A correlative study comparing different methods of calculating left ventricular ejection fraction

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Background: Left ventricular ejection fraction (EF) is a major determinant of survival in patients with coronary artery disease (CAD). Comparative accuracy of current modalities in calculating EF is not well investigated.

Methods: We compared EF as calculated by rest and post-stress Cedars automated quantitative gated SPECT (AQGS), rest and post-stress semi-automatically processed gated SPECT (MQGS), echocardiography and contrast ventriculography (LVG) to those determined by rest and post-stress cavity-to-myocardium ratio (CMR) in 109 patients. Gated SPECT was performed based on 2-day protocol using To-MIBI.

Results: Mean EF in LVG, echo, post-stress CMR, rest CMR, post-stress AQGS, rest AQGS, post-stress MQGS and rest MQGS were 41.8±12.1, 44.8±11.8, 38.1%±10.7, 35.7%±12.1, 44.5%±15.1, 46.9%±14.7, 40.1%±14.3 and 43.5%±14.3 respectively. Although significant differences were observed among some of these pairs, good and excellent linear correlations were present among values (all Pearson correlations >0.63). Considering LVG as gold standard, we defined 2 groups: EF<35% (class 1) and >35% (class 2). Discriminant analysis showed SPECT has the ability to predict patient’s class. In 4/8 of patients with normal SPECT (on both visual and quantitative analyses, SSS<4), EF on echo showed a significant drop on post-stress compared with rest (Delta EF = Rest EF-Stress EF).

Conclusion: 1. Good correlation exists among different routine methods (LVG, echocardiography, gated SPECT), but the raw values of EF in different techniques are not identical and cannot be used interchangeably.
2. Adding delta EF to other quantitative ischemic indices (SSS, SDS, SRS) can increase the CAD diagnostic accuracy. Thus performing gated procedure on both phases of stress study may allow identification of post-stress stress that may aid in diagnosis of CAD, particularly in multi-vessel disease. In patients with SSS (Summed Stress Score) >13, post-stress gated SPECT can not predict angiographic EF as accurately as patients with SSS<13. 4. Whenever gating is impossible, calculation of LVCMR is a reliable alternative.

Noninvasive evaluation of the systolic left ventricular blood flow dynamics

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Purpose: We have recently developed a novel software which permits an angle-independent flow velocity vector mapping deduced from color-Doppler ultrasound data by applying stream function. It allows us to calculate the momentum (M) of LV blood flow. We assessed the hypothesis that the momentum of systolic LV blood flow is reduced in subjects with systolic dysfunction.

Methods: 38 consecutive patients were studied. The subjects were ineligible if they had atrial fibrillation or valvular heart disease (aortic valve area <1.0 cm²; mitral valve area <1.5 cm²; aortic regurgitation 6-72%) or other Doppler ultrasound data sets in the apical long axis view were used to generate flow velocity vector maps with the newly developed software. The momentum (M) of LV blood flow was calculated as the sum of (blood density x pixel area x velocity vector). M was corrected for LV area (M/LVA). The standard assessment of LV systolic function included ejection fraction and stroke volume. We examined the relationship between M, M/LVA and the standard assessment.

Results: Results were shown in the figure. There was a good correlation between M and stroke volume (r=0.66, p<0.0001). On the other hand, the correlation between M and ejection fraction was poor (r=0.45, p=0.004). However, there was strong correlation between M/LVA and ejection fraction (r=0.85, p<0.0001).

Conclusions: M, M/LVA could be applied to assess systolic LV function.

The length of aortic valve closure

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Background and purpose: The aortic valve closure (AVC) can be timed by the abrupt changes in tissue velocities. This is the end of the cusp motion, as can be seen in high frame rate apical B-mode. Motion of the valves prior to AVC can be seen in several consecutive frames. The cusps move much more rapidly than the surrounding tissue. The high longitudinal velocity of the moving cusps is evident in tissue Doppler (TDI). The purpose of this study was to time the duration of the cusp movements during aortic valve closure, using the length of the interval showing high velocities.

Method: 11 healthy male subjects were examined using the M3S probe on a Vivid 7 scanner, acquiring a narrow sector covering the septum and the aortic valve. B-mode and TDI frame rates were set to be equal. Artificial grey-scale images visualizing velocities exceeding a threshold of ±12 cm/s were generated from TDI. Only high velocities at the level of the aortic valve, as visible in B-mode images, were considered. The number of consecutive high velocity frames near the timing of AVC, set from B-mode, was counted and the corresponding time interval was calculated.

Results and discussion: Mean frame rate was 147.5 frames/s in both B-mode and TDI. In 3 (4%) analysed recordings no high velocities were found, suggesting poor alignment. In 89 (96%) at least one frame with high velocities originating from the aortic valve was found. In 26 of 72 recordings (36%) in 7 of the 11 subjects the time intervals of high velocities exceeded 25 ms. As low velocities may be the result of poor alignment, the maximum time interval for each subject may be the closest to the “true” interval. Thus the aortic valve closure time interval is taken to be the average of the maximum time interval for each subject. Mean±SD was 31.3±8.1 ms. Range was 20.0 ms to 42.5 ms.

Conclusion: The time interval of aortic valve closure is at least 30.3 ms±8.4 ms.

Anatomic M-Mode measurements in children

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Anatomic M-Mode (AMM) allows for off-line M-Mode measurements at a perfect transverse plane, perpendicular to the longitudinal LV axis, which is often difficult to be obtained during conventional real time M-Mode (MM) scanning.

Aim: To evaluate whether AMM derived measurements and LV mass (LVM) estimates differ from those obtained by MM scanning, in a setting of large scale echocardiographic screening of healthy school age children.

Patients-Methods: A group of 72 consecutive children, (29 boys, 43 girls, median age 8.8 yrs, range 8.2-9.2 yrs) participating to the initial phase of Cretan Pediatric Cardiology Survey (CPCS), were enrolled to the study. During a detailed echocardiographic evaluation, AMM measurements (FS, LV dimensions) were obtained. AMM measurements were performed off-line, using appropriate software (EchoPAC PC workstation). LVM (LVM-AMM) and indexed LVM on BSA and H2.7 was estimated by each approach. The corresponding AMM and MM values were evaluated for significant differences using the paired T-Test.

Results: Anatomic MM measurements of LV wall thickness were significantly lower than the corresponding MM measurements, whereas no difference was found as regards the diastolic dimensions of LV cavity. The LV contractile function (FS) was significantly increased by AMM measurements, whereas AMM resulted in significantly lower LVMass estimates (both absolute and indexed), than the corresponding MM estimates (Table 1).

Conclusions: Anatomic M-Mode measurements significantly differ from those obtained by conventional M-Mode. Although AMM allows for accurate measurements of data obtained during large scale population screening, their interpretation should be based on AMM obtained normal values

Table 1

<table>
<thead>
<tr>
<th>MM</th>
<th>AMM</th>
<th>Difference (95% C.I.), p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>FS</td>
<td>39.3</td>
<td>37.3</td>
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<tr>
<td>IVS (mm)</td>
<td>0.65</td>
<td>0.58</td>
</tr>
<tr>
<td>LVd (mm)</td>
<td>3.98</td>
<td>3.98</td>
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<tr>
<td>PWT (mm)</td>
<td>0.58</td>
<td>0.56</td>
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<tr>
<td>LVM-AMM (g)</td>
<td>72.3</td>
<td>62.8</td>
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<tr>
<td>LVM-AMM/BSA (g/m²)</td>
<td>67</td>
<td>58.4</td>
</tr>
<tr>
<td>LVM-AMM/H2.7 (g/m²)</td>
<td>33.3</td>
<td>28.9</td>
</tr>
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Comparison of M-Mode with anatomic M-Mode measurements obtained from healthy 8 yrs old children