3-D ECHO

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Head to head comparison of left ventricular mass measurements with real-time three-dimensional echocardiography and magnetic resonance imaging

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Purpose: Left ventricular (LV) mass is an important predictor of morbidity and mortality. Because the reproducibility of LV mass measurements is far better with cardiac magnetic resonance (cMR) than with 2D-echo, cMR has become the reference method. The aim of this study is to test the accuracy and the reproducibility of real-time 3D-echocardiography (RT-3DE) in comparison with cMR.

Methods: 51 pts with normal or abnormal LV function were evaluated by RT-3DE and cMR. RT-3DE LV mass data were analyzed using a prototype version of the QLab software that allows for semi-automatic detection of endocardial and epicardial borders and calculation of LV mass from voxel counts. With cMR, LV mass was calculated by manually tracing endocardial and epicardial borders on short-axis slices. All measurements were made twice by 2 different observers. A day-to-day reproducibility was also performed.

Results: RT-3DE and cMR measurements of LV mass were highly correlated (r=0.93) and not significantly different from each other (145±42 g vs 146±45 g, p=0.7). Intertechniques bias was -1±35 g. RT-3DE and cMR showed excellent interobserver agreement as illustrated by the small absolute (-1±34 g for RT-3DE, 2±24 g for cMR) and relative (9±9 g for RT-3DE, 8±6 g for cMR) interobserver bias. 5 pts underwent RT-3DE and cMR twice on 2 days. LV mass by both techniques were similar on both days (p=NS), with small bias (3±9 g vs 0±8 g).

Conclusion: RT-3DE allows for the accurate determination of LV mass, when compared to cMR. In addition, RT-3DE measurements of LV mass are as reproducible as those obtained with cMR. This suggests that RT-3DE can be used in the follow-up of patients with LV hypertrophy and/or remodelling.

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Newly developed transesophageal real-time 3D-echocardiography system - accuracy of distance measurements

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Background: The prototype of a newly-developed system for transesophageal Real-Time 3D-echocardiography (Real-Time-3D-TEE) has shown excellent on-line imaging of three-dimensional structures in qualitative in-vitro studies. In addition to spatial imaging and navigation of medical instruments, the system should, however, also enable quantitative measurements in the heart and large vessels.

Method: The new Real-Time 3D-TEE technology enables continuous recording of a large echo volume of 70 mm in length and a sector angle of 120°. The presentation of the volume-reconstructed data is made with a time lag of less than 100 ms. The precision of the Real-Time-3D-TEE system in regard to distance measurements was examined in-vitro using agar models of the left ventricle (fig. 1) and the aorta.

Results: Slight mean deviations from the actual value were found in the ventricle model in the measurement of length (-1.6±2.6 mm), diameter (-1.3±1.1 mm) and wall thickness (-1.1±1.6 mm). In the aorta model as well, the mean deviations were only slight: Diameter measurement 1.1±1.4 mm, diameter 2.9±0.4 mm, wall thickness 1.0±0.6 mm. The intraobserver variability over all measurements was 0.8±2.0 mm and the interobserver variability 0.4±1.7 mm.

Conclusion: In addition to excellent qualitative imaging, the newly-developed system for Real-Time 3D-TEE with an initial measuring algorithm enables distance measurements with a precision of 1-2 mm.
611 Surface detection and color-encoding applied to real-time three-dimensional echocardiographic images as a basis for automated assessment of left ventricular wall motion

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Purpose: Color encoding of left ventricular (LV) endocardial motion in 2D echo (2DE) has been shown to improve visual detection of regional left ventricular wall motion abnormalities (RWMA). Our goals were: 1) to extend this technique to color encode detected LV endocardial surfaces from real-time 3D echo (RT3DE) images; 2) to automatically detect systolic RWMA and test its accuracy against visual interpretation of 2DE images.

Methods: 19 normal subjects (N), and 14 patients with RWMA (including 7 with global LV dysfunction) underwent RT3DE and 2DE (Philips). 2DE images (apical O, 4- and 3-chamber) were reviewed by an expert cardiologist, who graded wall motion (18 segments model) as normal or abnormal (AB). RT3DE datasets were analyzed using custom software: frame-by-frame semi-automated LV surface detection was followed by logical operations applied to each pair of consecutive frames, to track and color encode endocardial motion in 3D. Then, regional fractional volume change (RFVC) in % of regional end-diastolic volume was calculated automatically by colored voxels count, and displayed as stacked color-histograms. In RWMA, RFVCs were compared with regional thresholds, derived from RFVC computed in N and optimized using ROC analysis, for automated classification of wall motion.

Results: The generation of 3D color-encoded wall-motion and RFVC quantification took <10 sec. In RWMA, 182/252 segments were graded as AB (Figure 1, arrows). The automated technique agreed with the expert reader in 225/252 (89%) segments, with only 8/252 (3%) false positive and 19/252 (8%) false negative detections (sensitivity: 0.91; specificity: 0.80; accuracy: 0.84).

Conclusions: The proposed technique could improve the visual assessment of wall motion from RT3DE images, and represent the basis for automated detection of RWMA.

612 Real time 3 Dimensional Echo imaging (RT3DEI) during stress echo allows simultaneous assessment of left atrial (LA) and right ventricular (RV) function while detecting left ventricular (LV) ischemia

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Background: RT3DEI acquires volumetric data accurately and quickly. The aim of this study was to evaluate the feasibility of acquiring LA and RV data simultaneously with LV data using RT3DEI during dobutamine stress echochagraphy (DSE).

Methods: We obtained 3D full volume data using a matrix array transducer at baseline and peak DSE. We measured LA, RA, LV volume and LV Asynchrony index (ASI) of 16 segments using Qlab®TomTec software.

Results: Among 59 pts (66±15 yrs), 16 (Group A) had no RWMA, 13 (Group B) had RWMA (fixed in 5, ischemic in 3, and myocardial infarction before revascularization). The parametric assessment was very helpful in contractility borderline segments (e.g. hipoakinetic) analysis when it was difficult to qualify segments unambiguously.

Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>SE Sensitivity</th>
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<tr>
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<td>90%</td>
<td>90%</td>
<td>86%</td>
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</tbody>
</table>

613 Three dimensional parametric viability assessment during dobutamine stress echocardiography at patients after myocardial infarction before revascularization

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The aim of the study was to assess 3D quantification used during dobutamine stress echocardiography (DSE 3D) in viability assessment at patients (pts) after myocardial infarction before revascularization.

Methods: We analyzed 59 patients (pts) referred to viability assessment by DSE before planned revascularization after coronary angiography. Stress echo was done using standard protocol (0-10-20 mcg/min dobutamine if needed in 5-3-3 min) on Philips IE33 with 3D Glide advanced software. During base assessment and maximal dobutamine infusion 2D (DSE 2D) and 3D (DSE 3D) full volume were recorded. First observer described LV contractility using 17 segment model as normo, hipo, akinesis and dyskinesis in 2D. Second observer, using 3D reconstructed 17 segments 3D LV shape. Contractility of each segment was analyzed using following parameters: segment contractility fraction/SCF - change of segment thickness during systole-diastole, segment movement fraction/SMF - inward, systolic movement of segments and synchronicity time/st - segment-s contraction time. After 6 months at 55 pts the viability was assessed by 2D and 3D rest echocardiography.

Conclusion: Three dimensional analysis of DSE has better diagnostic value than standard assessment in viability assessment at patients after myocardial infarction before revascularization. The parametric assessment was very helpful in contractility borderline segments (e.g. hipoakinetic) analysis when it was difficult to qualify segments unambiguously.

614 3D left atrial volume with real-time 3D echocardiography as a marker of left ventricular diastolic function; A comparison study with the left atrial measurements by 2D echocardiography

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Purpose: To explore not only the feasibility of 3D left atrial (LA) volume measurement by real-time 3D echocardiography (RT3DE) but also its correlation with conventional echocardiographic parameters representing left ventricular (LV) diastolic function in comparison with the LA measurements by 2D echocardiography (2DE).

Method: 2DE and RT3DE were performed in 15 normal subjects (NL) and 31 patients with diastolic dysfunction. The patients group was sub-divided into 3 groups [impaired relaxation (IR): 15, pseudonormal (PN): 7, restrictive physiology (RP): 9] according to the LV diastolic dysfunction that was graded by conventional echocardiographic diastolic parameters (E/A, DT, S/D and E/E'). Full volume images including LA were acquired over 4 cardiac cycles from apical views using Sonos 7500 (Philips, Co.). 3D LA volume (3DLAV) was calculated by integrating the planimetrics of LA contours in 8 rotational planes during end systole with 3D computer software (4D CardioView, TomTec, Co.). LA dimension (LAD) was measured by M-mode 2DE. LA volume (2DLAV) also was calculated by monoplane Simpson’s rule (disc method) on the apical four-chamber view. All measurements were indexed by body surface area (BSA).

Results: 3DLAV (p<0.05) and 2DLAV revealed significant differences between 4 groups (NL, IR, PN and RP) by ANOVA test, while LAD did not (p>0.05). 3DLAV showed a closer correlation with 2DLAV (r=0.94, p<0.01) than LAD (r=0.79, p<0.05). In patients group, 3DLAV revealed significant correlation (p<0.01) with E/A (r=0.49) and E/E' (r=0.51) showing higher correlation coefficient than 2DLAV (r=0.43, r=0.41, p<0.05) while LAD did not (r=0.33, r=0.29, p>0.05).

Conclusion: 3DLAV assessed with combined use of RT3DE and 3D computer software seems to be a feasible method. 3DLAV showing better correlations with the conventional diastolic parameters seems to be a more useful marker of the LV diastolic function than other LA measurements by 2DE.