Doppler Myocardial Imaging for Improving Stress Echocardiography

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Location: Robert Stolz A

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291
Normal myocardial dose-response to dobutamine as assessed by tissue Doppler stress echocardiography

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Tissue Doppler echocardiography (TDE) allows quantification of regional LV function, and experimental studies show changes in both systolic and diastolic parameters during ischaemia. The application of TDE in dobutamine stress echo (DSE) has been limited by the time needed to sample from each segment 'on-line' and by the absence of data from normal subjects against which patients with coronary disease can be compared, but it is now being assessed in the multicentre MYDISE study (Myocardial Doppler in Stress Echocardiography).

50 subjects (25 male, 25 female, aged 50+11y) investigated for chest pain but normal by ECG-stress testing and angiography underwent DSE. TDE data (Vingmed System V) were acquired at each dose (5 to 40μg/kg/min ± atropine) and 5 parameters were measured off-line in 11 LV segments: peak systolic velocity (V), time to V (TTP), systolic velocity-time integral normalised for heart rate (NVTI), and peak E and A diastolic velocities. Heart rate increased from 68 (11) at rest to 141 (14) bpm at peak stress. V correlated with HR for all segments, particularly in the basal and mid posterior wall in the parasternal long axis (r=0.71, p<0.001).

The normal response to dobutamine for all segments was a progressive increase in V, NVTI and A, and a decrease in TTP. Results reported as mean (sd) for the basal inferior segment in the apical 2-chamber view at baseline and peak stress are shown in the table, and are typical of observed changes in all basal segments.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rest</th>
<th>Peak Stress</th>
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<tbody>
<tr>
<td>V cm/sec</td>
<td>5.8 (1.1)</td>
<td>14.0 (2.6)</td>
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<tr>
<td>TTP ms</td>
<td>153 (38)</td>
<td>60 (22)</td>
</tr>
<tr>
<td>NVTI cm/sec</td>
<td>2.68 (0.77)</td>
<td>2.86 (1.2)</td>
</tr>
<tr>
<td>A cm/sec</td>
<td>-3.7 (3.7)</td>
<td>-12.7 (3.7)</td>
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</tbody>
</table>

Significance p<0.001 p=0.001 p=0.001 p=0.001 p<0.001

These clear dose-responses of tissue Doppler indices to dobutamine can be used for off-line quantification of myocardial functional reserve. Their application may enhance the clinical value of stress echocardiography.

292
Assessment of left ventricular longitudinal contraction during stress echocardiography using Doppler myocardial imaging

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Background: Left ventricular longitudinal contraction (LVLC) impairment appears early during myocardial ischaemia and may be detected and quantified by doppler myocardial imaging (DMI). DMI assessment of LVLC during dobutamine (Dobu) echocardiography may be helpful for the detection of myocardial ischaemia.

Methods: LVLC was quantified by DMI in 19 pts during Dobu-echocardiography. Systolic myocardial segmental velocities as well as systolic velocity gradients between the base and the apex (SVGBA) of the left ventricle were measured using DMI at rest and under Dobu infusion (5 to 40 μg/kg/min). Measurements were obtained off-line using 4 and 2-chamber apical views; incremental changes in segmental SVGBA during Dobu infusion were compared between 9 normal pts and 10 pts with normal left ventricular function and one > 70% coronary stenosis (5 right coronary artery, 5 left anterior descending artery).

Results: In 9 normal pts, there was a significant increase in velocities and SVGBA from rest to high-dose Dobu. Percent increases of SVGBA were 91, 73, 95, and 80% in inferior, anterior, septal, and lateral wall segments, respectively, from rest to high-dose Dobu (p < 0.05).

Comparatively, among 10 pts with significant coronary stenosis, SVGBA increased in respective ischaemic areas only by 45% under high-dose Dobu, vs 80% in normal segments (p=0.03).

Conclusion: LVLC can be assessed by DMI at rest and during dobutamine echocardiography. Intramyocardial velocities and SVGBA increase during Dobu infusion in all normally perfused segments, but this increase appears smaller in ischaemic segments. DMI during dobutamine echocardiography is a promising technic for the detection and quantification of myocardial ischaemia.
Does assessment of regional myocardial function by Doppler myocardial tissue imaging make stress echocardiography more objective?

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Conventional dobutamine stress echocardiography (DSE) relies on subjective assessment of grey-scale images and has sub-optimal inter-observer and inter-centre reproducibility. Tissue Doppler echocardiography (TDE) allows accurate quantification of regional myocardial function, but from parasystolic waves the angle of incidence to many myocardial segments may be too high for accurate Doppler measurements of velocity. Assessment of regional longitudinal function from apical windows may overcome some of these problems. The feasibility and reproducibility of such methods are being evaluated as part of the MYDISE study (Myocardial Doppler in Stress Echocardiography). 10 patients (aged 63±7y) with >50% diameter stenosis were compared with control subjects (aged 60±7y) with normal coronary arteriography. All had standard DSE with simultaneous acquisition of TDE data at each dose level and stress induced WMA were detected in 61 (37.7%) out of 162 adequately visualized segments. In each segment we measured peak v. of systolic (S), early (E) and late (A) diastolic waves and calculated their ratio (E/A) as index of regional diastolic function.

Results: Myocardial velocities were measured in 267 (86.7%) out of 308 possible myocardial segments. During DE, in 17 (60.7%) pts WMA were detected in 61 (37.7%) out of 162 adequately visualized segments, while in 11 (39.3%) pts WMA were not detected. In segments with DE provoked WMA, ratio E/A decreased by 22.3% and S decreased by 9.6% compared to baseline values. Of 162 patients without stress induced WMA in 7 (3.4%) segments (3 in pts with positive DE, and 4 segments in two pts with negative DE) we also found inversion of E/A ratio. Evaluation of max. v. in other 199 segments without WMA showed increased ratio E/A by 24.2% in 8 pts by 12.7%.

Conclusion: PW-TDE allows quantification of regional myocardial systolic and diastolic function changes which improve the diagnosis of myocardial ischemia during conventional DE. Stress induced WMA are associated with inverted E/A ratio and decreased S. Inverted E/A ratio may be superior to WMA as an earlier, diastolic, marker of stress induced myocardial ischemia.