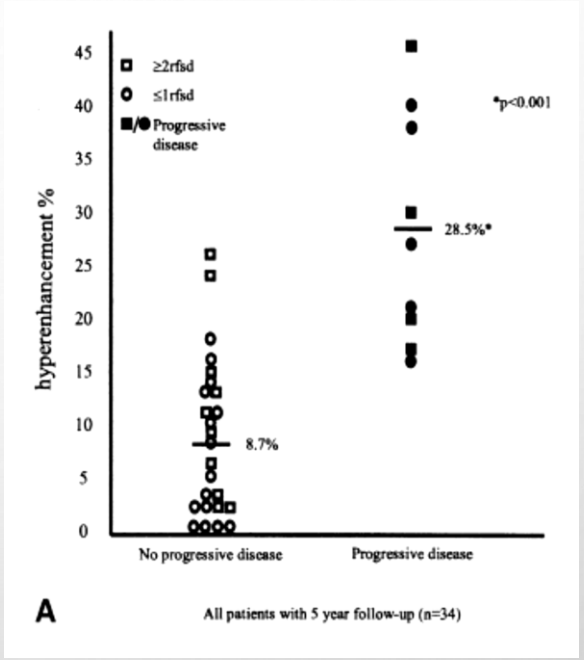
ГИПЕРТРОФИЧЕСКАЯ КАРДИОМИОПАТИЯ ЯВЛЯЕТСЯ ГЕНЕТИЧЕСКИ, ПАТОЛОГИЧЕСКИ, КЛИНИЧЕСКИ ГЕТЕРОГЕННЫМ ЗАБОЛЕВАНИЕМ

ОБУСЛОВЛЕНА ГЕНЕТИЧЕСКИМ ПОВРЕЖДЕНИЕМ СОКРАТИТЕЛЬНОГО АППАРАТА МИОКАРДА, НО КЛИНИЧЕСКИЕ ПРОЯВЛЕНИЯ МОГУТ БЫТЬ РАЗЛИЧНЫМИ (ОДИН И ТОТ ЖЕ ГЕНЕТИЧЕСКИЙ ДЕФЕКТ МОЖЕТ ПРОЯВЛЯТЬСЯ ДИЛАТАЦИОННОЙ КАРДИОМИОПАТИЕЙ, РЕСТРИКТИВНОЙ КАРДИОМИОПАТИЕЙ ИЛИ НЕКОМПАКТНЫМ МИОКАРДОМ)

ГИПЕРТРОФИЧЕСКАЯ КАРДИОМИОПАТИЯ



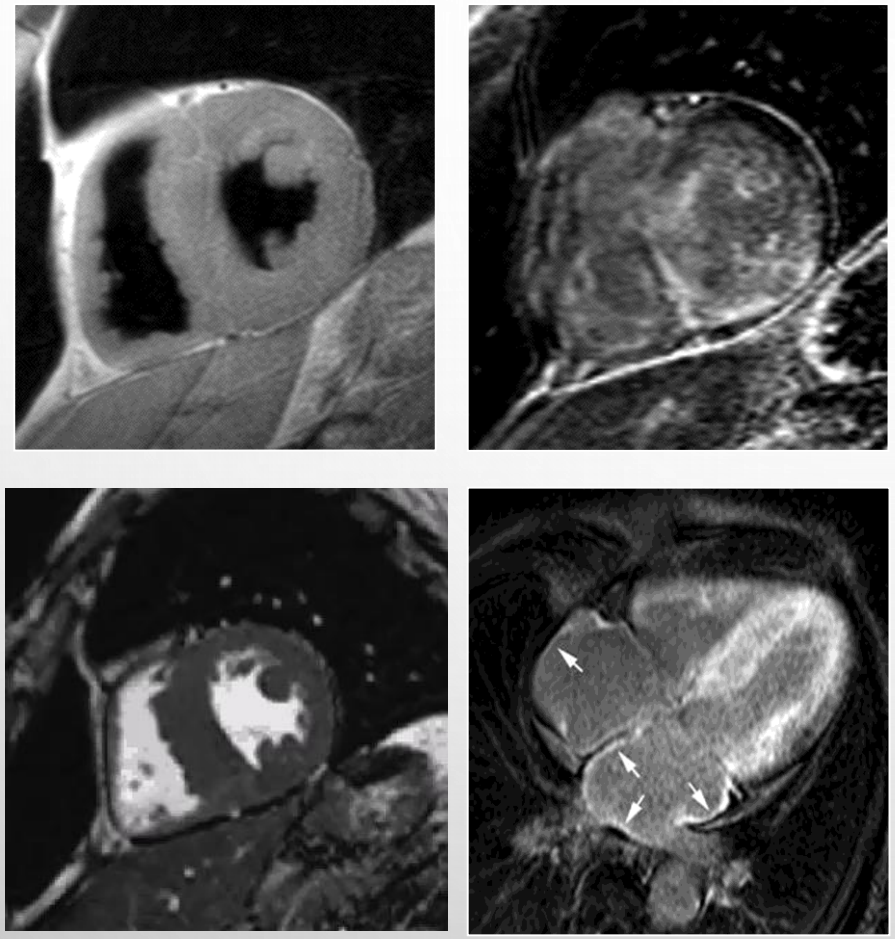


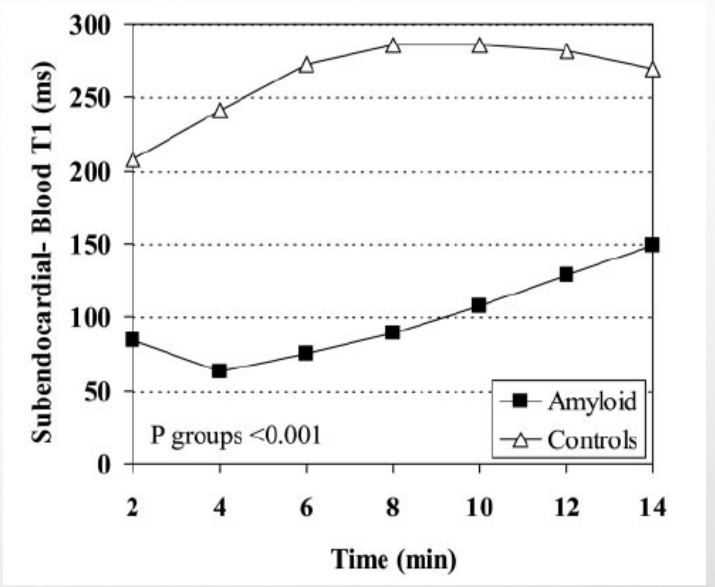


Gadolinium CMR reveals myocardial hyperenhancement in HCM. The extent of hyperenhancement is associated with progressive ventricular dilation and markers of sudden death. (J Am Coll Cardiol 2003;41:1561–7) © 2003 by the American College of Cardiology Foundation

Moon JC et al. J Am Coll Cardiol 2003 41:1561-1567
Kim RJ, Judd RM (Editorial) J Am Coll Cardiol 2003 41:1568-1572
Adabag AS, et al. J Am Coll Cardiol 2008;51:1369-1374 / Dimitrow PP et al. Int J Cardiovasc Imaging 2008;24:77-83
Paya E et al. J Cardiac Fail 2008;14:414-419 / Suk T et al. Heart, Lung and Circulation 2008;17:370-374

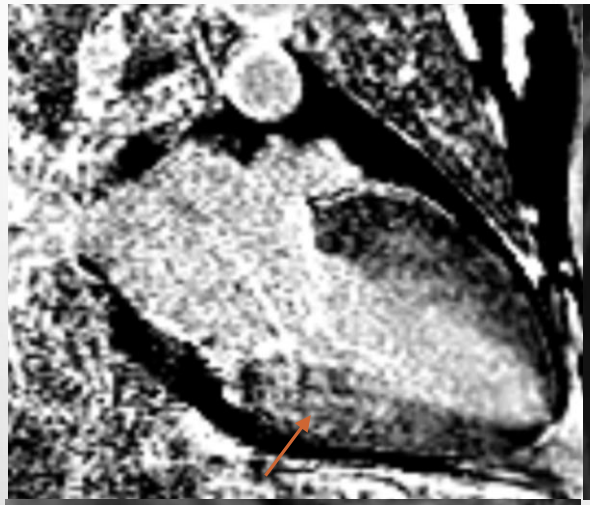
АМИЛОИДОЗ

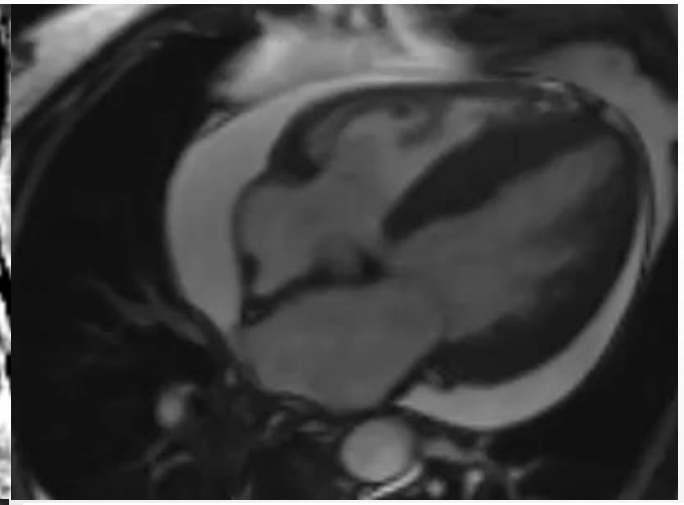


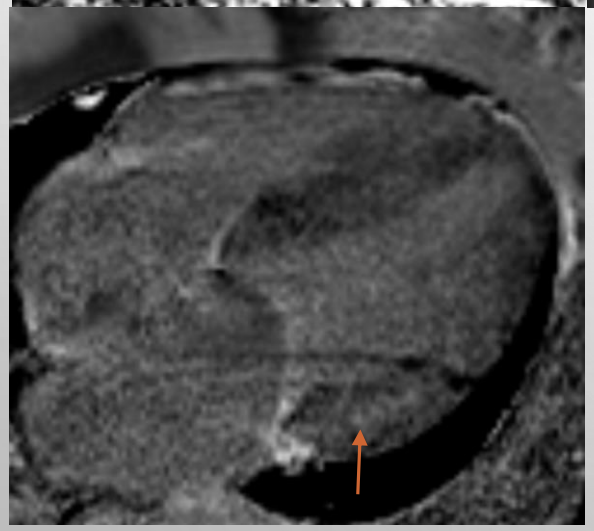


Conclusions—In cardiac amyloidosis, CMR shows a characteristic pattern of global subendocardial late enhancement coupled with abnormal myocardial and blood-pool gadolinium kinetics. The findings agree with the transmural histological distribution of amyloid protein and the cardiac amyloid load and may prove to have value in diagnosis and treatment follow-up. (***Circulation*. 2005;111:186-193.**)

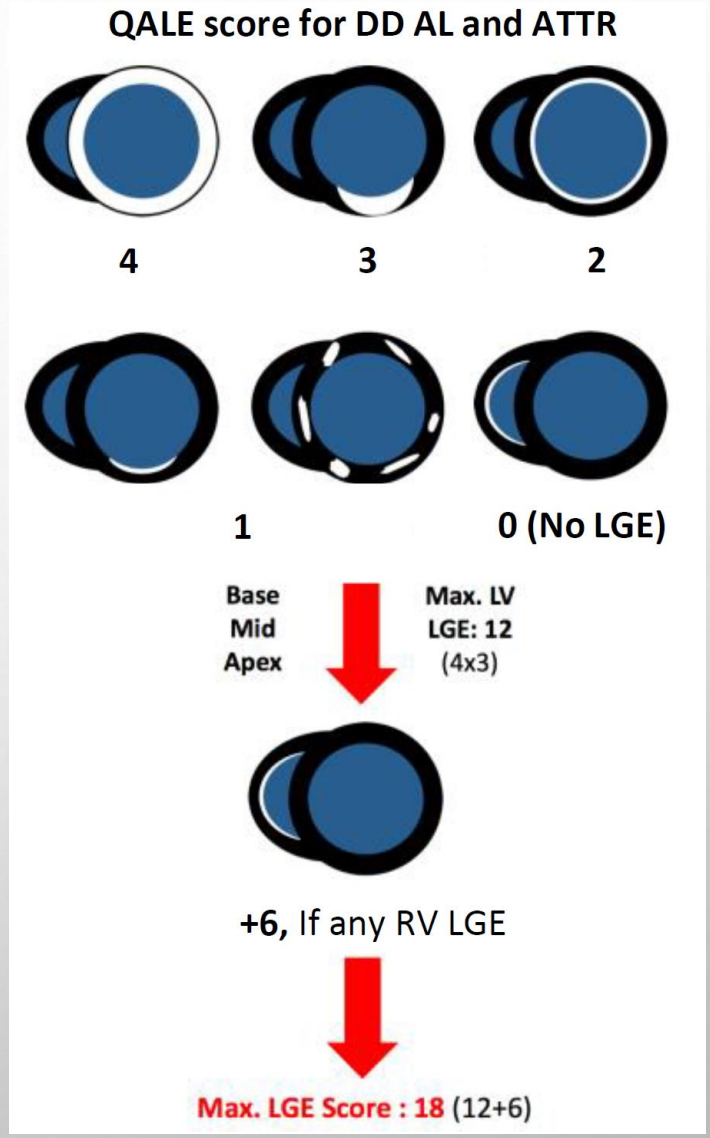
АМИЛОИДОЗ



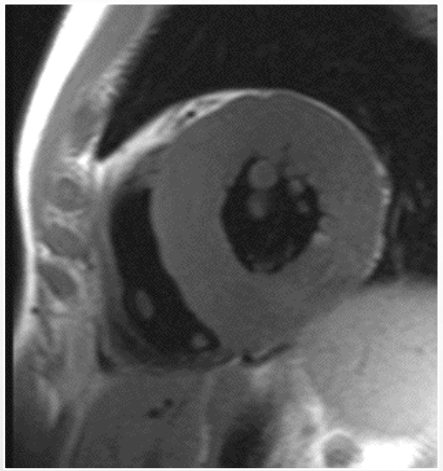


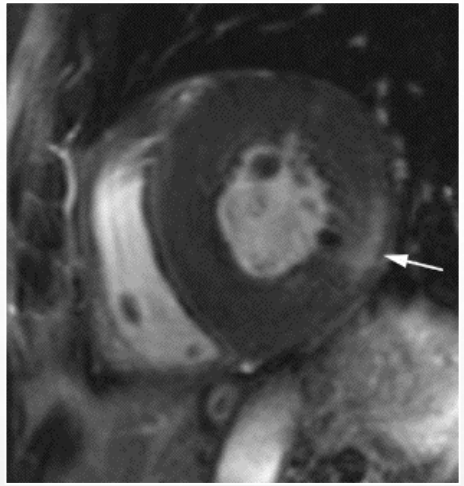


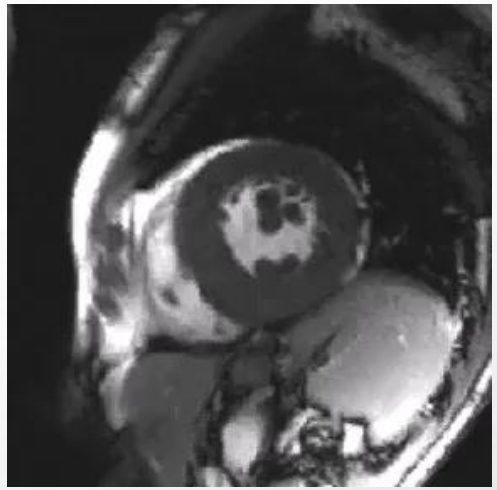
	AL amyloidosis	ATTR amyloidosis
LV mass	• Mildly increased < 100 g/m^2	• Markedly increased > 100 g/m^2
Septum thickness	Septum AL < Septum ATTR	
LGE	• Less extensive LGE • Often (global) subendocardial pattern • QALE score < 13	• More extensive LGE • Often more diffuse and transmural pattern • QALE score ≥ 13
Native T1	> 1050 - 1150 ms Native T1$_{AL}$ > Native T1$_{ATTR}$	
ECV	>0.40 ECV$_{AL}$ < ECV$_{ATTR}$	
Therapy	• Chemotherapy	• Novel TTR-specific treatment (Phase III)
Prognosis	• Worse (despite less extensive LGE)	• Better (despite more extensive LGE)



БОЛЕЗНЬ ФАБРИ







Gadolinium enhanced cardiovascular magnetic resonance in Anderson-Fabry disease[1]

Evidence for a disease specific abnormality of the myocardial interstitium

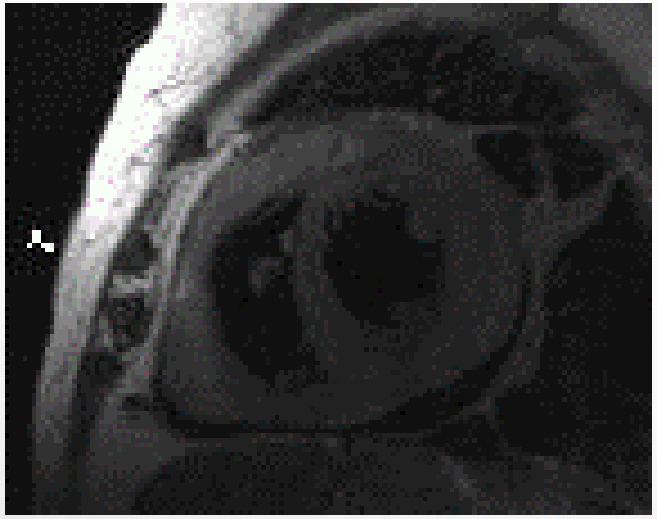
James C. C. Moon

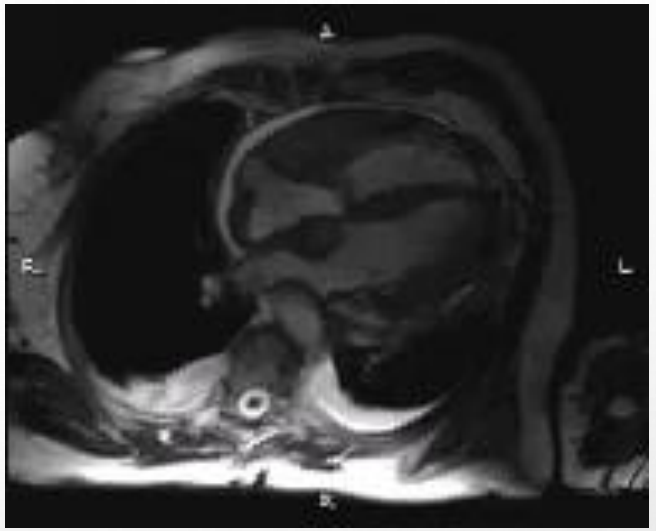
European Heart Journal (2003) 24, 2151–2155

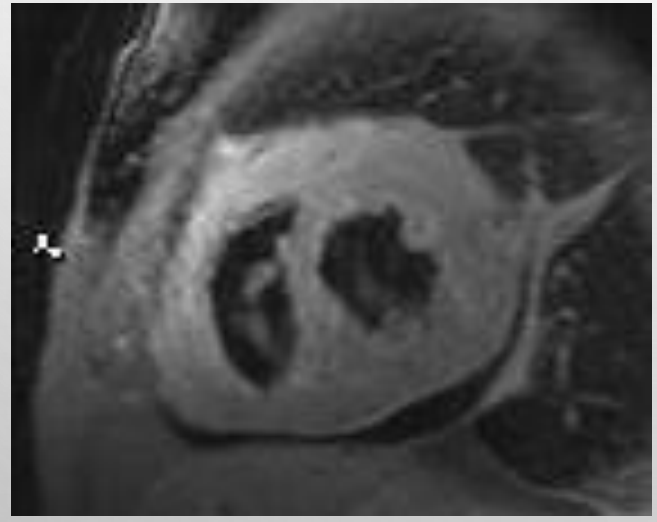
found in four (50%) heterozygous females (mean 4.6%). In 12 (92%) patients with abnormal gadolinium uptake, hyperenhancement occurred in the basal infero-lateral wall where, unlike myocardial infarction, it was not sub-endocardial. In two male

Conclusion These observations suggests that myocardial fibrosis occurs in AFD and may contribute to the hypertrophy and the natural history of the disease.

ЛИМФОМА СЕРДЦА

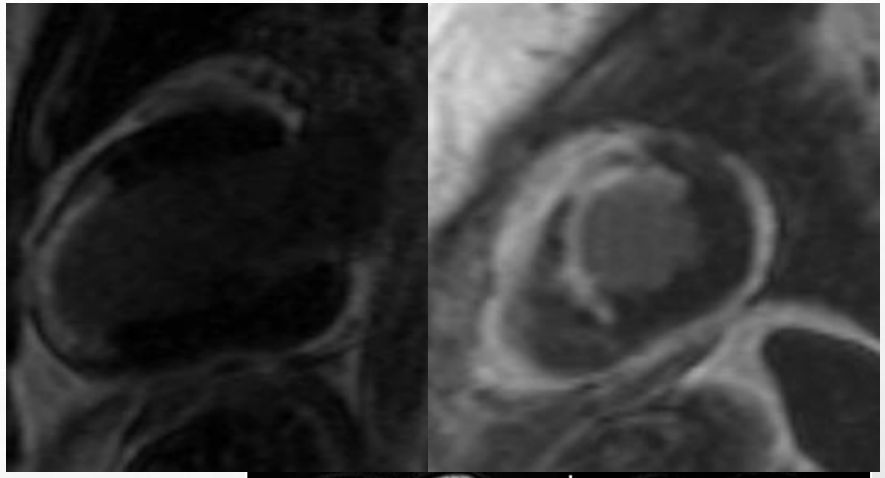


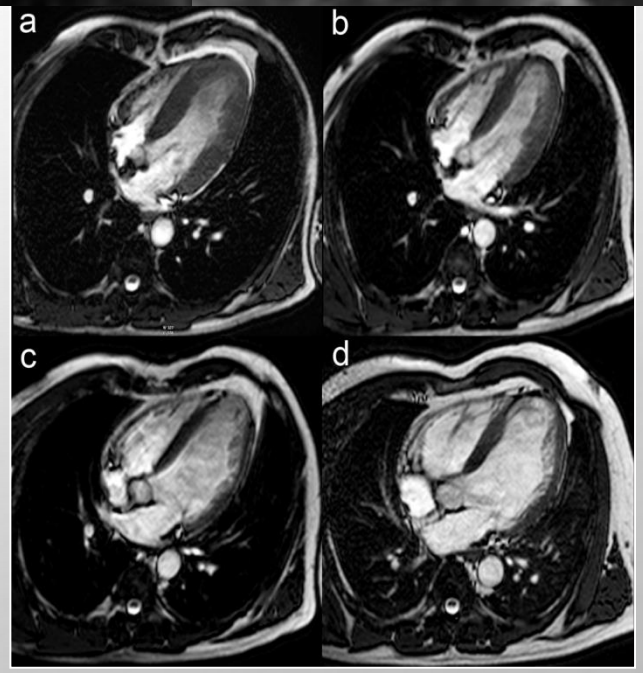




ДИЛАТАЦИЯ ПОЛОСТЕЙ

- КОМПЕНСАТОРНАЯ РЕАКЦИЯ
  - ФИЗИОЛОГИЧЕСКАЯ (ФИЗИЧЕСКАЯ НАГРУЗКА)
  - ПЕРЕГРУЗКА ОБЪЕМОМ
    - РЕГУРГИТАЦИЯ
    - НАЛИЧИЕ ШУНТА
  - РЕМОДЕЛИРОВАНИЕ
    - ИБС
    - ЛЕГОЧНОЕ СЕРДЦЕ
    - ГЕМОХРОМАТОЗ
- КАРДИОМИОПАТИЯ
  - ДИЛАТАЦИОННАЯ
  - ПОСТМИОКАРДИТИЧЕСКАЯ
  - НЕКОМПАКТНЫЙ МИОКАРД
  - ГИПЕРТРОФИЧЕСКАЯ В КОНЕЧНОЙ СТАДИИ

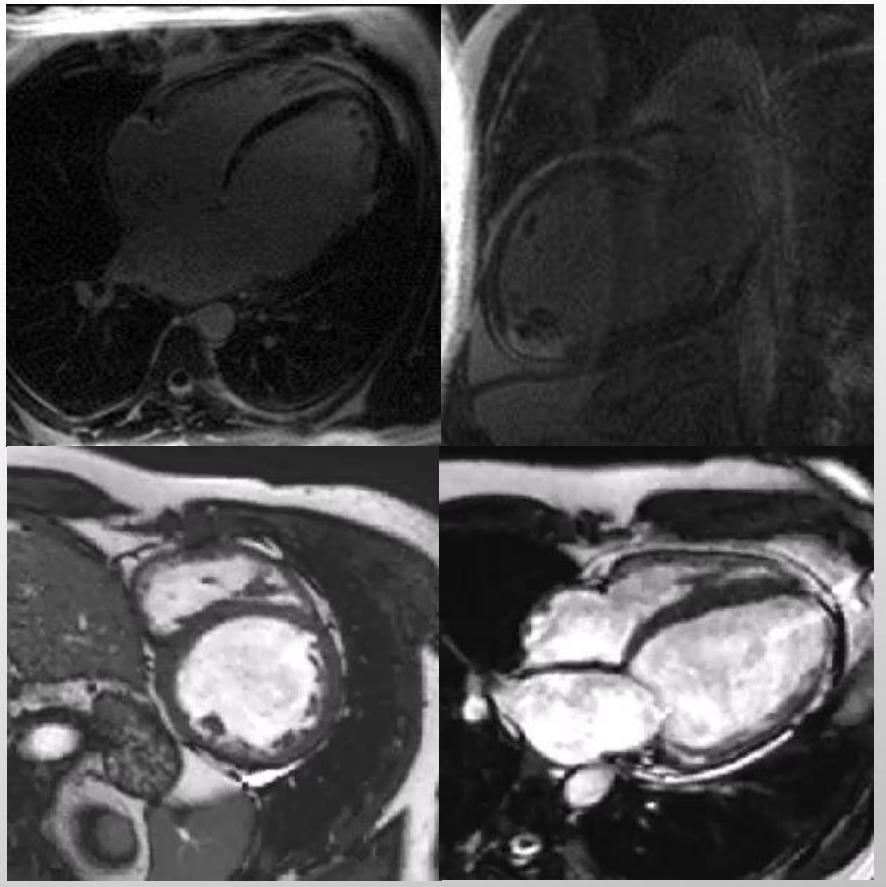




ДИЛАТАЦИОННАЯ КАРДИОМИОПАТИЯ

- ПЕРВИЧНОЕ ЗАБОЛЕВАНИЕ МИОКАРДА НЕИЗВЕСТНОЙ ЭТИОЛОГИИ СОПРОВОЖДАЮЩИЕСЯ ДИЛАТАЦИЯ ЛЕВОГО ИЛИ ОБОИХ ЖЕЛУДОЧКОВ И СНИЖЕНИЕМ СОКРАТИМОСТИ МИОКАРДА.

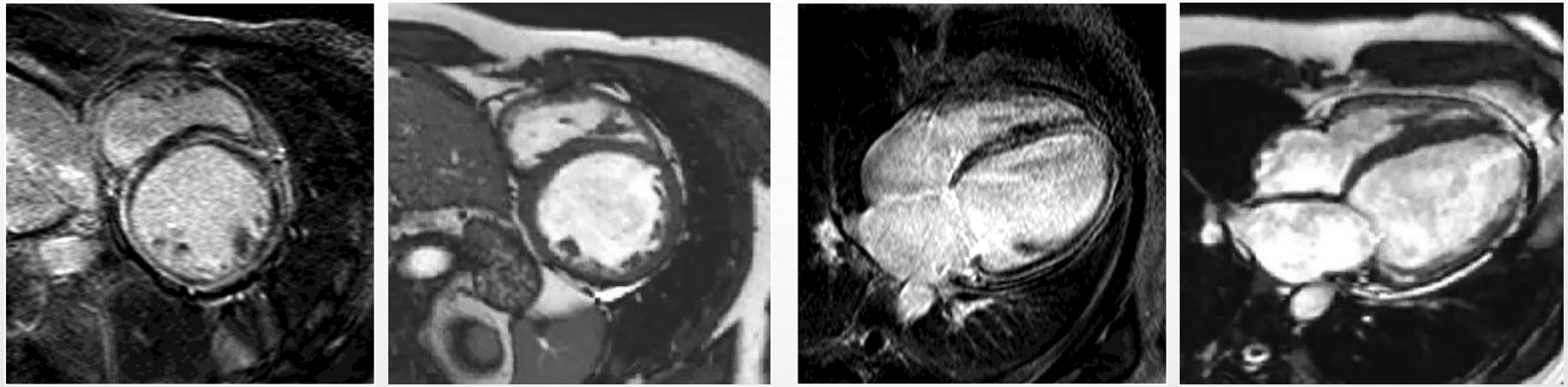
- Увеличением одного или двух желудочков
- Толщина стенки нормальная или утолщена
- ± пристеночные тромбы
- ± увеличение предсердий
- Систолической и диастолической дисфункцией
- Атриовентрикулярной регургитацией



Микроскопически

Дегенерация и гипертрофия кардиомиоцитов/интерстициальный фиброз, незначительная лимфоцитарная инфильтрация. Коронарные артерии не поражены (отличие от ишемической кардиомиопатии)

ДИЛЯТАЦИОННАЯ КАРДИОМИОПАТИЯ

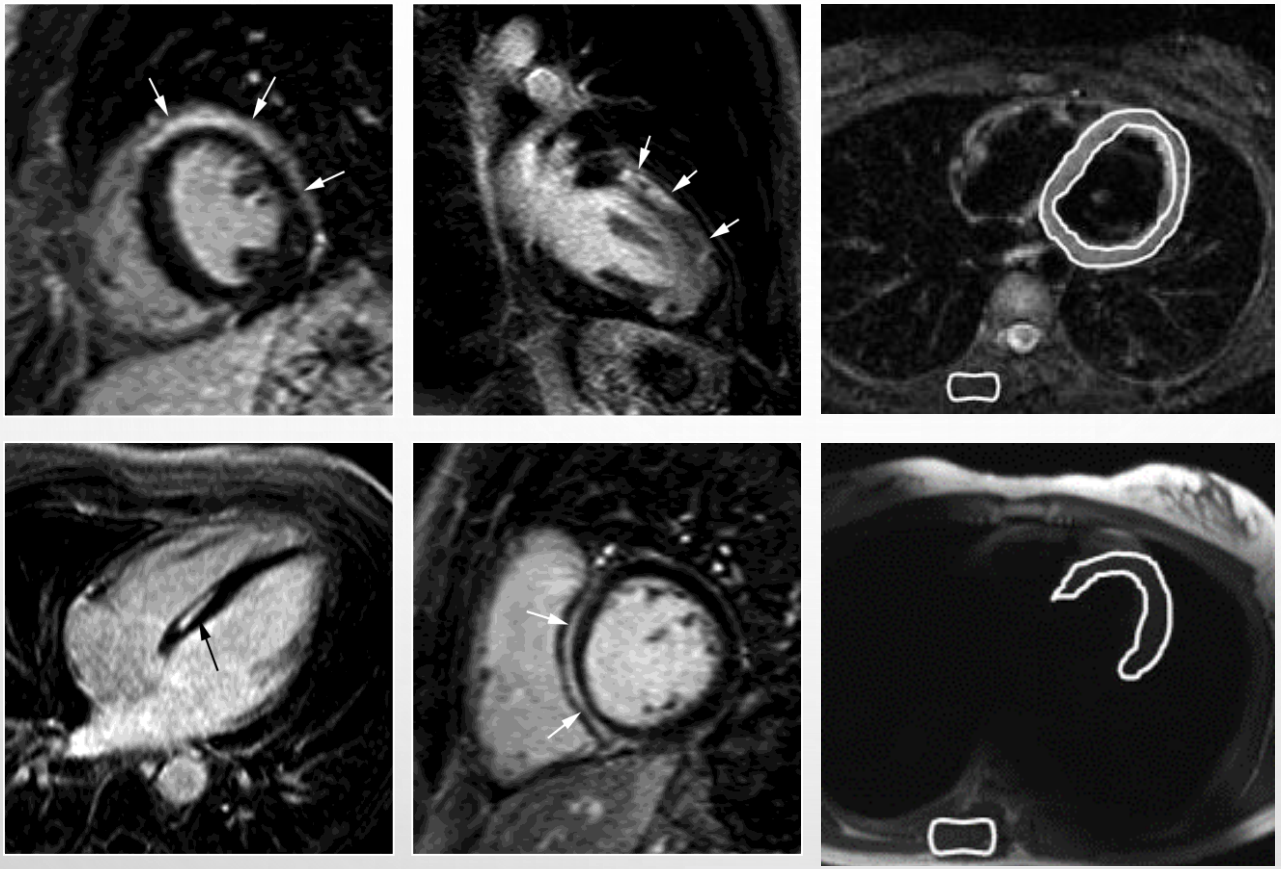


Differentiation of Heart Failure Related to Dilated Cardiomyopathy and Coronary Artery Disease Using Gadolinium-Enhanced Cardiovascular Magnetic Resonance

…ts with DCM, there were 3
…ents with CAD (13%); and
patchy or longitudinal striae of midwall enhancement clearly different from the distribution in patients with CAD (28%).

Conclusions—Gadolinium CMR is a powerful technique to distinguish DCM from LV dysfunction related to CAD and yields new insights in DCM. These data suggest that using the coronary angiogram as the arbiter for the presence of LV dysfunction caused by CAD could have lead to an incorrect assignment of DCM cause in 13% of patients, possibly because of coronary recanalization after infarction. The midwall myocardial enhancement in patients with DCM is similar to the fibrosis found at autopsy; it has not previously been visualized in vivo and warrants further investigation. CMR may become a useful alternative to routine coronary angiography in the diagnostic workup of DCM. **(*Circulation*. 2003;108:54-59.)**

МИОКАРДИТ



ER= SImyo/SIskm
ER>1.8-2.0 > миокардит

$$gRE = RE_{myo}/RE_{skm} = \frac{(postSI_{myo} - preSI_{myo})/preSI_{myo}}{(postSI_{skm} - preSI_{skm})/preSI_{skm}}$$

gRE > 4.0 > миокардит

Bogaert J et al. Clinical Cardiac MRI 2005

Suspected Chronic Myocarditis at Cardiac MR: Diagnostic Accuracy and Association with Immunohistologically Detected Inflammation and Viral Persistence[1]

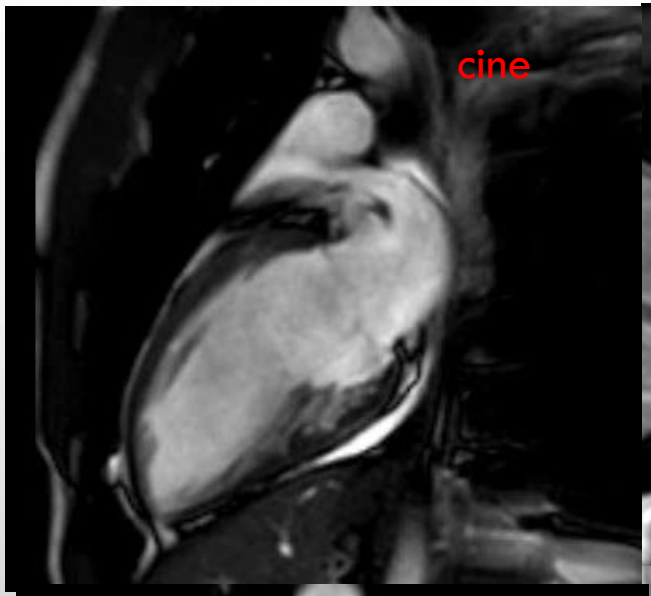
Diagnostic Accuracy of MR Parameters in a Single or Combined Approach for Detection of Myocardial Inflammation, with Immunohistologic Analysis as Reference Standard

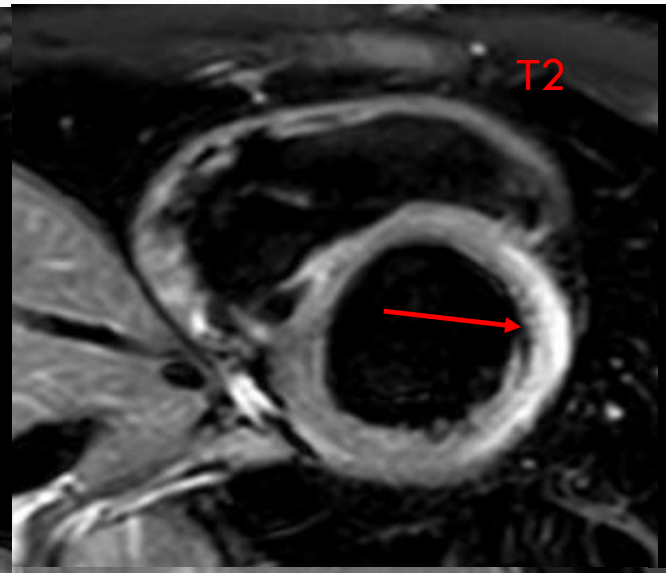
MR Detection Approach	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Single approach					
gRE	62 (30/48)	86 (30/35)	72 (60/83)	86 (30/35)	62 (30/48)
ER	67 (32/48)	69 (24/35)	68 (56/83)	74 (32/43)	60 (24/40)
LE	27 (13/48)	80 (28/35)	49 (41/83)	65 (13/20)	44 (28/63)
Combined approach*					
Any one, any two, or all three parameters	81 (39/48)	49 (17/35)	68 (56/83)	68 (39/57)	65 (17/26)
Any two parameters	62 (30/48)	89 (31/35)	74 (61/83)	88 (30/34)	63 (31/49)
Any one of two specific parameters (gRE or ER above cutoff)	79 (38/48)	63 (22/35)	72 (60/83)	74 (38/51)	69 (22/32)

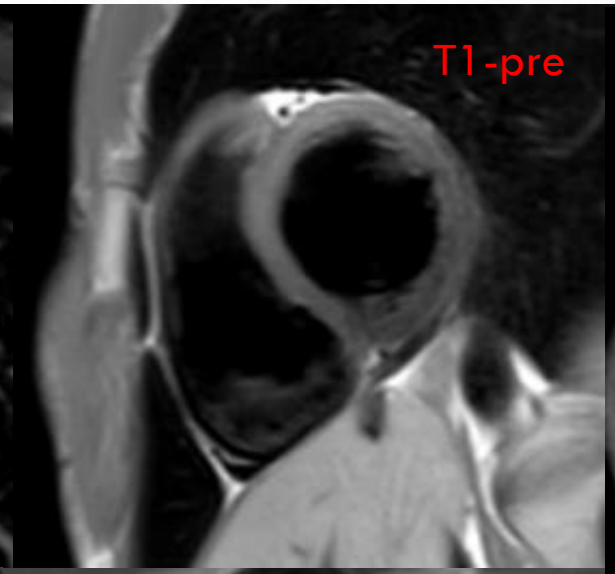
Note.—The numerators and denominators used to calculate the percentages are in parentheses. NPV = negative predictive value, PPV = positive predictive value.
* Refers to various combinations of gRE, ER, and LE.

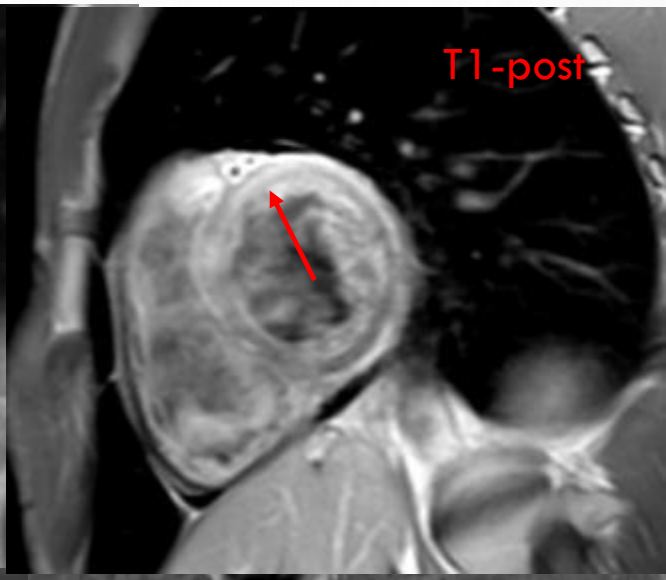
Gutberlet M at al. Radiology 2008; 246: 401-409

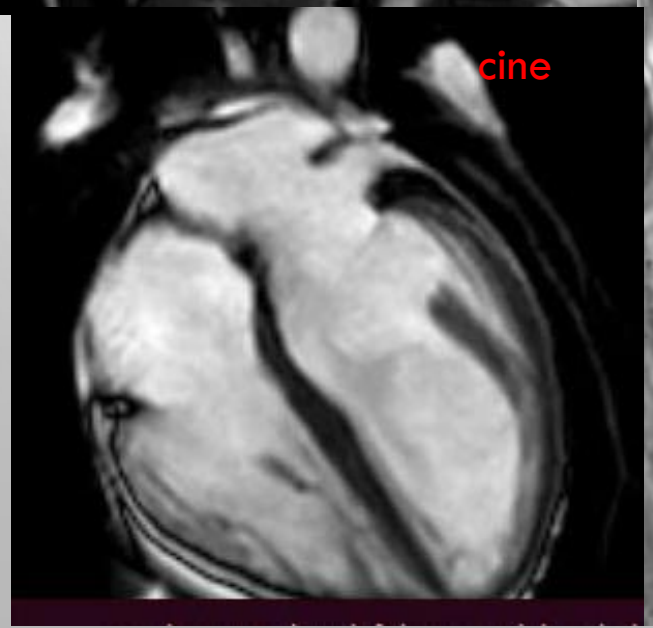
ОСТРЫЙ МИОКАРДИТ

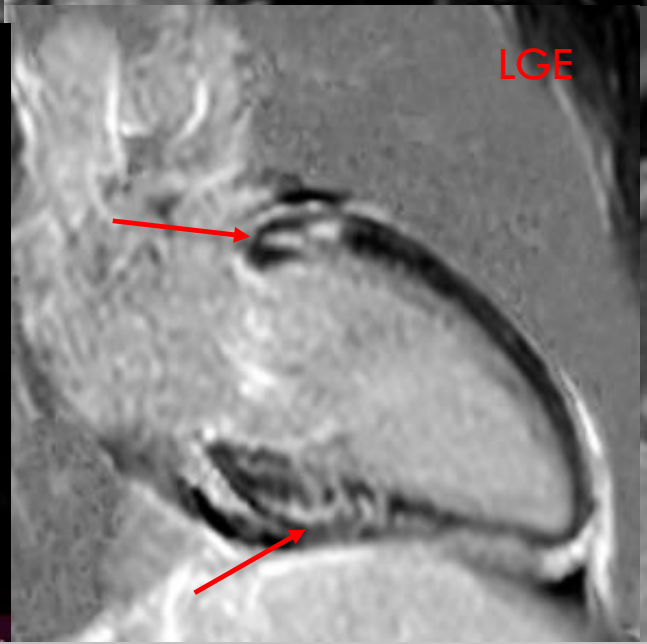


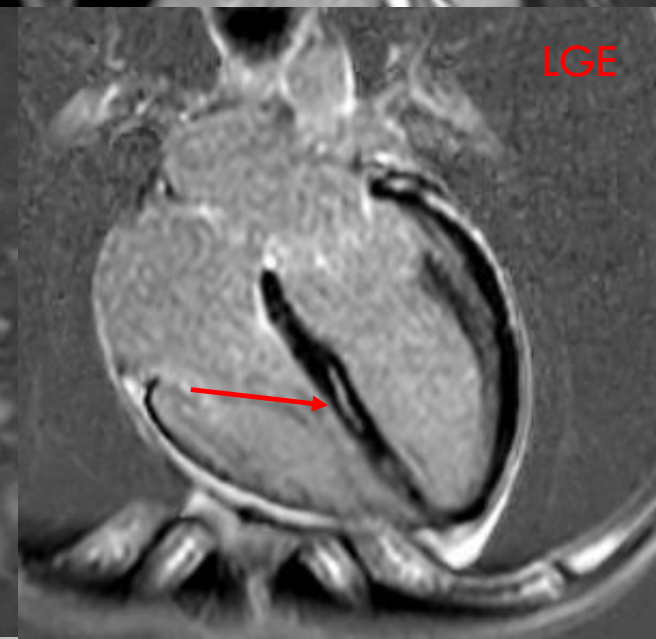




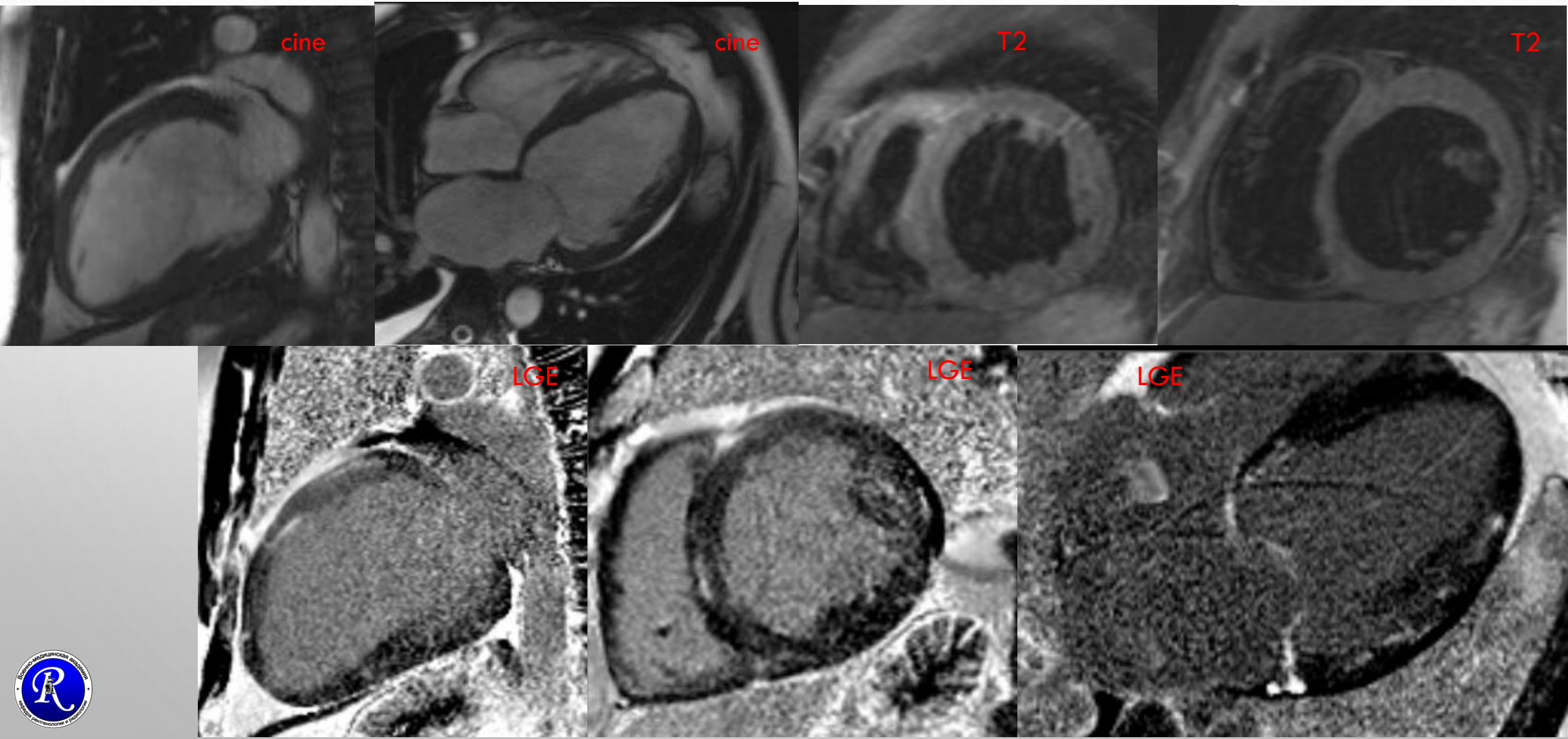








ХРОНИЧЕСКИЙ МИОКАРДИТ (САРКОИДОЗ)



ОТСРОЧЕННОЕ КОНТРАСТИРОВАНИЕ

Прогрессирующая мышечная дистрофия Беккера

ОТСРОЧЕННОЕ КОНТРАСТИРОВАНИЕ, ПРОГНОЗ

Radiology

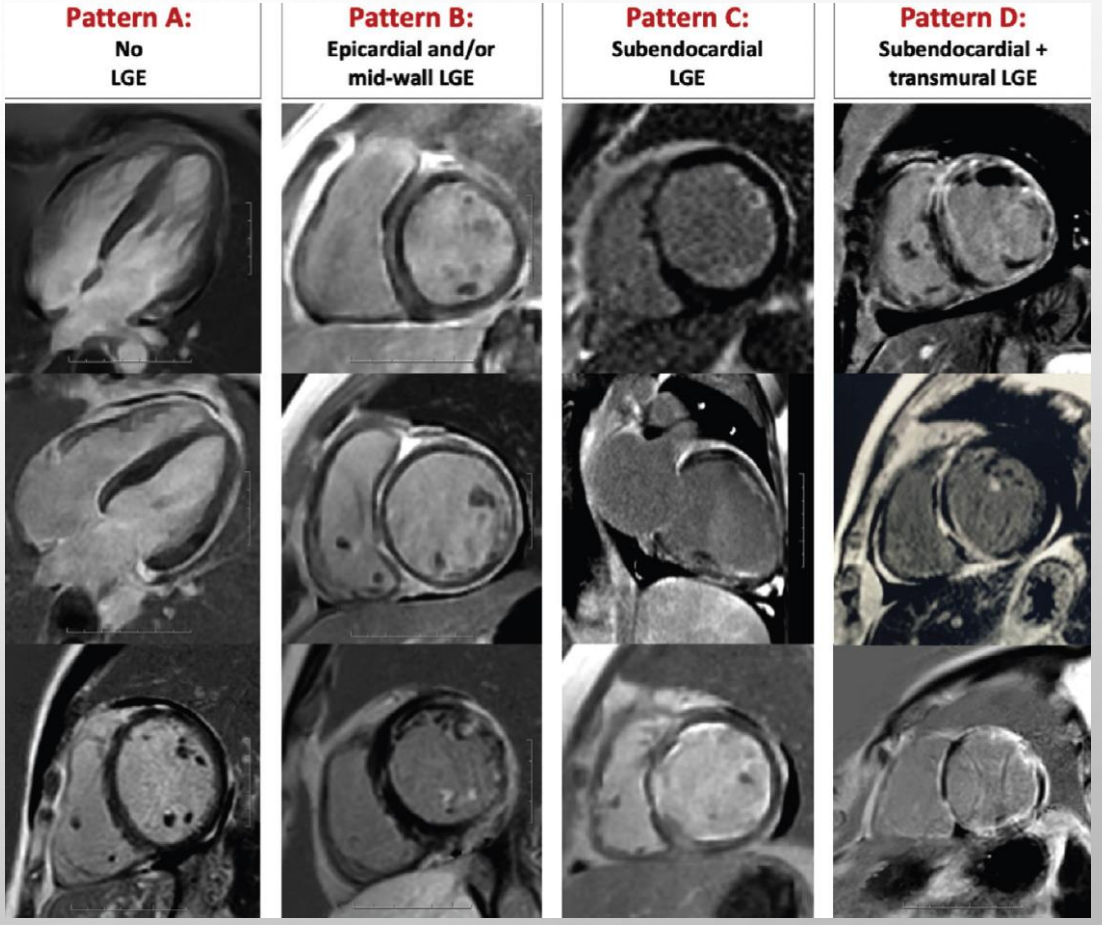
ORIGINAL RESEARCH · CARDIAC IMAGING

Subendocardial Involvement as an Underrecognized Cardiac MRI Phenotype in Myocarditis

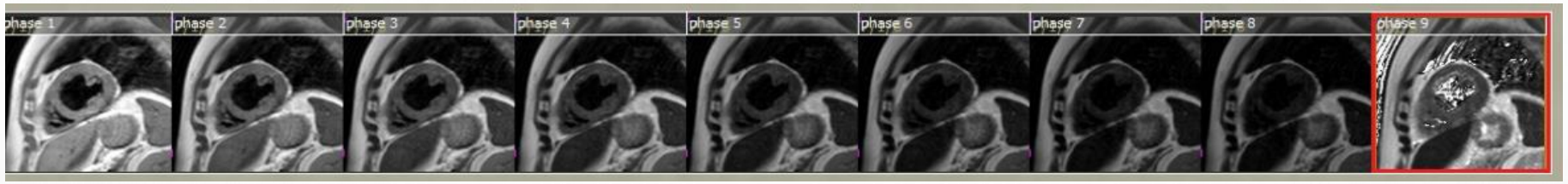
Jing-Hui Li, MD • Xi-Qi Xu, MD* • Yong-Jian Zhu, MD • Chun-Yan Cheng, MD, PhD • Min-Jie Lu, MD • Hong-Yue Wang, MD • Yi-Ning Wang, MD • Zhi-Cheng Jing, MD • Shi-Hua Zhao, MD*

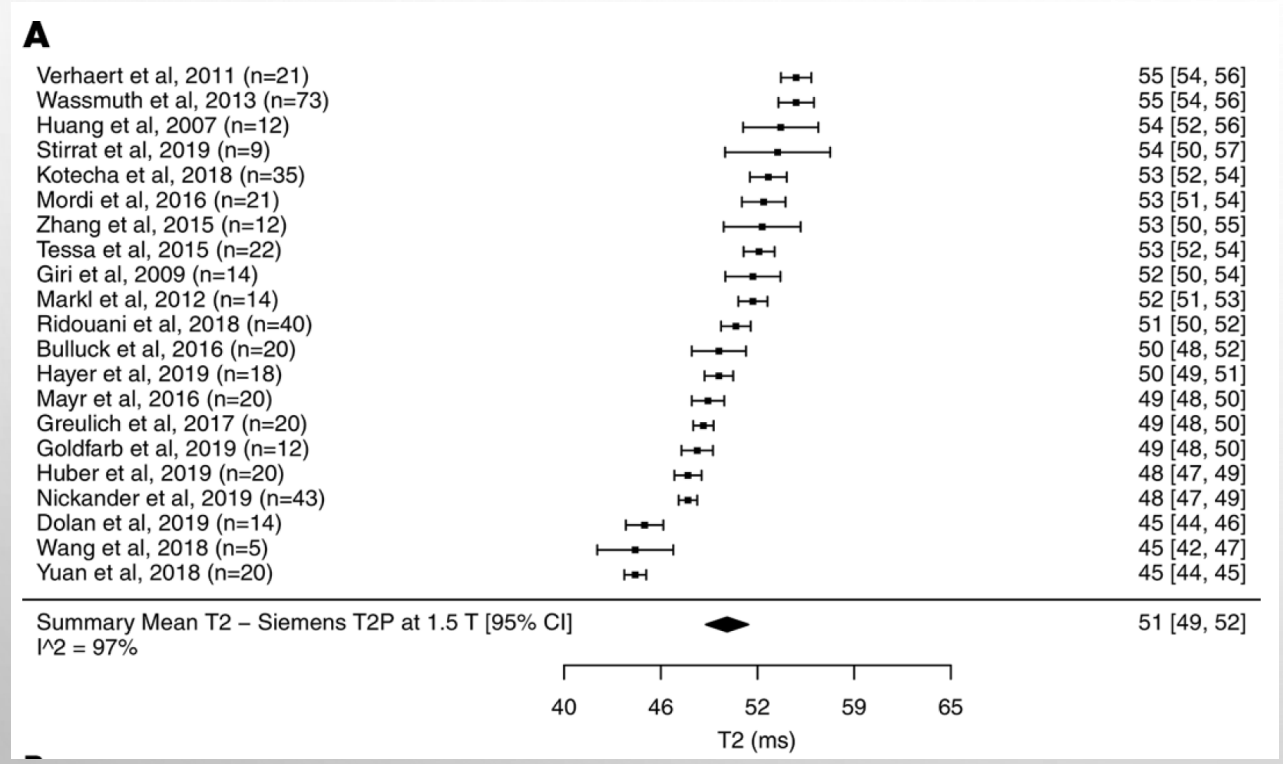
Patient Prognosis

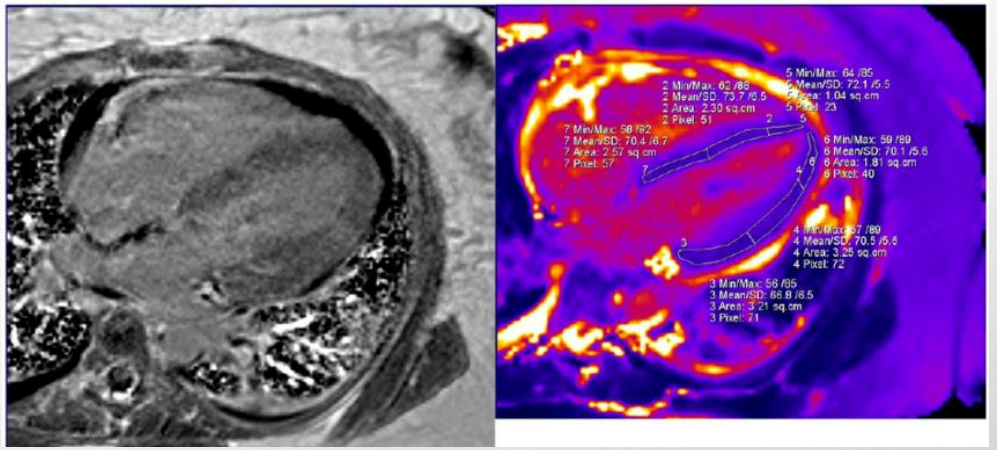
In a median follow-up period of 784 days (IQR, 90–1123 days), patients with subendocardial involvement had higher cardiac death or transplant rate (eight of 18 patients [44%] vs one of 21 [4.8%]; P = .006) and more MACE (15 of 18 [83%] vs seven of 21 [33%]; P = .002) than patients without subendocardial involvement (Table 1). There were more patients with normal echocardiographic findings at last follow-up among those with no subendocardial involvement than with subendocardial involvement (15 of 21 patients [71%] vs four of 18 [22%]; P = .004).



T2-картирование







T2 Relaxation Times at Cardiac MRI in Healthy Adults:
A Systematic Review and Meta-Analysis

Christopher A. Hanson, MD • Akshay Kamath, MD • Matthew Gottbrecht, MD • Sami Ibrahim, MD • Michael Salerno, MD, PhD, MSc

From the Department of Medicine, Cardiovascular Division (C.A.H., M.S.), Department of Medicine (A.K., S.I.), and Department of Radiology (M.S.), University of Virginia Health System, 1215 Lee St, Box 800158, Charlottesville, VA 22908; Department of Medicine, Cardiovascular Division, University of Massachusetts, Worcester, Mass (M.G.); and Department of Biomedical Engineering, University of Virginia, Charlottesville, Va (M.S.). Received March 17, 2020; revision requested May 1; revision received June 23; accepted June 25. **Address correspondence to** M.S. (e-mail: *ms5pc@virginia.edu*).

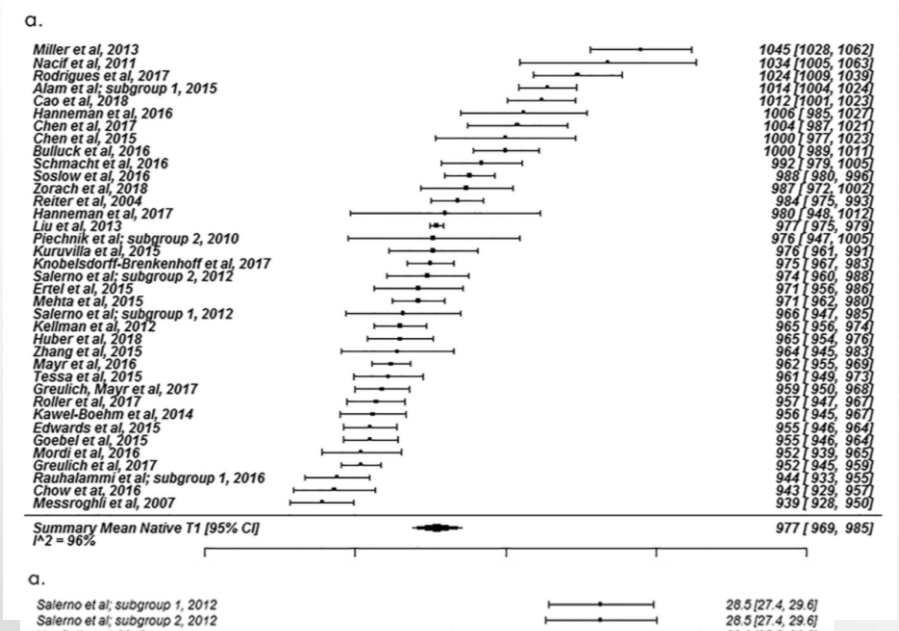
C.A.H. supported by National Institute of Biomedical Imaging and Bioengineering (grant no. 5T32EB003841). M.S. supported by Siemens Medical Solutions and the National Heart, Lung, and Blood Institute (5T32 EB003841, R01 HL131919).

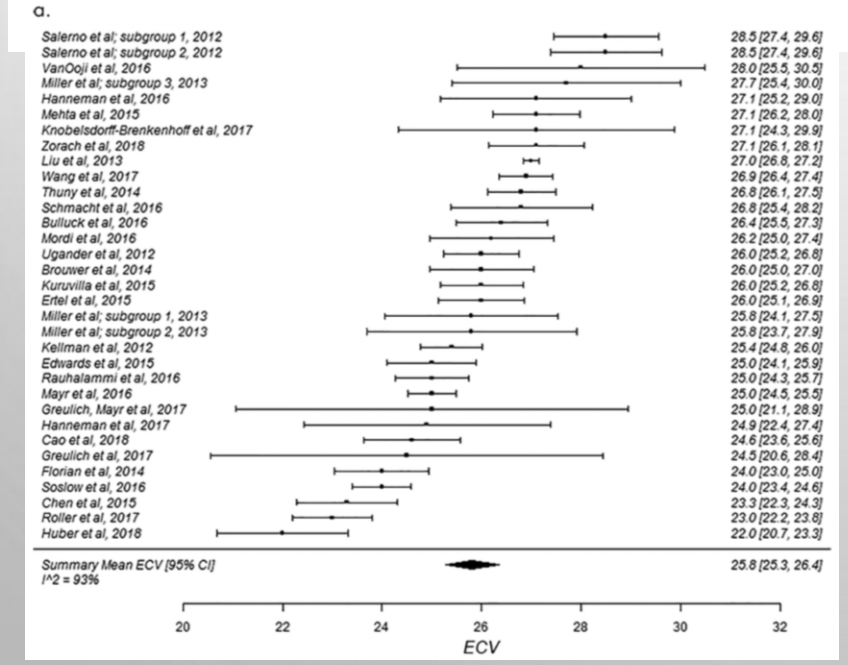
Conflicts of interest are listed at the end of this article.

Radiology 2020; 297:344–351 • https://doi.org/10.1148/radiol.2020200989 • Content codes: CA MR

T2 - картирование

T1-картирование





Native T1 and Extracellular Volume Measurements by Cardiac MRI in Healthy Adults: A Meta-Analysis

Matthew Gottbrecht, MD • Christopher M. Kramer, MD • Michael Salerno, MD, PhD

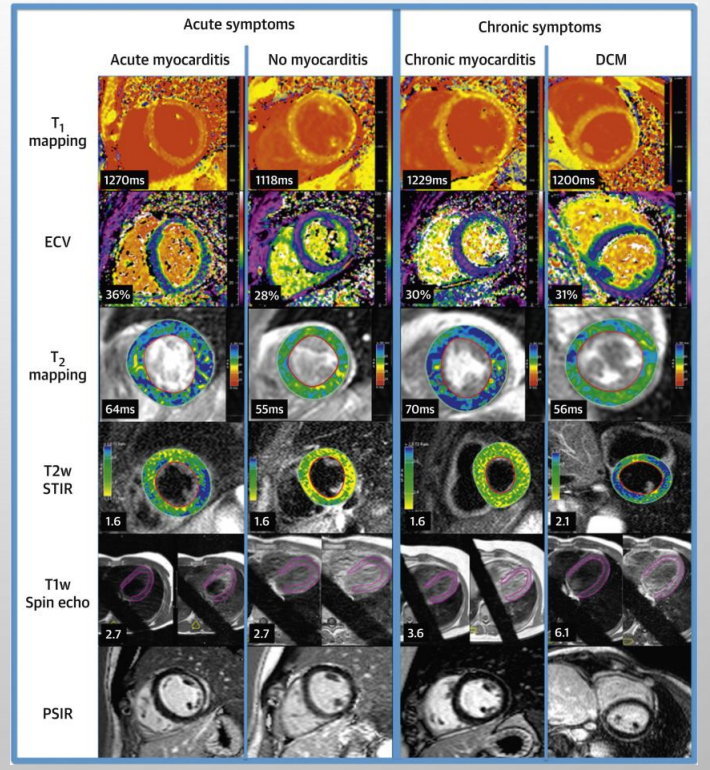
From the Departments of Medicine (M.G., C.M.K., M.S.), Radiology (C.M.K., M.S.), and Biomedical Engineering (M.S.) and Cardiovascular Imaging Center (M.G., C.M.K., M.S.), University of Virginia Health System, 1215 Lee St, Box 800158, Charlottesville, VA 22908. Received February 12, 2018; revision requested March 5; revision received August 30; accepted September 17. **Address correspondence to** M.S. (e-mail: *ms5pc@virginia.edu*).

Study supported by Siemens Medical Solutions and the National Institutes of Health (5T32 EB003841, K23 HL112910, R01 HL079110, R01 HL131919).

Conflicts of interest are listed at the end of this article.

See also the editorial by Dodd and Dewey in this issue.

Radiology 2019; 290:317–326 • https://doi.org/10.1148/radiol.2018180226 • Content codes: CA MR



T1-картирование

TABLE 1 CMR Findings in the Study Population

	Controls (n = 40)	Acute Myocarditis (n = 61)	Convalescent Myocarditis (n = 67)	p Value
Functional parameters				
LV-EDV index, ml/m^2	74 ± 12	94 ± 35*	86 ± 25	0.001
LV-ESV index, ml/m^2	30 ± 8	51 ± 33*	41 ± 25	0.001
LV mass index, ml/m^2	50 ± 14	70 ± 21*	60 ± 16	<0.001
LV ejection fraction, %	61 ± 5	49 ± 15*	55 ± 11*	<0.001
RV ejection fraction, %	57 ± 8	53 ± 13	57 ± 10	0.12
Tissue characterization				
Pericardial effusion	0 (0)	17 (28)	9 (13)	0.001
T2 edema ratio	1.3 (1.1-1.6)	2.3 (1.5-3.5)*	1.4 (1.1-2.3)†	<0.001
Increased T2 SI	0 (0)	38 (62)*	8 (12)*†	<0.001
Myocardium LGE				
Present	0 (0)	51 (84)	59 (88)	<0.001
Nonischemic pattern	0 (0)	51 (84)	59 (88)	<0.001
Pericardial enhancement	0 (0)	18 (29)*	5 (7)*†	<0.001
T1 mapping				
Native T1, ms				
1.5-T	940 ± 20	1,064 ± 37*	995 ± 19*†	<0.001
3.0-T	1,045 ± 23	1,189 ± 52*	1,099 ± 22*†	<0.001
Post-contrast T1, ms				
1.5-T	422 ± 68	373 ± 42*	383 ± 43*	0.03
3.0-T	442 ± 68	397 ± 62	426 ± 73	0.06
Lambda, %				
1.5-T	42 ± 4	50 ± 7*	46 ± 9	0.005
3.0-T	44 ± 5	53 ± 8*	45 ± 8†	0.002
Abnormal native T1, n (%)	0 (0)	60 (98)*	47 (76)*	0.001

Values are mean ± SD, n (%), or median (range). *Significant differences between patients with myocarditis compared with control subjects. †Between the disease groups.

CMR = cardiac magnetic resonance; EDV = end-diastolic volume; ESV = end-systolic volume; LGE = late gadolinium enhancement; LV = left ventricular; RV = right ventricular; SI = signal intensity.

Hinojar *et al.*
T1 Discrimination of Acute and Convalescent Myocarditis

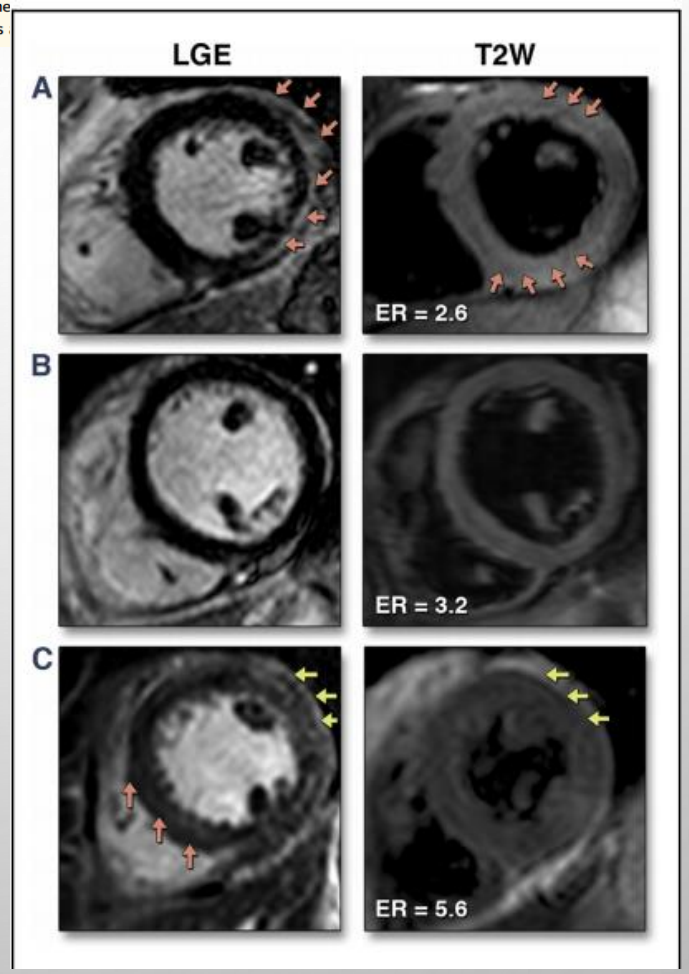
JACC: CARDIOVASCULAR IMAGING, VOL. 8, NO. 1, 2015
JANUARY 2015:37–46

Native T1 in Discrimination of Acute and Convalescent Stages in Patients With Clinical Diagnosis of Myocarditis

A Proposed Diagnostic Algorithm Using CMR

ABSTRACT

OBJECTIVES This study investigated whe
clinical evolution of disease in myocarditis



T1- T2- ECV КАРТИРОВАНИЕ

JACC: CARDIOVASCULAR IMAGING
VOL. 7, NO. 7, 2014

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http://dx.doi.org/10.1016/j.jcmg.2014.02.005

CMR in Patients With Severe Myocarditis

Diagnostic Value of Quantitative Tissue Markers Including Extracellular Volume Imaging

Ulf K. Radunski, MD,* Gunnar K. Lund, MD,† Christian Stehning, PhD,‡ Bernhard Schnackenburg, PhD,§ Sebastian Bohnen, MD,* Gerhard Adam, MD,† Stefan Blankenberg, MD,* Kai Muellerleile, MD*

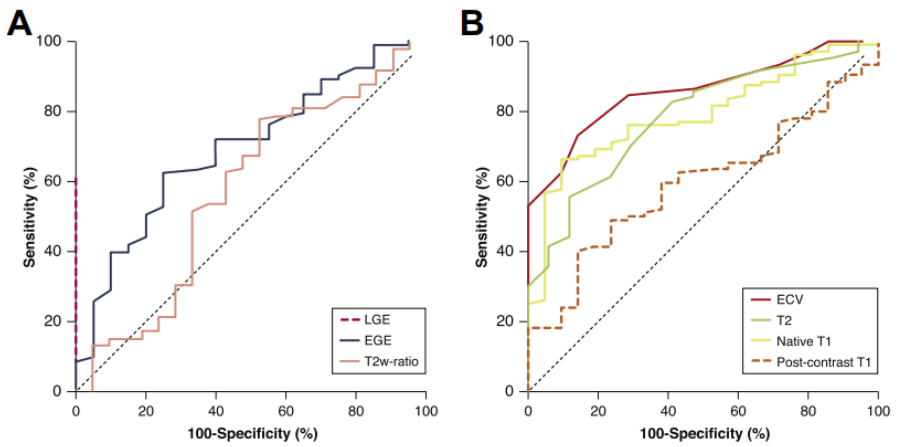


FIGURE 2 ROC Curves for CMR Parameters to Identify Patients With Myocarditis

Receiver-operating characteristic (ROC) curves illustrate the diagnostic performance of **(A)** "Lake-Louise" and **(B)** mapping parameters to discriminate patients with myocarditis from control subjects. LGE provided the best performance, with an area under the curve (AUC) of 0.80 ($p < 0.0001$) of the Lake-Louise parameters. The ROC curve of LGE is represented by the **dashed line** overlaying the axis of ordinates due to the 100% specificity of LGE **(A)**. Myocardial ECV offered the best AUC, with 0.86 ($p < 0.0001$) of the mapping parameters **(B)**. EGE = early gadolinium enhancement; T2w ratio = signal intensity ratio of myocardium to skeletal muscle on T2-weighted cardiac magnetic resonance; other abbreviations as in Figure 1.

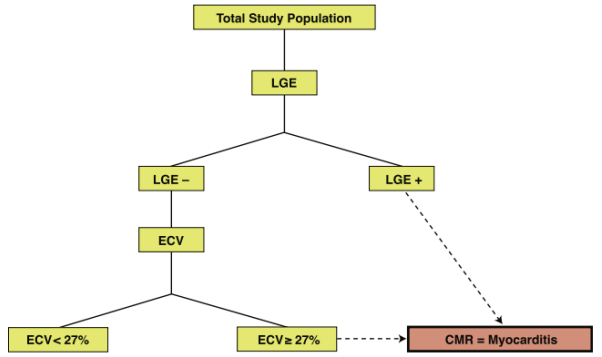
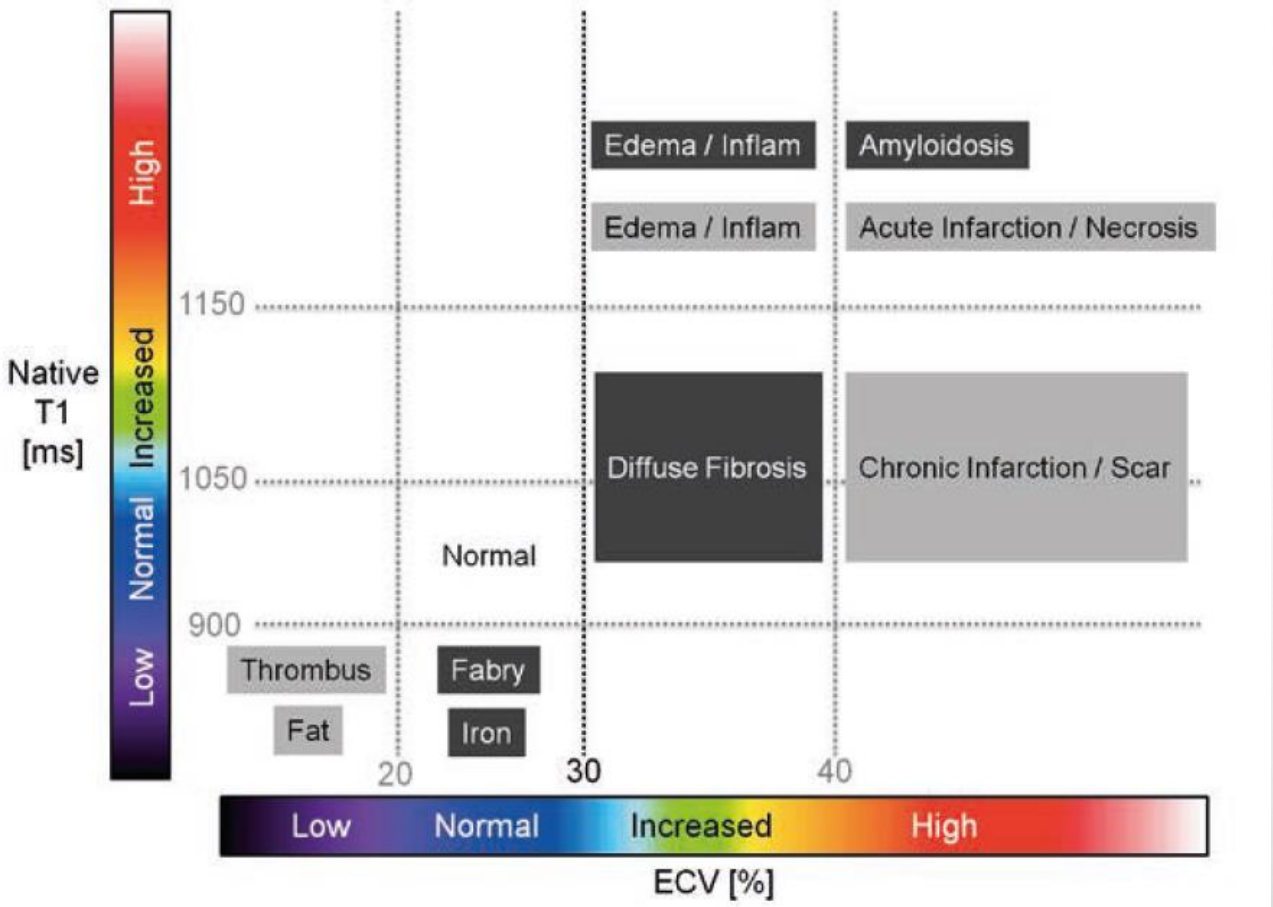


FIGURE 4 Proposed Diagnostic Algorithm to Identify Patients With Myocarditis Based on LGE and ECV Imaging

Myocarditis was defined stepwise by the presence of LGE or by an ECV ≥27% in LGE-negative patients. Abbreviations as in Figure 1.

T1- T2- ECV КАРТИРОВАНИЕ



Значения T1 и **ECV** могут отличаться в зависимости от используемой методики получения изображения

Magnus Lundin, M.D.; Martin Ugander, M.D., Ph.D., 2015

T1- T2- ECV КАРТИРОВАНИЕ

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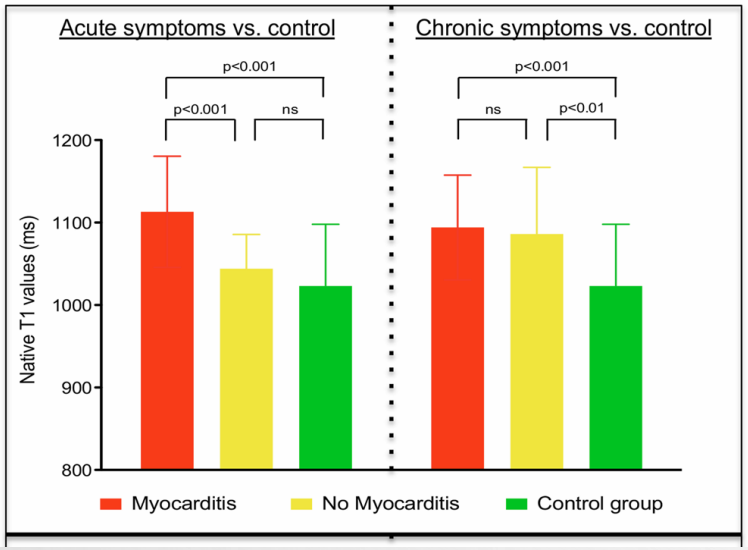
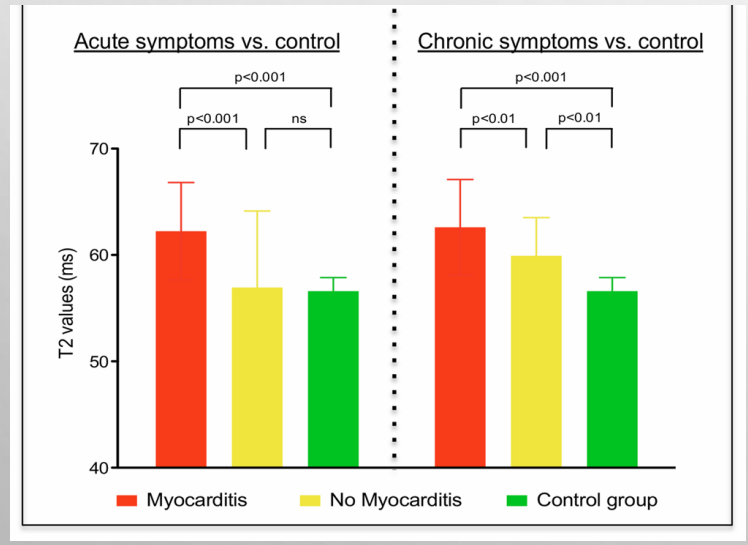
T1-mapping



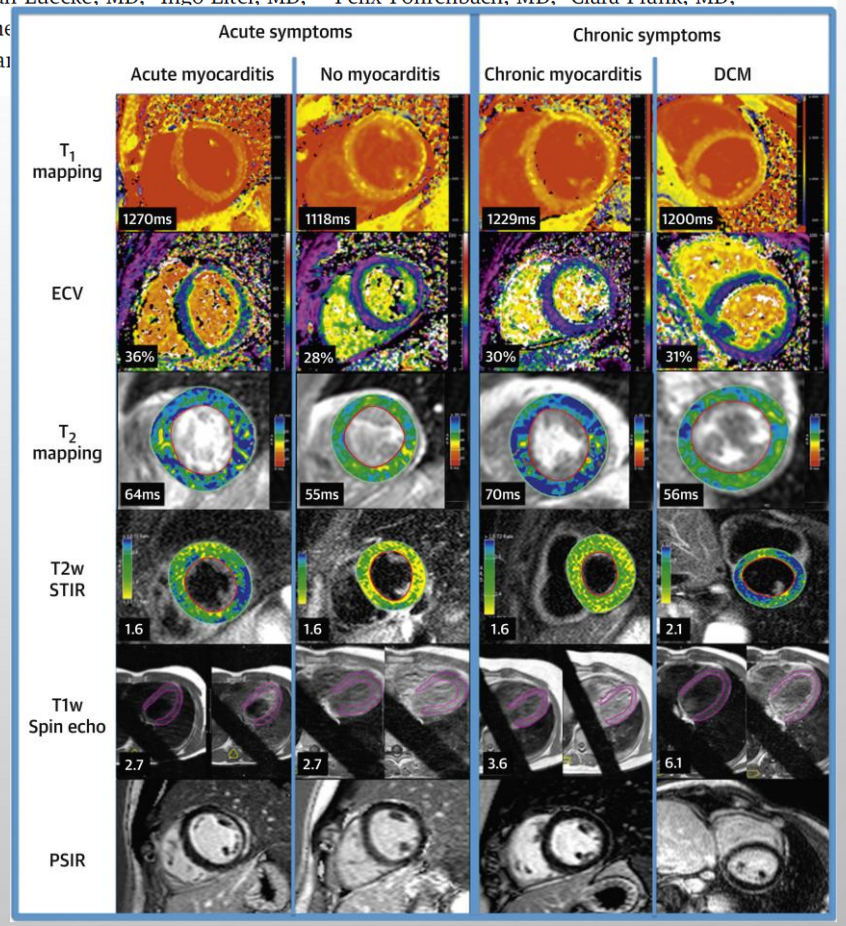


T2-mapping

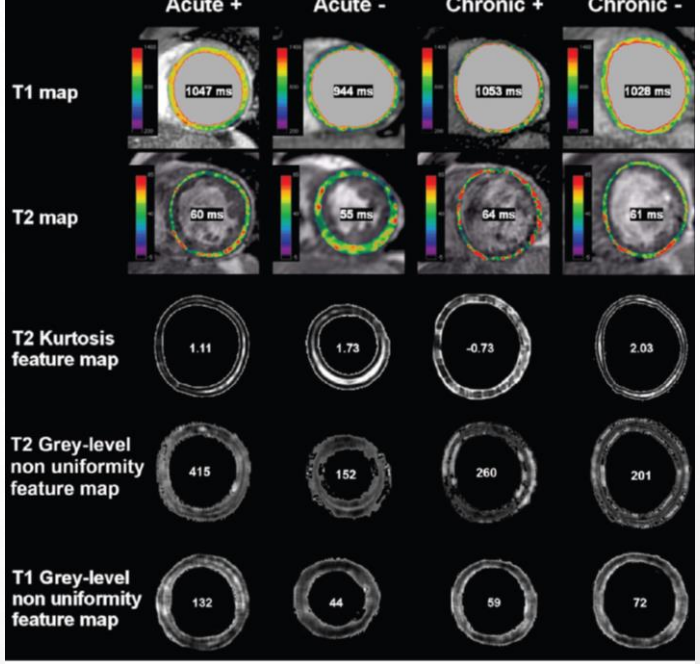
Comprehensive Cardiac Magnetic Resonance Imaging in Patients With Suspected Myocarditis

The MyoRacer-Trial

Philipp Lurz, MD, PhD,[a] Christian Luecke, MD,[b] Ingo Eitel, MD,[c,d] Felix Föhrenbach, MD,[a] Clara Frank, MD,[b]
Matthias Grothoff, MD,[b] Suzanne
Karin Klingel, MD,[f] Reinhard Kar



T1- T2- ECV КАРТИРОВАНИЕ, РАДИОМИКА



SEARCH • CARDIAC IMAGING

Radiology

Cardiac MRI and Texture Analysis of Myocardial T1 and T2 Maps in Myocarditis with Acute versus Chronic Symptoms of Heart Failure

Bettina Baessler, MD • Christian Luecke, MD • Julia Lurz, MD • Karin Klingel, MD • Arijit Das, PhD • Maximilian von Roeder, MD • Suzanne de Waha-Thiele, MD • Christian Besler, MD • Karl-Philipp Rommel, MD • David Maintz, MD • Matthias Gutberlet, MD • Holger Thiele, MD • Philipp Lurz, MD, PhD

From the Institute of Diagnostic and Interventional Radiology, University of Cologne, Medical Faculty and University Hospital Cologne, Kerpener Str 62, D-50937 Cologne, Germany (B.B., A.D., D.M.); Department of Diagnostic and Interventional Radiology, Heart Center Leipzig, Leipzig, Germany (C.L., M.G.); Department of Internal Medicine/Cardiology, Heart Center Leipzig-University Hospital, Leipzig, Germany (J.L., M.v.R., C.B., K.P.R., H.T., P.L.); Department of Cardiopathology, Institute for Pathology and Neuropathology, University Hospital Tuebingen, Tuebingen, Germany (K.K.); Institute of Medical Statistics and Computational Biology, University of Cologne, Medical Faculty and University Hospital Cologne, Cologne, Germany (A.D.); Department of Cardiology, Angiology, and Intensive Care Medicine, University Heart Center Luebeck, Luebeck, Germany (S.d.W.T.); German Center for Cardiovascular Research (DZHK), partner site Hamburg/Kiel/Luebeck, Luebeck, Germany (S.d.W.T.); and Leipzig Heart Institute, Leipzig, Germany (M.G., H.T., P.L.). Received January 17, 2019; revision requested March 15; revision received May 29; accepted June 18. **Address correspondence to** B.B. (e-mail: *bettina.baessler@usz.ch*).

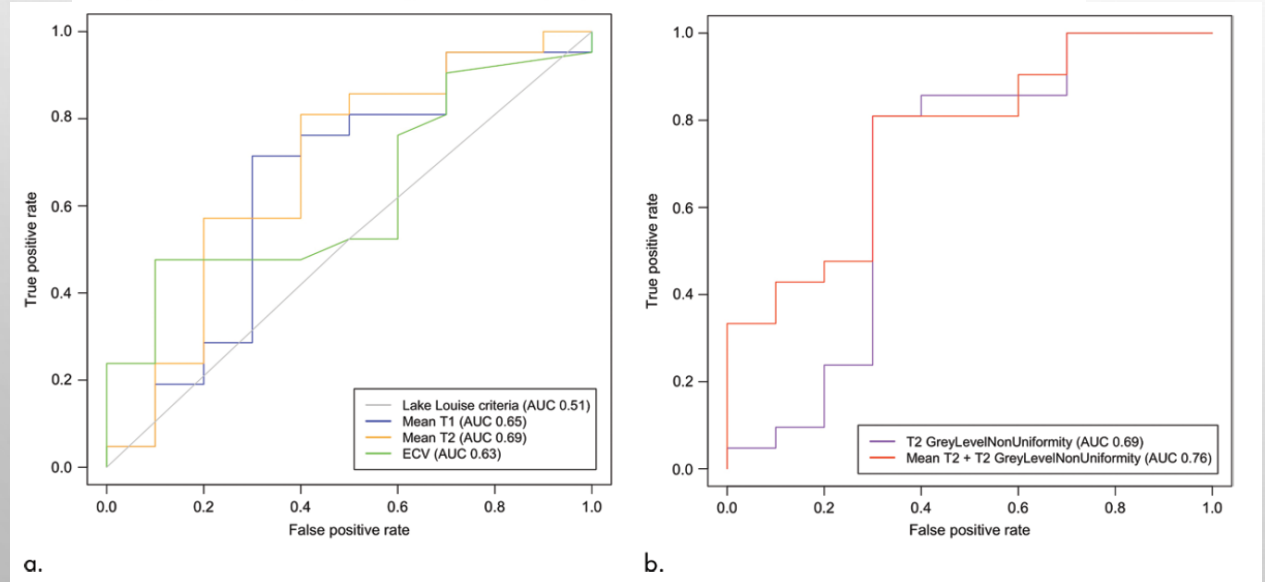


Figure 3: Receiver operating characteristics (ROC) analyses: EMB-positive versus EMB-negative acute myocarditis with symptoms of heart failure. ROC analysis indicating accuracy of **(a)** single and combined parametric imaging parameters and Lake Louise criteria, as well as **(b)** texture features for diagnosing EMB-positive versus EMB-negative myocarditis with acute symptoms of heart failure. AUC = area under the ROC curve, ECV = extracellular volume, EMB = endomyocardial biopsy.

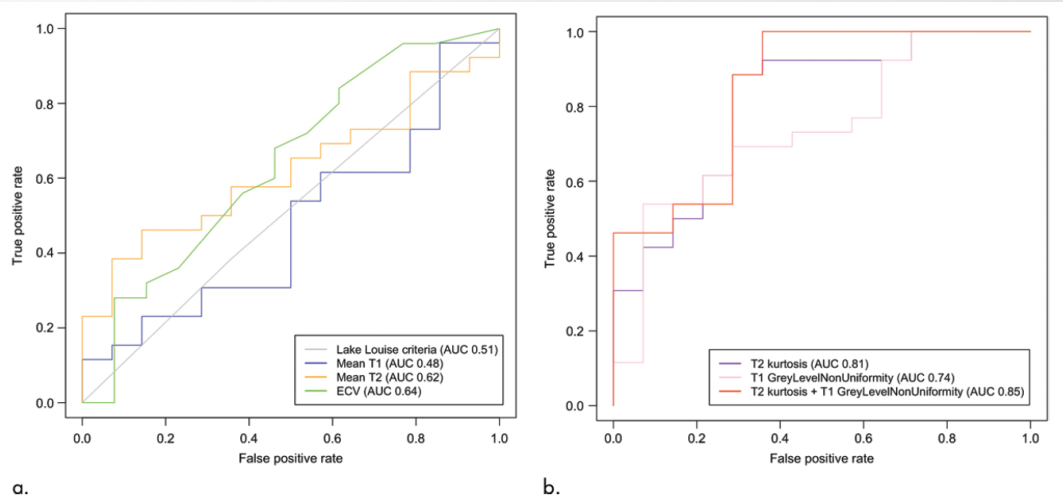
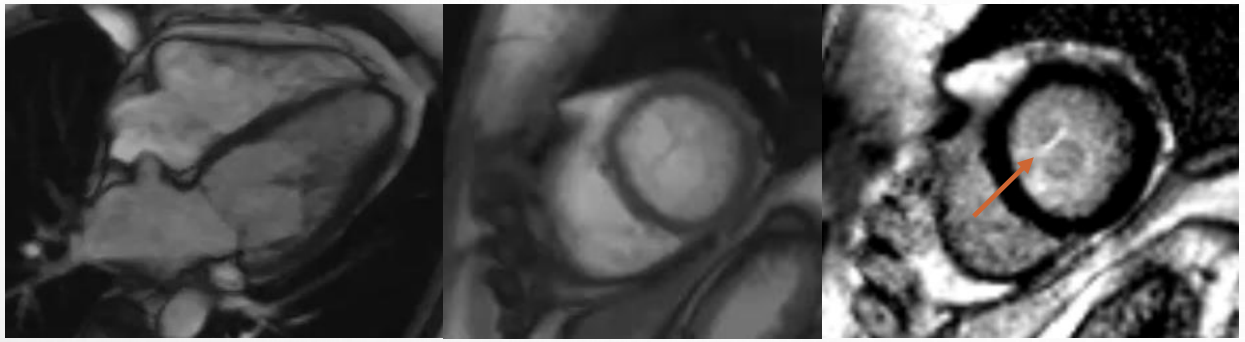
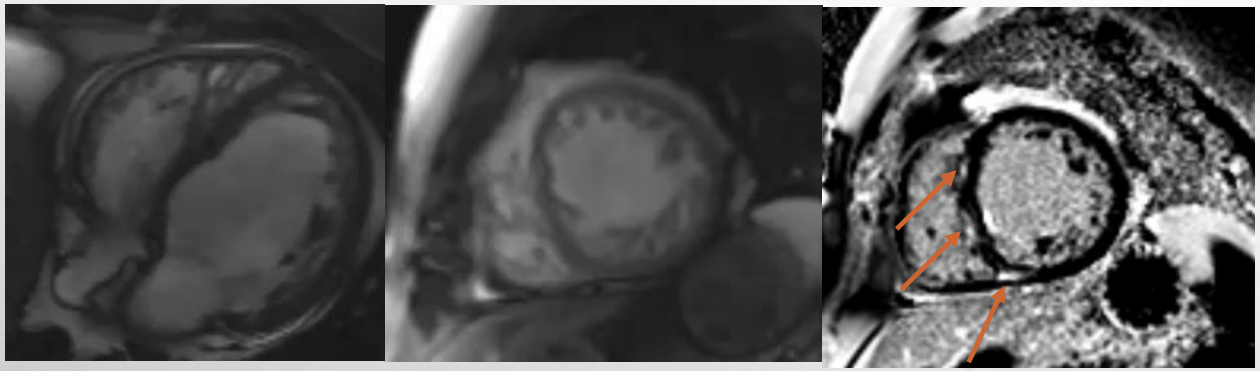
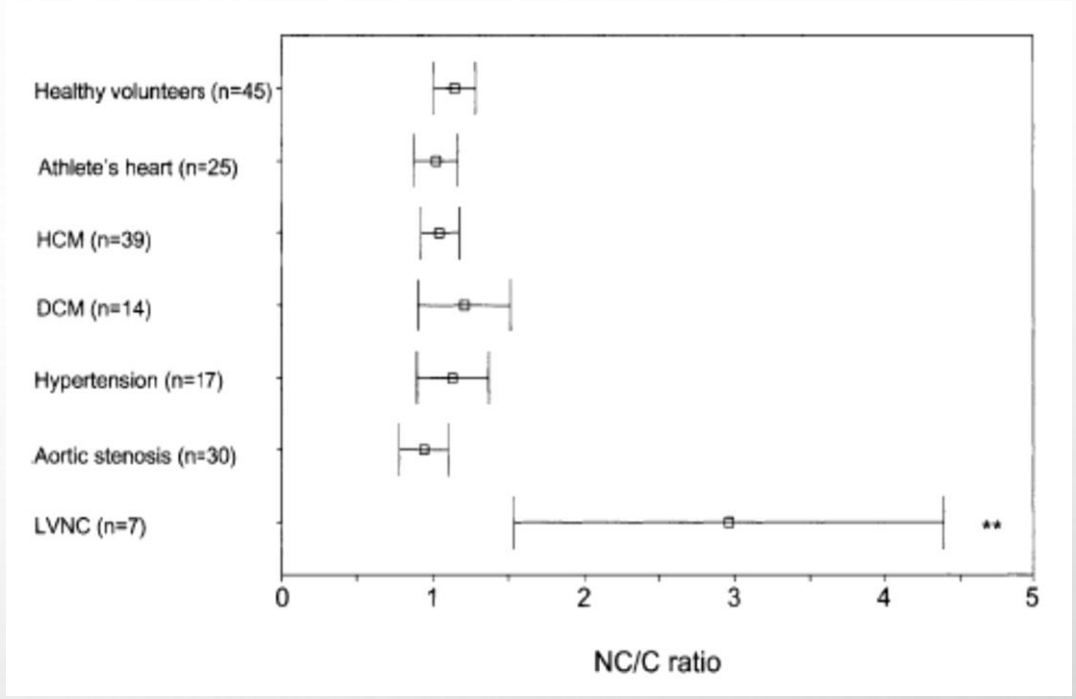


Figure 4: Receiver operating characteristics (ROC) analyses: EMB-positive versus EMB-negative chronic myocarditis with symptoms of heart failure. ROC analysis indicating accuracy of **(a)** single and combined parametric imaging parameters and Lake Louise criteria, as well as **(b)** texture features for diagnosing EMB-positive versus EMB-negative myocarditis with chronic symptoms of heart failure. Comparison of area under the ROC curve (AUC) of single and multiparametric models to Lake Louise criteria by using the Delong method with 10000-fold bootstrapping revealed the following *P* values: T1 versus Lake Louise criteria, $P = .99$; T2 versus Lake Louise criteria, $P = .87$; ECV versus Lake Louise criteria, $P = .89$; T2_kurtosis versus Lake Louise criteria, $P = .001$; T1GrayLevelNonUniformity versus Lake Louise criteria, $P = .001$; and T2_kurtosis + T1GrayLevelNonUniformity versus Lake Louise criteria, $P < .001$. ECV = extracellular volume, EMB = endomyocardial biopsy.

НЕКОМПАКТНЫЙ МИОКАРД







Left Ventricular Non-Compaction

Insights From Cardiovascular Magnetic Resonance Imaging

RESULTS Areas of non-compaction were common and occurred more frequently in all groups studied in apical and lateral, rather than in basal or septal, segments. A NC/C ratio of >2.3 in diastole distinguished pathological non-compaction, with values for sensitivity, specificity, and positive and negative predictions of 86%, 99%, 75%, and 99%, respectively.

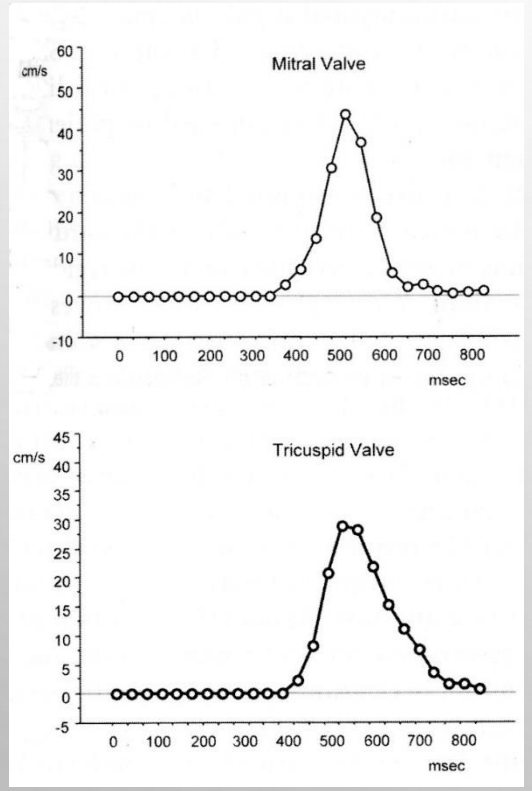
CONCLUSIONS Left ventricular non-compaction is diagnosed accurately with CMR using the NC/C ratio in diastole. (J Am Coll Cardiol 2005;46:101–5) © 2005 by the American College of Cardiology Foundation

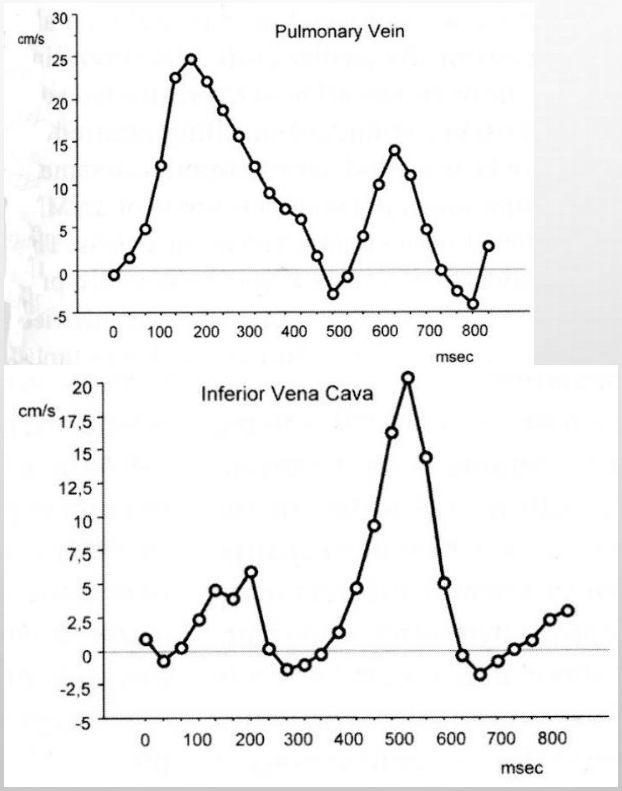
НЕКОМПАКТНЫЙ МИОКАРД

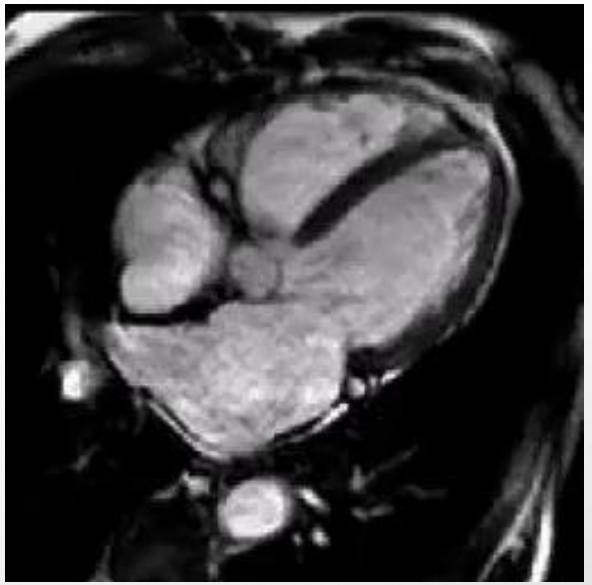
Modality	**Echo** (ref 43)	**CMR** (ref 44)	**CMR** (ref 45)	**CMR** (ref 46)	**CMR** (ref 47)
Criteria	• NC/C in parasternal SA • Deep perfused inter-trabecular recesses on Colour Doppler • Decreased thickening and hypokinesia within, but not limited to, NC segments	• Two-layered myocardium • Long axis SSFP cine • Measured at the most pronounced trabeculation • Measurement perpendicular to compacted myocardium	• Total LV mass (SA SSFP cines) • Compacted myocardial mass (SA SSFP cines) • Trabecular mass = Total LV mass minus compacted myocardial mass	• Apical SA views 16 to 24 mm from the true apical slice • Region with the largest NC/C ratio	• SA views • Loss of base-to-apex fractal dimension (FD)* gradient *FD is an index of how completely an object fills space.
Cardiac phase	End-systole	End-diastole	End-diastole	End-systole	End-diastole
Definition	NC/C ratio > 2	NC/C ratio > 2.3	Trabecular mass> 20%	NC/C ratio ≥ 2	FD ≥1.30
Sensitivity specificity	n/a	Sens 86% Specif 99%	Sens 93.7% Specif 93.7%	n/a	Sens 83-100% Specif 86-100%

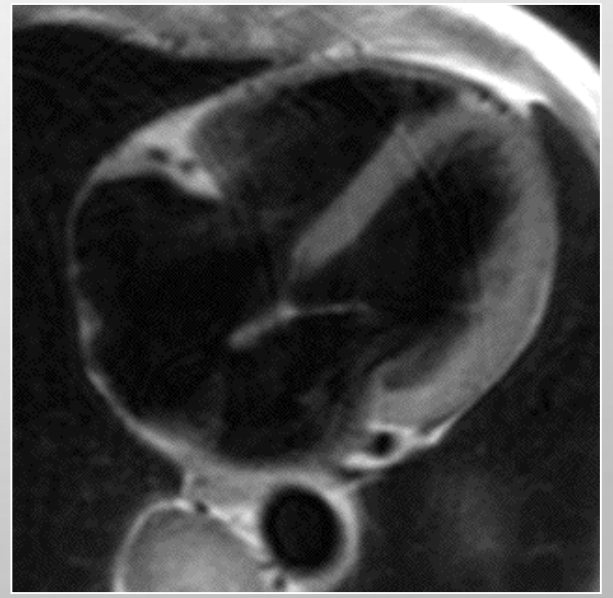
ВНЕШНЕ НЕИЗМЕНЕННЫЕ ЖЕЛУДОЧКИ

РЕСТРИКТИВНАЯ КАРДИОМИОПАТИЯ ЭТО ЗАБОЛЕВАНИЕ СЕРДЦА СОПРОВОЖДАЮЩИЕСЯ НАРУШЕНИЕМ НАПОЛНЕНИЯ ЖЕЛУДОЧКОВ С НОРМАЛЬНЫМ ИЛИ СНИЖЕННЫМ ОБЪЕМОМ ОДНОГО ИЛИ ДВУХ ЖЕЛУДОЧКОВ. СИСТОЛИЧЕСКАЯ ФУНКЦИЯ И ТОЛЩИНА СТЕНОК ОБЫЧНО СОХРАНЯЕТСЯ. СОСТОЯНИЕ КАК ПРАВИЛО ОБУСЛОВЛЕНО ПОВЫШЕННОЙ РИГИДНОСТЬ МИОКАРДА, ЧТО ПРИВОДИТ К ПОВЫШЕНИЮ ДАВЛЕНИЯ В ПОЛОСТЯХ ЖЕЛУДОЧКОВ С МИНИМАЛЬНЫМ ИЗМЕНЕНИЕМ ИХ ОБЪЕМА.

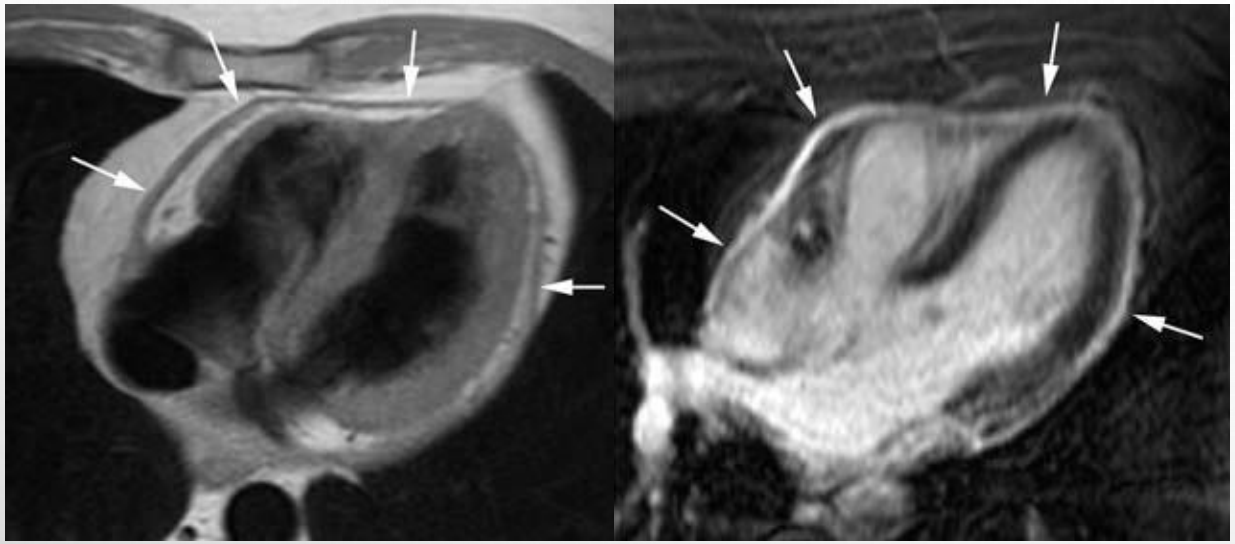


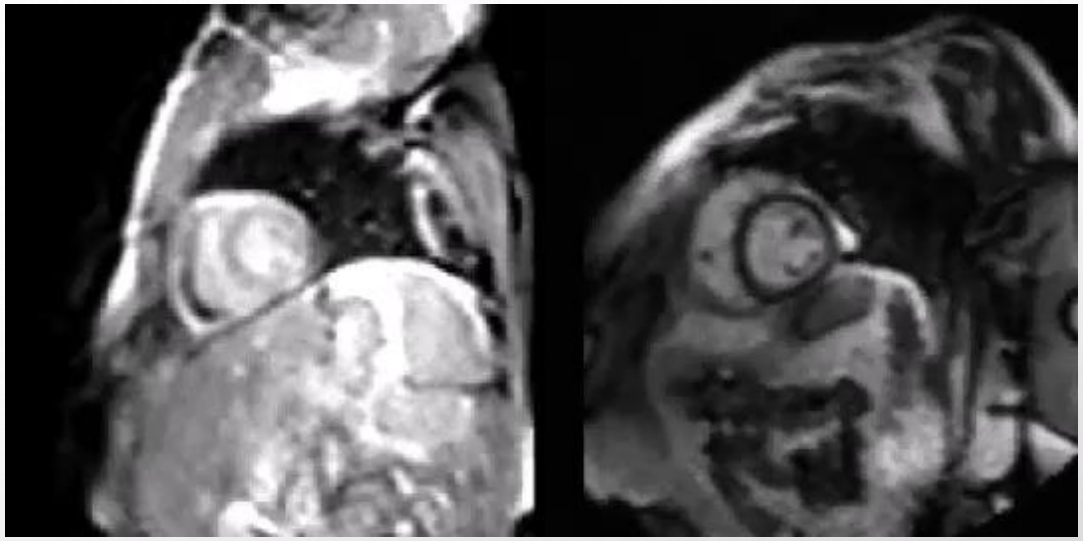




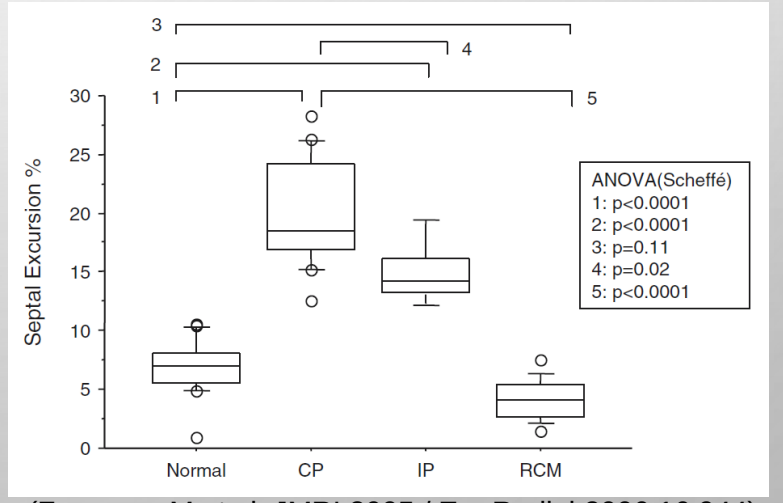


РЕСТРИКТИВНАЯ КАРДИОМИОПАТИЯ





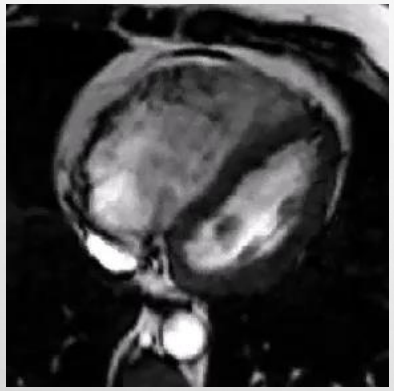
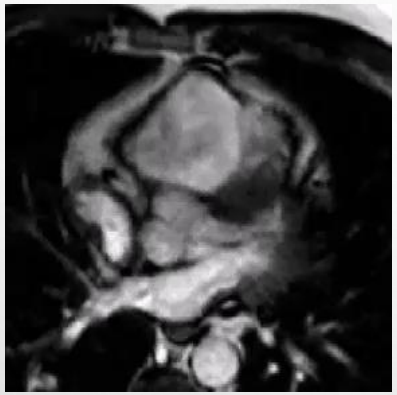
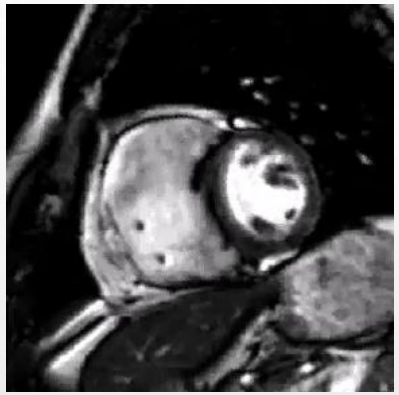
Дифференциальная диагностика с констриктивным перикардитом



(Francone M et al. JMRI 2005 / Eur Radiol 2006;16:944)

АРИТМОГЕННАЯ ДИСПЛАЗИЯ ПРАВОГО ЖЕЛУДОЧКА

- Жирового перерождения стенки
- Фиброза и воспалительных изменений
- Локальные истончения или утолщения стенки с формированием локальных псевдоаневризм
- Дилатация полости желудочка и снижение глобальной систолической его функции


- ОЦЕНКА ГЛОБАЛЬНОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА ЗАТРУДНЕНА
- В НОРМЕ МОГУТ НАБЛЮДАТЬСЯ ЖИРОВЫЕ ДЕПОЗИТЫ В ПРАВОМ ЖЕЛУДОЧКЕ И НЕРАВНОМЕРНОСТЬ СОКРАЩЕНИЯ СТЕНКИ
- ЛОКАЛЬНОЕ СУЖЕНИЕ СТЕНКИ, ФОРМИРОВАНИЕ ПСЕВДОАНЕРВИЗМ ОДИН ИЗ САМЫХ НАДЕЖНЫХ ПРИЗНАКОВ
- ЧАСТО НАБЛЮДАЕТСЯ ДИССИНХРОНИЯ СОКРАЩЕНИЯ ЖЕЛУДОЧКОВ
- ОТМЕЧАЕТСЯ СНИЖЕНИЕ ГЛОБАЛЬНОЙ ФУНКЦИИ ПРАВОГО ЖЕЛУДОЧКА

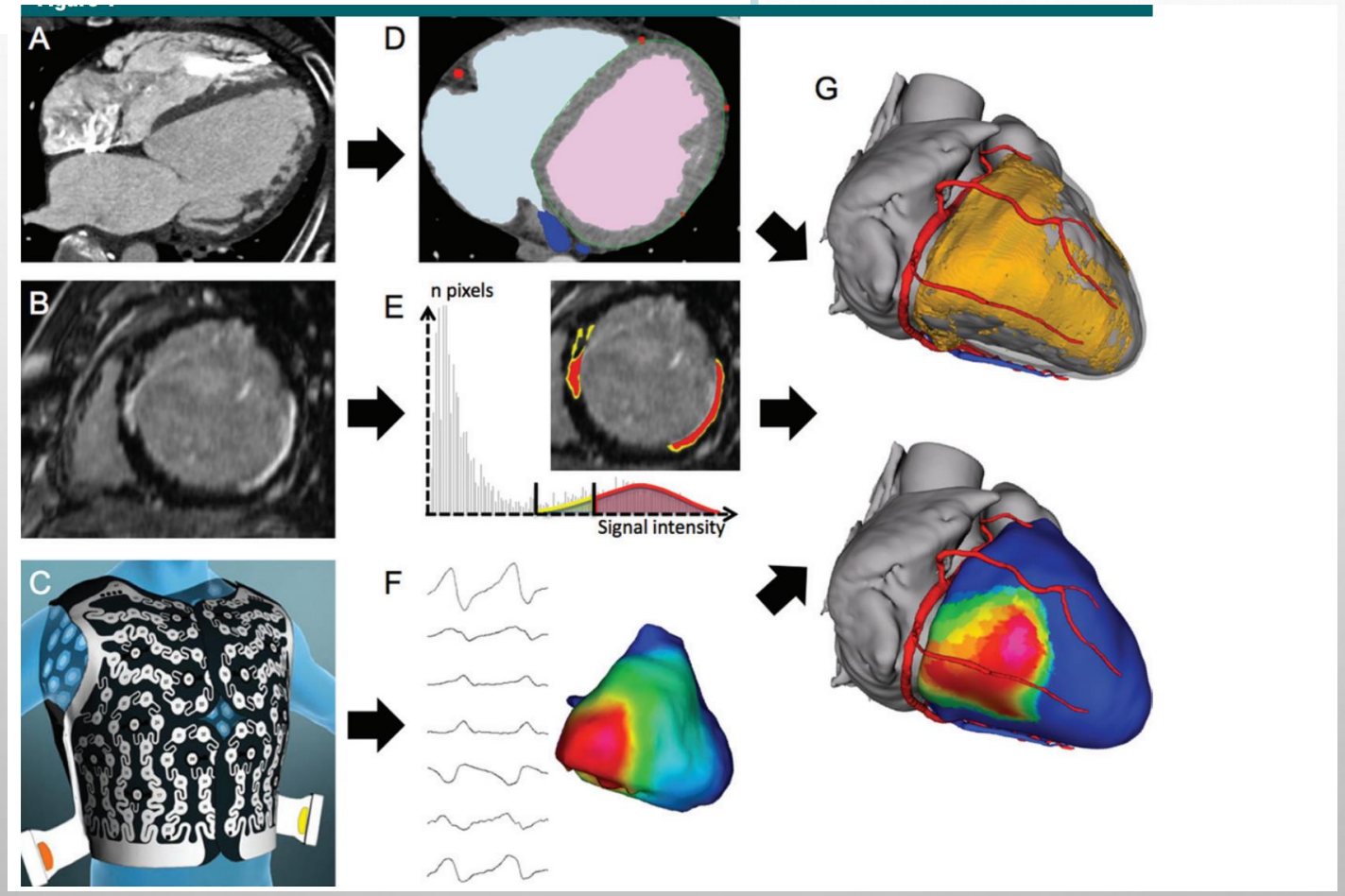
ПРЕДОПЕРАЦИОННАЯ ПОДГОТОВКА

Radiology

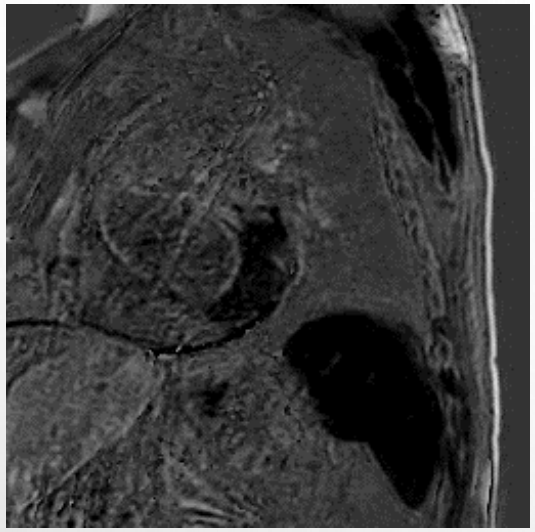
Cardiac Arrythmias: Multimodal Assessment Integrating Body Surface ECG Mapping into Cardiac Imaging[1]

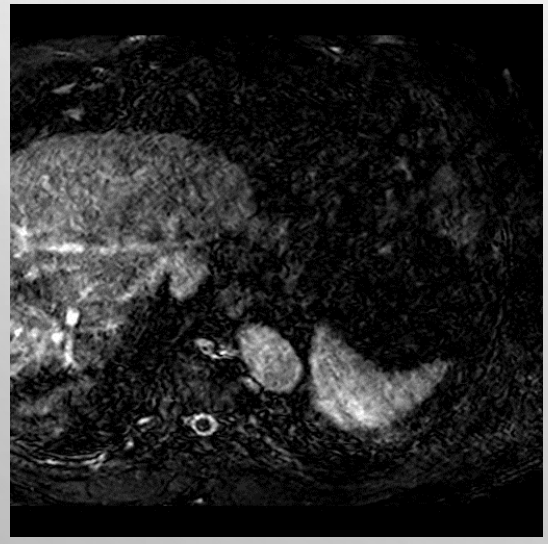
Hubert Cochet, MD
Rémi Dubois, PhD

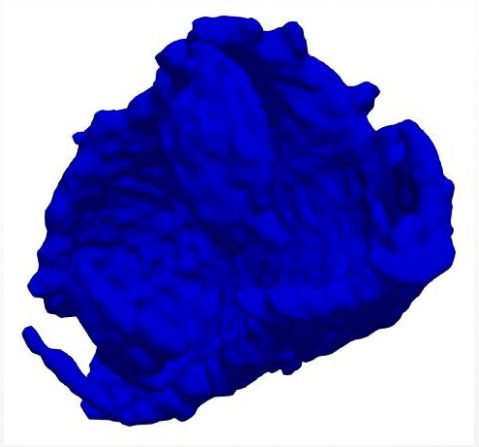
radiology.rsna.org ▪ **Radiology:** Volume 271: Number 1—April 2014

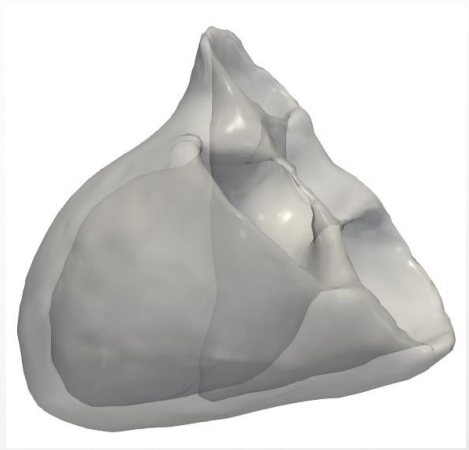


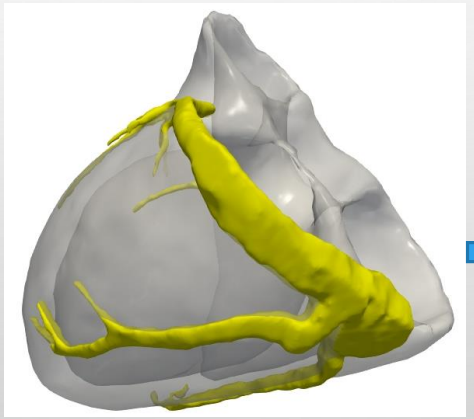
КАРТИРОВАНИЕ ФИБРОЗНЫХ ИЗМЕНЕНИЙ ЖЕЛУДОЧКОВ (CRT)











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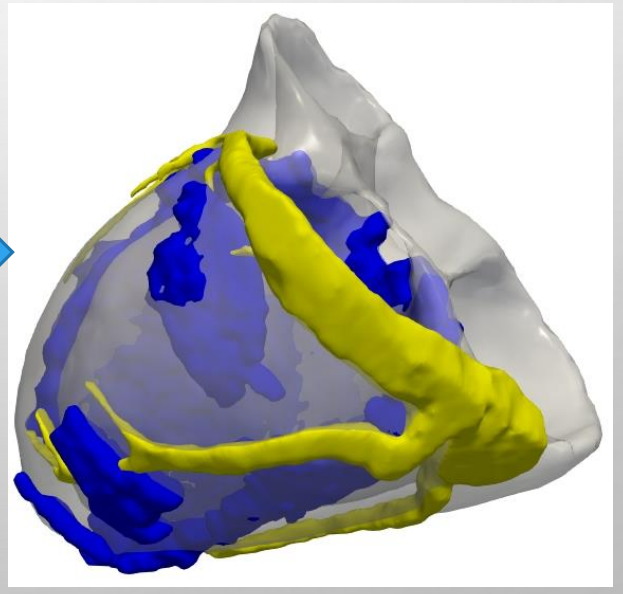

БЛАГОДАРЮ ЗА ВНИМАНИЕ!