Deformation Patterns in Coronary Disease

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Visual Function Assessment
semi-quantitative „wall motion score“

1 normal
2 hypokinesia
3 akinesia
dyskinesia

Quantitative Function Assessment

strain
strain rate

AVC
MVO

Chronic Infarction
septum with apical dyskinesia

How to Quantify Regional Dysfunction?

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Chronic Infarction

peak systolic
Strain Rate
[s⁻¹]

-2
-1.5
-1
-0.5
0
0.5
1
1.5
peak IVR
Strain Rate
[s⁻¹]

-2.5
-1.5
-0.5
0.5
1.5
2.5

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Acute Ischemia

acute myocardial infarction in man
(LAD occlusion)

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Ischaemia and Reperfusion

Kukulski et al., JASE 2002: Acute Changes in Systolic and Diastolic Events During Clinical Coronary Angioplasty...

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Deformation Imaging

Post-systolic Shortening
... in acute ischemia

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Regional Response to Ischemia

Baseline 5s ischemia 10s ischemia 20s ischemia

Post-systolic Shortening...

...in ischemia & reperfusion

Ischaemia and Reperfusion

recovery

acute MI 1 day after MI 2 weeks

Ischaemia and Reperfusion

recovery

acute MI 1 day after MI 2 weeks

Post-systolic Shortening...

...in normals

Deformation Imaging
**Post Systolic Deformation**

- Healthy volunteer

**Post Systolic Shortening**

- "PSS" defined as predominantly negative SR between AVC and E-wave
- Occurrence: 81 / 313 segm. (26%)

**Post Systolic Shortening**

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**How to define pathology?**

**Post Systolic Deformation**

- Histogram of normal segments

**Post Systolic Deformation**

- Histogram of chronically infarcted segments
**Post Systolic Index**

- AVC
- MVO
- PSS > 20% of syst. Strain

**Postsystolic Shortening**

- AVC
- MVO
- PSS > 20% of syst. Strain

**How to use it Clinically?**

Detecting Chronic Scar

**Detecting Subtle Dysfunction**

*post-infarct patient?*

**Detecting Subtle Dysfunction**

*post-infarct patient!*

**Chronic Infarction**

- Velocity vs. deformation
  - Long. velocity
  - Long. strain

**Chronic Infarction**

- Speckle tracking: systolic strain
Chronic Infarction

speckle tracking: postsystolic index

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Post-systolic index

PSI: 37%

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Chronic Infarction

speckle tracking: postsystolic index

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How to use it clinically?

Ischemia detection during Stress Echo

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Strain Rate Imaging in Stress Echo

rest

stress

strain ischemic segment

strain non-ischemic segment

ECG

Strain Rate Imaging in Stress Echo

Voigt et al., Circulation 2003

Visual Assessment

post-systolic shortening

regular replay

slow replay

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Strain Rate Imaging in Stress Echo

ROC analysis of quantitative parameters

parameter | AUC
---|---
PSS | 0.90
systolic strain rate | 0.74
systolic strain | 0.65

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Case: Dobutamine Stress Echo, 4CV

Case: Quantitative Assessment

Case: Strain Rate in Stress Echo

Summary

Changes in strain and strain rate patterns are sensitive markers of myocardial dysfunction.

Post-systolic shortening is a characteristic, easy to recognize feature which is hardly affected by noise.

Newly developing post-systolic shortening has a high accuracy for detecting ischemia.