Up-to-Date Assessment of Left Ventricular Systolic Function

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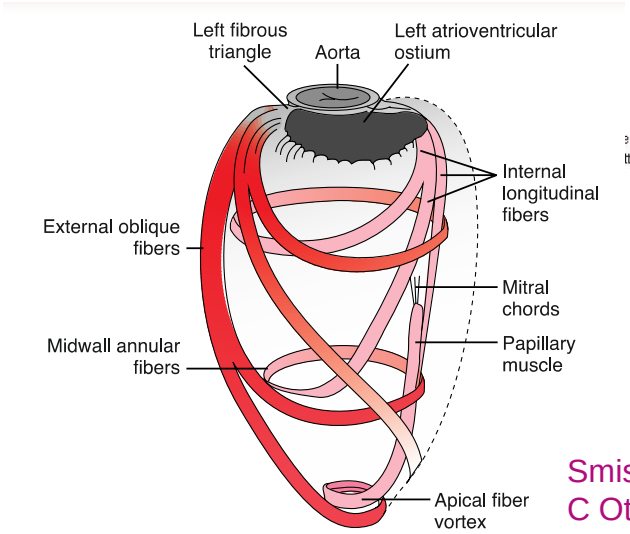
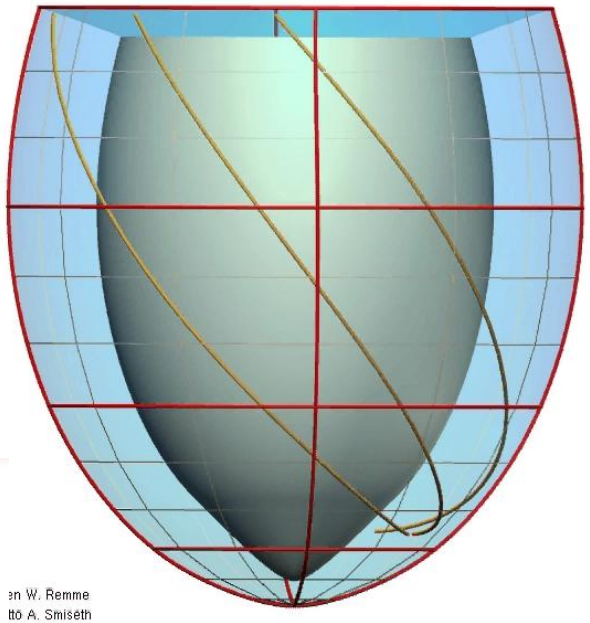
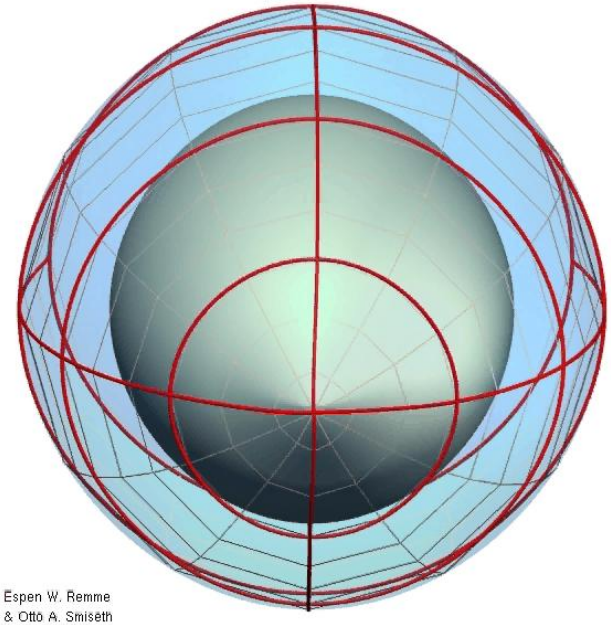
LV function by echocardiography

- **Fractional shortening**
- **Visual assessment**
  - *WMSI (Wall motion score index)*
- **Ejection fraction (EF)**
- **Stroke volume / Cardiac output**
- **Tissue velocities**
- **Mitral annulus displacement**
- **Regional strain / Global strain**

Left ventricle - complicated fiber pattern



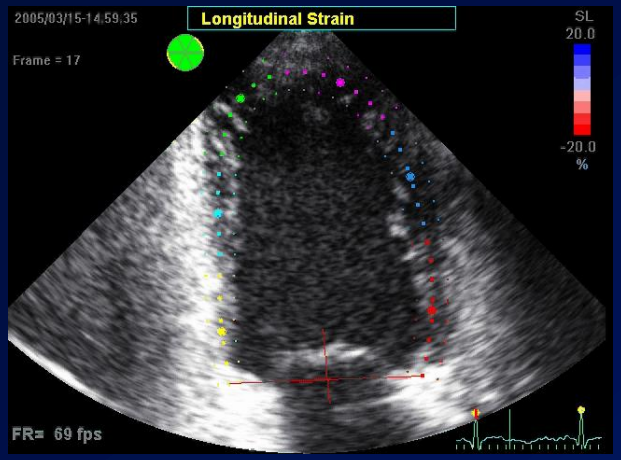




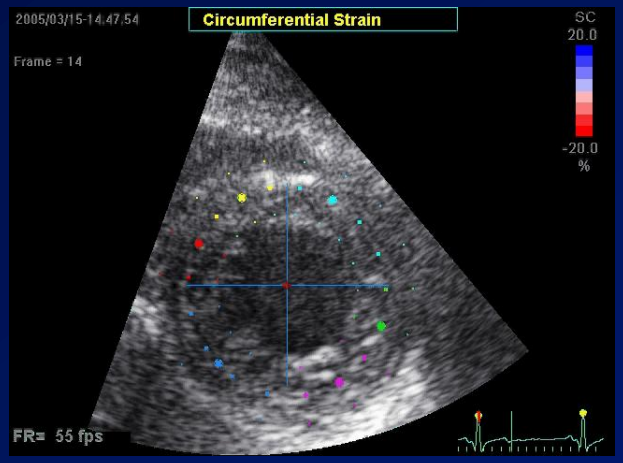
- **Ideally:**
  - *Measure contractility*
  - *Independent of load / pressure*

Smiseth, Edvardsen.
C Otto, Echocardiography 4.ed, 2012

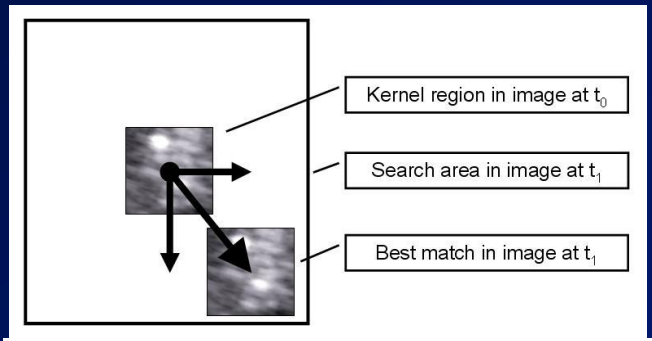
Speckle tracking



Longitudinal (LS)

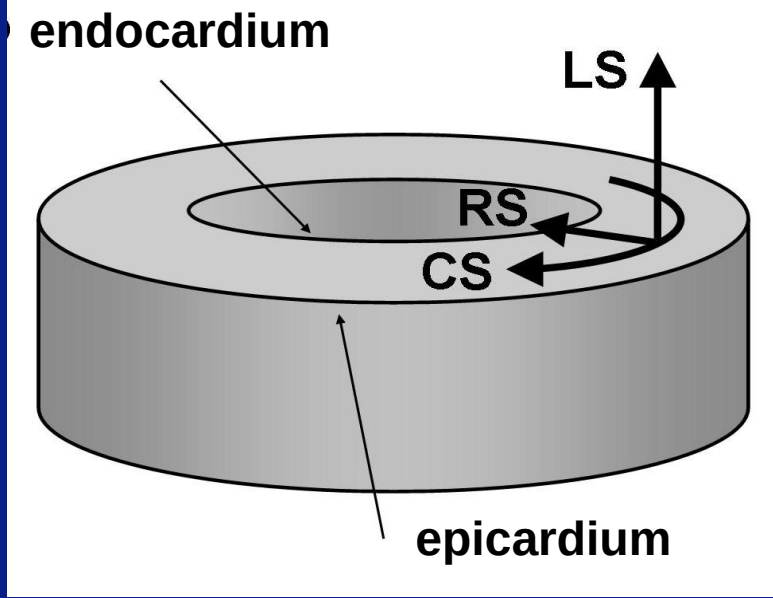


Circumferential (CS)
Radial (RS)



Noninvasive Myocardial Strain
Measurement by Speckle Tracking Echocardiography
Validation Against Sonomicrometry
and Tagged Magnetic Resonance Imaging

Brage H. Amundsen, MD,* Thomas Helle-Valle, MD,† Thor Edvardsen, PhD, MD,†
Hans Torp, DrTechn,* Jonas Crosby, MSc,* Erik Lyseggen, MD,† Asbjørn Støylen, MD, PhD,*‡
Halfdan Ihlen, MD, PhD,† João A. C. Lima, MD, FACC,§ Otto A. Smiseth, MD, PhD, FACC,†
Stig A. Slørdahl, MD, PhD*‡
Trondheim and Oslo, Norway; and Baltimore, Maryland

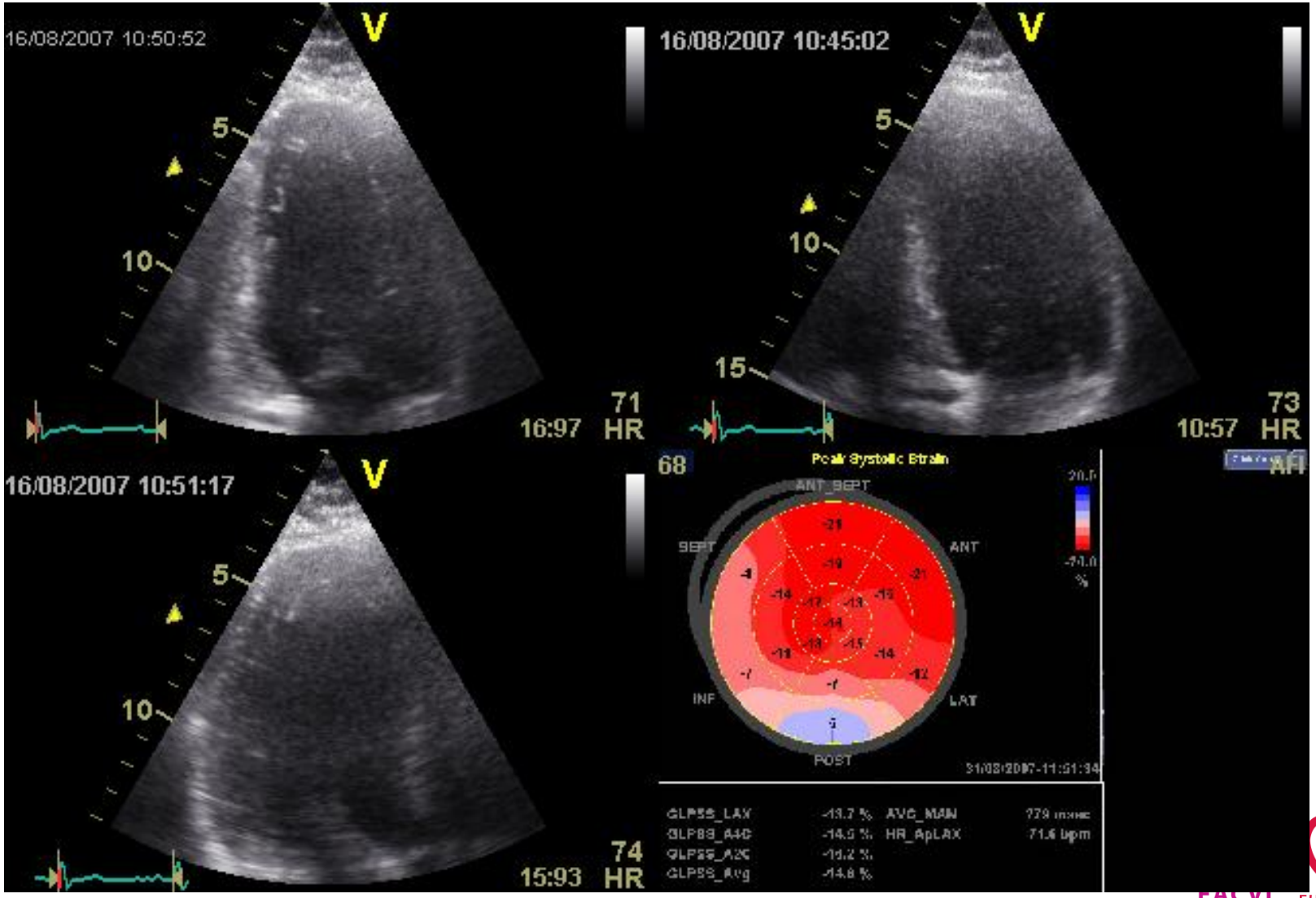


Angle independent assessment of myocardial deformation

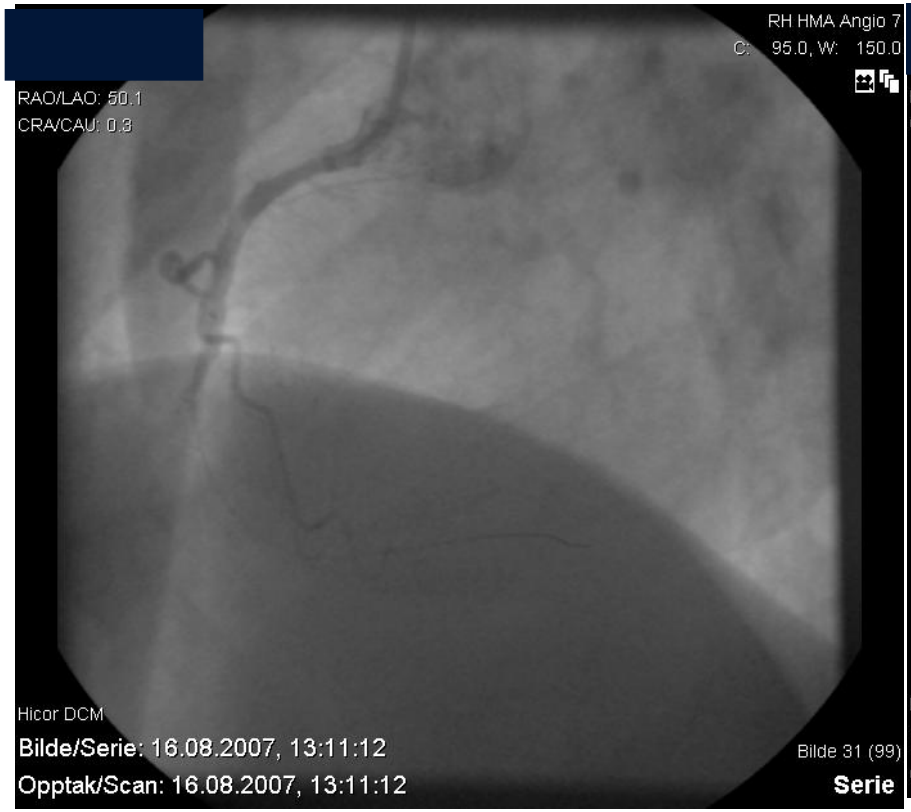
Strain - Examples of use

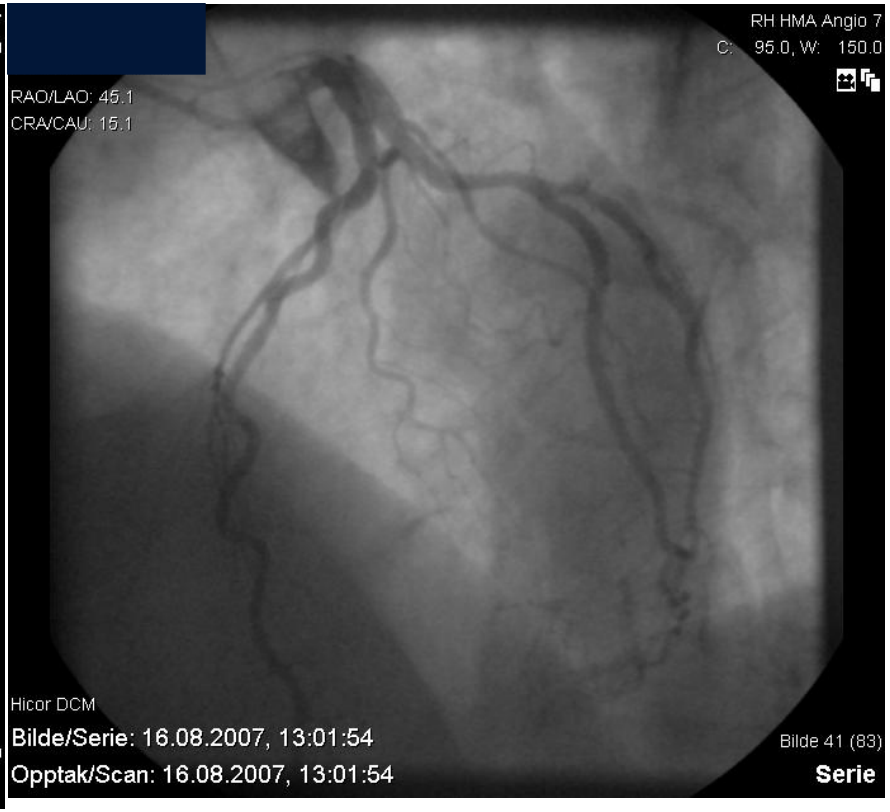
- Acute coronary syndrom
- Cardiotoxicity
- Prognosis

Non ST elevation MI



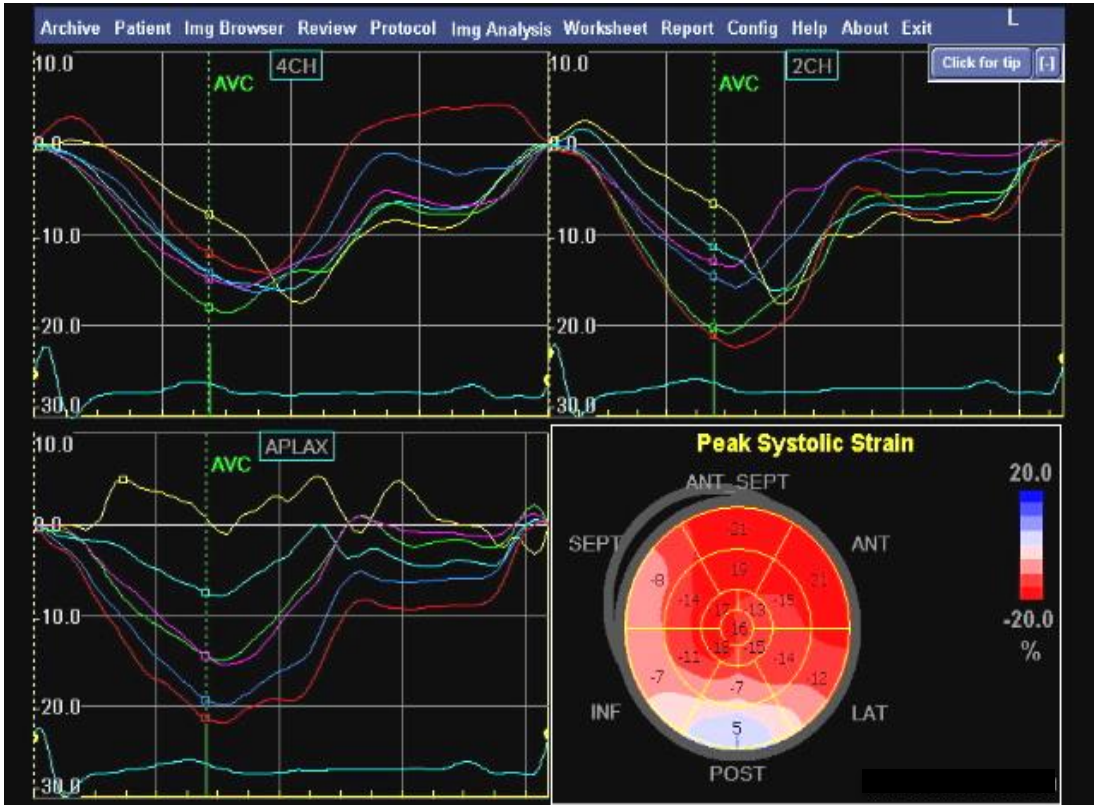
Coronary angiogram





Non ST elevation MI

- Early systolic lengthening
- Decreased systolic strain
- Post systolic strain

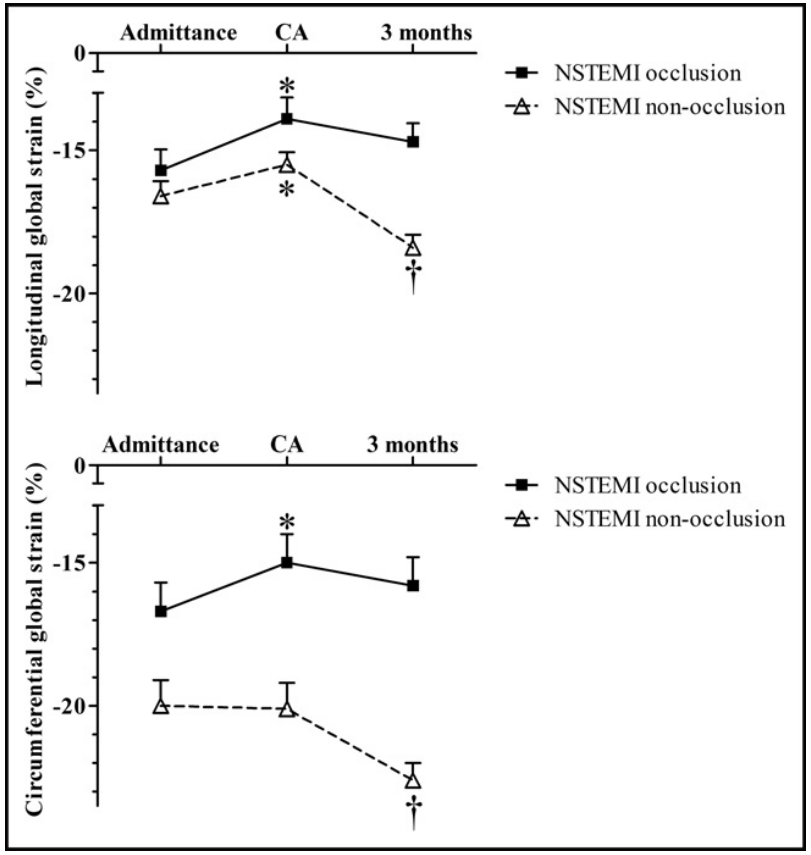


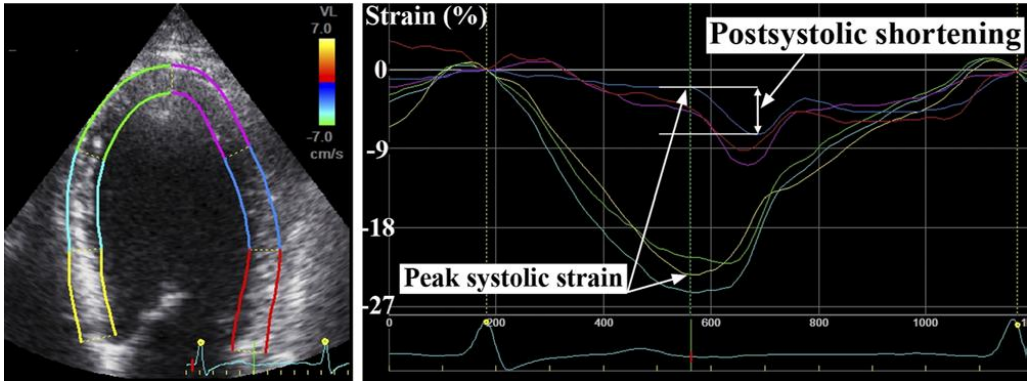
Changes of Myocardial Function in Patients with Non-ST-Elevation Acute Coronary Syndrome Awaiting Coronary Angiography

Bjørnar Grenne, MD[a], Christian Eek, MD[b], Benthe Sjøli, MD[a], Helge Skulstad, MD, PhD[b], Svend Aakhus, MD, PhD[b], Otto A. Smiseth, MD, PhD[b], Thor Edvardsen, MD, PhD[b], and Harald Brunvand, MD, PhD[a,*]

Approx 30% of all NSTEMI patients had coronary artery occlusion

AJC 2010
Heart 2010





HEART

Diagnosing coronary artery occlusion in NSTEACS with strain echocardiography

Graham Cole, Jamil Mayet and Iqbal S Malik

Heart 2010 96: 1516-1517
doi: 10.1136/hrt.2010.209437

Is there really any good clinical reason to delay? The promise of better outcomes and shorter lengths of stay with better early triaging of patients with acute coronary syndromes lends further weight to the case for all such patients to be delivered directly to specialist cardiac centres for initial assessment.

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Myocardial strain can detect coronary artery occlusion

Table 3 Identification of patients with non-ST-elevation acute coronary syndrome with acute coronary occlusions

	Cut-off point	Sensitivity (%)	Specificity (%)	AUC
Territorial circumferential strain	−10.0%	90	88	0.93*
Territorial longitudinal strain	−14.0%	76	66	0.78†
Wall motion score index	1.23	71	73	0.81†
Territorial circumferential post-systolic shortening	3.4%	81	70	0.79†
Territorial longitudinal post-systolic shortening	1.9%	71	76	0.74
CK-MB, admittance	5.0 µg/l	53	53	0.60
Left ventricular ejection fraction	55%	57	56	0.61

*$p<0.05$ compared with territorial longitudinal strain, territorial circumferential and longitudinal post-systolic shortening and wall motion score index, and $p<0.001$ compared with left ventricular ejection fraction (LVEF) and CK-MB.
†$p<0.05$ compared with LVEF and CK–MB.
AUC, area under the curve.

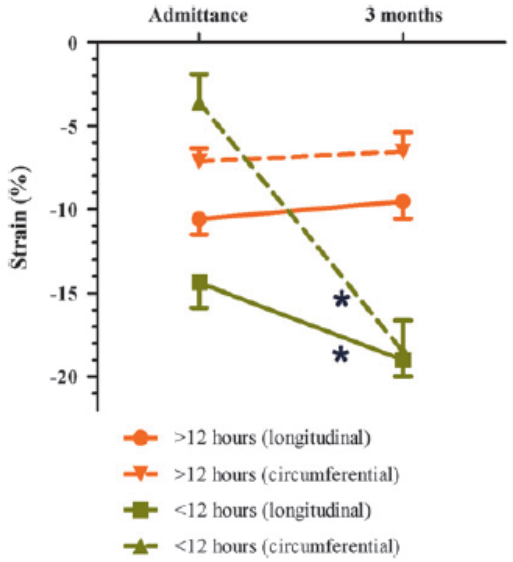

Figure 5 Changes in strains according to timing of revascularisation in patients with non-ST-elevation myocardial infarction due to acute coronary occlusions. Longitudinal and circumferential territorial strains (mean±SEM) in the culprit territory according to whether percutaneous coronary intervention was performed within 12 h of symptom onset (n=6) or later (n=15). *$p<0.01$ for change from admittance to 3 months.

HEART

Acute coronary occlusion in non-ST-elevation acute coronary syndrome: outcome and early identification by strain echocardiography

Bjørnar Grenne,[1] Christian Eek,[2] Benthe Sjøli,[1] Thomas Dahlslett,[1] Michael Uchto,[3] Per K Hol,[4] Helge Skulstad,[5] Otto A Smiseth,[2] Thor Edvardsen,[2] Harald Brunvand[3]

Key points - ACS

- EF is preserved in many patients with acute coronary syndrome
- Fast revascularization is important
- Difficult to see regional wall motion abnormalities
- Use assessment of long axis function for additional information on LV function

Cardiotoxicity

EACVI / ASE Recommendations

Expert consensus for multimodality imaging evaluation of adult patients during and after cancer therapy: a report from the American Society of Echocardiography and the European Association of Cardiovascular Imaging

Juan Carlos Plana[1], Maurizio Galderisi[2], Ana Barac[3], Michael S. Ewer[4], Bonnie Ky[5], Marielle Scherrer-Crosbie[6], Javier Ganame[7], Igal A. Sebag[8], Deborah A. Agler[1], Luigi P. Badano[9], Jose Banchs[4], Daniela Cardinale[10], Joseph Carver[11], Manuel Cerqueira[1], Jeanne M. DeCara[12], Thor Edvardsen[13], Scott D. Flamm[1], Thomas Force[14], Brian P. Griffin[1], Guy Jerusalem[15], Jennifer E. Liu[16], Andreia Magalhães[17], Thomas Marwick[18], Liza Y. Sanchez[4], Rosa Sicari[19], Hector R. Villarraga[20], and Patrizio Lancellotti[15]

Expert consensus for multi-modality imaging evaluation of cardiovascular complications of radiotherapy in adults: a report from the European Association of Cardiovascular Imaging and the American Society of Echocardiography

Patrizio Lancellotti[1]*, Vuyisile T. Nkomo[2], Luigi P. Badano[3], Jutta Bergler[4], Jan Bogaert[5], Laurent Davin[6], Bernard Cosyns[7], Philippe Coucke[8], Raluca Dulgheru[9], Thor Edvardsen[10], Oliver Gaemperli[11], Maurizio Galderisi[12], Brian Griffin[13], Paul A. Heidenreich[14,15], Koen Nieman[16,17], Juan C. Plana[13], Steven C. Port[18], Marielle Scherrer-Crosbie[19], Ronald G. Schwartz[20,21], Igal A. Sebag[22,23], Jens-Uwe Voigt[24], Samuel Wann[25], and Phillip C. Yang[26], In collaboration with the European Society of Cardiology Working Groups on Nuclear Cardiology and Cardiac Computed Tomography and Cardiovascular Magnetic Resonance and the American Society of Nuclear Cardiology, Society for Cardiovascular Magnetic Resonance, and Society of Cardiovascular Computed Tomography

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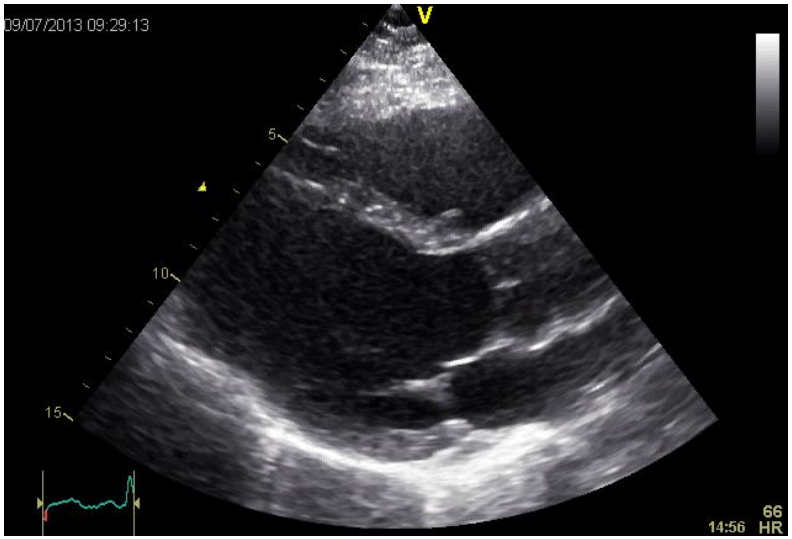
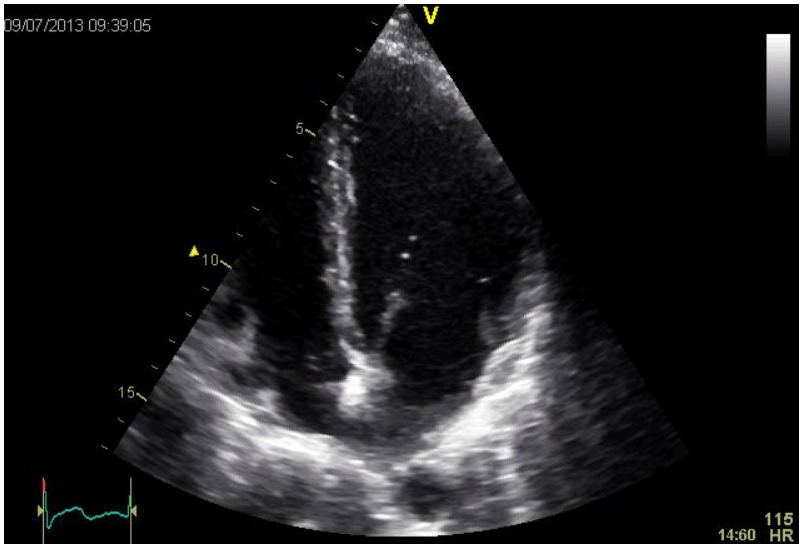
After 1 chemotherapy

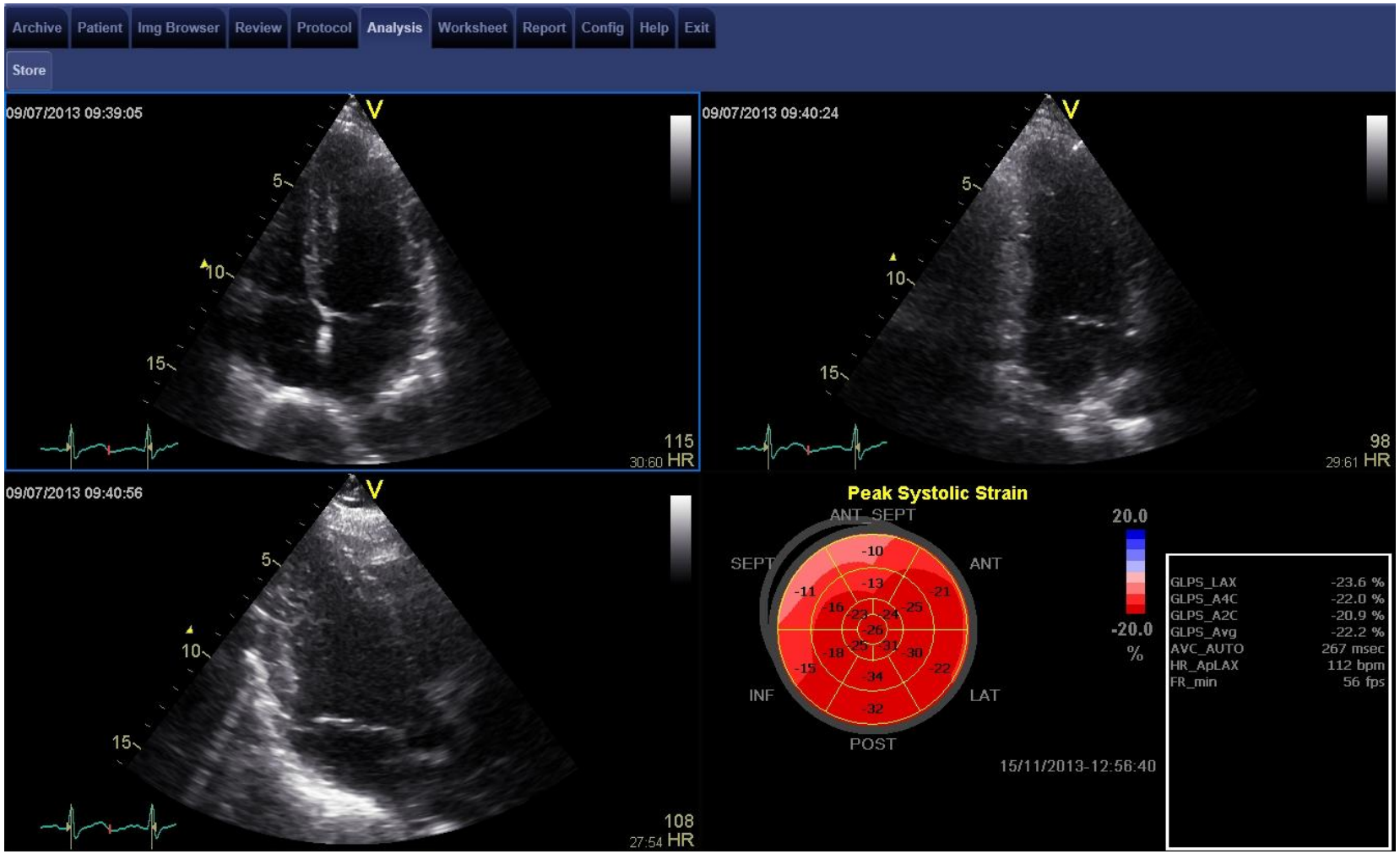
Women 36 yo
Lymphoma

Dyspnoe and cough
Echocardiography

6 x CHOP – treatment – June 2013



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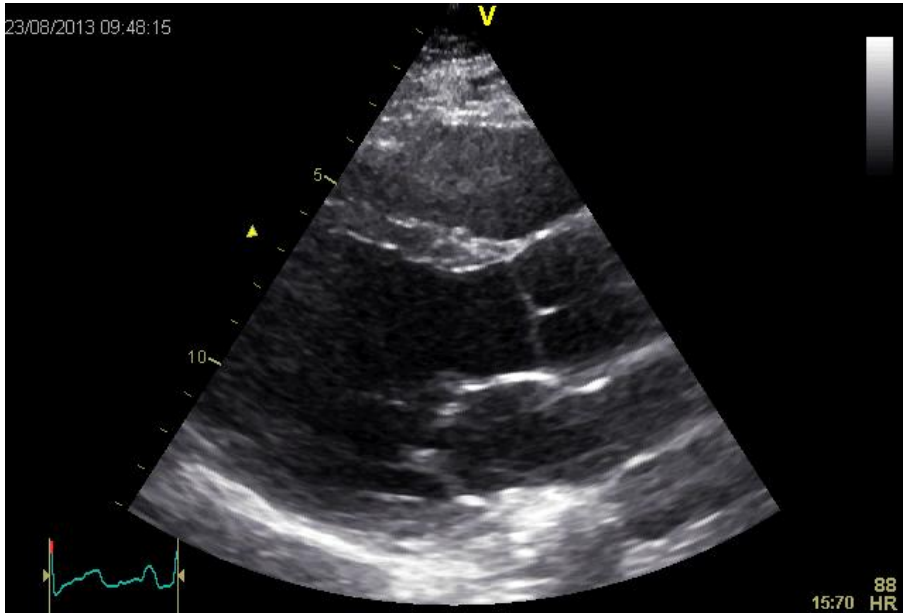
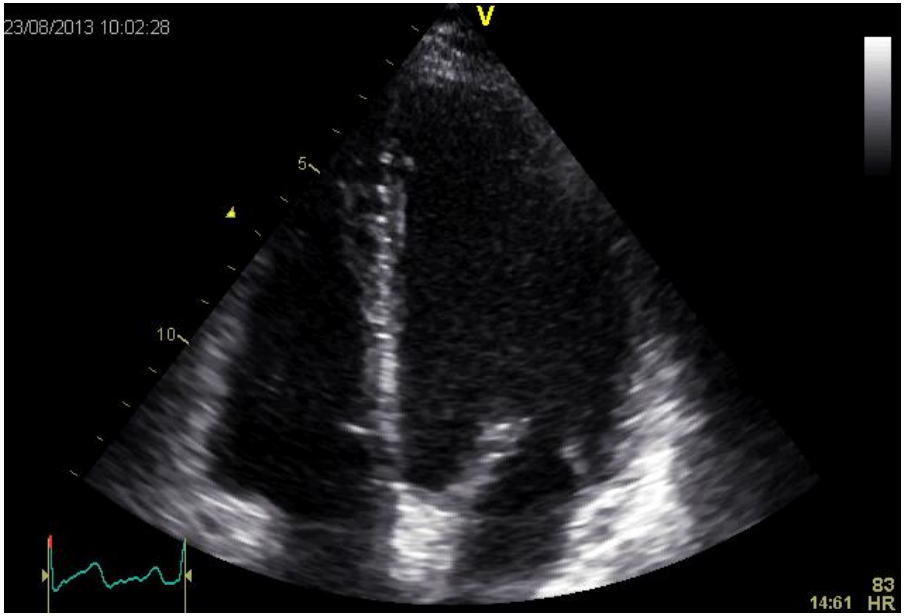
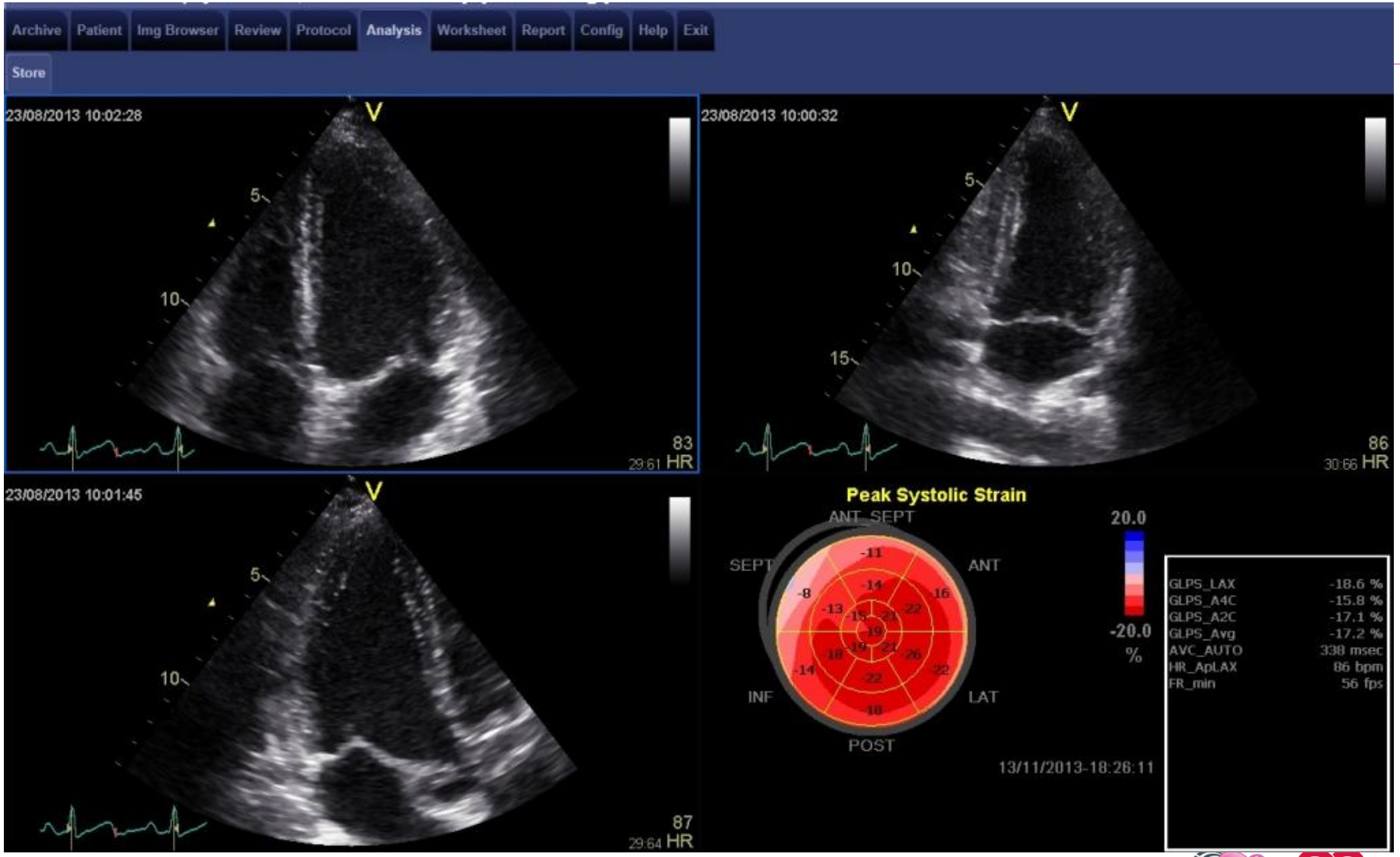
GLPS_A4C -22.0 %
GLPS_A2C -20.9 %
GLPS_Avg -22.2 %
AVC_AUTO 267 msec
HR_ApLAX 112 bpm
FR_min 56 fps

After 3 x chemotherapy



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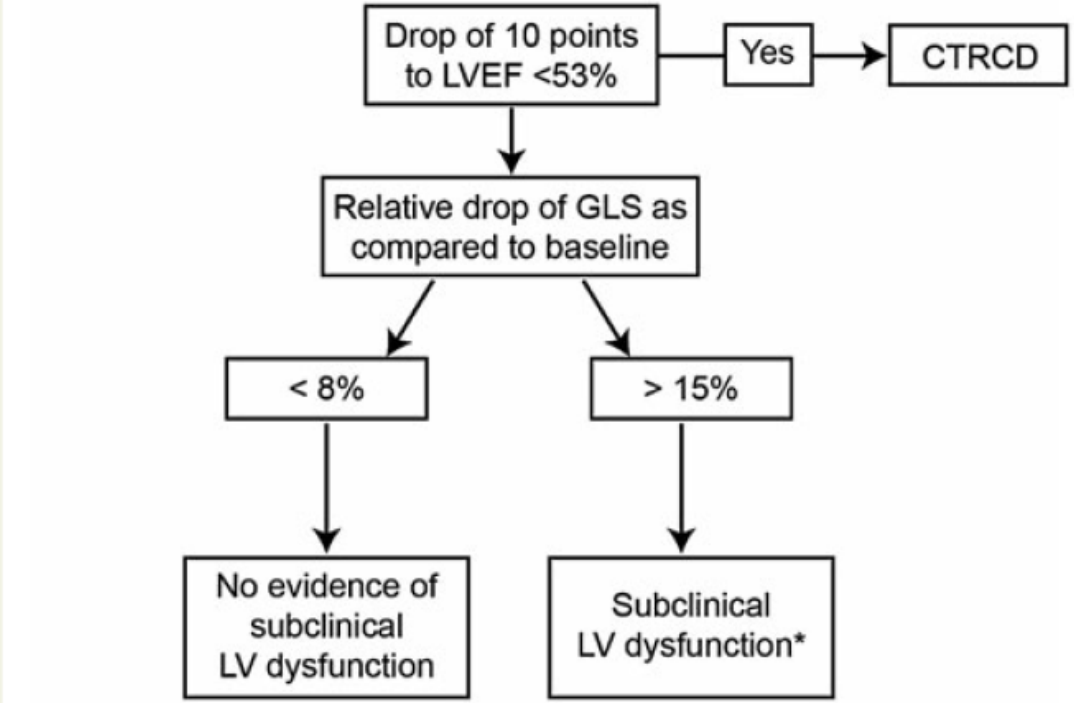
GLPS_LAX -18.6 %
GLPS_A4C -15.8 %
GLPS_A2C -17.1 %
GLPS_Avg -17.2 %
AVC_AUTO 338 msec
HR_ApLAX 86 bpm
FR_min 56 fps

Cancer therapeutics-related cardiac dysfunction



* The data supporting the initiation of cardioprotection for the treatment of subclinical LV dysfunction is limited.

Plana et al, EHJ CI 2014

PROGNOSIS

Prediction of All-Cause Mortality From Global Longitudinal Speckle Strain

Comparison With Ejection Fraction and Wall Motion Scoring

Tony Stanton, MBChB, PhD; Rodel Leano, BS; Thomas H. Marwick, MBBS, PhD

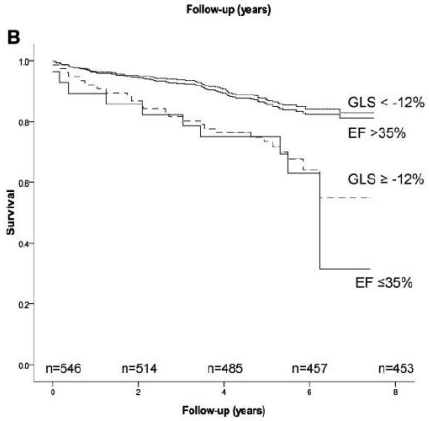


Figure 4. Kaplan-Meier curve depicting event-free survival for individuals using EF (A) with and without wall motion abnormalities (B) using EF and GLS cutoffs.

GLS = global longitudinal strain, EF = ejection fraction, WMSI = wall motion score index

- 546 unselected patients, known or suspected LV impairment
- 5.2±1.5 years
- 91 deaths

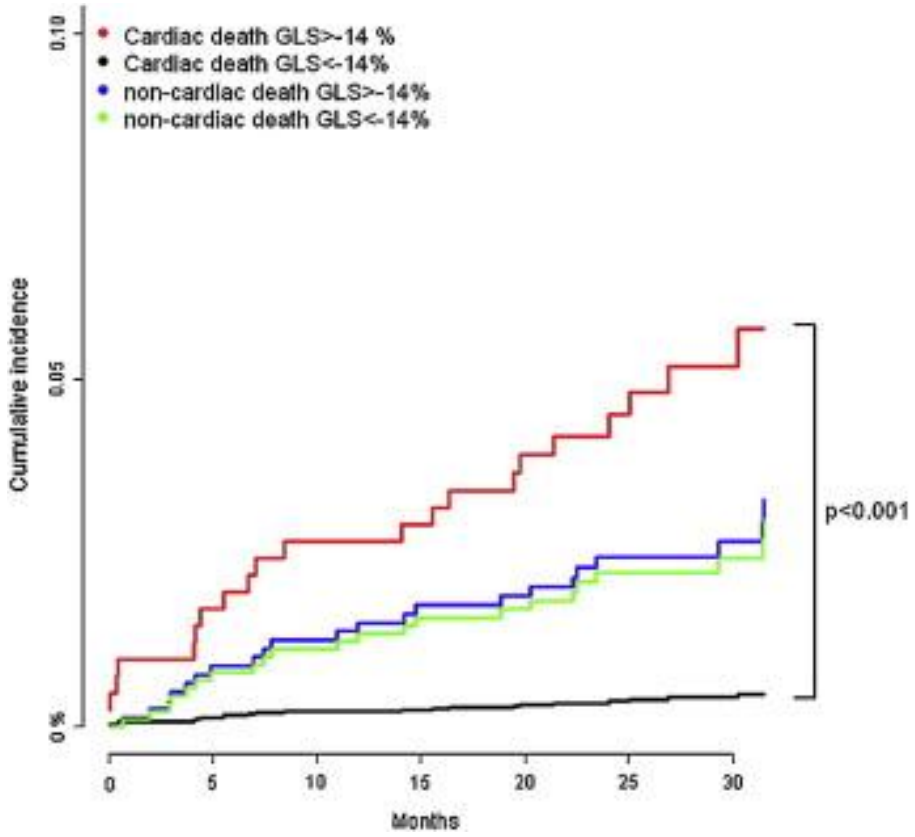
Table 4. Predictors of All-Cause Mortality and Overall Model χ^2 After Addition of Information Obtained From Imaging

Baseline+EF				Baseline+WMSI				Baseline+GLS			
	P	HR	95% CI		*P*	HR	95% CI		*P*	HR	95% CI
Age	<0.01	1.44	1.15–1.82	Age	<0.01	1.41	1.12–1.79	Age	<0.01	1.4	1.11–1.76
Diabetes	0.03	1.68	1.06–2.66	Diabetes	0.03	1.68	1.06–2.66	Diabetes	0.03	1.64	1.04–2.61
Hypertension	0.14	1.38	0.9–2.11	Hypertension	0.16	1.36	0.89–2.09	Hypertension	0.22	1.31	0.85–2.01
EF	0.03	1.23	1.02–1.5	WMS	<0.01	1.28	1.08–1.53	GLS	<0.001	1.45	1.19–1.77
Significance from baseline			Model χ^2	Significance from baseline			Model χ^2	Significance from baseline			Model χ^2
P=0.04			25.3	*P*<0.01			28.6	*P*<0.001			34.9

Model χ^2 from baseline=20.2.

Conclusions—GLS is a superior predictor of outcome to either EF or WMSI and may become the optimal method for assessment of global left ventricular systolic function. (*Circ Cardiovasc Imaging*. 2009;2:356-364.)

Prognosis

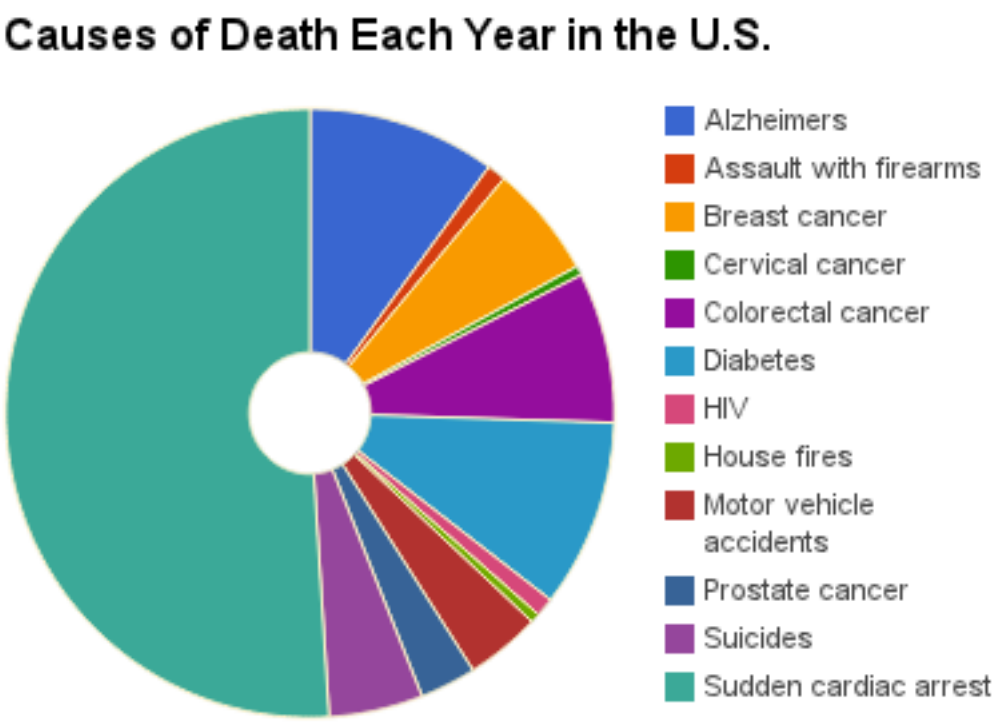


849 patients
AMI
EF >40%

Global longitudinal strain

Figure 2 Cumulative Incidence Curve for Cardiac Death With Adjustment for Competing Risk
Mads Ersbøll et al
JACC, 2013

Sudden cardiac arrest
Problem #1



SCA-Aware.org online (with data from CDC.gov)

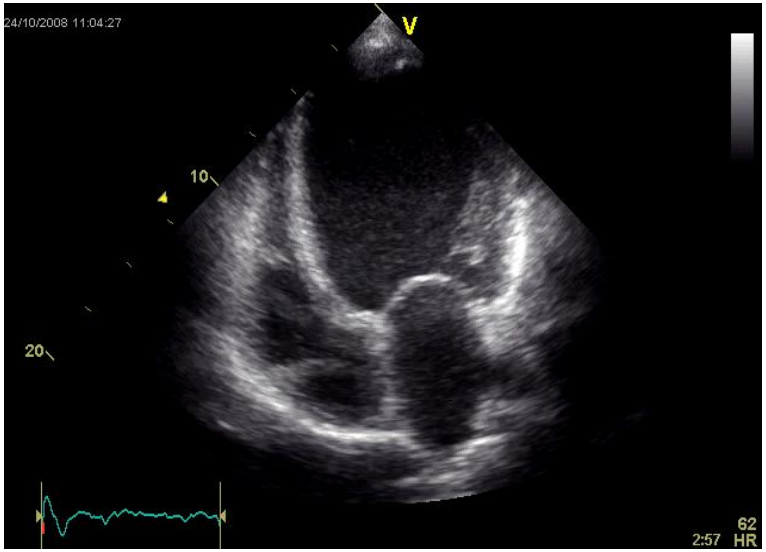
>35 years:

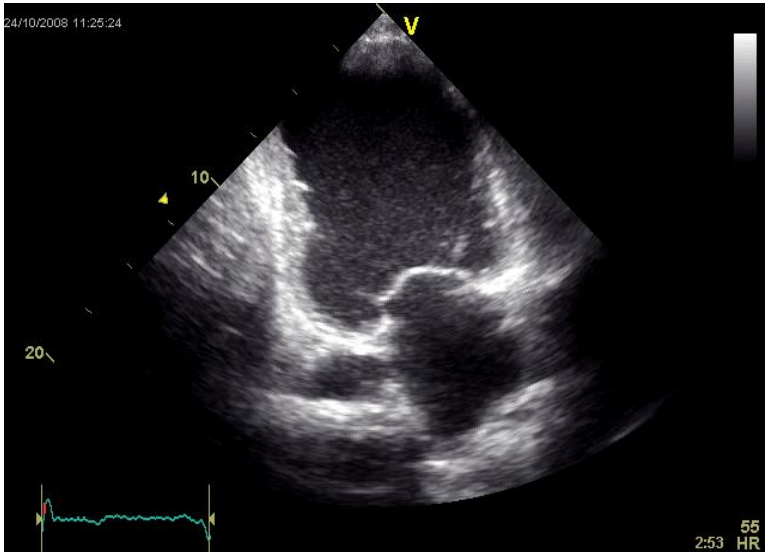
Coronary artery disease

<35 years:

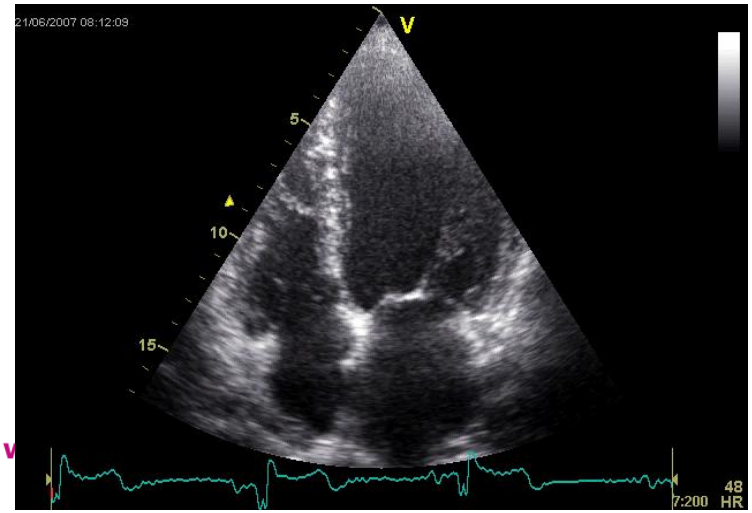
Genetic disease

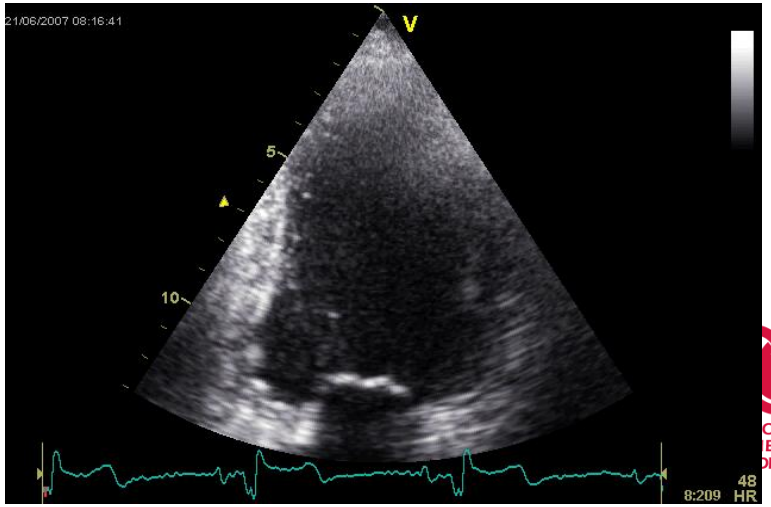
EF 20%, no arrhythmia





EF 50%, arrhythmia ICD





Selection of post-MI patients for ICD

1. Many patients who not fulfill ICD indications die suddenly
2. ICD never in use (14/15)

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Heart Rhythm Disorders

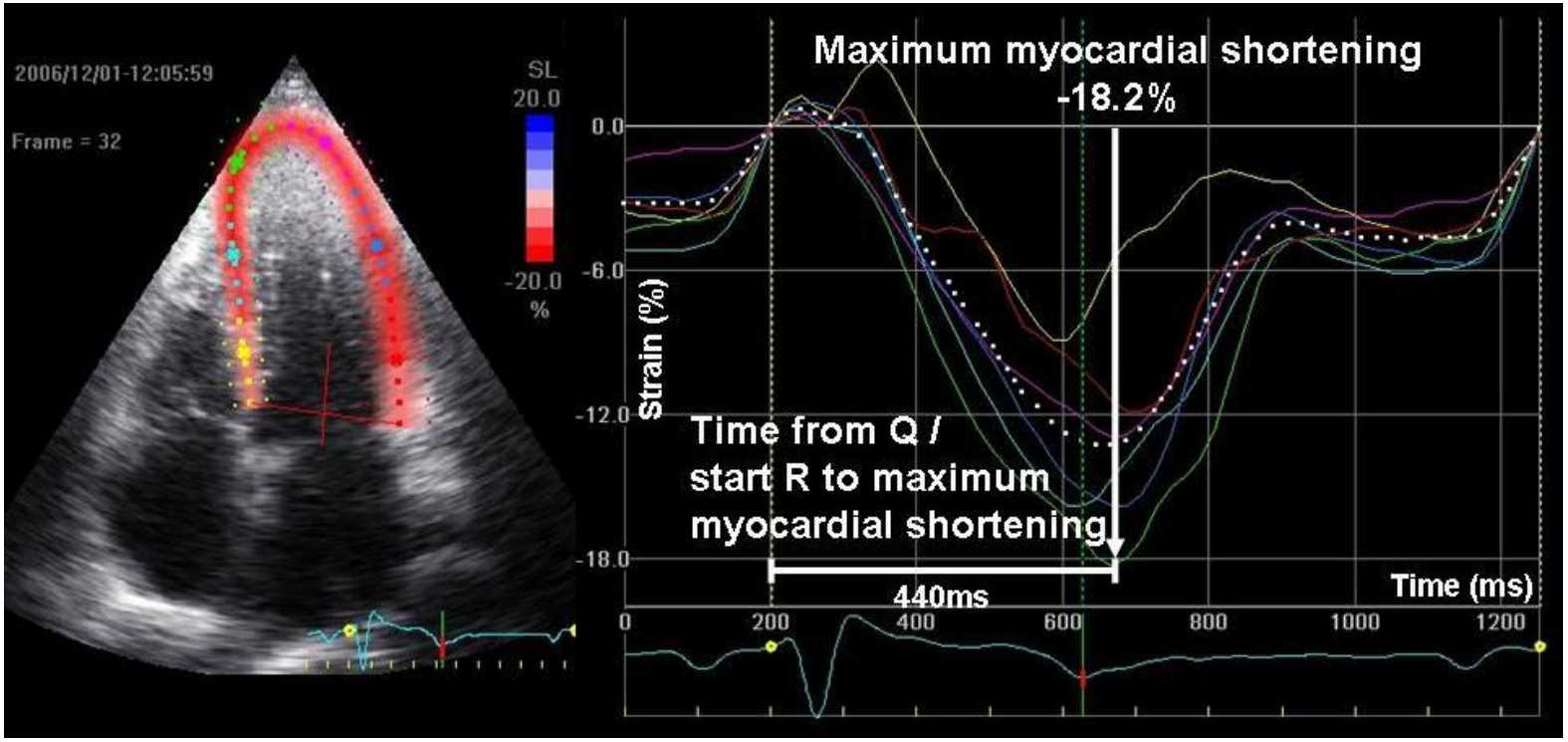
Limitations of Ejection Fraction for Prediction of Sudden Death Risk in Patients With Coronary Artery Disease

Lessons From the MUSTT Study

Alfred E. Buxton, MD, FACC,* Kerry L. Lee, PHD,† Gail E. Hafley, MS,† Luis A. Pires, MD,‡
John D. Fisher, MD,§ Michael R. Gold, MD,‖ Mark E. Josephson, MD,#
Michael H. Lehmann, MD,** Eric N. Prystowsky, MD,†† for the MUSTT Investigators

Providence, Rhode Island; Durham, North Carolina; Detroit and Ann Arbor, Michigan; Bronx, New York; Charleston, South Carolina; Boston, Massachusetts; and Indianapolis, Indiana

Amplitudes or durations?



Global strain – average strain from 16 LV segments

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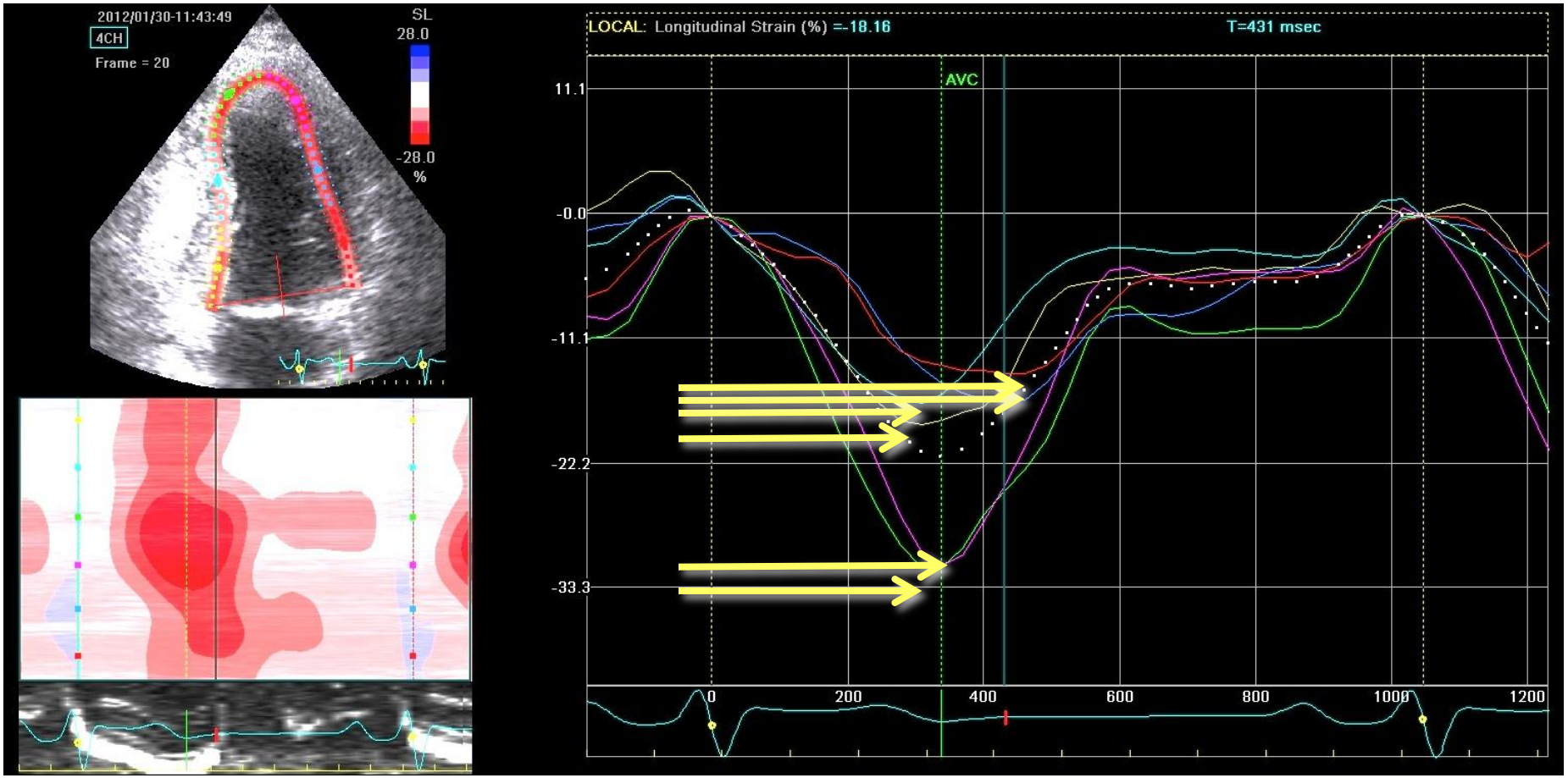
Mechanical dispersion
=SD of TIME to max shortening in 16 LV segments



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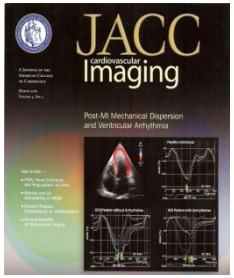
Myocardial mechanical dispersion
85 patients after mycoardial infarction with ICD



Mechanical Dispersion Assessed by Myocardial Strain in Patients After Myocardial Infarction for Risk Prediction of Ventricular Arrhythmia

Kristina H. Haugaa, MD,*† Marit Kristine Smedsrud, MD,*† Torkel Steen, MD, PHD,‡ Erik Kongsgaard, MD, PHD,* Jan Pål Loennechen, MD, PHD,§‖ Terje Skjaerpe, MD, PHD,‖ Jens-Uwe Voigt, MD, PHD,¶ Rik Willems, MD, PHD,¶ Gunnar Smith, MD,‡ Otto A. Smiseth, MD, PHD,* Jan P. Amlie, MD, PHD,* Thor Edvardsen, MD, PHD*

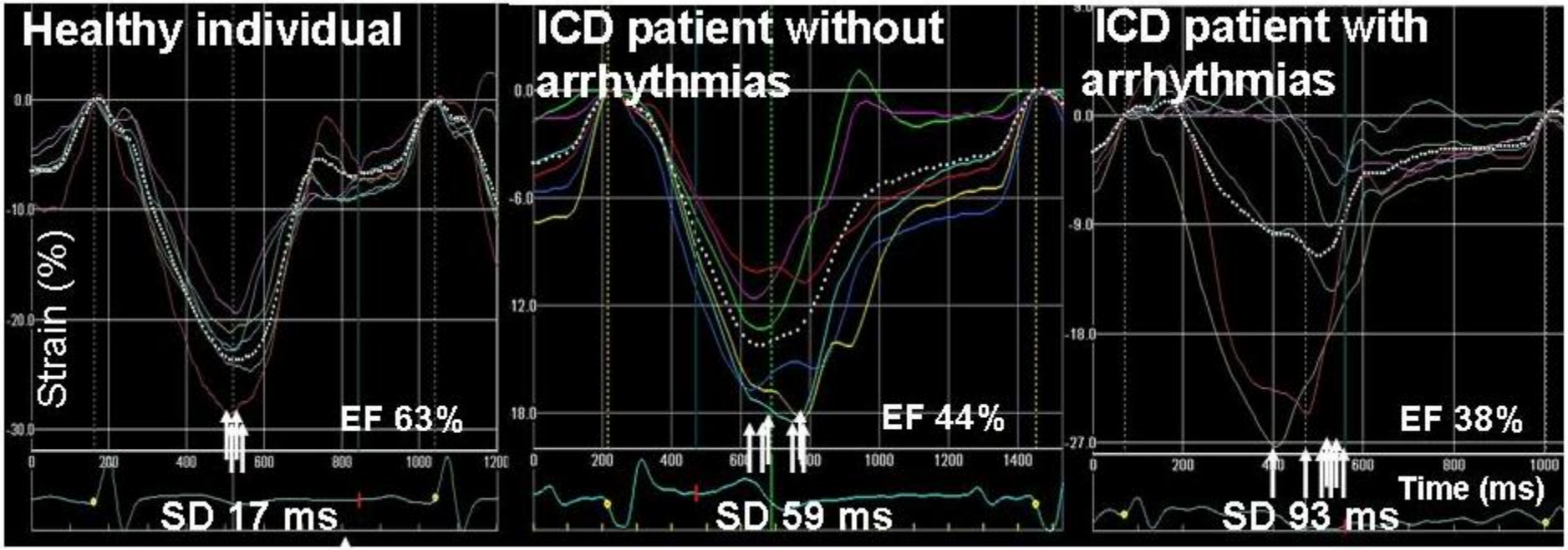
Oslo and Trondheim, Norway; and Leuven, Belgium

2010

EDITOR'S PAGE

Is Mechanical Dispersion a Raven of Ventricular Arrhythmias?

William A. Zoghbi, MD,* Jagat Narula, MD, PHD†



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2.3 (0.6-5.5) years follow up

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Strain Echocardiography Improves Risk Prediction of Ventricular Arrhythmias After Myocardial Infarction

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- 569 patients
- Prospective / multicenter study
- Mechanical dispersion was a marker of arrhythmias
- EF approx 52%

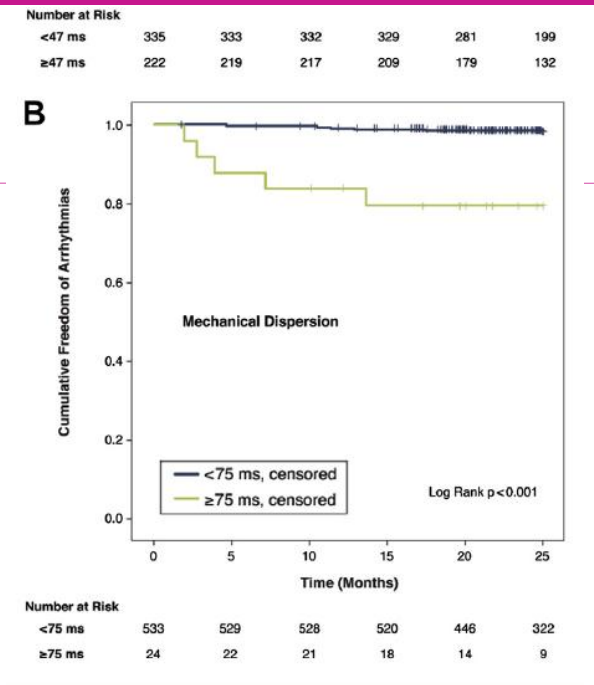
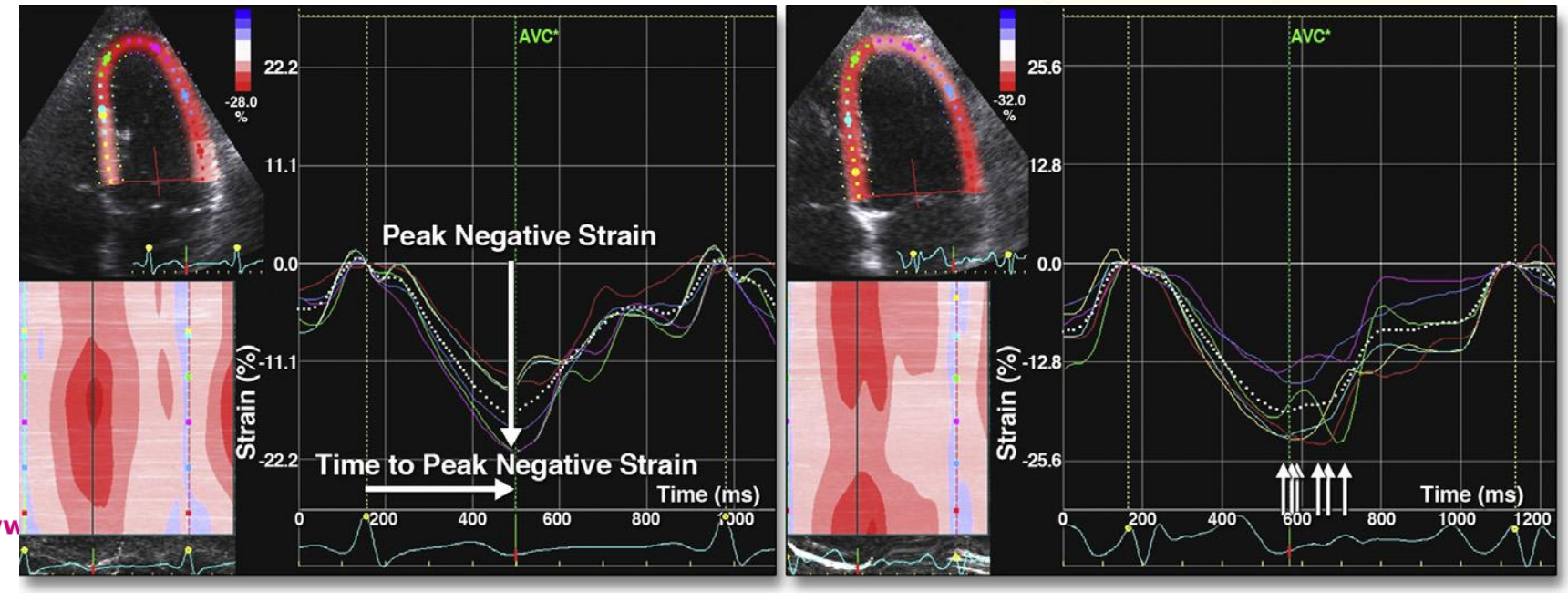


Figure 2. Kaplan-Meier Curves Showing Freedom From Arrhythmias in Patients After Myocardial Infarction



Summary

- **Myocardial strain**
  - *is useful in ACS patients and detects myocardial ischemia*
  - *can add important information in cardiotoxicity*
  - *has valuable prognostic information*
  - *might predict arrhythmias*