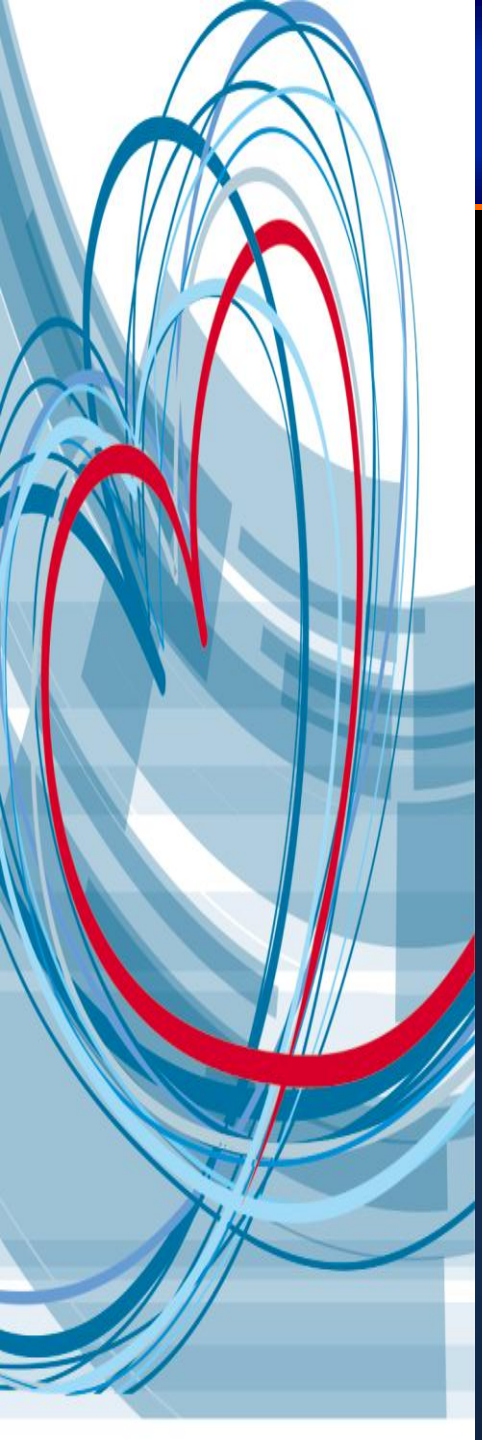


Global and regional function in patients with Acute Myocardial Infarction

Krasimira Hristova

University National Heart Hospital
Sofia – Bulgaria

06.04.2012

No conflicts to disclose for this presentation.

Acute Myocardial Infarction –the clinical questions

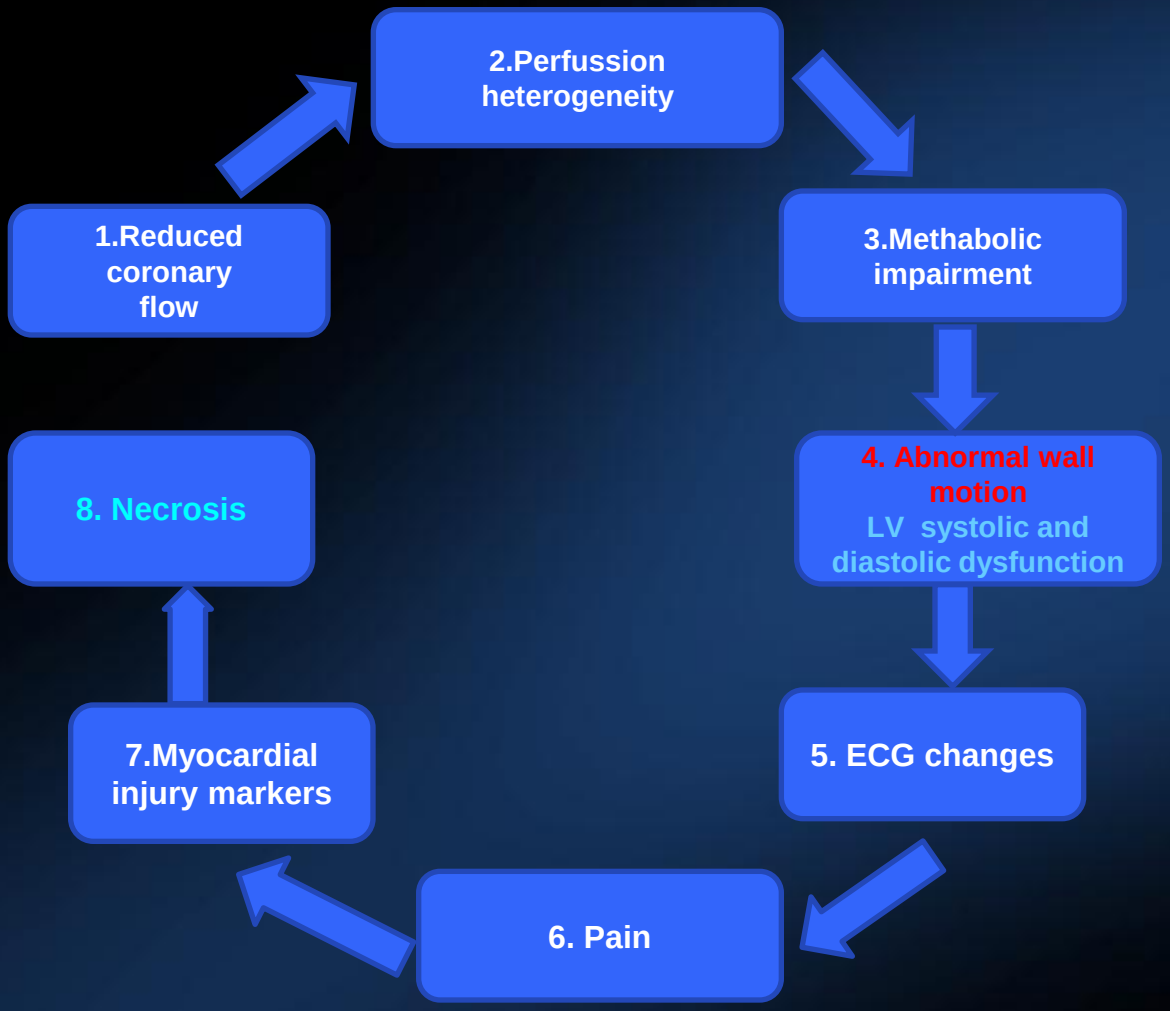
- **Presence and the extent of area of risk and necrosis**

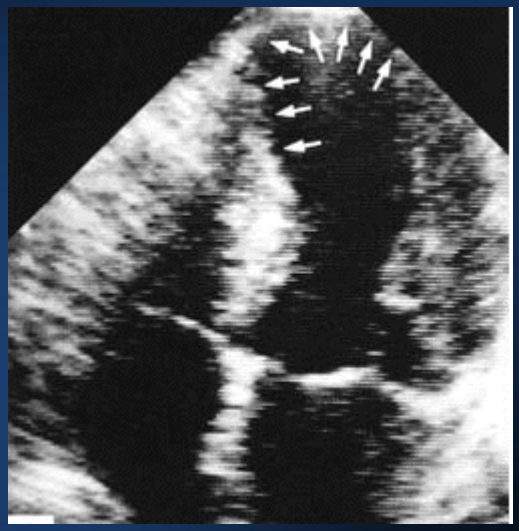
- **Function**
- **Infarct Imaging**
- **Viability**

- **Presence of ischemia (IRA stenosis, ischemia at distance)**
- **Function**
- **Perfusion**

- **Establishing prognosis**
- **Choosing the correct therapy**

The role of echocardiography on estimation pts with AMI





Conventional Echo

Sens.80-90 %,
Spec. 80-90 %
for nontransmural AMI

Sens. 90-95%,
Spec. 80-90%
for transmural AMI

Horowitz et all, Circ.1982

Acute Myocardial Infarction – Echo in ED / CCU

• **Detection of AMI** :

- **2D echo** – regional wall motion abnormalities
  high Sens, low Spec. for detecting AMI (PPV: 30%)
- **Rest WMSI** > 1,7 > perfusion defects > 20%
- **MCE** > Perfusion defect

• **Detection of mechanical complications of AMI**

- **LV failure and remodelin**
- **RV infarction**
- **Free wall rupture,ventricular septal rupture (VSD), papillary muscle rupture (masive MR)**
- **Ischemic MR**

AMI – the role of noninvasive imaging

• **Anatomical Imaging:** Non-invasive Angiography

- TTE / TEE
- Multislice CT
- MRI

• **Functional Imaging**: hemodynamic consequences of AMI

Acute phase

1. Doppler , TDI, 2DS
2. Myocardial Contrast Echocardiography
3. SPECT
4. c MRI

Sub acute and chronic phase

1+2+3+4 and

5 Exercise or DSE

EchoCG

Myocardial infarction: Clinical Applications of Strain Imaging

- Detection of myocardial ischemia
- Assessment of myocardial viability
- Detection and sizing of myocardial infarction
- Prediction of post- MI arrhythmias

Myocardial infarction: Clinical Applications of Strain Imaging

- Detection of myocardial ischemia
- Assessment of myocardial viability
- Detection and sizing of myocardial infarction
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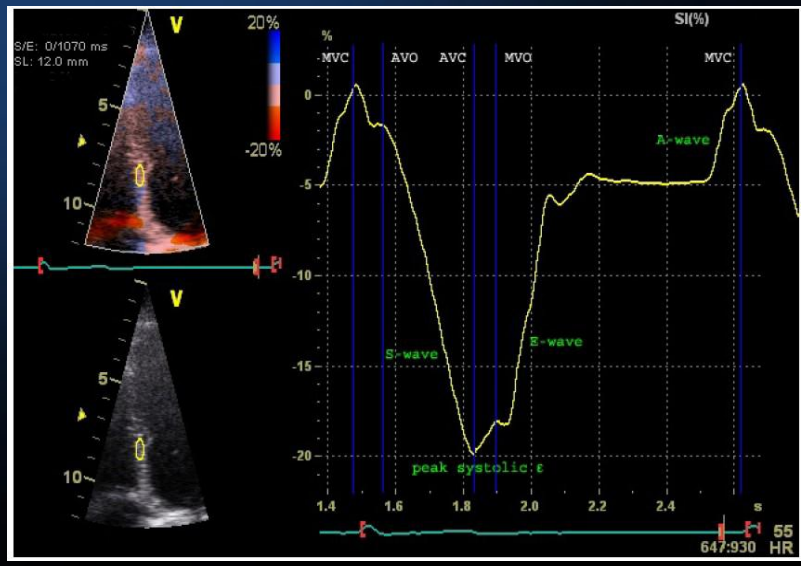
Tissue Doppler Imaging

Pros:

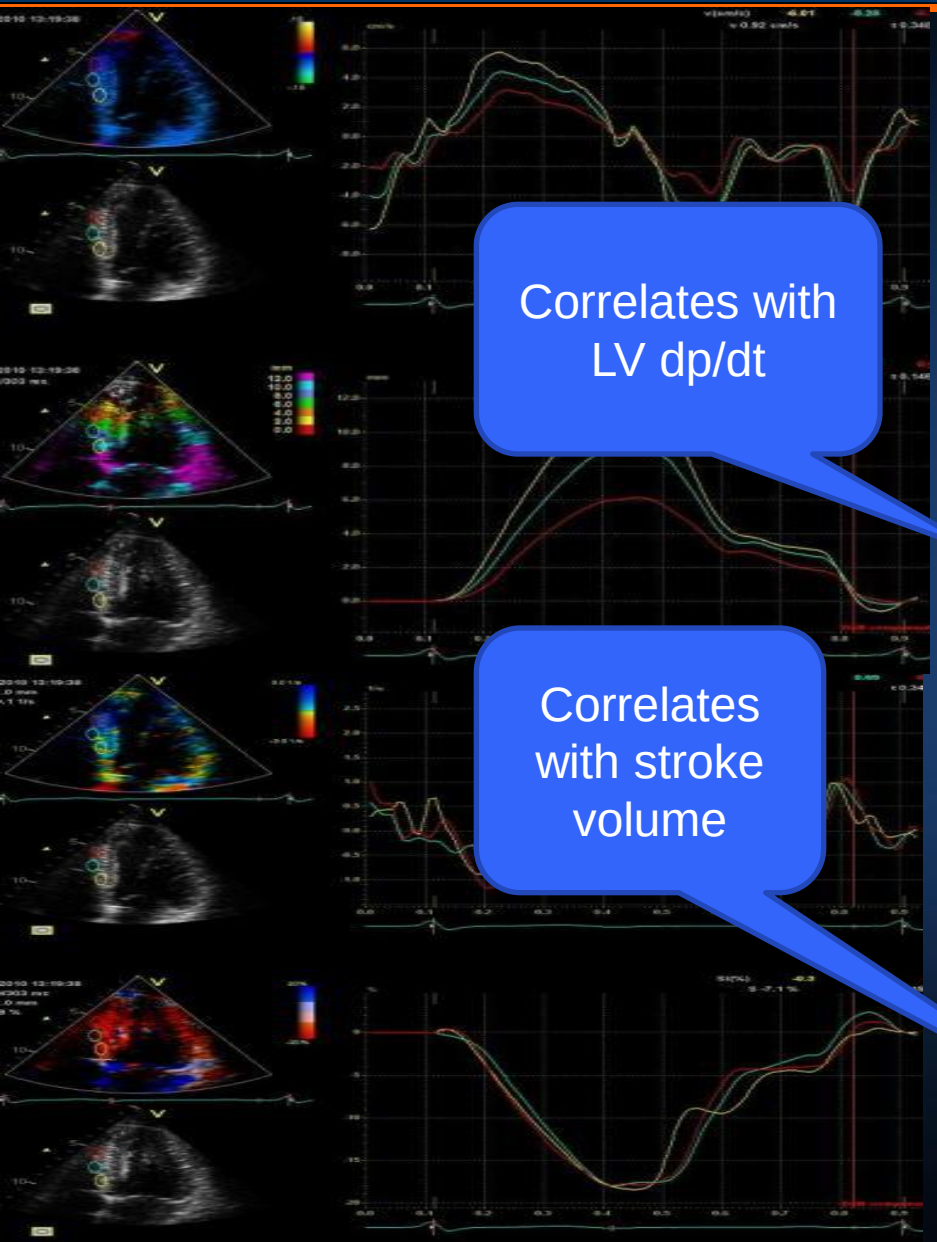
- 1D tool to assess the velocity of the myocardial dislpacement
- studies have proven relevant of the in assessment myocardial viability

Cons:

- angle dependent
- possible noise artifacts
- no segmental assessment



Tissue Doppler and Strain Rate imaging
from velocity to deformation



Correlates with LV dp/dt

Correlates with stroke volume

Vel (v)

$$SR = \frac{v_2 - v_1}{d}$$

$$\varepsilon = \int_{t_0}^{t} SR.\, dt$$

The velocity of which myocardium moves

The rate of which myocardium deforms

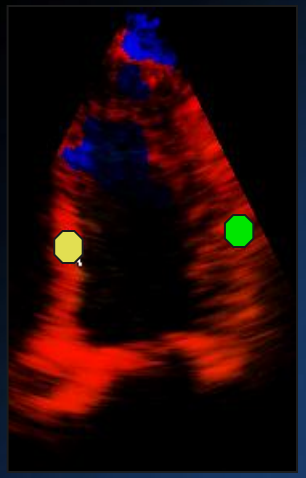
The % of local deformations

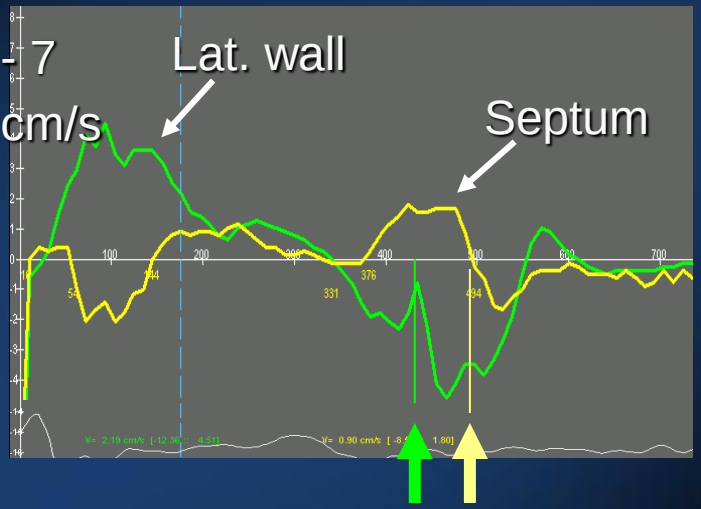
Weidemann et al., Am. J. Physiol. 2002

Acute Myocardial Ischemia

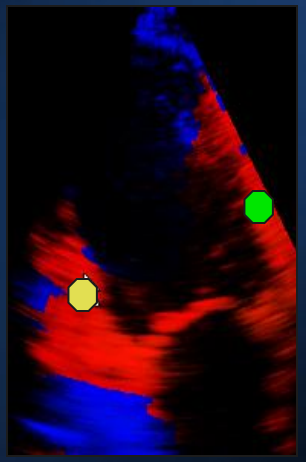
DEPARTMENT OF NONINVASIVE CARDIOVASCULAR IMAGING AND FUNCTIONAL DIAGNOSTIC

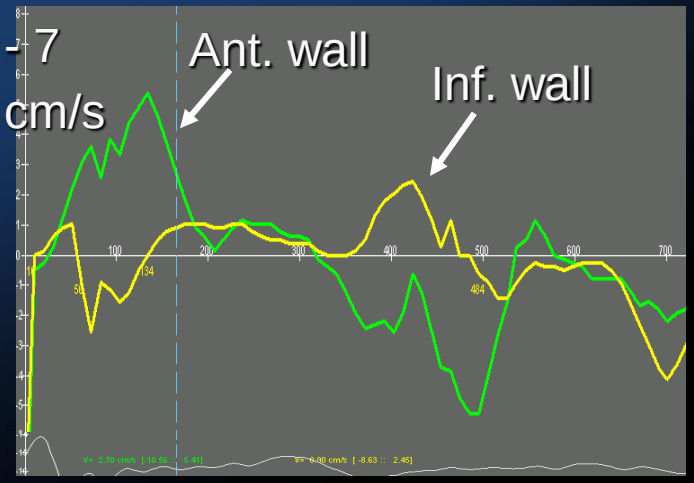
4 chamber view





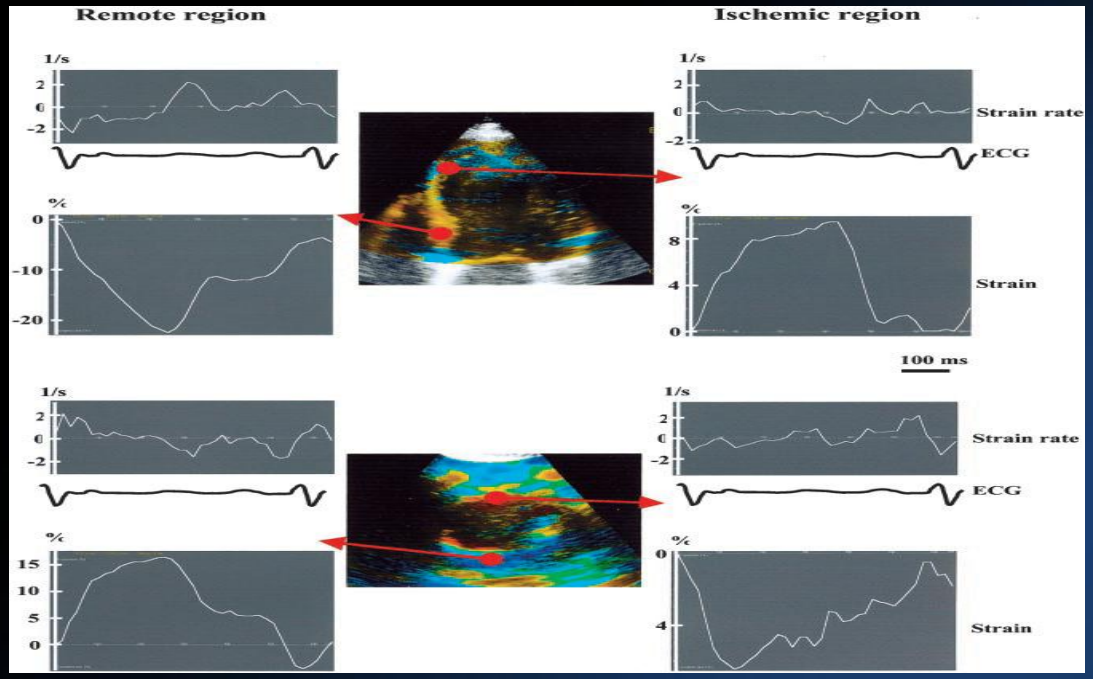
2 chamber view





Regional Function by TDI

DEPARTMENT OF NONINVASIVE CARDIOVASCULAR IMAGING AND FUNCTIONAL DIAGNOSTIC



- **TDI derived SR can identify and quantify ischemic myocardial abnormalities and Identify viable myocardium**

- **Acute coronary occlusion reduced peak systolic strain in radial and longitudinal directions in ischemic regions and after reperfusion returned close to preoclusions value**

- **Ultrasonic strain indexes differentiate acutely ischemic segments from normal's .**

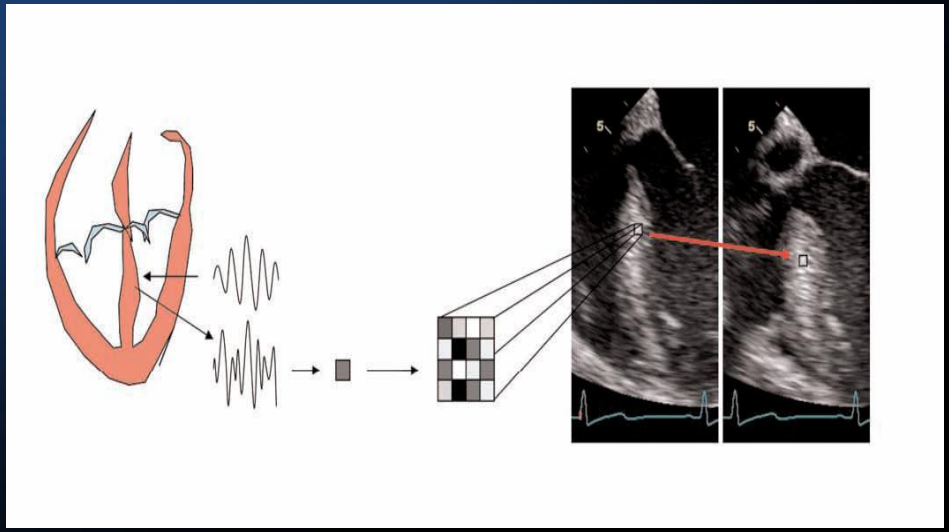
Kukulski T et all.JACC2002

Limitations of TDI Strain

- Detects only single component of strain
- Limited scope of radial (anteroseptum and posterior wall) and circumferential (septum and lateral wall) strain from parasternal window
- Subject to noise, particularly strain rate
- Very tedious to perform

Derivation of Strain by 2DEcho Speckle Tracking

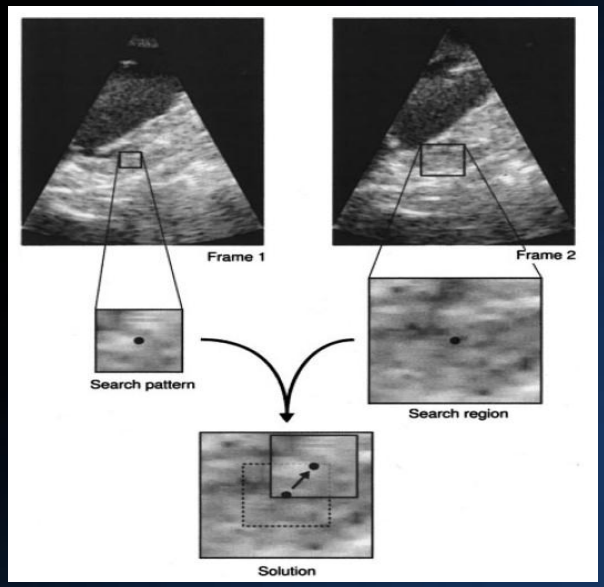
- 20-40 pixels = ‘Speckle’ →tissue marker
- Using pattern recognition algorithms → position speckles tracked and stored in dig. cine-loop of cardiac cycle
- Independent of the insonation angle

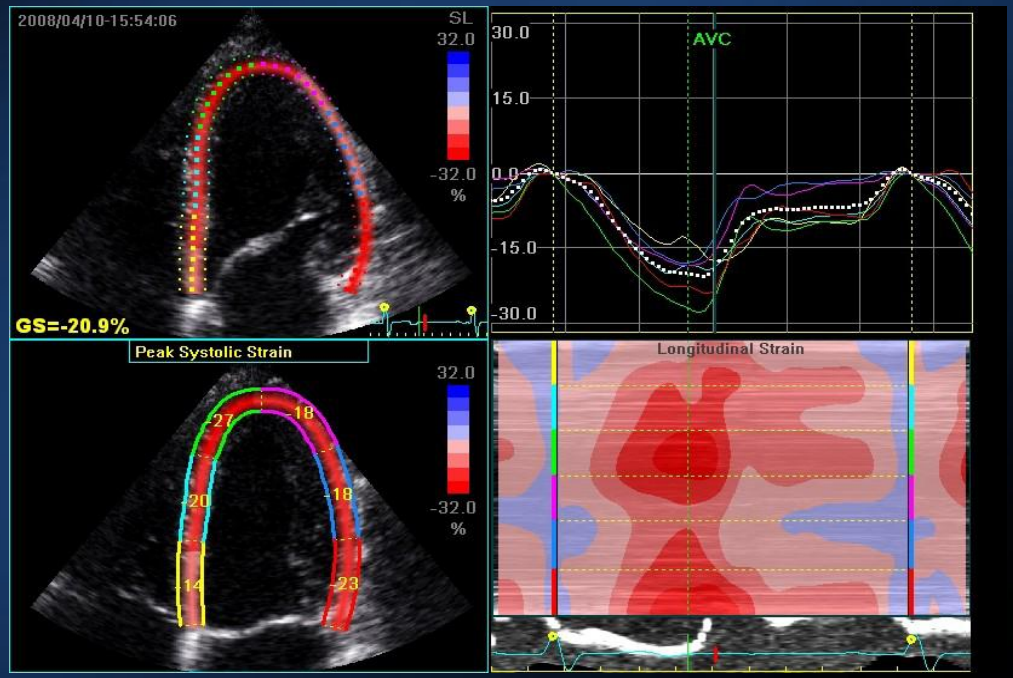


Speckle Tracking

DEPARTMENT OF NONINVASIVE CARDIOVASCULAR IMAGING AND FUNCTIONAL DIAGNOSTIC

- **2D strain with Speckle tracking**

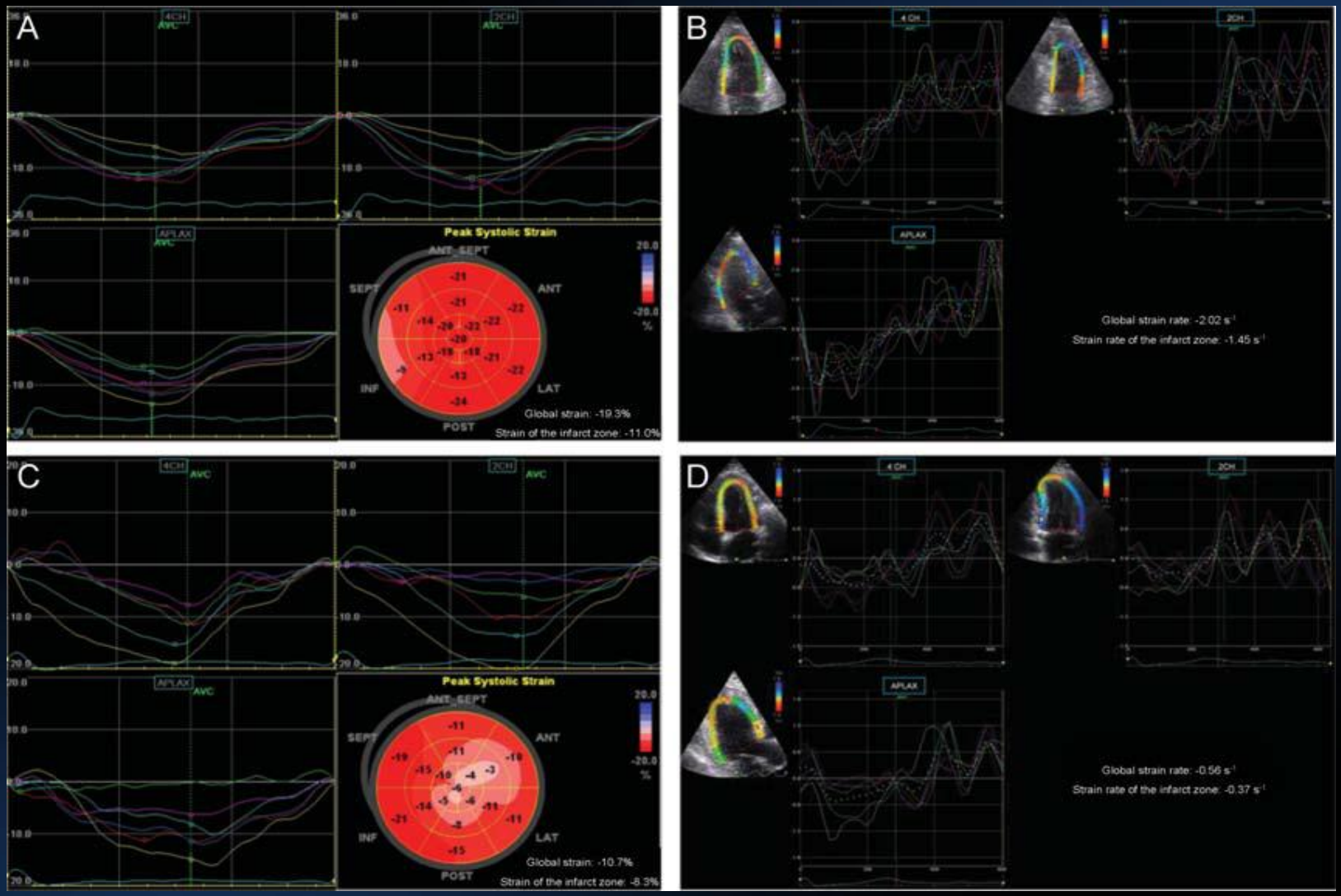




ε_LL , ε_CC, ε_RR extracted in 18 segments model

Screenshot from EchoPac (GE Vingmed, Norway)with longitudinal strain traces estimated with Speckle Tracking

LAD Infarct- Bull's eye Plot from 3 Apical Views



Myocardial infarction: Clinical Applications of Strain Imaging

- Detection of myocardial ischemia
- Assessment of myocardial viability
- Detection and sizing of myocardial infarction
- Prediction of post- MI arrhytmias

Myocardial Deformation Imaging Based on Ultrasonic Pixel Tracking to Identify Reversible Myocardial Dysfunction

Michael Becker, Alexandra Lenzen, Christina Ocklenburg, Katharina Stempel, Harald Kühl, Miria Neizel, Markus Katoh, Rafael Kramann, Joachim Wildberger, Malte Kelm, and Rainer Hoffmann

J. Am. Coll. Cardiol. 2008;51;1473-1481
doi:10.1016/j.jacc.2007.10.066

- **53 pts with chronic ischemic dysfunction undergoing revascularization**
- **Preoperative assessment with Gd –MRI and resting strain echo imaging**
- **Analysis for prediction of global and regional systolic recovery**

Nontransmural vs Transmural MI

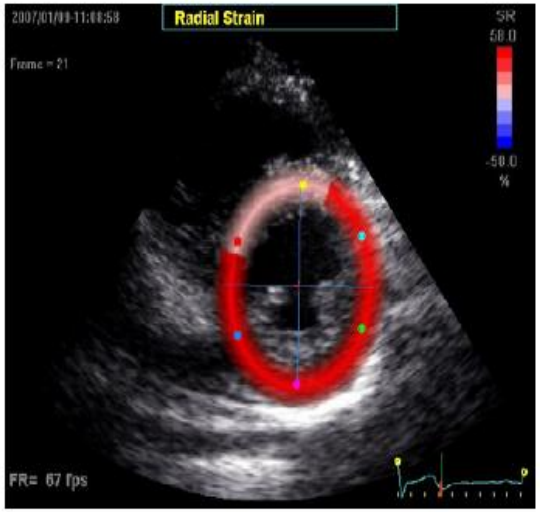
DEPARTMENT OF NONINVASIVE CARDIOVASCULAR IMAGING AND FUNCTIONAL DIAGNOSTIC

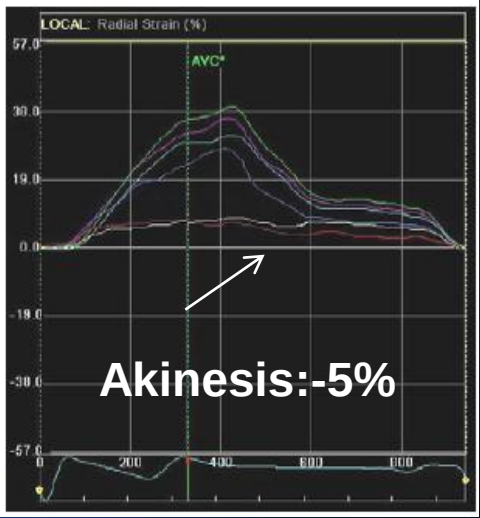
Transmural

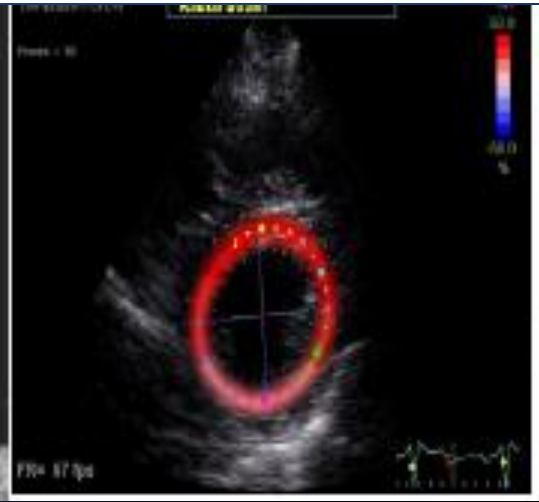
AMI

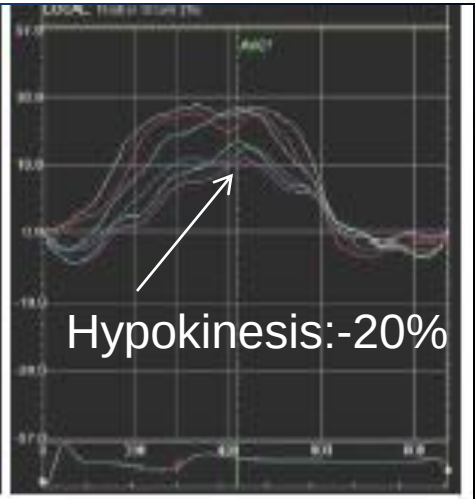
Nontransmural

AMI









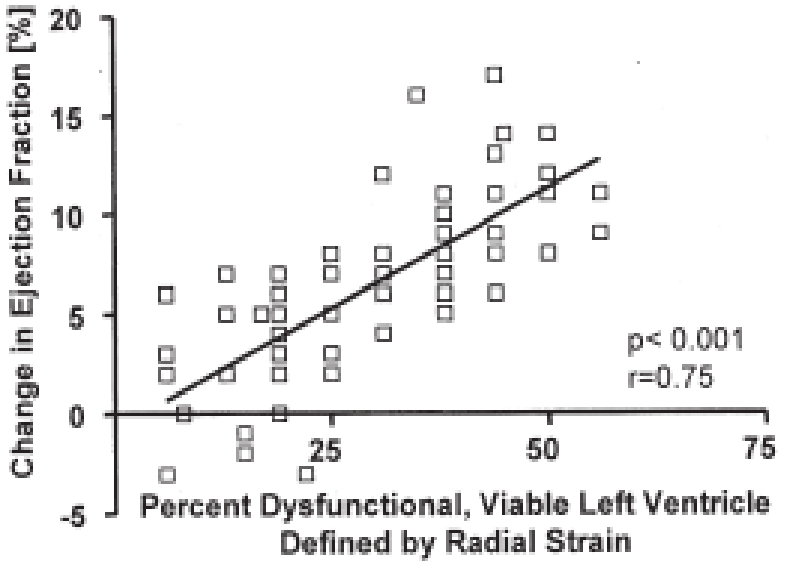
Gd-MRI

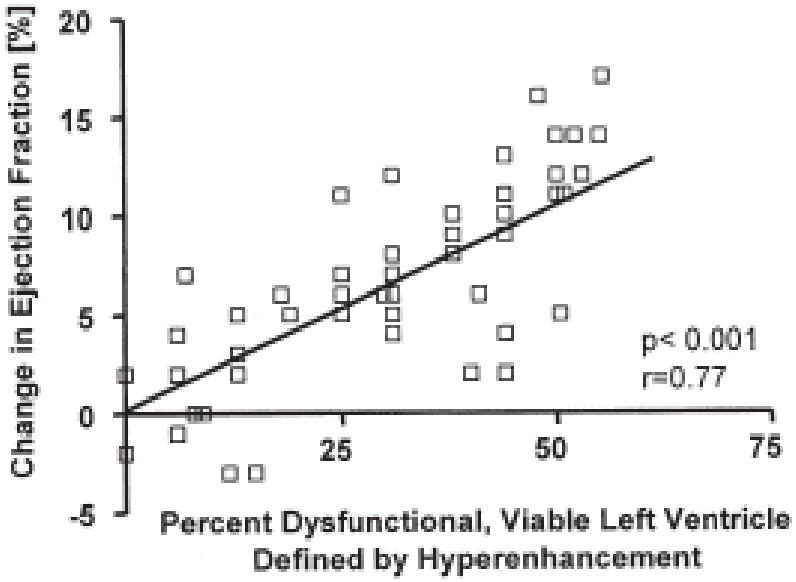
2D – STE

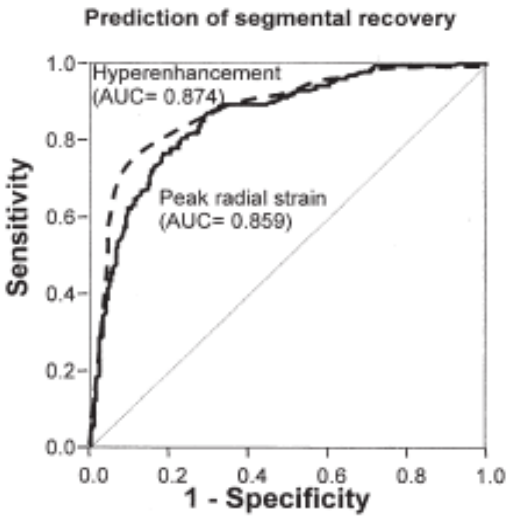
Strain curves

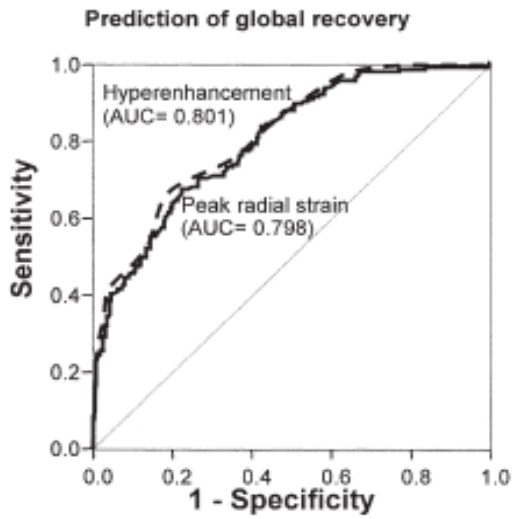
Becker et all. JACC,2008

Improvement of EF % and Prediction of Global and Regional Recovery









Becker et al.JACC,2008

Myocardial infarction: Clinical Applications of Strain Imaging

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- Detection and sizing of myocardial infarction
- Prediction of post- MI arrhytmias

Circulation
Cardiovascular Imaging
JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association
Learn and Live

Noninvasive Separation of Large, Medium, and Small Myocardial Infarcts in Survivors of Reperfused ST-Elevation Myocardial Infarction : A Comprehensive Tissue Doppler and Speckle-Tracking Echocardiography Study

Ola Gjesdal, Thomas Helle-Valle, Einar Hopp, Ketil Lunde, Trond Vartdal, Svend Aakhus, Hans-Jørgen Smith, Halfdan Ihlen and Thor Edvardsen

Circ Cardiovasc Imaging 2008;1;189-196;
DOI: 10.1161/CIRCIMAGING.108.784900
Circulation: Cardiovascular Imaging is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514
 Print ISSN: 1941-9651. Online ISSN: 1942-0080

- **40 pts studied 8.5 ±5.4 months post 1 st MI**
- **Global infarct mass measured by Gd – MRI**
- **Comparison with LV global longitudinal, circumferential and radial strain and torsion**

MRI vs Echo Strain for Infarct Size

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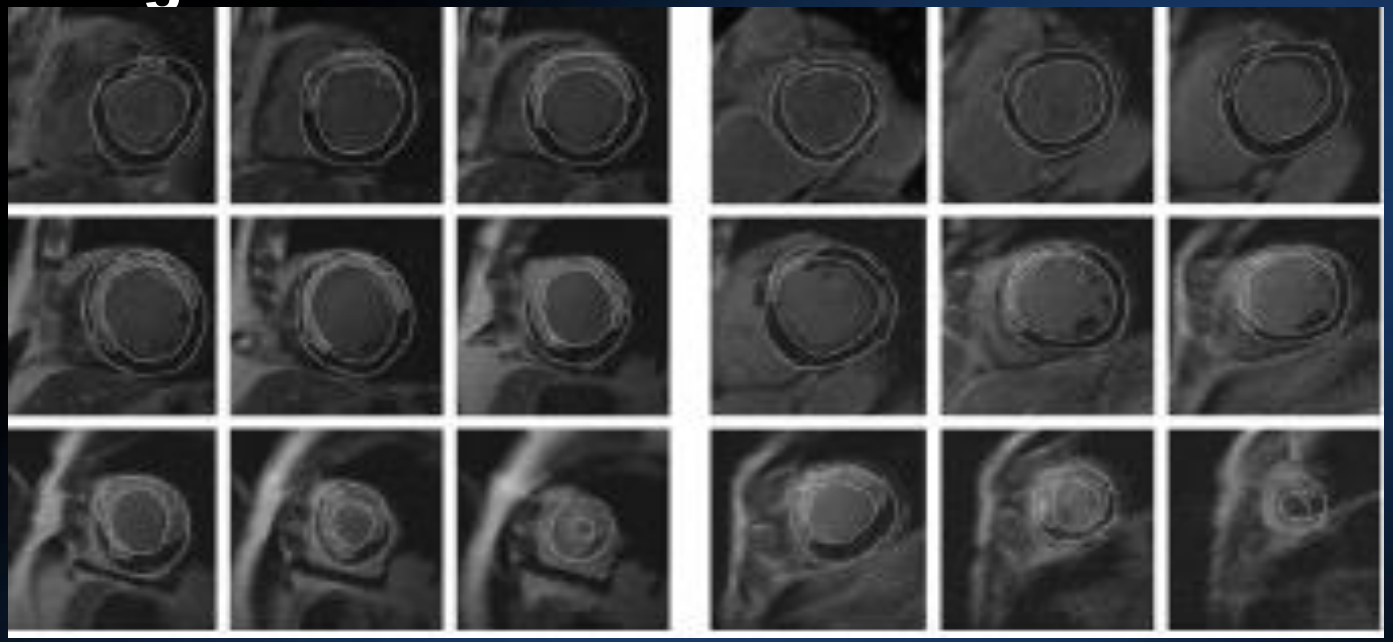
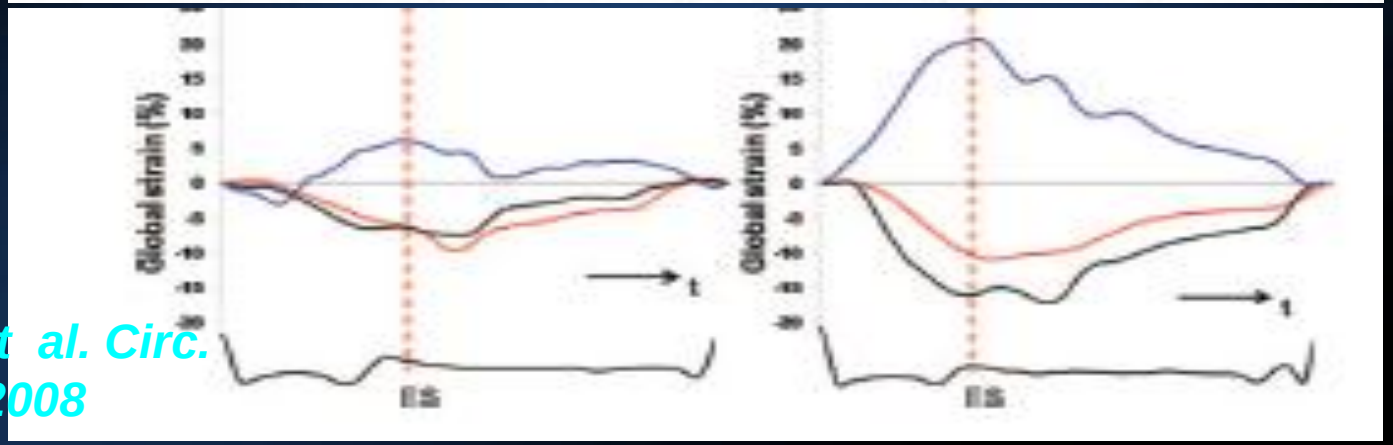
Large infarct **Medium infarct**

115 g



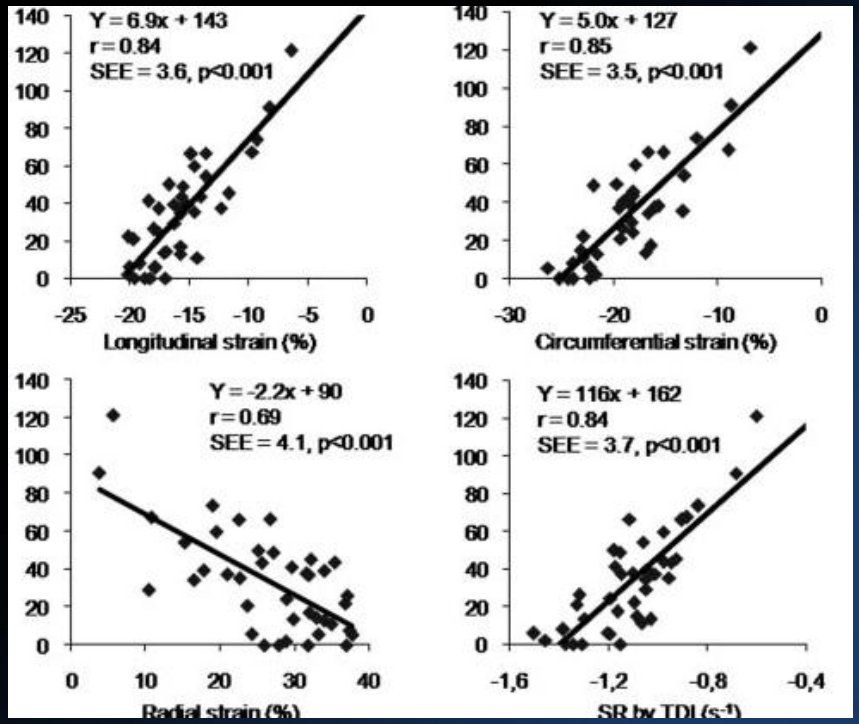
36 g

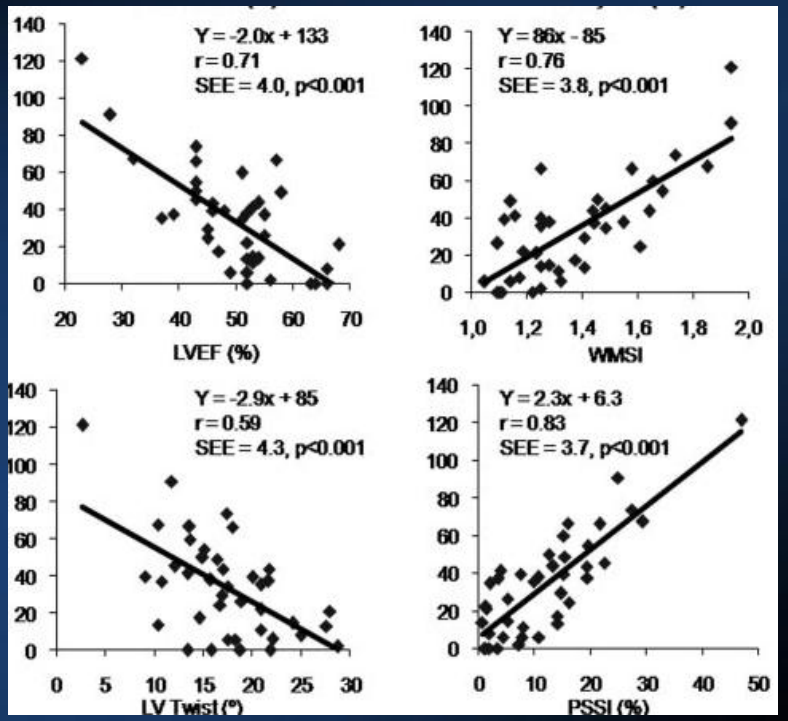


Gjesdal et al. Circ. Imaging 2008

Echo Indices vs. MRI Infarct Size

DEPARTMENT OF NONINVASIVE CARDIOVASCULAR IMAGING AND FUNCTIONAL DIAGNOSTIC

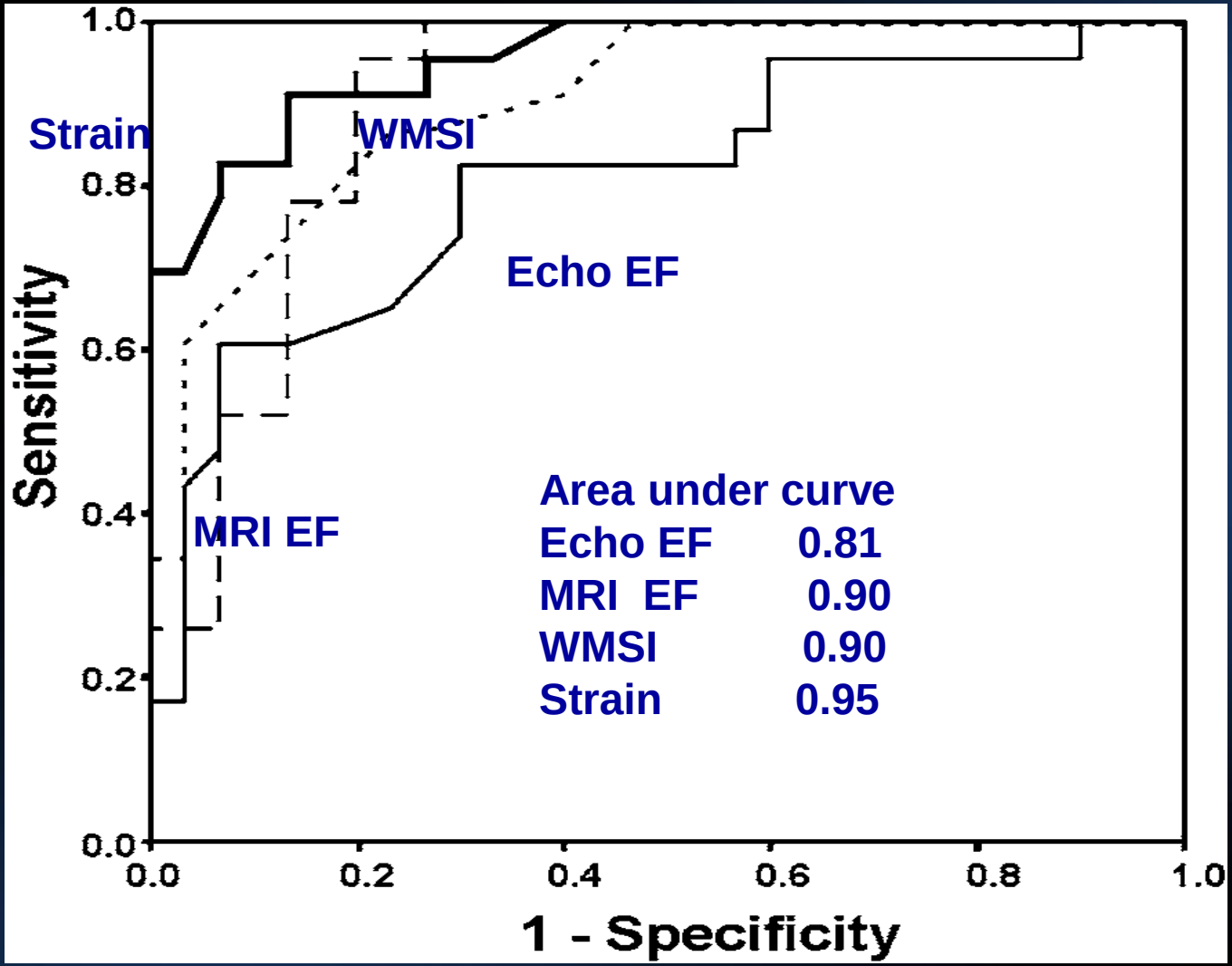




Best predictors : Longitudinal and Circumferential Strain, TDI Strain rate , post-Systolic shortening

Gjesdal et al. Circ. Imaging 2008

Detection of 30 g MI Size



Gjesdal et al. Clinical Science 2007; 113:287-96

European Journal of Echocardiography (2011) **12**, 156–165
doi:10.1093/ejechocard/jeq168

Global longitudinal strain by speckle tracking for infarct size estimation

Kim M
Hans E
[1]Department
Hospital Skejb

Received 16 Au

Aims

Methods and resu

European Heart Journal (2010) **31**, 1640–1647
doi:10.1093/eurheartj/ehq105

CLINICAL RESEARCH
Imaging

Prognostic importance of strain and strain rate after acute myocardial infarction

M. Louisa Antoni[1], Sjoerd A. Mollema[1], Victoria Delgado[1], Jael Z. Atary[1], C. Jan Willem Borleffs[1], Eric Boersma[2], Eduard R. Holman[1], Ernst E. van der Wall[1], Martin J. Schalij[1], and Jeroen J. Bax[1]*

[1]Department of Cardiology, Leiden University Medical Center, Albinusdreef 2, 2333 ZA Leiden, the Netherlands; and [2]Erasmus Medical Center University, Rotterdam, the Netherlands

Received 8 September 2009; revised 5 March 2010; accepted 12 March 2010; online publish-ahead-of-print 27 April 2010

infarct size in patients with non–ST-segment–elevation myocardial infarction, as well as the ability of these parameters to identify patients with substantial infarction.

Methods and Results—Sixty-one patients with non–ST-segment–elevation myocardial infarction were examined by echocardiography immediately before revascularization, 2.1±0.6 days after hospitalization. LV systolic function was assessed by ejection fraction, wall motion score index, and circumferential, longitudinal, and radial strain in a 16-segment LV model. Global strain represents average segmental strain values. Infarct size was assessed after 9±3 months by late-enhancement MRI, as a percentage of total LV myocardial volume. A good correlation was found between infarct size and wall motion score index (r=0.74, P<0.001) and global longitudinal strain (r=0.68, P<0.001). Global longitudinal strain >−13.8% and wall motion score index >1.30 accurately identified patients with substantial infarction (≥12% of myocardium, n=13; area under the receiver operator curve, 0.95 and 0.92, respectively).

Conclusions—Echocardiographic parameters of LV systolic function correlate to infarct size in patients with non–ST-segment–elevation myocardial infarction. Global longitudinal strain and wall motion score index are both excellent parameters to identify patients with substantial myocardial infarction, who may benefit from urgent reperfusion therapy. (*Circ Cardiovasc Imaging*. 2010;3:187-194.)

Key Words: myocardial infarction ■ echocardiography ■ MRI ■ myocardial contraction

Myocardial infarction: Clinical Applications of Strain Imaging

- Detection of myocardial ischemia
- Assessment of myocardial viability
- Detection and sizing of myocardial infarction
- Prediction of post- MI arrhythmias

JACC: CARDIOVASCULAR IMAGING
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DOI:10.1016/j.jcmg.2009.11.012

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

- **85 post MI pts with ICDs studied w/ longitudinal strain imaging**
- **After 2,3 y, 38 pts had 1 or more appropriate shocks**
- **Echo indices analyzed for prediction of appropriate shocks**

Haugaa et al .JACC Img 2010, 3,247-56

Mechanical Dispersion of LV Strain Predictor of Future Arrhythmias

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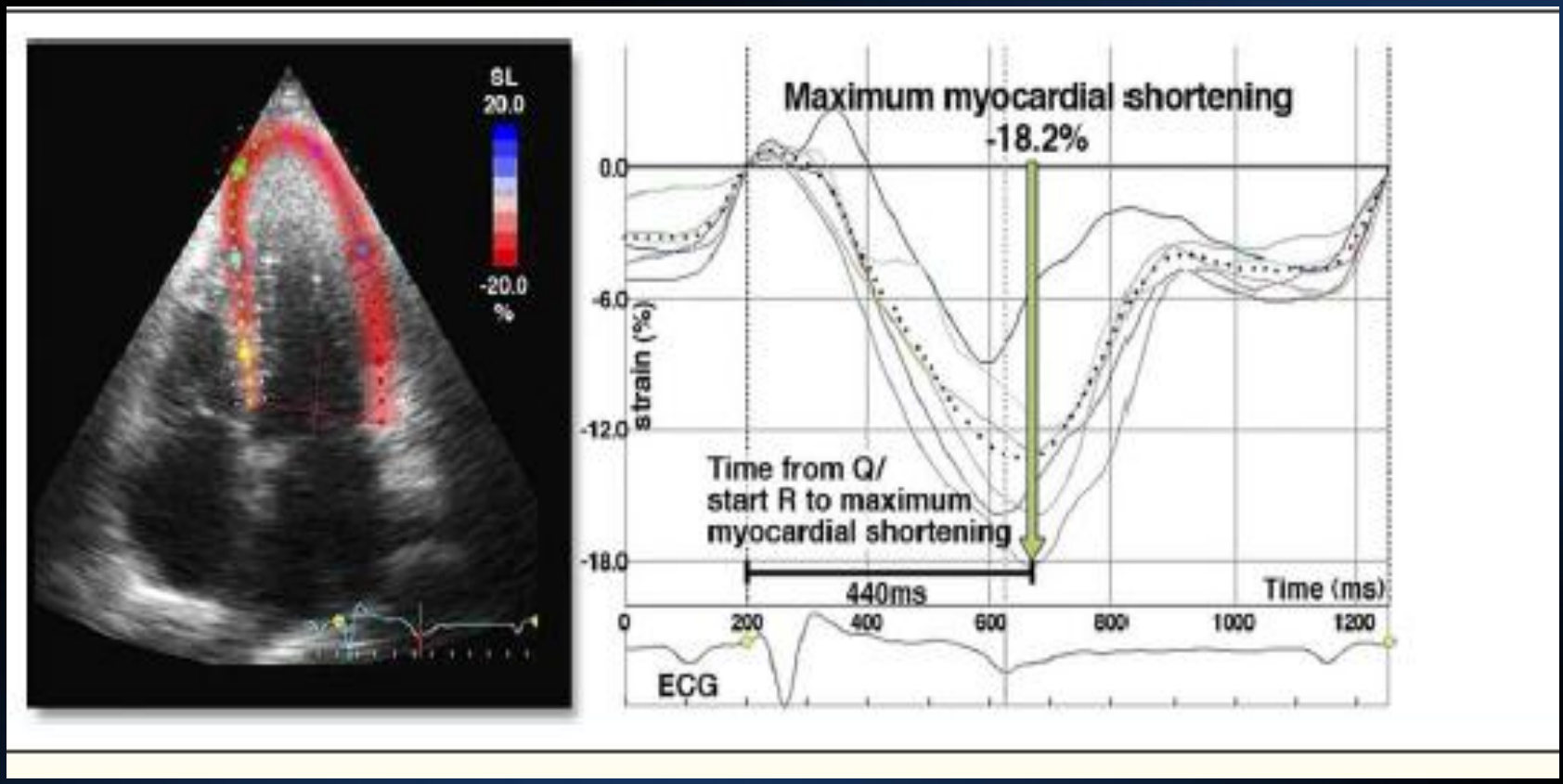
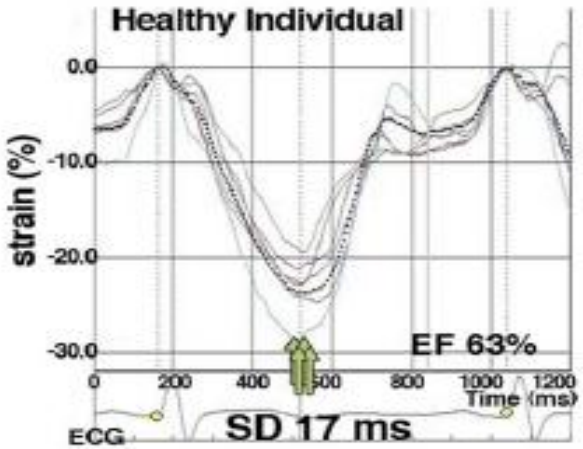
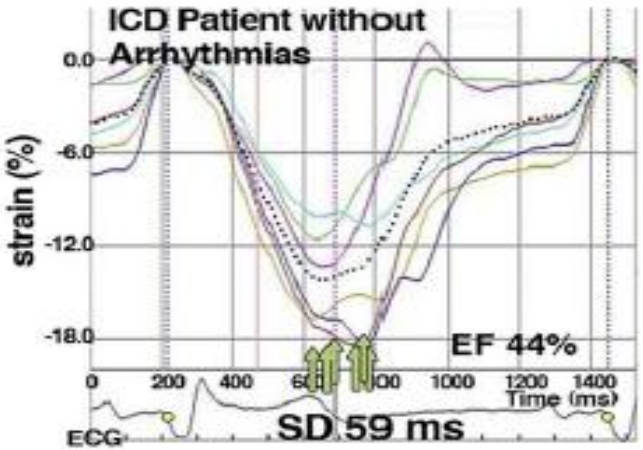


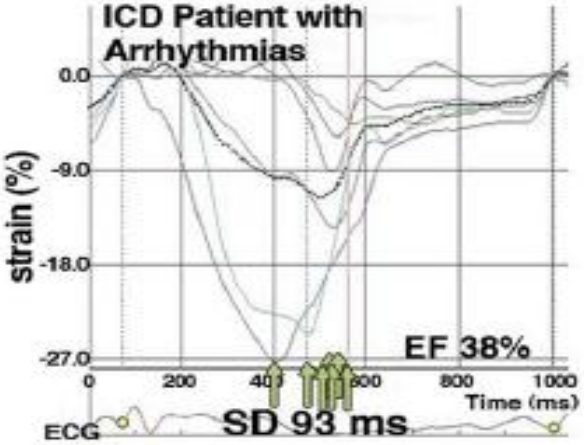
Standard deviation of time to peak longitudinal strain

Haugaa et al .JACC Img 2010, 3,247-56

Mechanical Dispersion of LV Strain

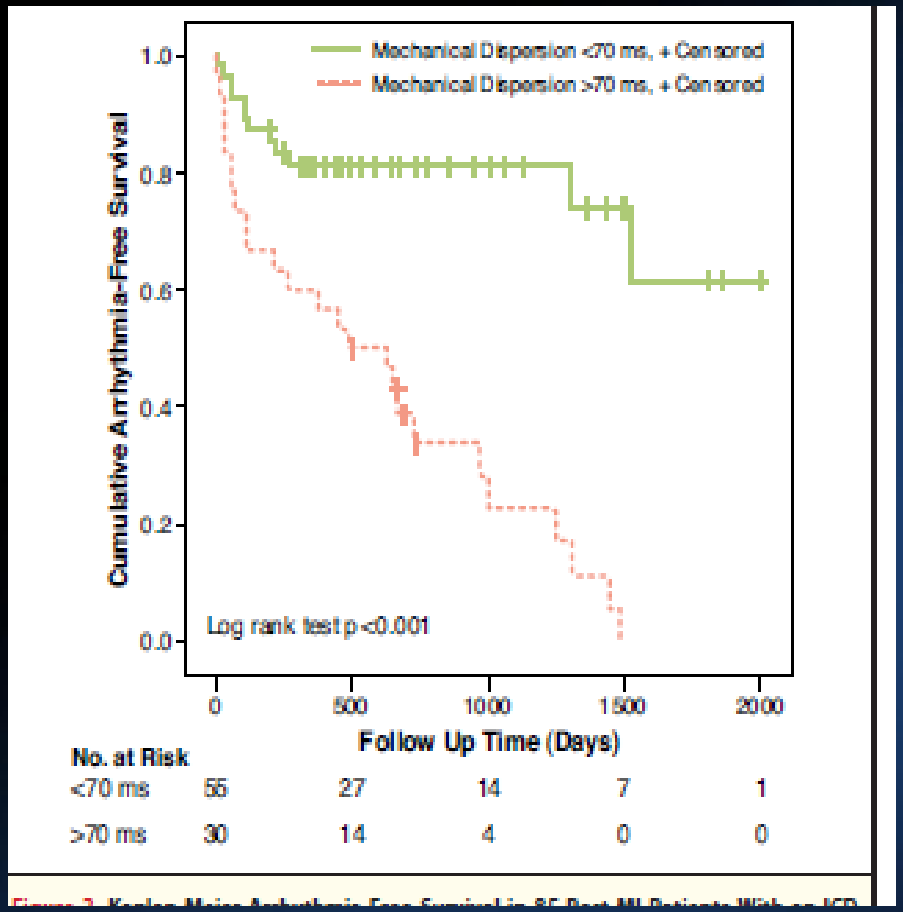


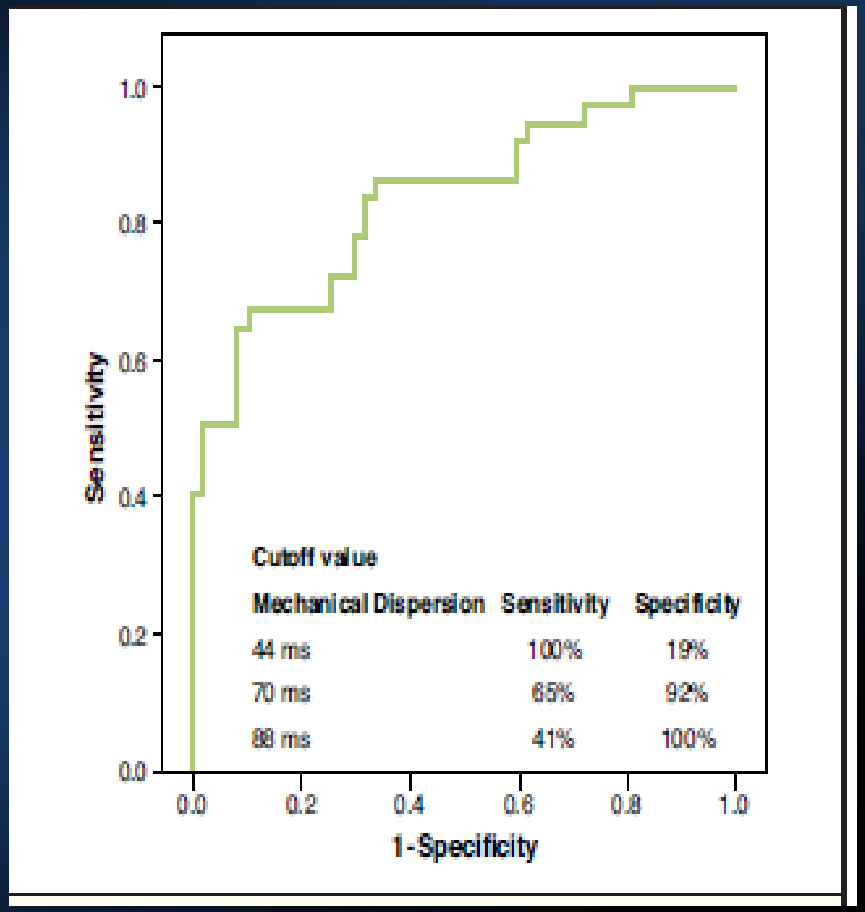




Haugaa et al .JACC Img 2010, 3,247-56

Mechanical Dispersion of LV Strain

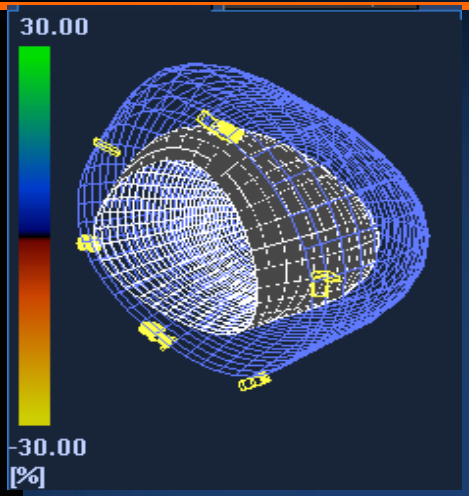




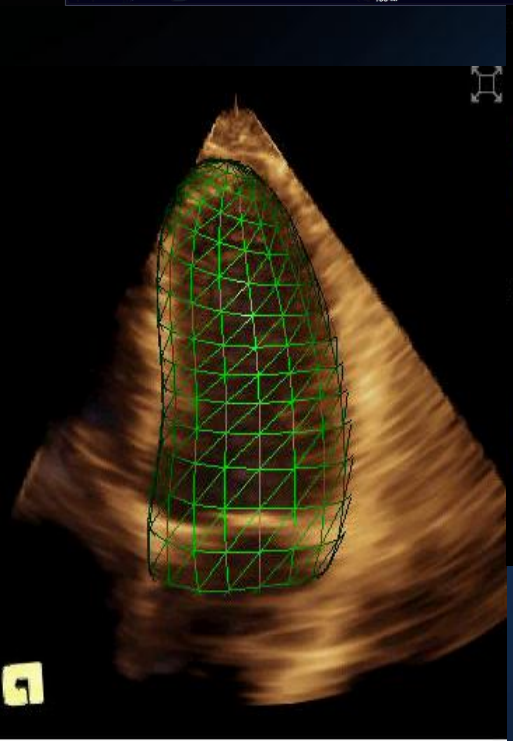
- **No difference in EF : 34±11% vs 35±9%**
- **Mechanical dispersion: 85±29 msec vs 56±13 msed , p<0.001**

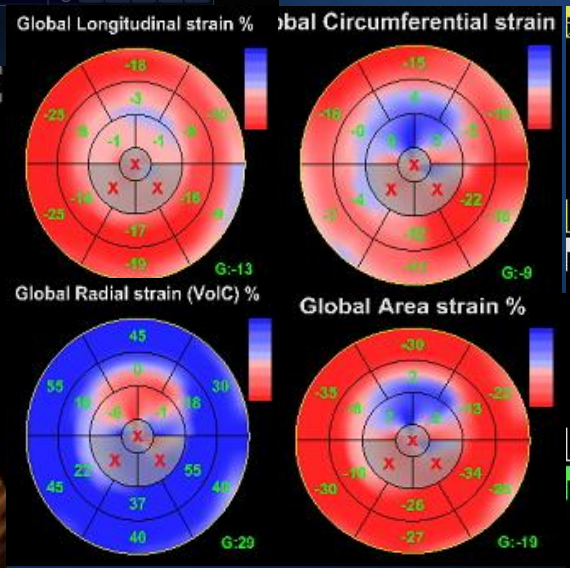
Haugaa et al .JACC Img 2010, 3,247-56

New Era : 3D Speckle Tracking

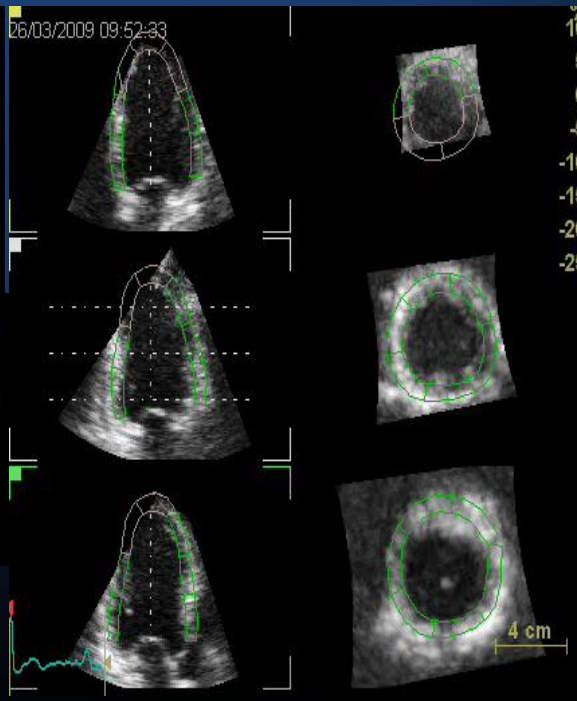


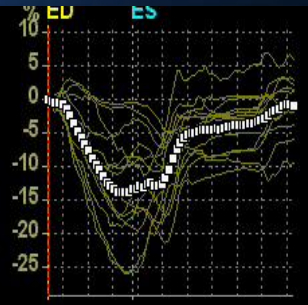
We now have the echocardiographic tools available
to let us assess LV contraction, Relaxation, compliance, suction,
and filling pressure.

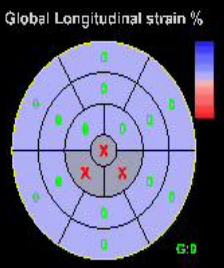




Data courtesy by L. Badano







Limitation of Strain Imaging for Analysis of Myocardial Ischemia and Viability

- Need of adequate 2D echo image quality
- Limitations of current analysis of software –no regional adjustment to differences in wall thickness
- Dependences on volume load of the LV – not applicable in patients with severe valve diseases.
- Currently better evaluated for analysis of chronic ischemic dysfunction, less for analysis of viability in acute infarction
- Pts with rhythm disorders (atrial fibrillation, conduction, disturbance) should not be evaluated
- No validation against histologic findings in human

Conclusion

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- **Myocardial deformation analysis allows sensitive identification of ischemic myocardium**
- **Myocardial deformation imaging allows analysis of myocardial viability in chronic and acute ischemic dysfunction**
- **Recovery of segmental and global LV function can be predicted with good accuracy using myocardial deformation analysis performed on rest echocardiography**

Thank you for your attention !