ORAL PRESENTATIONS

Strain rate imaging in ischaemic heart disease

Thursday, 8 December 2005, 8:30–10:00

Location: Giotto

155 Combined assessment of segmental circumferential strain and segmental rotation by speckle tracking echocardiography in normal and ischemic myocardium

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Background: MRI-tagging has been the only non-invasive, angle independent method for assessment of regional myocardial strain. Recently, 2-D speckle tracking echocardiography (STE) has been proposed as an alternative method.

Aim of the study: To validate combined assessment of peak segmental circumferential strain (CS) and segmental rotation by STE in normal and ischemic myocardium, using MRI-tagging as reference method.

Methods: In 9 healthy controls and 7 patients with previous anterior infarctions, LV apical short-axis images were obtained by conventional echocardiography and MRI-tagging. From the echocardiographic recordings peak CS and rotation were measured in six apical segments by automatic tracking of speckle pattern displacement from frame to frame. Corresponding measurements were done by MRI-tagging analysis.

Results: In healthy controls mean peak CS for all segments was 33.8±3.5 (%SD) by STE and 30.8±3.5% by MRI, as compared to 14.2±10.1 (p<0.0001) and 16.8±9.8% (p<0.0001), respectively, in patients. In contrast to controls, patients had substantial variation in segmental CS. In controls, peak rotation for all segments was 10.9±2.6° by STE and 11.8±3.1° by MRI, and 7.7±4.0° (p<0.0001) and 9.0±5.3° (p<0.002), respectively, in patients. Correlation (Fig.) and agreement was good for both segmental CS (r=0.89, p<0.0001, mean difference 2.9±4.8%), and for segmental rotation (r=0.70, p<0.0001, mean difference -0.8±3.7%).

Conclusion: Segmental CS and rotation can be measured accurately by STE, which is a promising non-invasive tool for quantification of regional LV function.

156 Speckle tracking echocardiography (2-D strain) allows diagnosis of left ventricular regional systolic and diastolic dysfunction in patients with coronary artery disease at rest

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Background: Diagnosis of regional myocardial disturbances at rest in patients with coronary artery disease (CAD) is challenging in absence of overt left (LV) ventricular dysfunction. The new 2-D strain, a grey- scale based software, called Speckle tracking (STE), may differentiate healthy from diseased LV walls at rest. By virtue of its ability to register velocity and its derivatives from longitudinal, radial, circumferential and global level, STE may provide data to understand LV motion dynamics in CAD. The aim of the present study was to investigate whether regional myocardial dysfunctions could be diagnosed at rest.

Methods: 12 subjects (54±8 yrs) without CAD and 8 with angiographically documented CAD (62±7 yrs) underwent STE on a new version of VIVID 7 equipment. Parasternal short axis and apical LV images were post processed using a custom STE software to measure longitudinal isovolumic contraction ($S_1$), peak systolic ($S_2$), early (E') & late (A') diastolic velocities (cm/s), systolic displacement and end-systolic strain ($S_E$) from 16 LV segments. Results: LV dimensions and ejection fraction did not differ (all p>0.05). Longitudinal $S_1$, $S_2$, E' velocities, & S_E differed regionally. Correlation (Fig.) and agreement was good for both segmental CS ($r=0.89$, p<0.0001) and for segmental rotation ($r=0.70$, p<0.0001) that became worse in CAD (r=0.7, p<0.001).

Conclusion: STE obtained regional $S_1$, $S_2$, and E' velocities and $S_E$ can differentiate healthy from diseased LV segments already at rest. STE also reveals altered LV motion dynamics in patients with CAD.

157 Alteration of left ventricular mechanics in subendocardial infarction: assessment by strain rate imaging

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Previous animal studies have suggested that myocardial contractile function at rest is dependent on longitudinal fibres in the subendocardium.

Aim: We aim to investigate how short and long axis functions are affected by subendocardial infarction in humans.

Methods: Fifty-five (n=55) patients post myocardial infarct undergone tissue Doppler imaging (TDI) and gadolinium contrast enhanced cardiac magnetic resonance imaging (CE-MRI). Transmural extent of infarct (TME) was measured by the degree of delayed gadolinium enhancement on Ce-MRI. Transmural extent of infarct (TME) was measured by the degree of delayed gadolinium enhancement on Ce-MRI. Subendocardial infarct was defined as TME<50% and transmural infarct as TME>50%. Regional short-axis contractile function was assessed by measuring regional ejection fraction (EF), and percentage systolic radial thickening of the myocardium (%ST) on
MRI. Long axis function was assessed by measuring peak longitudinal strain (PS) and strain rate (SR) on TDI.

Results: Out of a total of 860 segments, Co-MRI identified 206 scar segments of which 199 were subendocardial infarcts. There was significant preservation of contractile short axis function (EF and %ST) in subendocardial infarcts compared to transmural infarcts. Similarly, long axis function on TDI showed significant preservation of PS but not SR in subendocardial infarcts.

TME vs. Long and Short axis function

<table>
<thead>
<tr>
<th>Subendocardial (n=199)</th>
<th>PS Long axis</th>
<th>PS Short axis</th>
<th>SR Long axis</th>
<th>SR Short axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>TME (%)</td>
<td>40±10</td>
<td>15±10</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>EF (%)</td>
<td>34±8</td>
<td>18±8</td>
<td>1.0±0.6</td>
<td>1.0±0.6</td>
</tr>
<tr>
<td>P value</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Conclusion: Increasing TME is associated with deterioration of short and long axis contractile function. However, contrary to previous animal studies, some contractile function is preserved in subendocardial infarction. Further studies are needed to elucidate the anatomical orientation of different layers of fibres in the myocardium.

158
Comparison of time to peak velocity measurements by tissue synchronous imaging and 2 dimensional strain, a novel software to coronary angiocardiography in patient with suspected coronary disease

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Background: Several investigators have demonstrated that delayed myocardial shortening in the long axis and loss of relations between the long and short-axis motion for patients with coronary artery disease. We proposed that delayed time to peak contraction velocity in regional myocardium as measured by Tissue Synchronous Imaging (TMI), which is a rapid and simple analysis method designed to simplify the detection of dys synchronous wall motion could potentially identify the group of patients manifesting myocardial asynchrony related to ischemia. And we also proposed that 2-dimensional(2D) strain on the basis of the estimation that a discrete set of tissue velocities are present per each small element on the ultrasound image could measure deformation of normal and dysfunctional myocardium.

Methods: Novel computer software for tissue tracking echocardiography for advanced wall-motion analysis and TMI imaging(Vis/2 7 Dimension, GE Medical) were performed in 26 patients with chest pain but without visually apparent wall-motion abnormalities by conventional echocardiography prior to coronary angiography. Segmental longest time to peak contraction velocity (Tpv) was acquired by TMI imaging through 3 apical views. Radial(R) and circumferential(C) strains were measured through 3 level of short axis views. Longitudinal(L) and transverse(T) strains were measured through 3 apical views. Significant coronary disease was considered if stenoses > 50% from quantitative angiography.

Results: Delay in Tpv on 1 or more of the 12 nonapical segments was noted in 8 of 26 patients. There was a significant positive correlation between Tpv and severity of coronary disease (r=0.35, p=0.01). There was no significant correlation between Tpv and conventional angiographic parameters.

Conclusion: The new ultrasound method of measuring TMI imaging and 2D strain on the basis of the estimation that a discrete set of tissue velocities are present per each small element on the ultrasound image could measure deformation of normal and dysfunctional myocardium.

159
Mean systolic annular velocity and strain score index: new and non-invasive parameter for the evaluation of acute myocardial infarction patients

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Background: We aimed to evaluate the role of mean annular velocity and strain score index in the diagnosis of patients with first acute myocardial infarction (AMI) and the relation of these parameters with left ventricular systolic function.

Methods: Seventy-two patients (55 male, mean age: 62±13 years) were tolerated procedures without significant complications. The percent change of TR showed distinct but statistically insignificant linear correlation with LVEDP (r=0.40, p=0.10) but, change of psSR and WMSI didn't showed any significances. Also, interestingly, percent change of TR showed distinct but statistically insignificant linear correlation with the diastolic echocardiographic parameter, the difference of pulmonary venous atrial flow reversal duration and mitral A wave duration (r=0.44, p=0.07).

Conclusion: Myocardial viability may have an influence on left ventricular end diastolic pressure(LVEDP) and LV diastolic function reflecting chamber remodeling in the early phase after AMI.

P < 0.001. A cut of value of 8.44 cm/s differentiated AMI patients from controls with 97.2% sensitivity, 99.3% specificity, 97.2% positive predictive value and 93.3% negative predictive value. The patients with AMI have also decreased mean systolic strain score index (11.2±2.8 vs 19.1±2.0, p<0.001). A cut of value of 15.33% differentiated AMI patients from controls with 94.7% sensitivity and 100% specificity. There was a good correlation between left ventricular ejection fraction and mean systolic annular velocity (r=0.73, p<0.001) and mean systolic strain score index (r = -0.68, 0.63, p< 0.001).

Conclusions: The patients with first myocardial infarction have decreased mean systolic annular velocity and mean systolic strain score index. These two parameters might be useful in the diagnosis and follow up of patients with myocardial infarction. They also provide a simple, rapid, quantitative and non-invasive tool for assessing left ventricular systolic function in patients with first acute myocardial infarction.

160
Correlation of myocardial viability by strain rate imaging with left ventricular diastolic function in the early phase after acute myocardial infarction

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Background: Myocardial viability may influence the diastolic function of left ventricle(LV) reflecting chamber remodeling in early phase after acute myocardial infarction(AMI). However there were few reports about this relationship in human. In this prospective study, we aimed to evaluate whether myocardial viability by strain rate imaging has an influence on LV end diastolic pressure(LVEDP) in selected patients in the early phase after AMI.

Methods: Twenty-four consecutive patients with AMI and angiographically significant coronary stenosis and 2 patients without angiographically significant coronary stenosis were included in the study. Conventional echocardiography with tissue Doppler imaging was performed in the early phase after AMI. Myocardial viability was quantitated by strain rate imaging by means of combination of peak systolic strain rate (psSR) and percent change of time to onset of regional relaxation (TR) and classical wall motion score index (WMSI). And various echocardiographic parameters showing LV diastolic function were measured. Within 6 hours after the study, left heart catheterization for recording of LVEDP was performed.

Results: Patients (68±13 years) were tolerated procedures without significant complications. The percent change of TR showed distinct but statistically insignificant linear correlation with LVEDP (r=0.40, p=0.10) but, change of psSR and WMSI didn't showed any significances. Also, interestingly, percent change of TR showed distinct but statistically insignificant linear correlation with the diastolic echocardiographic parameter, the difference of pulmonary venous atrial flow reversal duration and mitral A wave duration (r=0.44, p=0.07).

Conclusion: Myocardial viability may have an influence on left ventricular end diastolic pressure(LVEDP) and LV diastolic function reflecting chamber remodeling in the early phase after AMI.

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