CONGRESSO REGIONALE
CONGIUNTO SID-AMD
PIEMONTE | VALLE D'AOSTA 2023

CARDIOIMAGING NEL DIABETE MELLITO ASINTOMATICO

Alessandro Andreis, MD, PhD, GCSRT

SSD Ecocardiografia Avanzata Cardiovascolare
Dipartimento Cardiovascolare e Toracico
AOU Città della Salute e della Scienza di Torino

Disclosures

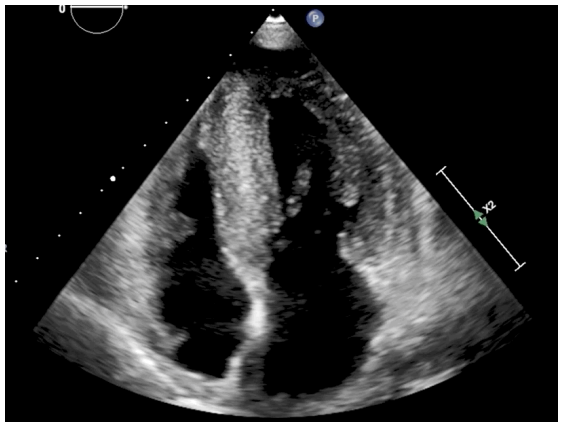
SOBI Srl (July 2021)

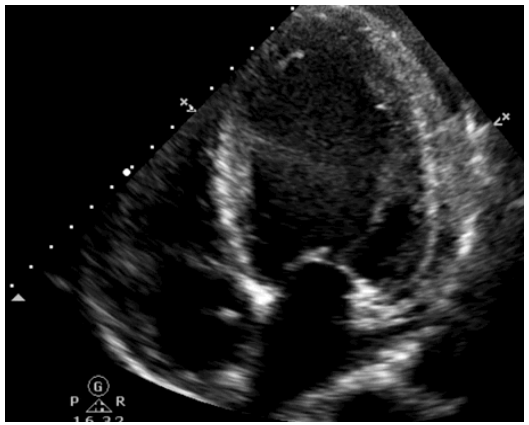
DIABETES

High prevalence: 1/10 worldwide (undiagnosed in > 1/3)
Increased risk (2-5 fold) of **Major CV events** (HF, AF/stroke, CAD)

Cardiac dysfunction

54% Diastolic Dysfunction (RR 3.74 for death)
17% Diabetic Cardiomyopathy (RR 5.06 for death)
(overt systolic dysfunction or at least moderate diastolic dysfunction)

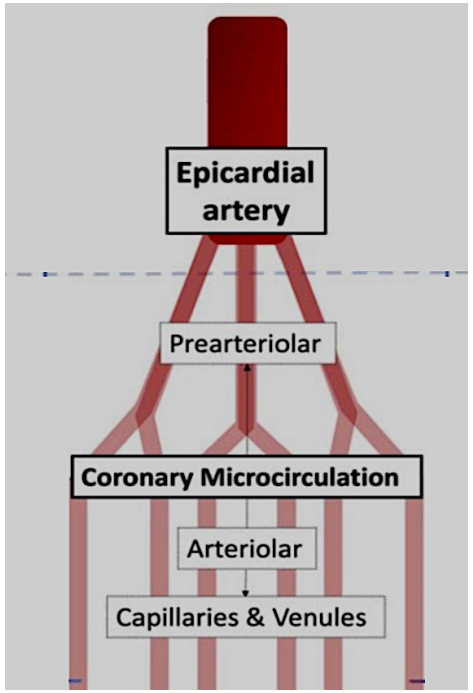




Myocardial ischemia (CAD / INOCA)

23% >moderate (>50%) **coronary artery stenosis**
20-58% perfusion defects on SPECT

What's the role of CARDIAC IMAGING in asymptomatic DM patients ?

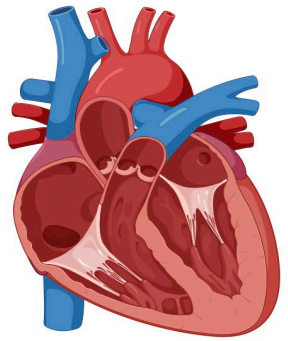


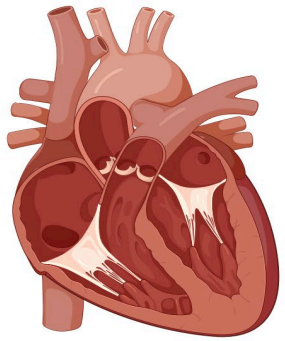
IDF Diabetes Atlas 2022 Reports; Dandamudi, J Card Fail 2014; Muhlestein JAMA 2014; From Am J Card 2009; Rajagopalan JACC 2005, Beagley J, et al. Diabetes Res Clin Pract 2014; Sarwar N, et al. Lancet 2010

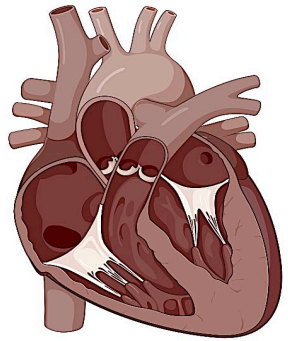
(1) Early identification of CARDIAC DYSFUNCTION

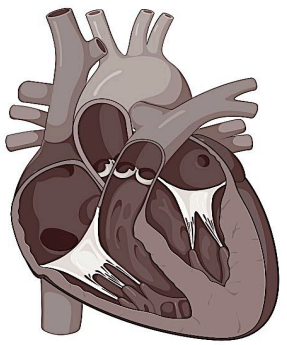
Pre-clinical stages

SYMPTOMS

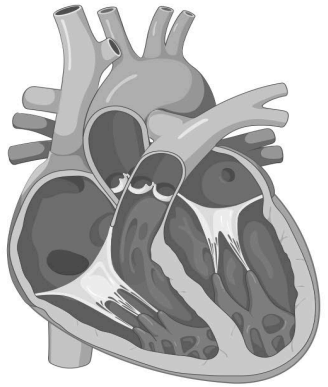








HFpEF

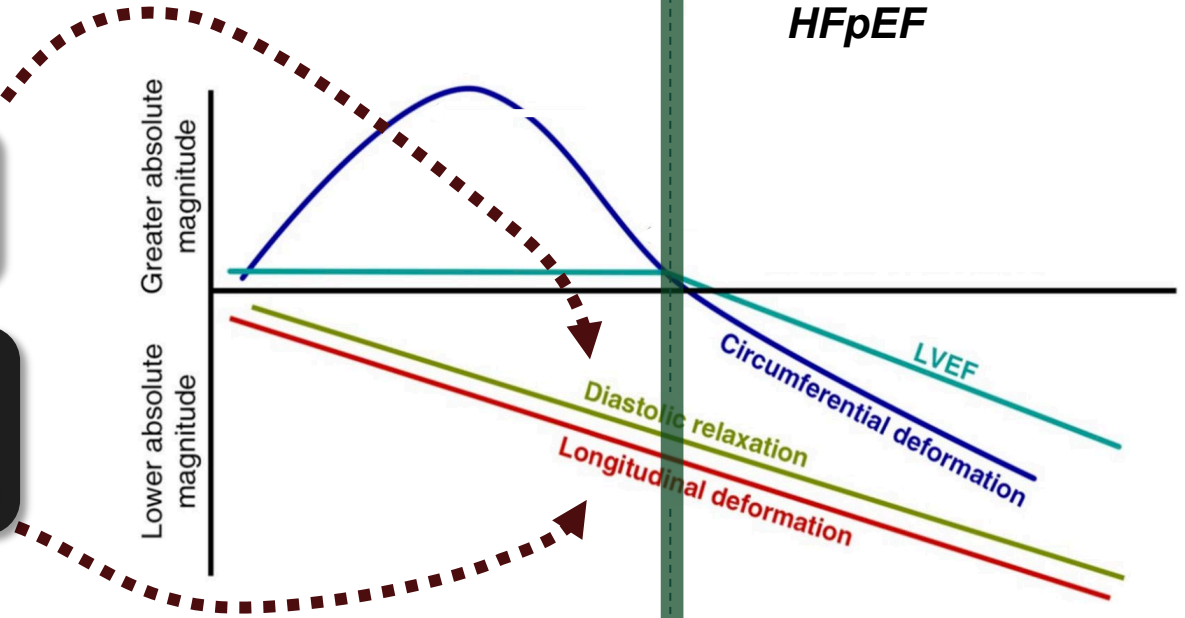


HFrEF

Early identification

Pre-clinical DIASTOLIC dysfunction

Pre-clinical SYSTOLIC dysfunction

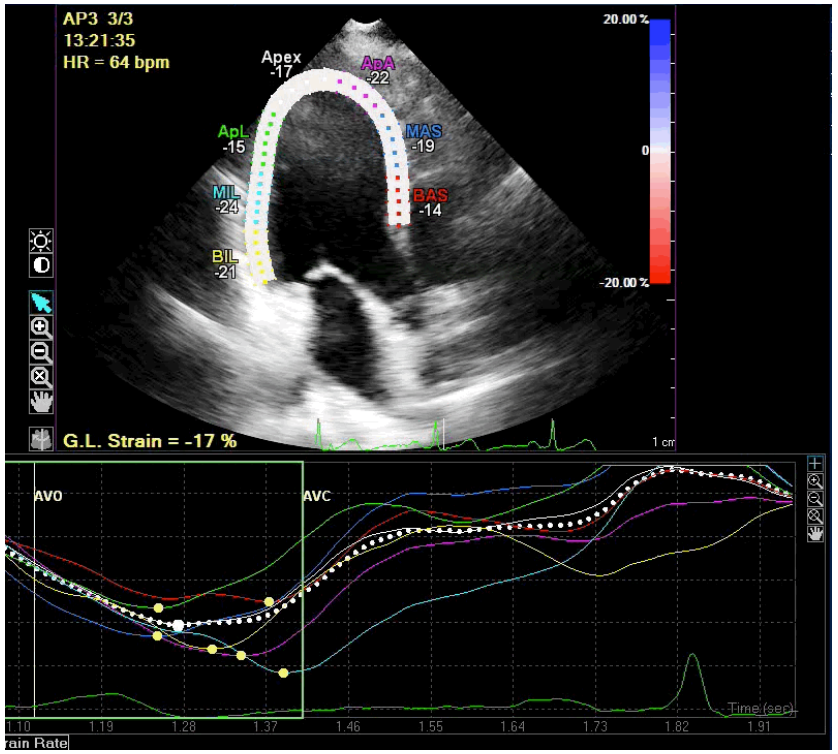


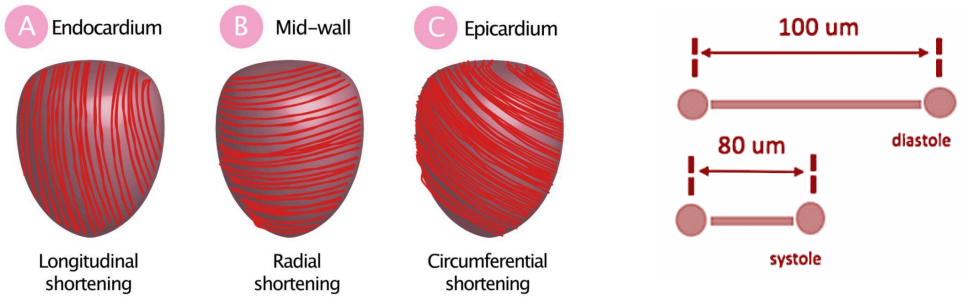
Progressive LV dysfunction

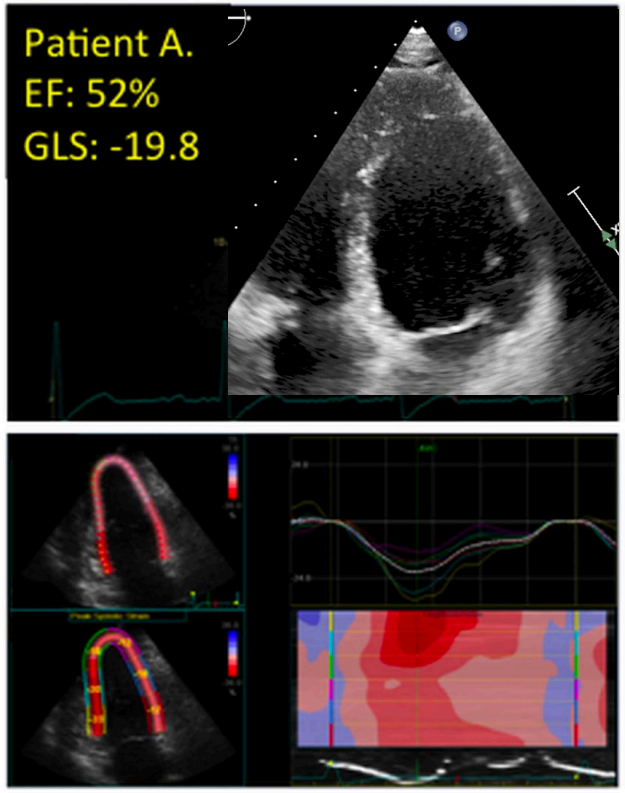
Voigt et al, JACC 2019; Cikes et al, EHJ 2016

(1) Early identification of CARDIAC DYSFUNCTION

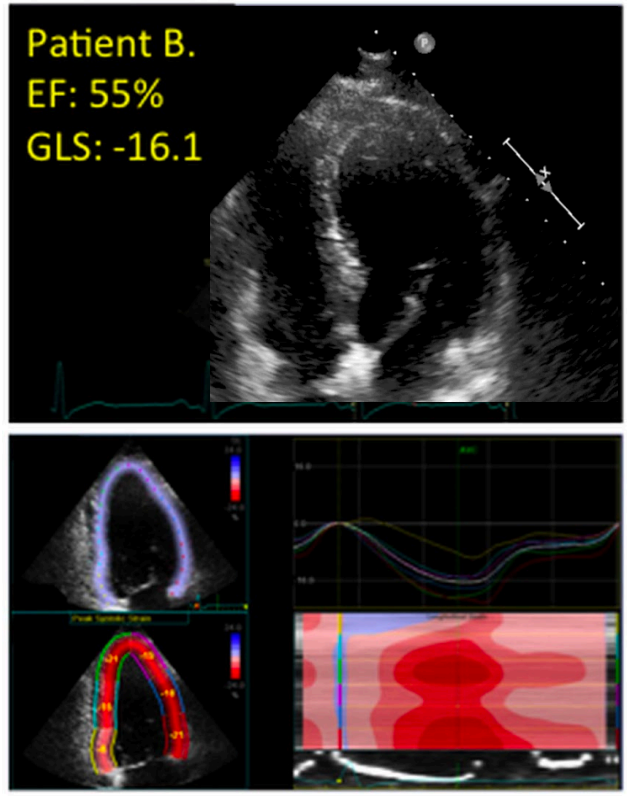
Speckle Tracking Echocardiography







Normal



Systolic dysfunction

Global Longitudinal Strain (GLS) vs. Ejection Fraction (EF)

- Higher **reproducibility** than Echocardiography (r=0.93 vs. cardiac magnetic resonance)
- Higher **prognostic value** for major CV events (AUC 0.82 vs. 0.72)

Voigt et al., JACC 2019; Cikes et al., EHJ 2016; Haugaa et al., JASE 2012

(1) Early identification of CARDIAC DYSFUNCTION

ORIGINAL ARTICLE

Subclinical LV dysfunction and 10-year outcomes in type 2 diabetes mellitus

David J Holland,[1,2,3] Thomas H Marwick,[4] Brian A Haluska,[1] Rodel Leano,[1]

236 asymptomatic DMT2 patients with normal EF (mean 66.3±6.9) assessed with speckle tracking echocardiography

Pre-clinical left ventricular dysfunction in **45%** (GLS < -18.9%)

Table 1 Clinical characteristics

	Normal (n=126)	LVD (n=104)	p Value
Clinical variables			
Age (years)	56±10	56±10	0.834
Male sex	56 (44%)	70 (67%)	0.001
Body mass index (kg/m^2)	31.7±6.0	31.9±5.5	0.844
Waist-to-hip ratio	0.94±0.08	0.97±0.09	0.004
Systolic BP (mm Hg)	130±13	132±14	0.228
Diastolic BP (mm Hg)	79±8	81±7	0.019
Aerobic capacity (METs)	6.4±2.0	6.3±1.9	0.943
Biochemical variables			
Total cholesterol (mmol/L)	4.82±1.09	4.88±0.95	0.663
eGFR (mL/min/1.73m^2)	114±36	120±45	0.316
Fasting glucose (mmol/L)	8.36±3.08	8.65±3.28	0.490
HbA_{1c} (%)	7.5±1.5	7.7±1.6	0.291
Echocardiography			
EF (%)	66.7±6.7	65.9±7.0	0.337
EDV (mL)	66.1±16.7	67.7±20.7	0.528
ESV (mL)	22.3±7.6	23.7±10.3	0.236
Left atrial area (cm^2)	18.5±3.6	18.9±4.0	0.503
LV mass index (g/m$^{2.7}$)	42±14	44±13	0.396
E (cm/s)	68.4±14.7	66.9±15.2	0.481
A (cm/s)	68.0±14.7	66.9±17.7	0.338
E/A	1.04±0.26	1.02±0.37	0.674
Sm (cm/s)	6.9±1.4	6.7±1.1	0.184
Em (cm/s)	6.5±1.6	6.0±1.7	0.049
E/Em	11.0±2.9	11.8±3.6	0.099
GLS (%)	−20.8±1.5	−16.6±1.9	<0.001
Strain rate (s^{-1})	−1.12±0.13	−0.98±0.13	<0.001
Medication use			
Use of metformin	72 (57%)	69 (66%)	0.191
Use of ACE inhibitors	40 (32%)	26 (25%)	0.231
Use of β-blockers	5 (4%)	4 (4%)	0.945

Data are mean±SD or n (%).
A, late diastolic transmitral flow; BP, blood pressure; E, early diastolic transmitral flow; EDV, end diastolic volume; eGFR, estimated glomerular filtration rate; Em, early diastolic tissue velocity; ESV, end systolic volume; GLS, global longitudinal strain; HbA_{1c}, glycosylated haemoglobin; LVD, LV dysfunction; METs, metabolic equivalents; Sm, systolic tissue velocity.

Holland, Heart 2015

(1) Early identification of CARDIAC DYSFUNCTION

Cardiac risk factors and prevention

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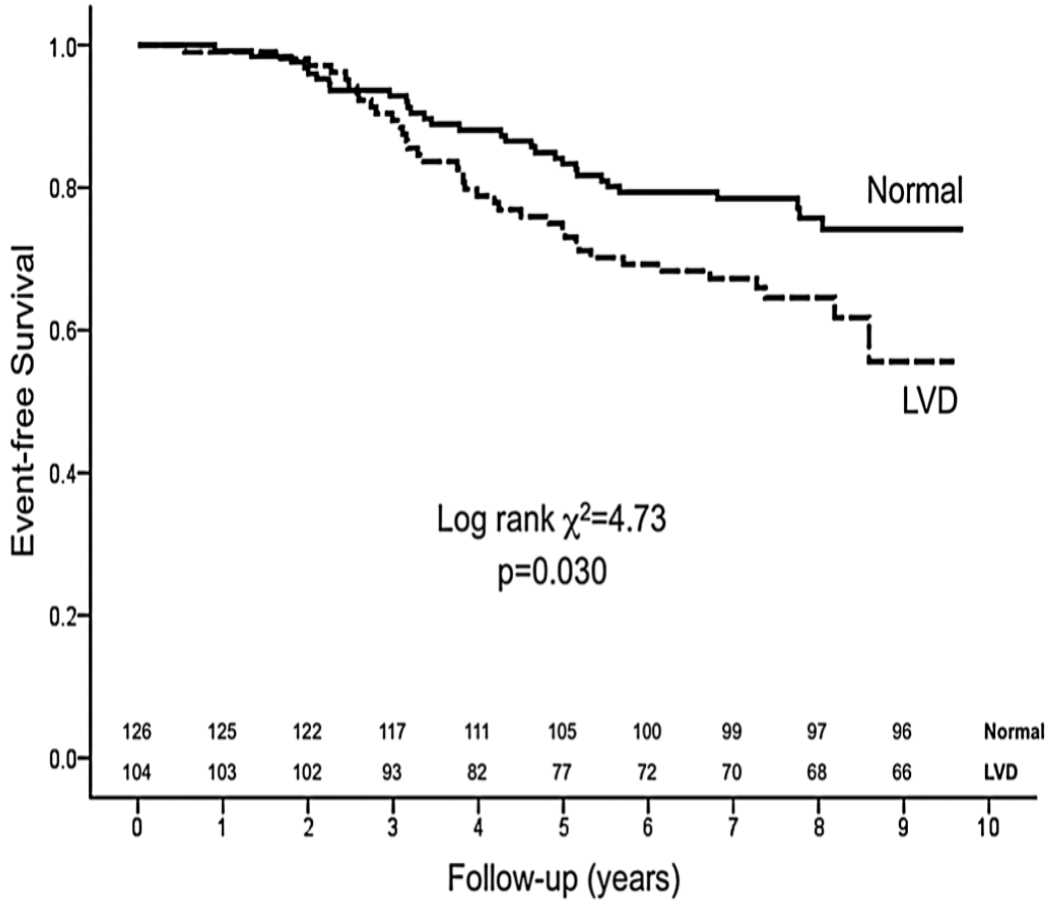
Pre-clinical left ventricular dysfunction in **45%** (GLS < -18.9%)

…increased risk of **all-cause mortality and hospitalization**

Table 2 Statistical predictors of the primary endpoint

	Univariate analysis		Multivariate analysis	
	HR (95% CI)	p Value	HR (95% CI)	p Value
Clinical				
Age	1.04 (1.01 to 1.07)	0.004*	1.04 (1.00 to 1.07)	0.025
Male sex	0.90 (0.56 to 1.46)	0.678		
Height (m)	0.98 (0.97 to 1.02)	0.824		
Weight (kg)	1.01 (1.00 to 1.02)	0.148		
Body mass index (kg/m^2)	1.03 (1.00 to 1.07)	0.083		
Systolic BP (mm Hg)				
Exercise capacity (METs)				
Biochemical				
Total cholesterol (mmol/L)				
eGFR (mL/min/1.73m^2)				
Fasting glucose (mmol/L)				
HbA_{1c} (%)				
Echocardiography				
EF (%)†				
GLS (%)				

*Multivariate analysis performe
†EF was not a significant indep
BP, blood pressure; eGFR, estim



Holland, Heart 2015

(1) Early identification of CARDIAC DYSFUNCTION

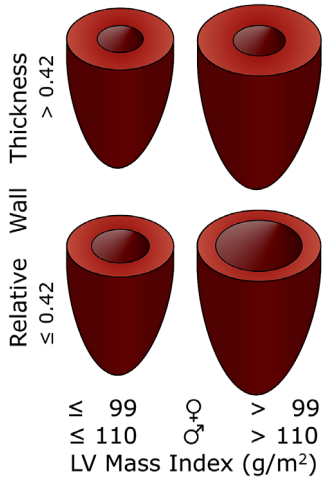
Longitudinal Myocardial Strain Alteration Is Associated with Left Ventricular Remodeling in Asymptomatic Patients with Type 2 Diabetes Mellitus

Laura Ernande, MD, PhD, Cyrille Bergerot, MD, Nicolas Girerd, MD, Hélène Thibault, MD, PhD,

172 asymptomatic DMT2 patients with normal EF (mean 70±7) assessed with speckle tracking echocardiography

Pre-clinical left ventricular dysfunction in **23%** (GLS < -18%)

…**associated with higher relative wall thickness and end-systolic volume**



Variable	Total population (*n* = 154)	Normal strain ($\|\varepsilon_L\| \geq 18\%$) (*n* = 118)	Altered strain ($\|\varepsilon_L\| < 18\%$) (*n* = 36)	*P**
Clinical characteristics				
Age (y)	58 ± 8	58 ± 8	57 ± 8	.51
Men	88 (57%)	60 (51%)	28 (78%)	.003
BMI (kg/m^2)	29.5 ± 4.4	29.1 ± 4.3	30.6 ± 4.9	.09
Diabetes duration (y)	13 ± 8	13 ± 8	13 ± 7	.84
Treated hypertension	80 (52%)	58 (49%)	22 (61%)	.11
Dyslipidemia	90 (58%)	71 (60%)	19 (53%)	.30
Current smokers	26 (17%)	18 (15%)	8 (22%)	.21
Peripheral artery disease	51 (33%)	39 (33%)	12 (33%)	.37
Retinopathy	33 (21%)	25 (21%)	8 (22%)	.48
Systolic blood pressure (mm Hg)	132 ± 16	131 ± 16	135 ± 18	.20
Heart rate (beats/min)	75 ± 11	74 ± 12	78 ± 10	.07
Medications				
Metformin	110 (71%)	87 (74%)	23 (64%)	.21
Sulfonylureas	64 (42%)	55 (47%)	9 (25%)	.02
Glitazones	33 (21%)	28 (24%)	5 (14%)	.17
Insulin	70 (45%)	50 (42%)	20 (56%)	.07
ACE inhibitors or ARBs	89 (58%)	61 (52%)	28 (78%)	.002
Statins	89 (58%)	69 (58%)	20 (56%)	.52
Antiplatelet agents	45 (29%)	32 (27%)	13 (36%)	.18
Biologic characteristics				
HbA_{1c} (%)	7.7 ± 1.3	7.8 ± 1.3	7.4 ± 1.4	.17
Triglycerides (mmol/L)	1.8 ± 1.4	1.8 ± 1.4	1.8 ± 1.4	.93
Total cholesterol (mmol/L)	4.7 ± 1.1	4.8 ± 1.1	4.5 ± 1.0	.17
eGFR (mL/min/1.73 m^2)	83 ± 19	83 ± 22	83 ± 19	.96
Microalbuminuria (mg/L)	24 (11–69)	18 (10–60)	42 (15–148)	.045
Echocardiographic characteristics				
LV dimensions				
Total LV wall thickness (mm)	20 ± 3	20 ± 3	21 ± 2	.12
LV mass index (g/m^2)	93 ± 18	92 ± 19	95 ± 17	.48
RWT	0.41 ± 0.07	0.40 ± 0.07	0.44 ± 0.06	.008
2D/speckle-tracking imaging				
LVEDV (mL)	79 ± 22	77 ± 20	85 ± 24	.08
LVEDVi (mL/m^2)	42 ± 10	79 ± 22	79 ± 22	.50
LVESV (mL)	24 ± 9	23 ± 9	28 ± 11	<.001
LVESVi (mL/m^2)	13 ± 5	12 ± 4	14 ± 5	.01
LVEF (%)	70 ± 7	71 ± 7	67 ± 7	.002
ε_L (%)	−19.8 ± 2.4	−20.8 ± 1.8	−17.7 ± 1.2	—
LV diastolic function				
E/A ratio	1.0 ± 0.2	1.0 ± 0.3	1.0 ± 0.2	.63
mDT (msec)	240 ± 54	240 ± 51	239 ± 61	.91
E/e′ ratio	9.7 ± 2.7	9.8 ± 2.8	9.3 ± 2.6	.32
LA volume (mL)	46 ± 13	45 ± 13	47 ± 14	.42

(1) Early identification of CARDIAC DYSFUNCTION

Longitudinal Myocardial Strain Alteration Is Associated with Left Ventricular Remodeling in Asymptomatic Patients with Type 2 Diabetes Mellitus

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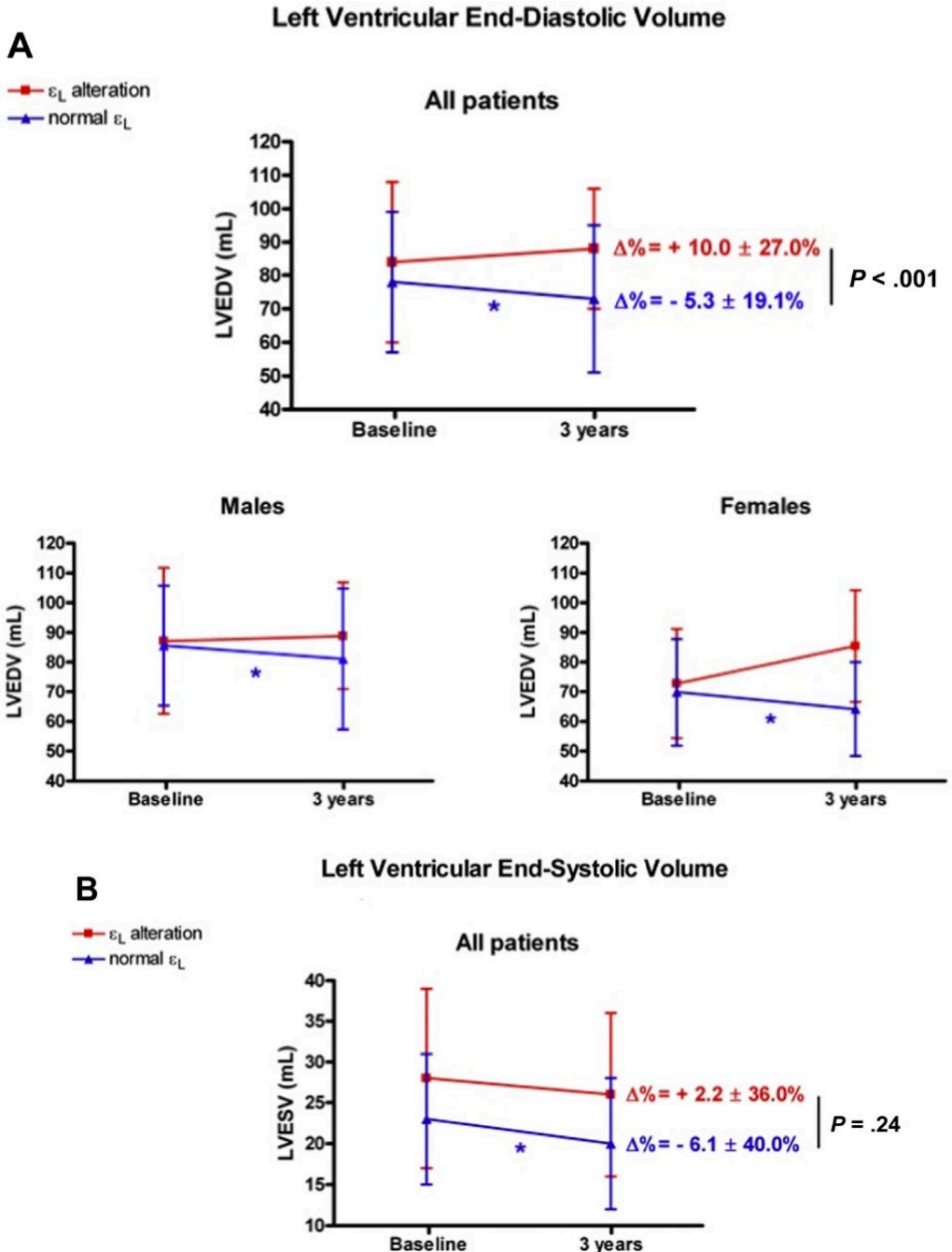
172 asymptomatic DMT2 patients with normal EF (mean 70±7) assessed with speckle tracking echocardiography

Pre-clinical left ventricular dysfunction in **23%** (GLS < -18%)

…**associated with higher relative wall thickness and end-systolic volume**

…**associated with adverse LV remodeling at 3 years**



(1) Early identification of CARDIAC DYSFUNCTION

The International Journal of Cardiovascular Imaging (2023) 39:977–989
https://doi.org/10.1007/s10554-023-02810-4

ORIGINAL PAPER

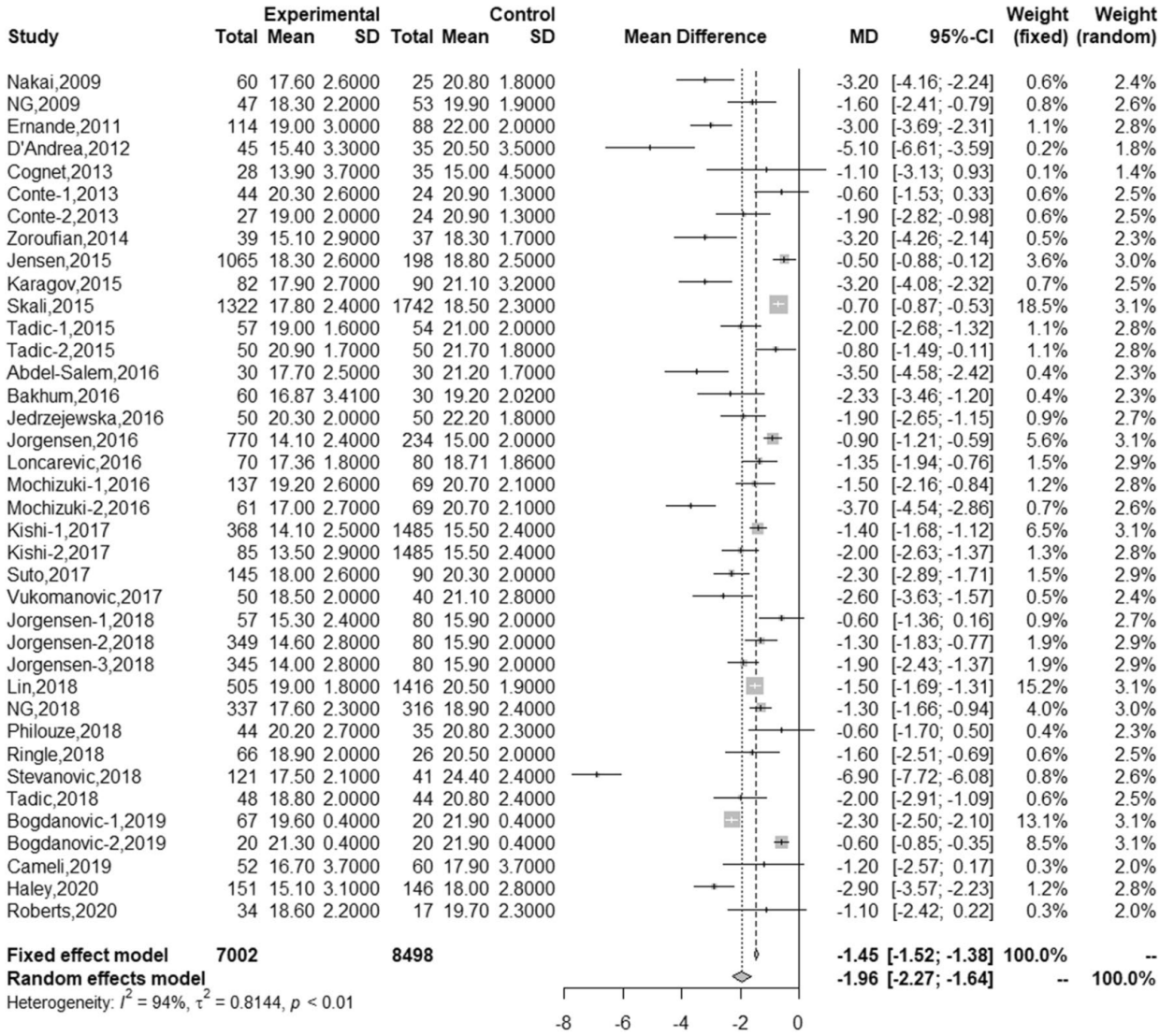
Subclinical systolic dysfunction detected by 2D speckle tracking echocardiography in adults with diabetes mellitus: systematic review and meta-analysis of 6668 individuals with diabetes mellitus and 7218 controls

Seyed-Mohammad Ghoreyshi-Hefzabad[1] · Prajith Jeyaprakash[1,2] · Ha Q. Vo[2,3] · Alpa Gupta[1] · Koya Ozawa[1] · Faraz Pathan[1,3] · Kazuaki Negishi[1,2,3,4]

6668 asymptomatic DM patients compared with 7218 controls, assessed with speckle tracking echocardiography

…lower LV strain, LA reservoir strain, RV strain

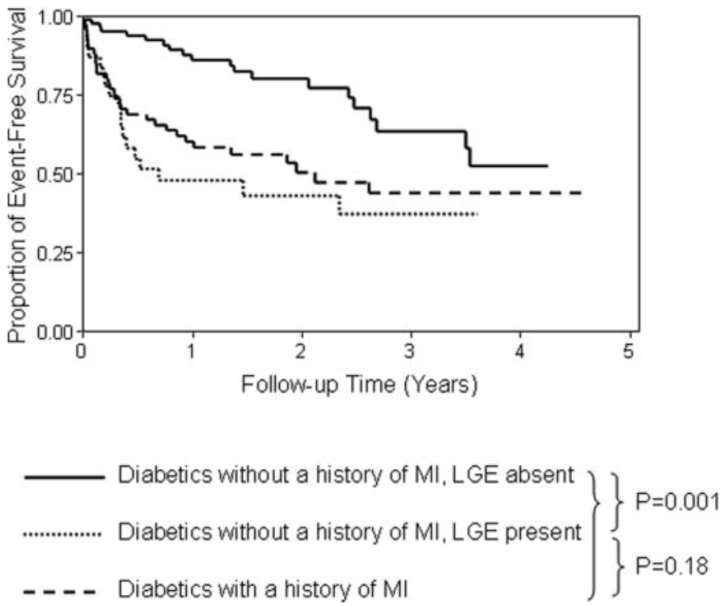
Strain variable	Studies (n)	DM (n)	Control (n)	Mean [95% CI] in DM	Mean [95% CI] in Control	MD [95% CI] Random Effects model
LVGLS	32	6114	6729	17.9 [17.1, 18.4]	19.8 [19.1, 20.5]	− 1.98 [− 2.46, − 1.51]
LVGCS	14	1626	3549	20.3 [18.6, 21.9]	21.3 [19.6, 22.9]	− 0.96 [− 1.48, − 0.45]
LVGRS	9	529	400	42.7 [39.7, 45.6]	47.0 [43.1, 50.9]	− 4.0 [− 5.50, − 2.52]
LVSR	13	1029	924	1.0 [0.9, 1.1]	1.1 [1.0, 1.2]	− 0.07[− 0.13, − 0.02]
LA reservoir strain	7	543	428	28.0 [24.4, 31.6]	36.5 [34.0, 39.0]	− 8.42[− 11.6, 5.25]
RVGLS	7	341	311	23.8 [20.1, 27.4]	26.0 [23.4, 28.6]	− 2.38 [− 4.67, − 0.09]

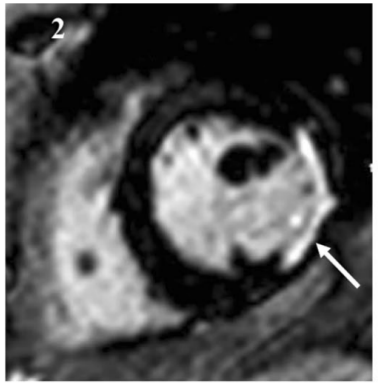


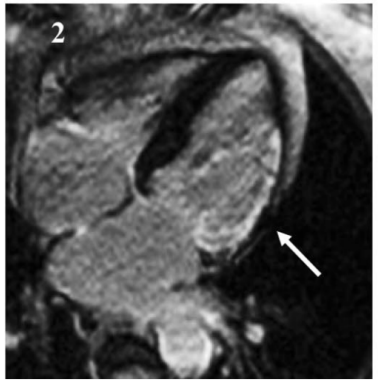
(1) Early identification of CARDIAC DYSFUNCTION

Cardiac Magnetic Resonance

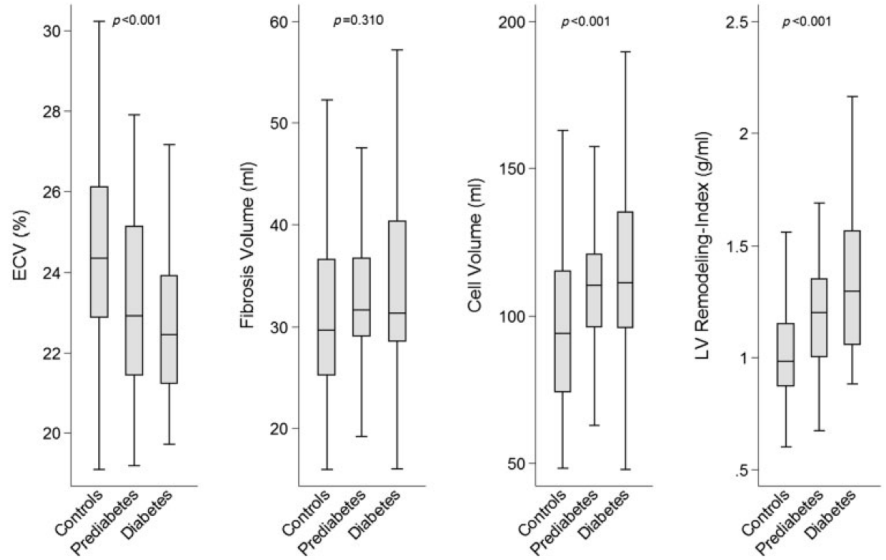
Focal fibrosis (ischemic LGE scar)
- observed in **28%** **asymptomatic DM patients** without clinical evidence of MI (normal ECG)
- associated with increased risk of **MACE (HR 4.13)** comparable with those with history of MI

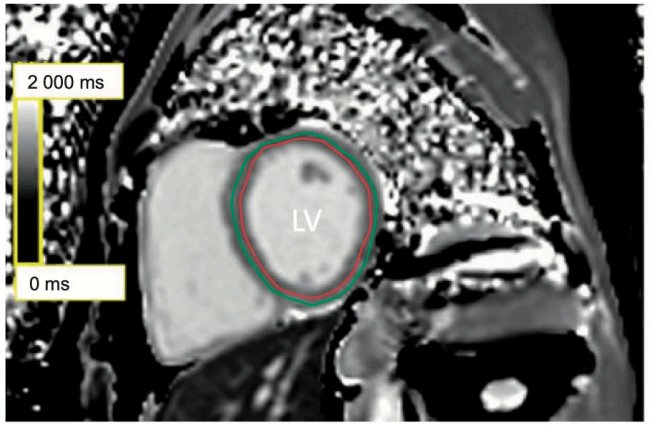


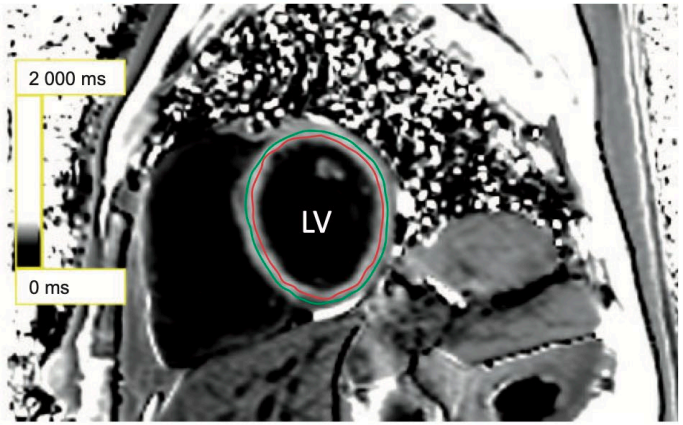




Diffuse fibrosis (T1 mapping, ECV)
- **decreased ECV in asymptomatic DM patients**, higher cell volume (consistent with early LV remodelling)





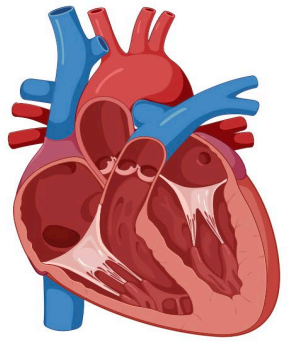


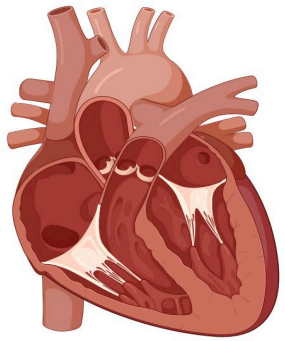
Kwong, Circulation 2008; Storz, EHJ 2018

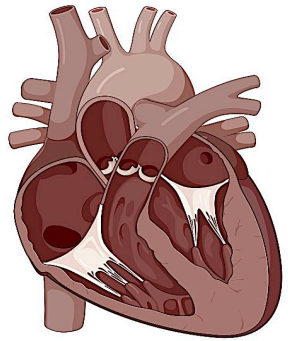
(1) Early identification of CARDIAC DYSFUNCTION

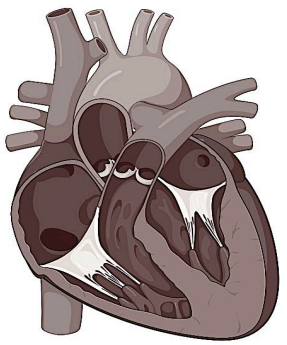
Pre-clinical stages

SYMPTOMS

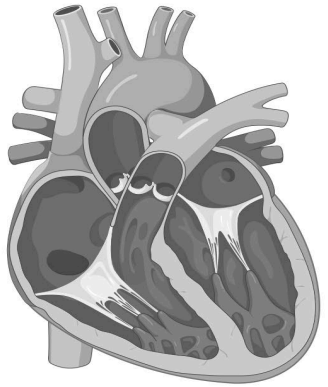








HFpEF

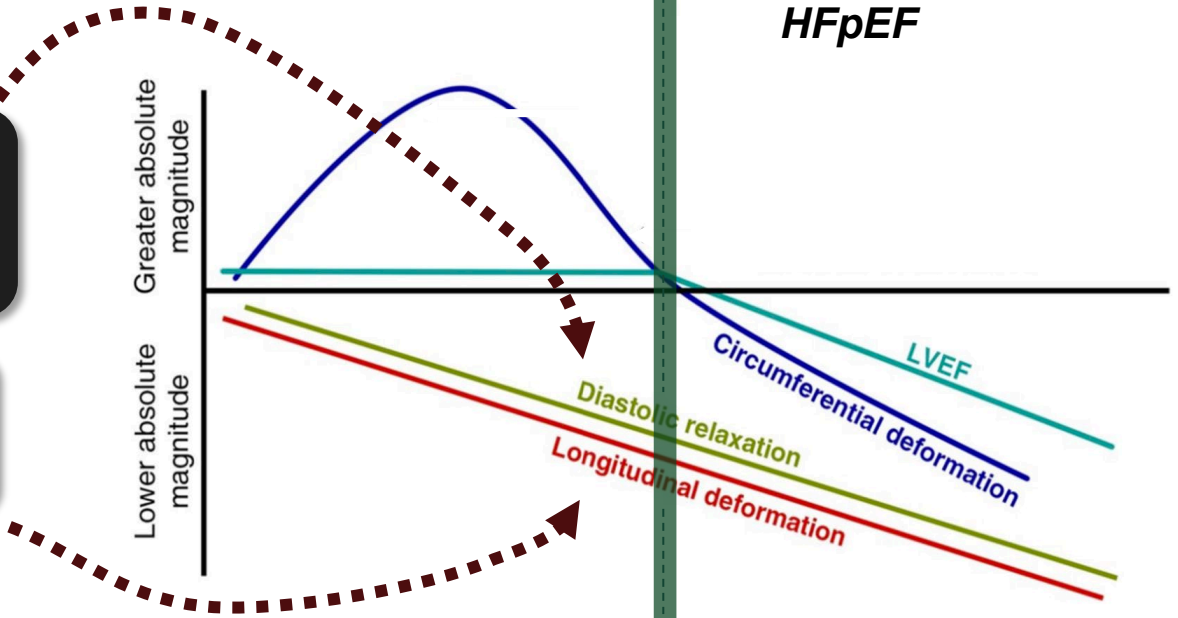


HFrEF

Early identification

Pre-clinical DIASTOLIC dysfunction

Pre-clinical SYSTOLIC dysfunction



Progressive LV dysfunction

Voigt et al, JACC 2019; Cikes et al, EHJ 2016

(1) Early identification of CARDIAC DYSFUNCTION

Stress-Echocardiography

ESC European Society of Cardiology

European Heart Journal - Cardiovascular Imaging (2020) **21**, 876–884
doi:10.1093/ehjci/jeaa070

Incremental value of diastolic stress test in identifying subclinical heart failure in patients with diabetes mellitus

Tomoko Nishi[1,2†], Yukari Kobayashi [1,2†*], Jeffrey W. Christle[1,3], Nicholas

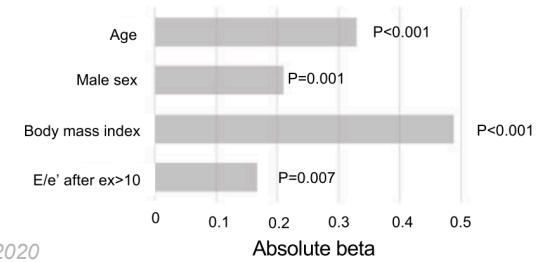
180 asymptomatic DMT2 patients assessed with stress-echocardiography

Diastolic dysfunction: at rest **45%**, after exercise → **57%**
… associated with **impaired exercise capacity** (lower exercise peak METs)

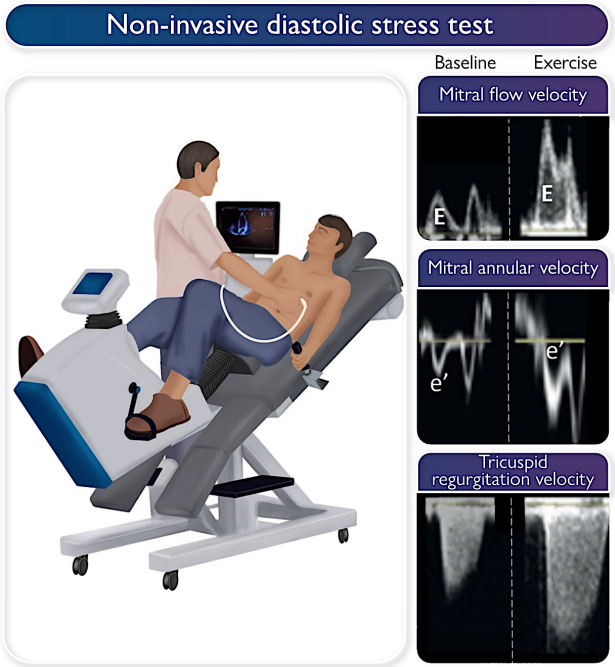
Table 3 **Baseline characteristics and echocardiographic parameters according to diastolic function**

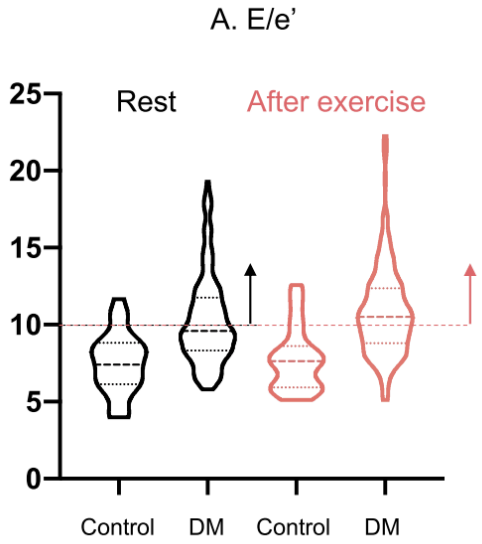
	Normal (*N* = 63)	Resting DD (*N* = 72)	Revealed DD (*N* = 26)	*P*-value
Peak METs	9.0 ± 2.6	7.3 ± 2.3*	7.3 ± 2.1*	<0.001
Percent-predicted METs (%)	105 ± 28	98 ± 29	91 ± 30	0.13
<85% ppMETs, *n* (%)	15 (26)	25 (37)	12 (52)	0.07

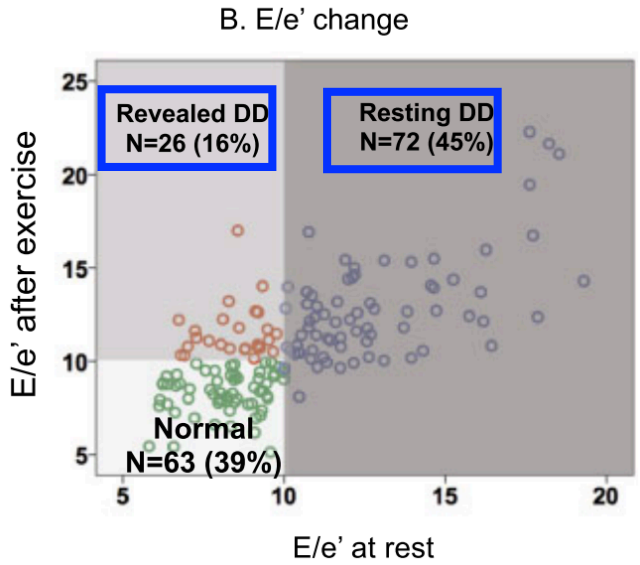
Associates of peak METs (R^2=0.46)



Nishi, EHJ Cardiovasc Imaging 2020; Won-Ha, JACC 2020

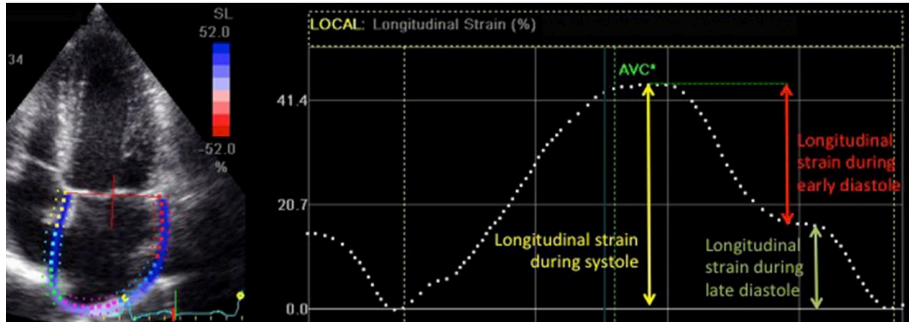


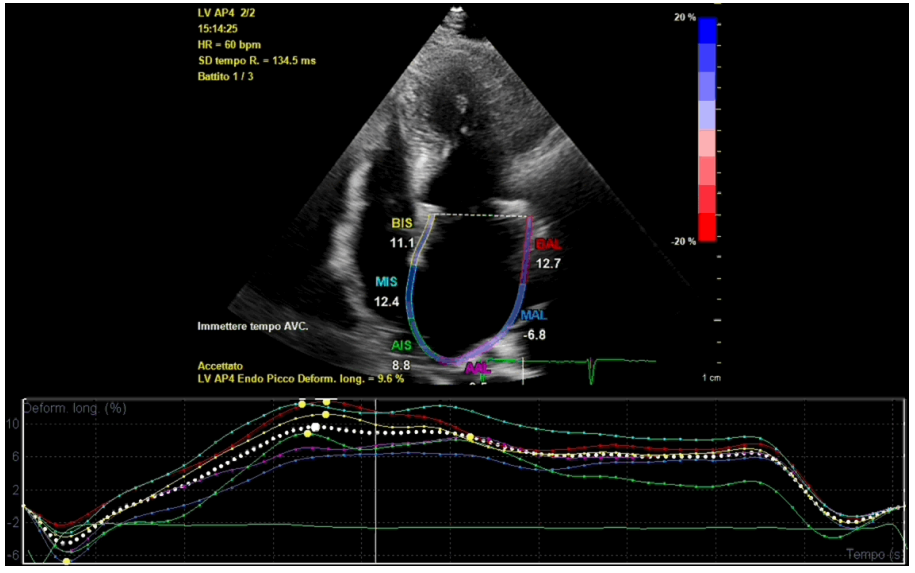




(1) Early identification of CARDIAC DYSFUNCTION

Left atrial deformation

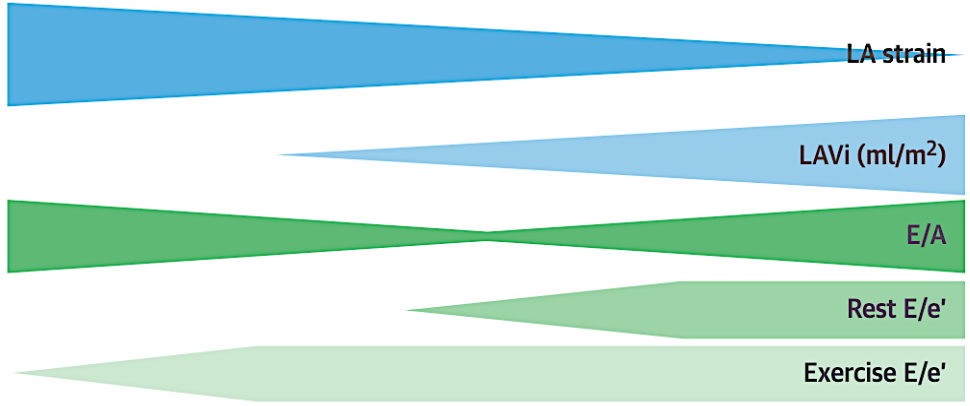




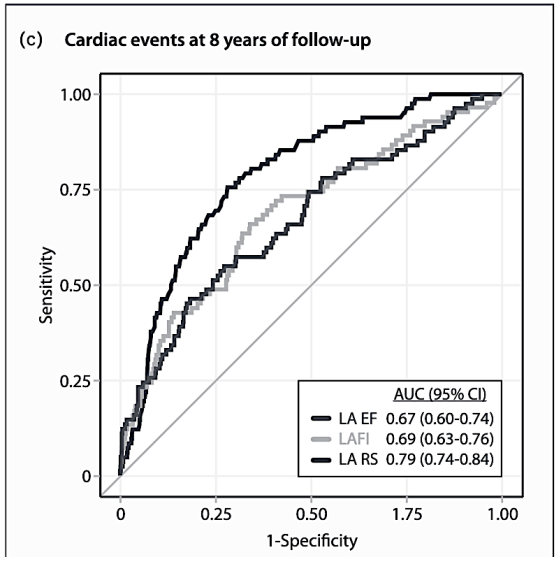
Left atrial deformation vs. traditional assessment of diastolic dysfunction

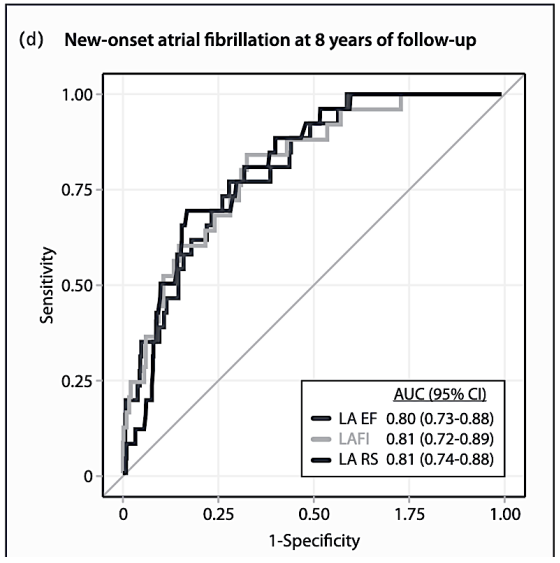
- More sensitive marker of early phases of DD, improved stratification of stage
- Independent predictor of all-cause mortality and hospitalization
- Independent predictor of CV events (HR 2.10) and Atrial Fibrillation (HR 6.45)

CENTRAL ILLUSTRATION Evolution of LV Diastolic Parameters With Increasing Disease Severity



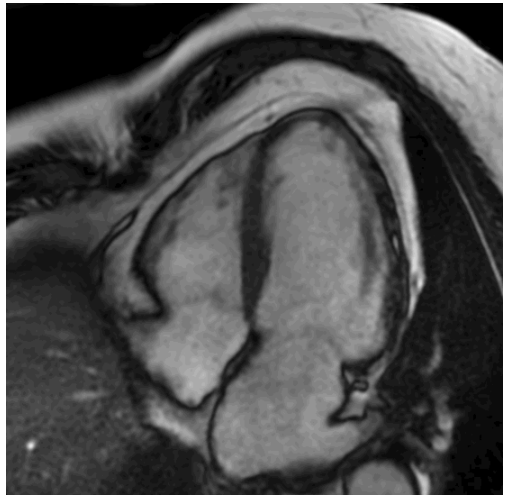
	Normal	Early St1	Late St1	Early St2	Late St2	Early St3	Late St3
LA strain	>35%	24-35%	24-35%	19-24%	19-24%	<19%	<19%
LAVi (ml/m²)	<34	<34	34-42	34-42	42-48	42-48	>48
E/A	0.8-1.5	<0.8	<0.8	0.8-1.5	0.8-1.5	>1.5	>1.5
Rest E/e'	<10	<10	<10	10-15	>15	>15	>15
Exercise E/e'	<12	<12	>12	>12	>12	>12	>12





Thomas, JACC 2019; Jia, Frontiers 2022; Cameli, AJC 2012

(1) Early identification of CARDIAC DYSFUNCTION



536 asymptomatic DM patients, assessed with cardiac magnetic resonance

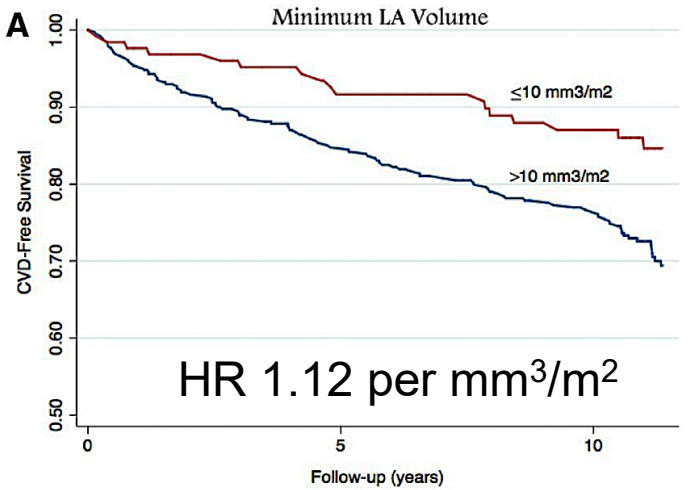
Left atrial size and function impairment associated with incident CV events (Heart Failure, Myocardial infarction, Atrial Fibrillation, Stroke)

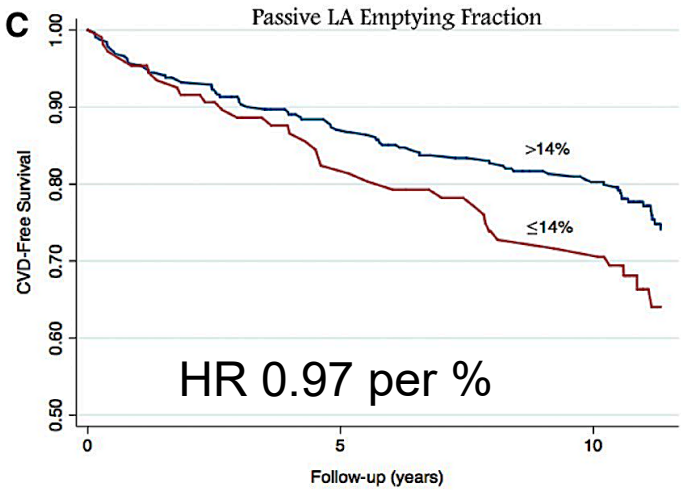
Impact of LA EDVi stronger than ESVi

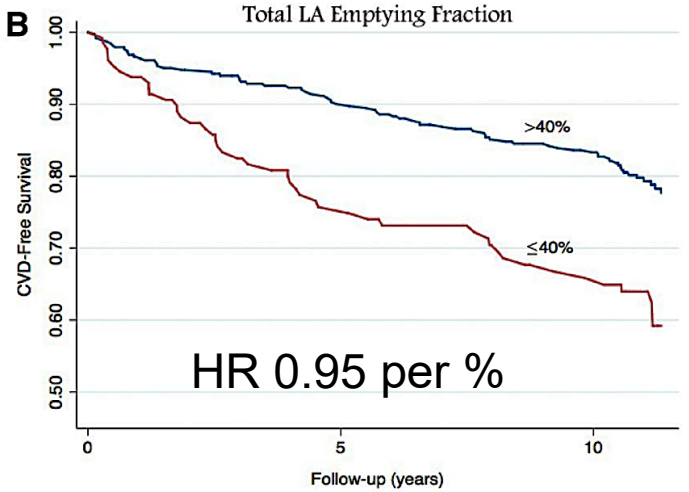
ESC European Society of Cardiology
European Heart Journal - Cardiovascular Imaging (2017) **18**, 1138–1144
doi:10.1093/ehjci/jew332

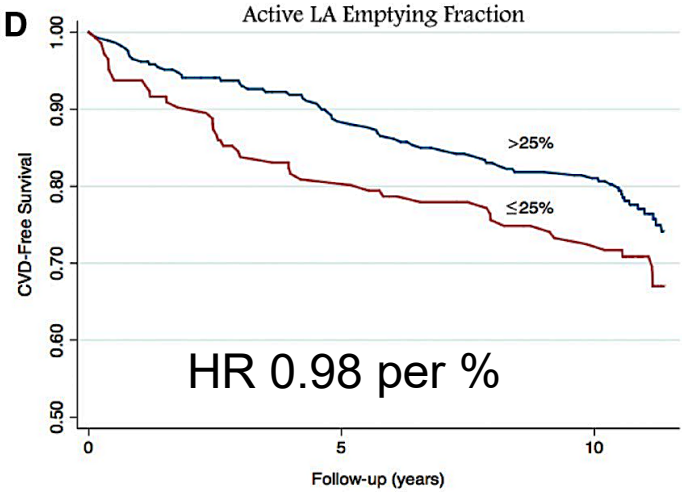
Association of left atrial structure and function and incident cardiovascular disease in patients with diabetes mellitus: results from multi-ethnic study of atherosclerosis (MESA)

Timothy M. Markman[1], Mohammadali Habibi[2], Bharath Ambale Venkatesh[3],









Merkman, EHJ Cardiovasc Img 2017

Early identification of DIASTOLIC dysfunction

Open Access Full Text Article

ORIGINAL RESEARCH

Increased Left Atrial Stiffness is Significantly Associated with Paroxysmal Atrial Fibrillation in Diabetic Patients

Diana-Aurora Arnautu [1,2], Sergiu-Florin Arnautu [1,3], Mirela-Cleopatra Tomescu [1,3],

60 DM patients (50% with paroxysmal atrial fibrillation), assessed with speckle-tracking echocardiography

LA stiffness (E/A ratio / LA reservoir) **had strongest association with paroxysmal atrial fibrillation** (OR=5.2)

Parameter	Univariate Analysis OR (95% CI)	P value	Multivariate Analysis OR (95% CI)	P value
LAS	0.73 (0.56–0.96)	0.02	0.58 (0.37–0.92)	0.02
LA-pool strain	0.78 (0.64–0.94)	<0.01	0.74 (0.58–1.95)	0.018
LA- pump strain	0.78 (0.64–0.94)	<0.01	0.68 (0.50–0.94)	0.019
LAsf	0.73 (0.56–0.96)	0.01	5.2 (4.05–7.17)	0.007

Abbreviations: OR, Odds ratio; CI, confidence interval; LAS, left atrial global strain; LAsf, left atrial stiffness.

Table 2 Echocardiography Parameters in Diabetic Patients

	Diabetes with PAF n = 30	Diabetes without PAF n = 30	P value
LVEDV (mL)	97.8±21.0	102.5±17.9	0.34
LVESD (mL)	46.1 ± 10.2	49.3±12.6	0.28
LVMI (g/m2)	143 ± 41	139 ± 35	0.68
LVEF (%)	57 ± 2	60 ± 14	0.25
Mitral E/A-ratio	1.3 ± 0.4	1.2 ± 0.2	0.22
Septal E/E´ average ratio	13.9 ± 4.2	13.1 ± 3.6	0.43
TAPSE (cm)	2.5 ± 0.43	2.4 ± 0.49	0.40
GLS (%)	−14.4 ± 3.1	−15.2 ± 3.2	0.32
LAVI (mL/m2)	42.1 ± 9.3	43.5 ± 10.3	0.58
LAEF (%)	47.7 ± 4.7	49.7 ± 5.9	0.15
LA global strain (%)	14.9 ± 1.9	16.8 ± 2.5	<0.01
LA-pool strain (%)	20.0 ± 4.3	23.8 ± 3.6	<0.001
LA- pump strain (%)	9.6 ± 3.0	12.3 ± 3.4	<0.01
LAsf (%)	0.42±0.09	0.35±0.11	0.02

Abbreviations: LVEDV, left ventricular end diastolic volume; LVESV, left ventricular end systolic volumes; LVEF, left ventricular ejection fraction; LVMI, left ventricular mass index; E, peak transmitral early diastolic inflow; A, peak transmitral late diastolic inflow; TAPSE, tricuspid annular plane systolic excursion, GLS, global longitudinal strain, LA, left atrium; LAVI, indexed left atrial volume; LAEF, left atrial total emptying fraction; LAsf, left atrial stiffness.

(1) Early identification of CARDIAC DYSFUNCTION

3D-Echocardiography

Contents lists available at ScienceDirect

Journal of Diabetes and Its Complications

journal homepage: www.elsevier.com/locate/jdiacomp

Diabetic microvascular complications are associated with left atrial structural alterations in asymptomatic type 2 diabetes patients: A cross-sectional study☆

Mingxia Gong [a], Min Xu [a,*], Jun Meng [a], Shu Jiang [a], Xiaohong Jiang [b]

319 asymptomatic DM patients, assessed with 3D echocardiography with semi-automatic quantification of LA volume over time

LA size (LAVi min and LAVIpre) associated with no. of microvascular complications

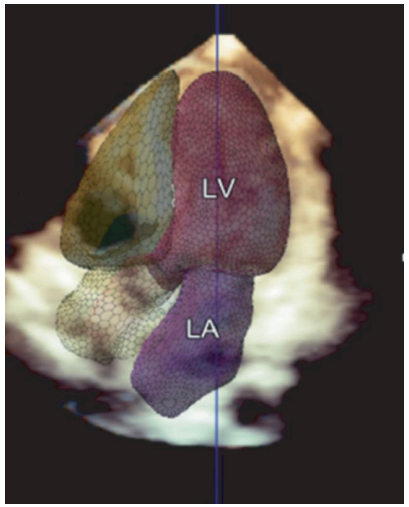
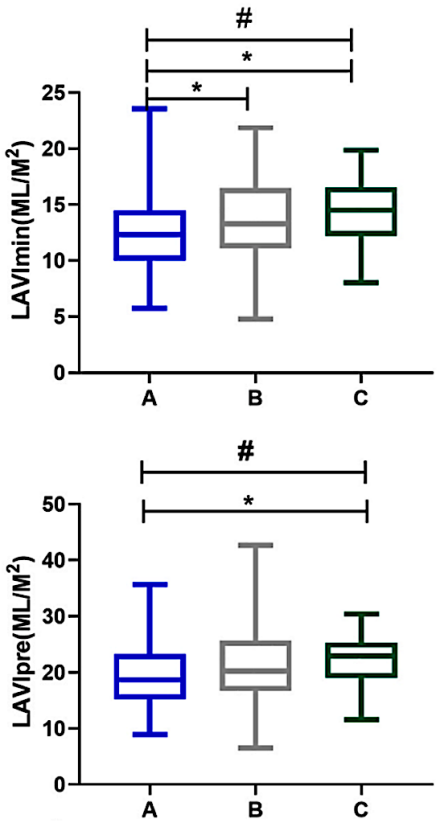


Table 2
Characteristics of echocardiographic parameters grouped by microvascular complications in 279patients.

Group by number of microvascular complications	Group A (n = 144)	Group B (n = 96)	Group C (n = 39)	*P*-value
LVDd (mm)	47.2 ± 4.0	47.2 ± 3.6	46.2 ± 3.8	0.364
LVSd (mm)	30.8 ± 3.1	30.8 ± 2.8	30.4 ± 2.8	0.770
IVSD (mm)	10.4 ± 1.2	10.8 ± 1.5	11.4 ± 2.0	0.445
PWD (mm)	10.3 ± 1.0	10.6 ± 1.2	11.1 ± 1.7	0.307
LVEF (%)	63.8 ± 2.5	63.5 ± 3.3	63.5 ± 2.5	0.615
GLS	−17.25 ± 2.57	−16.74 ± 2.46	−16.54 ± 2.49	0.293
E (cm/s)	69.9 ± 15.2	66.9 ± 14.7	72.9 ± 16.8	0.089
A (cm/s)	91.1 ± 16.3	89.8 ± 13.9	90.2 ± 14.7	0.797
E/A	0.8 ± 0.2	0.7 ± 0.1	0.8 ± 0.2	0.085
e′ septal (cm/s)	6.3 ± 1.9	5.9 ± 1.8	5.7 ± 1.2	0.094
e′ lateral (cm/s)	7.9 ± 2.1	7.8 ± 2.4	7.7 ± 1.8	0.796
E/e′	9.9 ± 3.4	10.1 ± 3.4	10.8 ± 2.5	0.310
LAVImin (ml/m^2)	12.5 ± 3.6	13.7 ± 3.9	14.5 ± 3.1	0.004
LAVImax (ml/m^2)	26.4 ± 7.0	28.8 ± 8.4	29.2 ± 5.9	0.047
LAVIpre (ml/m^2)	19.6 ± 5.9	21.2 ± 6.5	22.2 ± 4.5	0.022



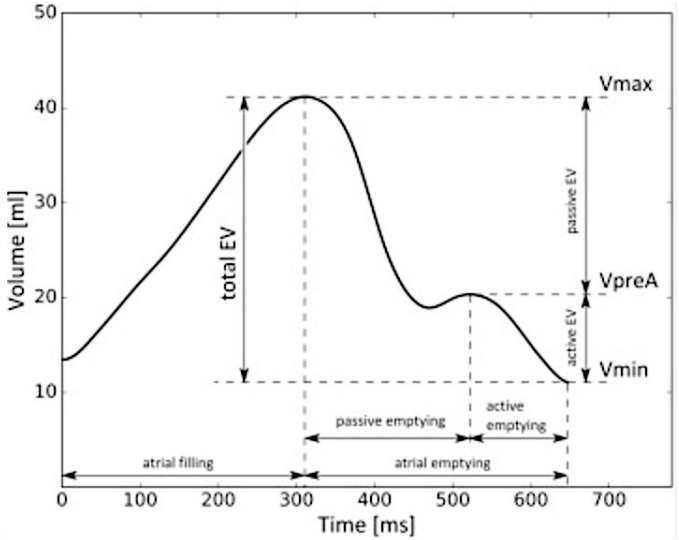


Fig. 2. Distribution of echocardiographic parameters in diabetes geometries by microvascular complications.
A: No microvascular complications; B: 1 microvascular complication; C: 2–3 microvascular complications.

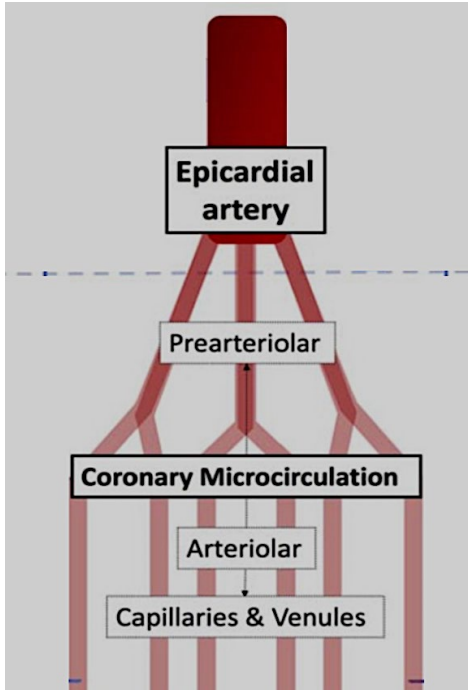
Gong, Journal of Diabetes, 2023; Spitzer, CFR 2017; Linden, JASE 2019

DIABETES

High prevalence: 1/10 worldwide (undiagnosed in > 1/3)

Increased risk (2-5 fold) of **Major CV events** (HF, AF/stroke, CAD)

Myocardial ischemia (CAD / INOCA)



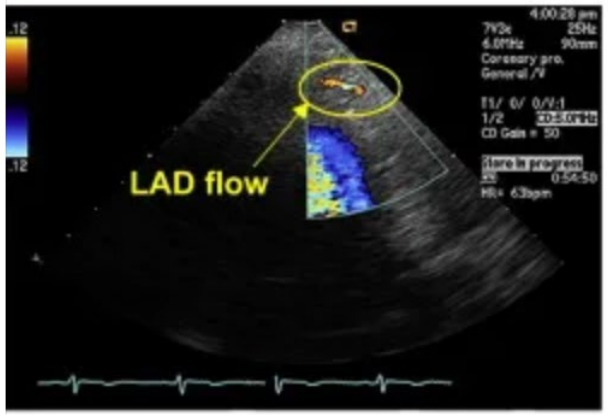
IDF Diabetes Atlas 2022 Reports; Dandamudi, J Card Fail 2014; Muhlestein JAMA 2014; From Am J Card 2009; Rajagopalan JACC 2005, Beagley J, et al. Diabetes Res Clin Pract 2014; Sarwar N, et al. Lancet 2010

(2) Early identification of MYOCARDIAL ISCHEMIA

Stress-Echocardiography

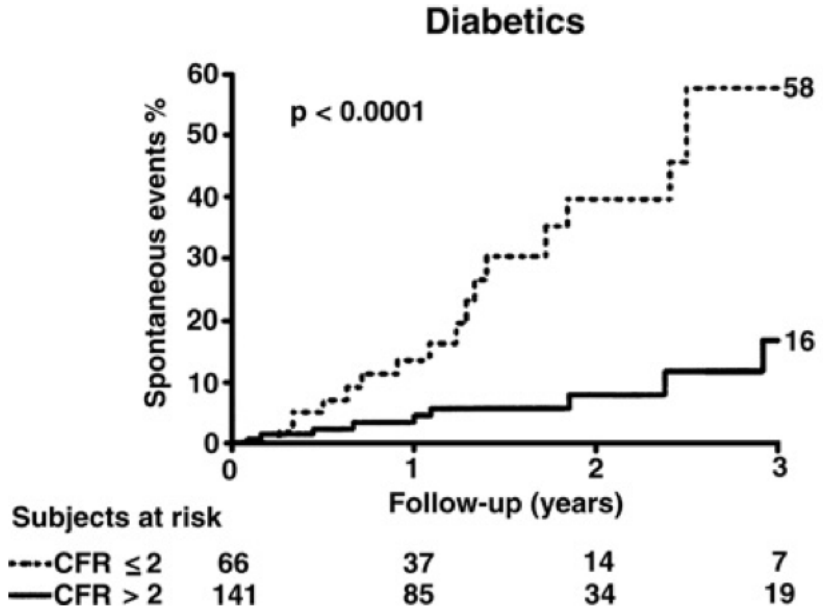
Abnormal coronary flow reserve (≤2) present in **27%** DM patients (and negative stress-echocardiography)

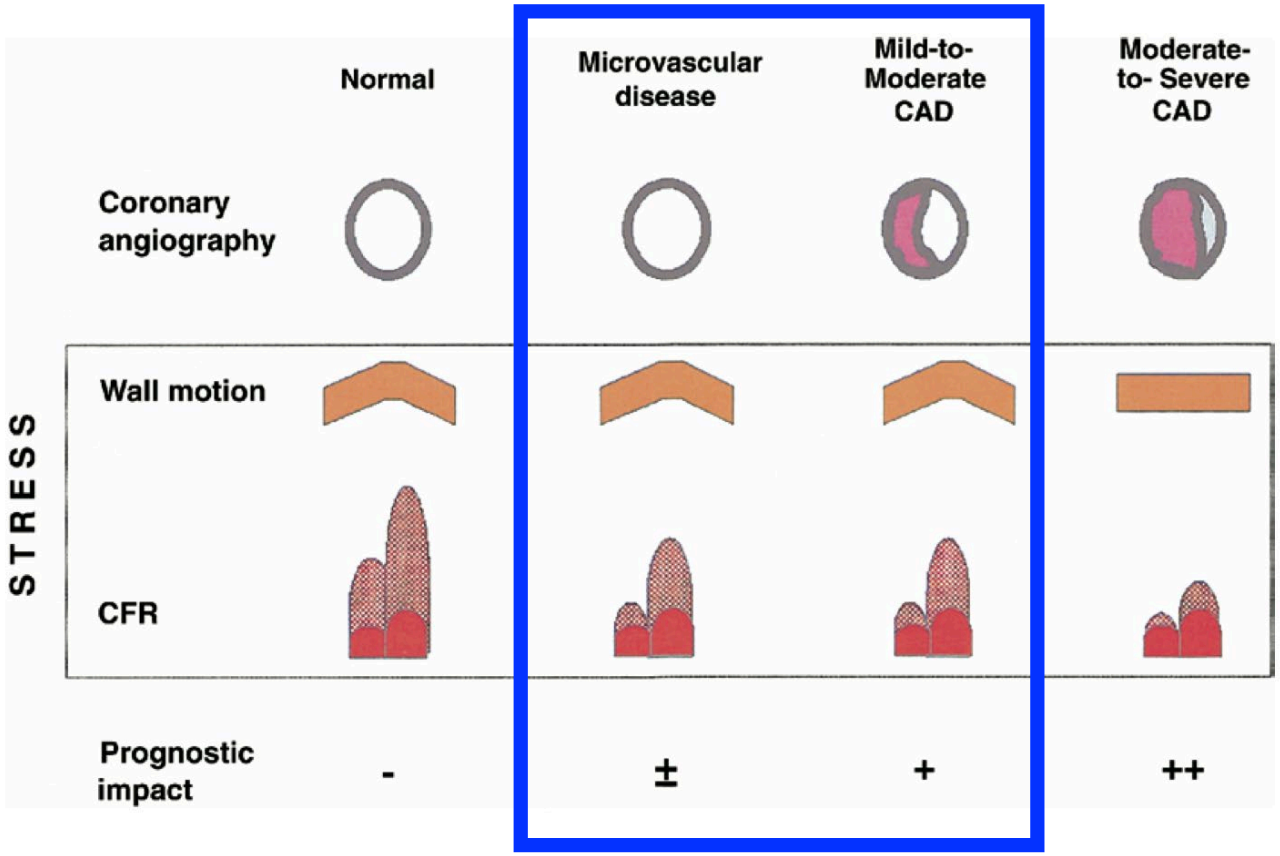
..associated with **increased risk of MACE** (**HR 1.50**, 95% CI 1-2.25)



Additional Prognostic Value of Coronary Flow Reserve in Diabetic and Nondiabetic Patients With Negative Dipyridamole Stress Echocardiography by Wall Motion Criteria

Lauro Cortigiani, MD,* Fausto Rigo, MD, FESC,† Sonia Gherardi, MD,‡





(2) Early identification of MYOCARDIAL ISCHEMIA

Computed Tomography

Original Article

J Atheroscler Thromb, 2021; 28: 1052-1062. http://doi.org/10.5551/jat.59386

Coronary Artery Calcium Score Predicts Long-Term Cardiovascular Outcomes in Asymptomatic Patients with Type 2 Diabetes

Meng-Huan Lei[1], Yu-Lin Wu[2], Sheng-Liang Chung[1], Chao-Chin Chen[1], Wei-Cheng Chen[1] and Yu-Chen Hsu[1]

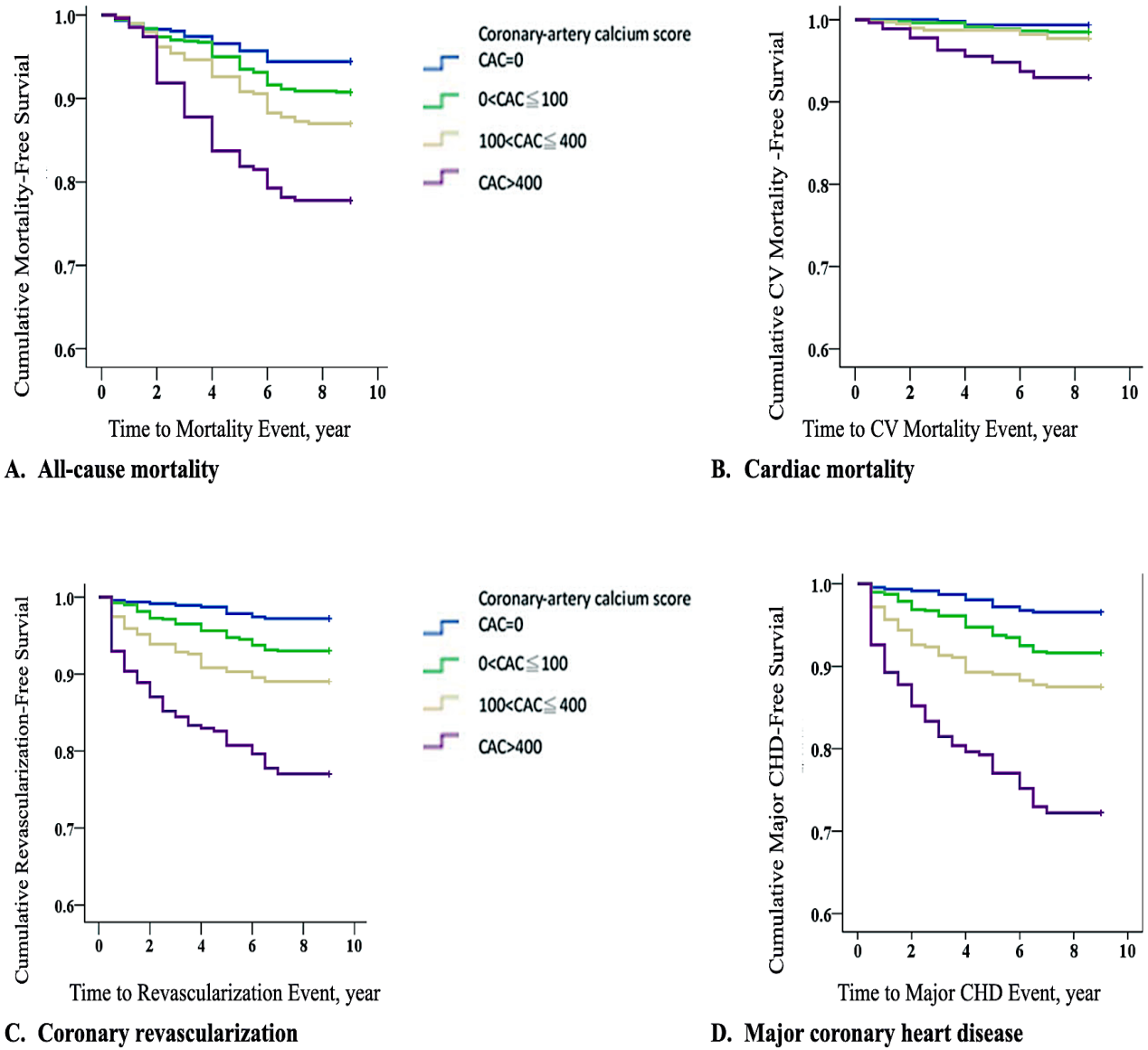
2162 asymptomatic DMT2 patients assessed with CT coronary calcium score scan
(low radiation 1-2 mSV, no contrast media).

Patients stratified by Agatston Score
High risk: score > 400, **HR 8.67 for cardiac mortality, HR = 10.83 for coronary revascularization**

	All cause mortality				Cardiac mortality				Non-cardiac mortality			
CAC score category	Hazard Ratio	(95% CI)		p value	Hazard Ratio	(95% CI)		p value	Hazard Ratio	(95% CI)		p value
CAC=0	1 (reference)				1 (reference)				1 (reference)			
0<CAC≦100	1.07	0.63	1.81	.797	2.16	0.46	10.11	.329	0.95	0.54	1.67	.862
100<CAC≦400	1.45	0.84	2.52	.184	3.35	0.69	16.30	.134	1.22	0.68	2.22	.505
CAC>400	2.08	1.18	3.66	.011	8.67	1.87	40.27	.006	1.38	0.73	2.59	.324
	Cox model: $p < .001$				Cox model: $p < .001$				Cox model: $p < .001$			

	Major CHD				Coronary revascularization				AMI				Ischemic stroke			
CAC score category	Hazard Ratio	(95% CI)		p value	Hazard Ratio	(95% CI)		p value	Hazard Ratio	(95% CI)		p value	Hazard Ratio	(95% CI)		p value
CAC=0	1 (reference)				1 (reference)				1 (reference)				1 (reference)			
0<CAC≦100	3.14	1.54	6.41	.002	3.39	1.52	7.58	.003	5.71	0.73	44.44	.096	1.19	0.63	2.25	.590
100<CAC≦400	4.18	1.99	8.80	< .001	4.57	1.98	10.52	< .001	6.31	0.76	52.23	.087	1.18	0.57	2.43	.652
CAC>400	10.52	5.07	21.83	< .001	10.83	4.76	24.62	< .001	4.19	0.44	39.51	.211	2.11	2.11	4.32	.410
	Cox model: $p < .001$				Cox model: $p < .001$				Cox model: $p < .047$				Cox model: $p < .001$			

All models were adjusted for age, diabetes duration and the number of risk factors.



Assessment of coronary artery calcium score with computed tomography may be considered as a risk modifier[c] in the cardiovascular risk assessment of asymptomatic subjects.[449,457]

IIb | B

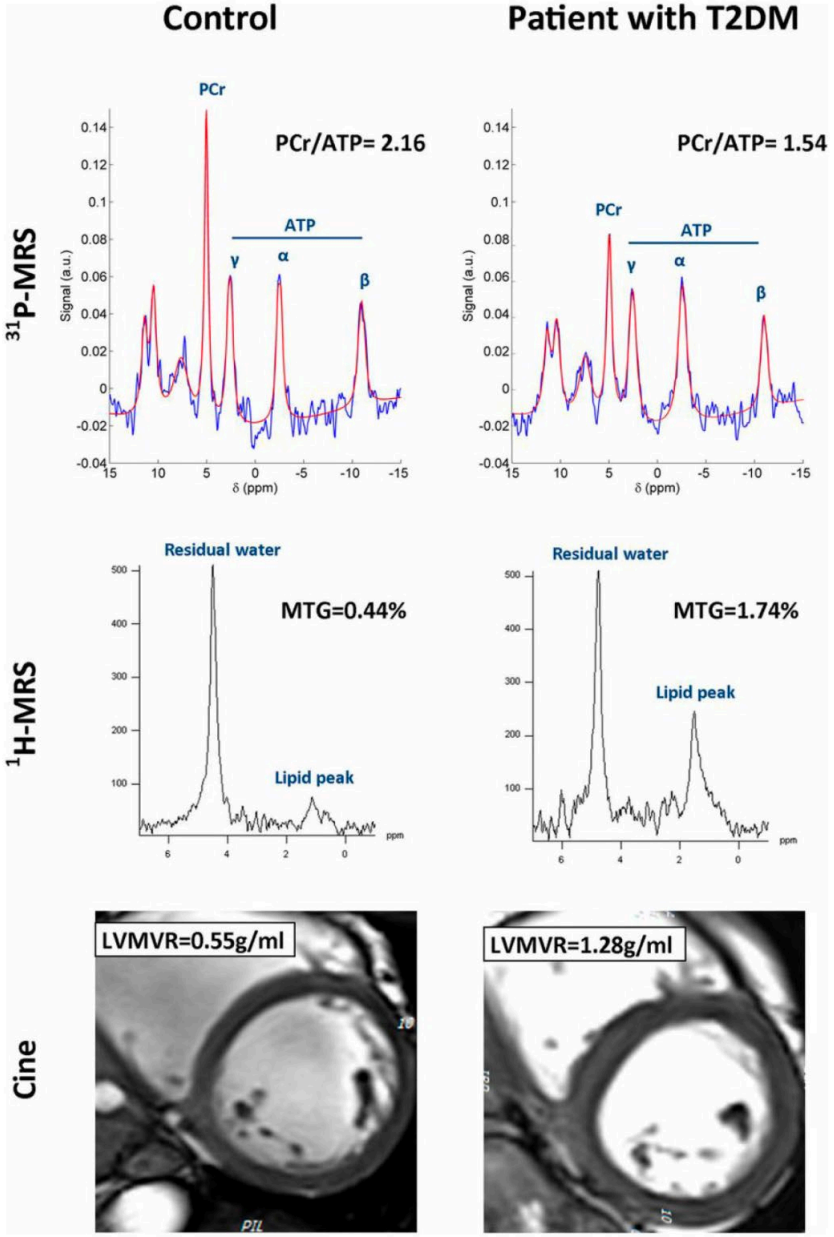
(3) Early identification of CARDIAC STEATOSIS

^{31}P Cardiac magnetic resonance spectroscopy

46 T2DM patients (non hypertensive) vs. controls:

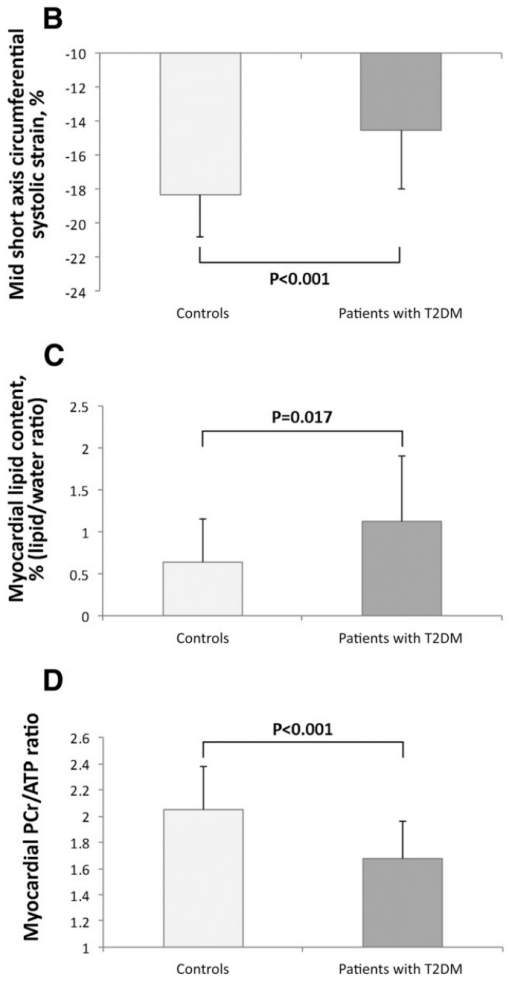
Myocardial steatosis (DM had 2-fold increase in myocardial trygliceride content) **was independent predictor of LV remodeling and reduced systolic strain.**

..Associated with impairement of myocardial energetics (-18% reduction in myocardial phosphocreatine to ATP ratio)



Eylem Levelt,[1,2] Masliza Mahmod,[1] Stefan K. Piechnik,[1] Rina Ariga,[1] Jane M. Francis,[1] Christopher T. Rodgers,[1] William T. Clarke,[1] Nikant Sabharwal,[3] Jurgen E. Schneider,[1] Theodoros D. Karamitsos,[1,4] Kieran Clarke,[2] Oliver J. Rider,[1] and Stefan Neubauer[1]

Relationship Between Left Ventricular Structural and Metabolic Remodeling in Type 2 Diabetes



(3) Early identification of CARDIAC STEATOSIS

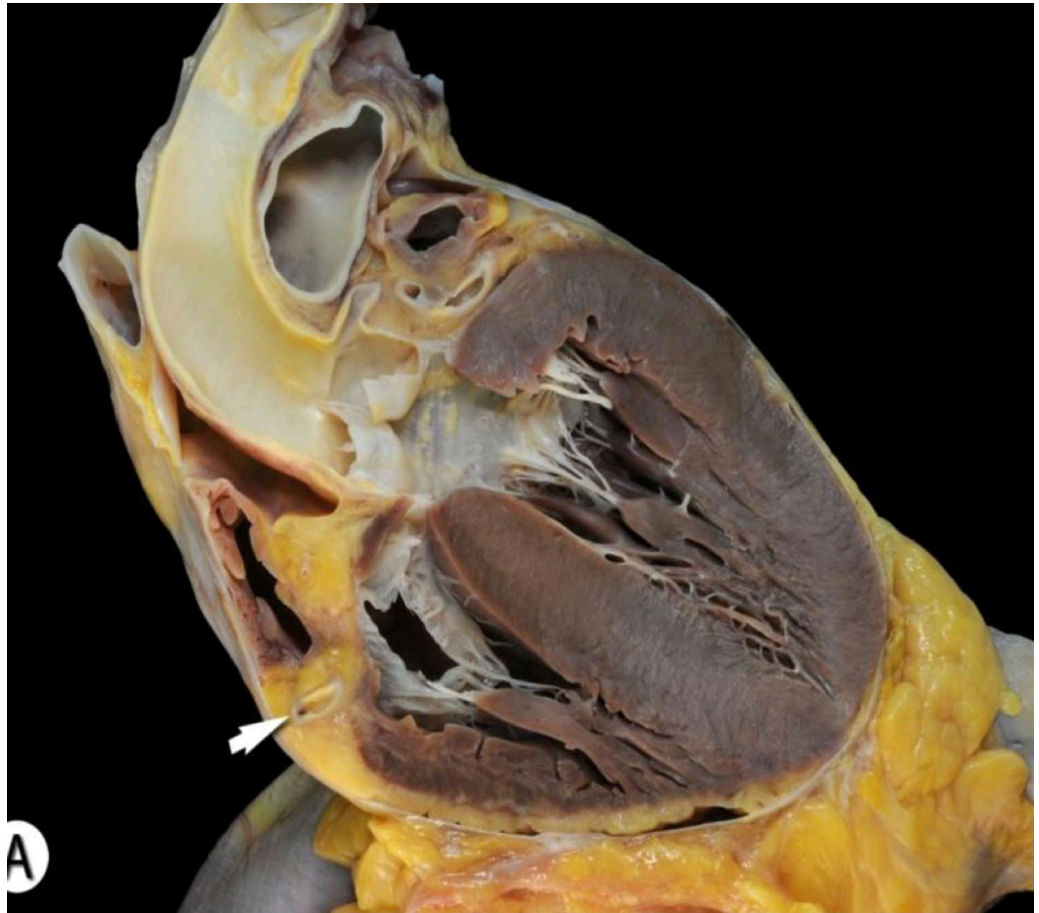
^{31}P Cardiac magnetic resonance spectroscopy

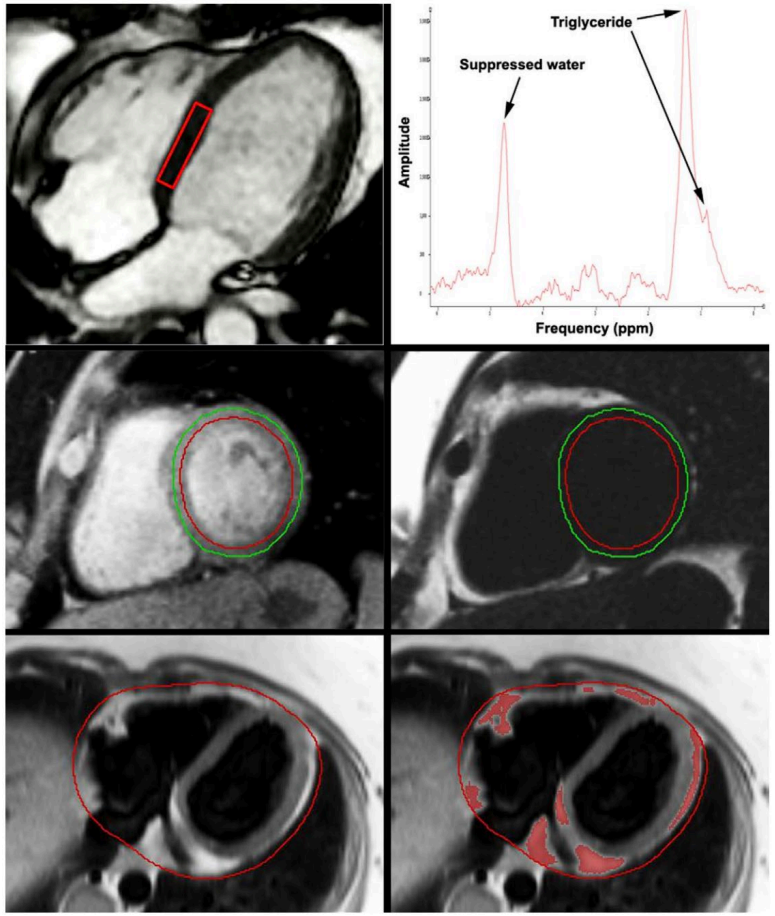
Epicardial adipose tissue volume and insulin-resistance both independently associated with
-increased myocardial fat content
-higher burden of interstitial fibrosis
-impaired LV longitudinal strain

Circulation: Cardiovascular Imaging

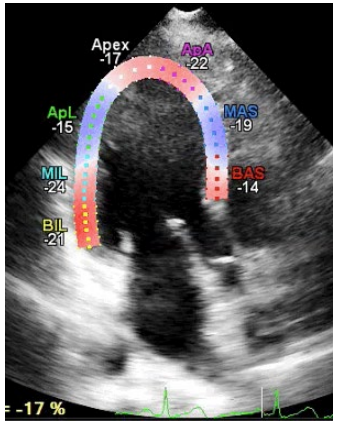
ORIGINAL ARTICLE

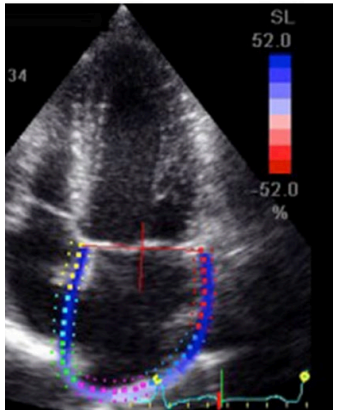
Impact of Epicardial Adipose Tissue, Left Ventricular Myocardial Fat Content, and Interstitial Fibrosis on Myocardial Contractile Function

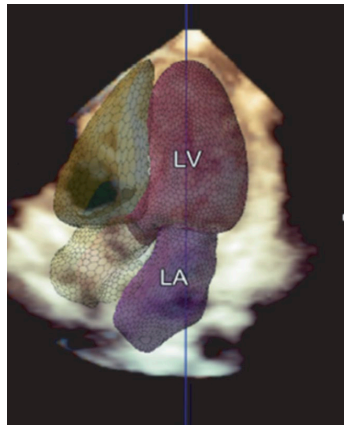




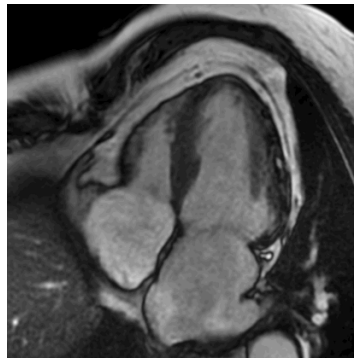
CONCLUSIONS – Take home messages







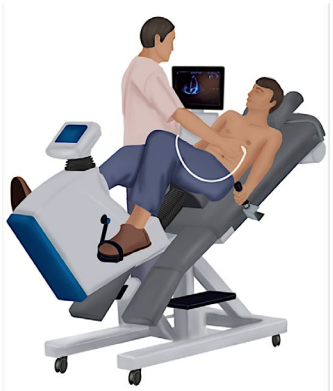
What's the role of CARDIAC IMAGING in asymptomatic diabetic patients ?

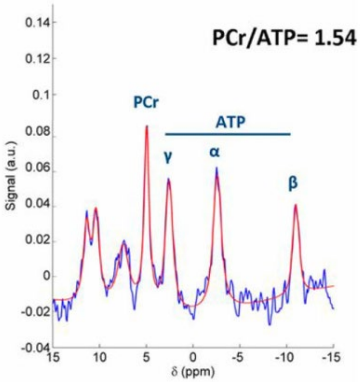


Detection of preclinical:

- ✓ systolic and/or diastolic dysfunction
- ✓ impaired exercise capacity
- ✓ cardiac remodeling
- ✓ focal and/or diffuse fibrosis
- ✓ risk of microvascular complications
- ✓ impaired left atrial deformation predisposing to AF
- ✓ cardiac steatosis, epicardial adipose tissue volume

Risk stratification (adverse remodeling, CV events, mortality, hospitalizations)





Thank you for your attention!

E-mail: alessandro.andreis@unito.it