

resulting in an excellent overall concordance (163/171, 95%) of viability between PET and DISA SPECT. Furthermore, there was good agreement for LVEF measurements by gated SPECT and MRI ($r=0.92$).

Conclusion: ECG-gated FDG/MIBI DISA SPECT permits simultaneous assessment of myocardial glucose metabolism, perfusion and function in a single study. Because the acquisition procedure can be completed within 20 minutes, this imaging protocol may be suitable for clinical routine.

1213-64

Accuracy of Gated Perfusion Single-Photon Emission Tomography for Left Ventricular Ejection Fraction Assessment in the Presence of Large Perfusion Defects: Correlation With Cardiac Magnetic Resonance

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Background. Gated perfusion single-photon emission computed tomography (SPECT) assessment of left ventricular ejection fraction (LVEF) and volumes has been well validated, but there is controversy about its accuracy in the presence of large perfusion defects. We aim to validate the accuracy of gated SPECT measurements in the presence of large perfusion defects, using cardiac magnetic resonance (MR) as the gold-standard. Methods. 22 male subjects (mean age 53 ± 11 years; mean MR LVEF 40.5%, range 9% to 70%; 15 had prior myocardial infarcts; 11 had large rest perfusion defects > 20% of left ventricle on SPECT) who had undergone gated perfusion SPECT (25 mCi 99m Tc-tetramethylammonium perrhenate, dual head detector, 64 stops, 25 sec/stop, 8 frames/cycle) were enrolled. MR (1.5T MR scanner, cine MR with segmented fast low-angle shot pulse sequence) was performed on each subject within a week. LVEF, left ventricular end-diastolic (LVEDV) and end-systolic (LVESV) volumes were determined using automated software (Autoquant) for gated SPECT, and semi-automated software (Argus) for MR.

Results. There was excellent correlation ($r = 0.94$, $p < 0.0005$) between LVEF assessed by gated SPECT and MR (mean LVEF 41.8% and 40.5%, respectively). Difference of the means was 1.1% (95% CI -1.9% to 4.0%), and was not statistically different ($p = 0.07$) for patients with small or no perfusion defect (-1.5%, 95% CI -5.7% to 2.7%) versus patients with large defects (3.6%, 95% CI 0.5% to 6.8%). By Bland-Altman analysis, no significant trend in difference was found between the two methods across the range of LVEF values (95% limits of agreement -11.9% to 14.0%). There was also excellent correlation between LVEDV ($r = 0.94$, $p < 0.0005$) and LVESV ($r = 0.969$, $p < 0.0005$) assessed by gated SPECT and MR, but the respective mean differences (21.1 ml, 95% CI 7.7 ml to 34.5 ml; 14.9 ml, 95% CI 4.7 ml to 25.1 ml) and 95% limits of agreement by Bland-Altman analysis (-38.2 ml to 80.4 ml; -30.2 ml to 60 ml) were considerably wider.

Conclusion. There was an excellent correlation between gated SPECT and MR evaluation of LVEF, despite the presence of large rest perfusion defects on gated SPECT. The limits of agreement were excellent for LVEF, but were wider for LVEDV and LVESV.

1213-65

Does ECG-Gated SPECT Provide Accurate Measurement of Left Ventricular Ejection Fraction and Volumes? A Meta-Analysis

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Background

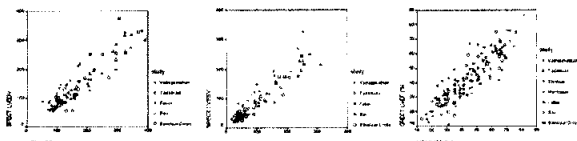
ECG-gated SPECT has been proposed as an accurate method for evaluating left ventricular (LV) end-diastolic volume (EDV), end-systolic volume (ESV) and ejection fraction (EF). Several comparisons against the gold standard of cardiac MRI have been performed, but each has considered few subjects, leaving uncertainty about the frequency of discrepancies between the two methods.

Methods and Results

We performed a meta-analysis of data on 134 subjects from 8 studies comparing ECG-gated SPECT vs. cardiac MRI. Data were pooled in correlation and regression analyses relating ECG-gated SPECT and cardiac MRI measurements. The frequency of discrepancies of at least 30 ml in EDV, 20 ml in ESV and 5% or 10% in EF, and concordance for EF=40% were determined. There was an overall excellent correlation between the two methods for EDV ($r=0.92$), ESV ($r=0.94$) and EF ($r=0.89$) (FIGURE). However, rates of discrepancies for individual subjects were considerable (41% [95% CI, 30-53%] for at least 30 ml in EDV; 33% [95% CI, 20-50%] for at least 20 ml in ESV; 48% [95% CI, 34-62%] for at least 5% in EF; and 20% [95% CI, 8-44%] for at least 10% in EF). The misclassification rate for the 40% EF cut-off was 10%.

Conclusions

ECG-gated SPECT measurements of EDV, ESV and EF show high correlation with cardiac MRI measurements, but substantial errors may occur in individual patients. ECG-gated SPECT offers useful functional information, but more accurate imaging modalities should be used when exact determinations are required.



1213-66

Prone Imaging Adds Significant Independent Diagnostic Accuracy to Supine SPECT Perfusion Images and is Superior to the Contribution of Wall Motion

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Prone imaging (PI) and wall motion (WM) each aid artifact identification in, and specificity (spec) of, myocardial perfusion scintigraphy (MPS). We studied the effect on accuracy of PI ($n=87$) performed with abnormal supine MPS and WM ($n=117$) acquired with regular rhythm in 131 consecutive patients (pts) (79 with both PI and WM) having SPECT sequential dual isotope MPS within a month of coronary angiography (CA). Supine stress "defects", persisting on PI, were abnormal, while defects resolving on PI were technical in origin. Abnormal WM established a defect as perfusion based and abnormal, while preserved WM with a "fixed defect" indicated its technical origin, and normal WM was ambiguous and non-diagnostic in the presence of an apparent reversible defect. The independent effects of PI and WM on sensitivity (sens) and spec were compared to baseline values derived from blind readings of supine SPECT images.

	Baseline (B)	With PI	With WM
Sens/Vessel	162/201=81%	145/201=72%, $p < 0.05$ vs B	128/201=64%, $p < 0.05$ vs PI; $p < 0.01$ vs B
Sens/Pt	92/103=89%	90/103=87%, NS vs B	61/103=59%, $p < 0.01$ vs B and PI
Spec/Vessel	163/192=85%	175/192=92%, $p < 0.05$ vs B	170/192=89%, $p=NS$ vs B
Spec/Pt	18/26=64%	26/26=93%, $p < 0.05$ vs B	22/26=79%, $p=NS$ vs B

There were 95 men and 41 women with average age 65.2 years (range 21-91), 103 pts with CAD and 28 pts with none. The findings (See Table) on PI, modestly reduced sens/vessel but not sens/pt while improving spec/vessel and greatly increasing spec/pt and overall accuracy (89% vs 84%, $p < 0.05$). However, WM, normal in 29 pts with abnormal PI and CAD, 11 with fully reversible defects, more often misled, decreasing sens/vessel and sens/pt, while increasing both spec/vessel and spec/pt but less than PI. PI and WMA both increase spec aiding identification of artifact with a cost in sens. PI is a far greater independent aid.

1213-67

Accuracy of Dynamic SPECT Acquisition for Tc-99m Teboroxime Myocardial Perfusion Imaging: Preliminary Results

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Background: Tc-99m teboroxime is a myocardial perfusion tracer with a high extraction fraction and fast clearance, optimal for flow imaging. A dynamic SPECT acquisition, where 90° dual detectors are fanned 180° every 36 seconds for up to 4 minutes, was implemented. All the fanned projections were mathematically combined to yield a "static" acquisition to reduce artifacts by accounting for both changing concentration and increasing liver activity. The purpose of this investigation is to test the quality and accuracy of the images from this protocol.

Methods: 46 patients were imaged using a thallium-rest / teboroxime-stress protocol (20 with fanning and adenosine stress) and correlated with results from conventional myocardial perfusion rest-stress protocols. Either the results of the conventional SPECT studies or the patients' low likelihood for CAD were used as the gold standard. One observer interpreted the teboroxime studies and another independent observer blindly interpreted the correlative SPECT studies. Teboroxime images were evaluated for technical quality (free of inferior wall liver artifact) and accuracy of the stress study to detect CAD and localize it to the LAD, LCX, and RCA vascular territories.

Results: The teboroxime studies demonstrated high technical quality by protocol: 95% (243/257 slices) for adenosine-stress fanning, and 74% (196/265 slices) for conventional SPECT. The teboroxime studies using the fanning protocol resulted in 89% accuracy for detecting CAD and 78%, 78% and 89% for localizing disease to the LAD, LCX and RCA vascular territories respectively.

Conclusion: These preliminary results show that dynamic SPECT fanning acquisition and processing of Tc-99m teboroxime can yield high quality, accurate studies for diagnosing coronary artery disease. These results should be verified in a larger, prospective clinical trial.

1213-68

A Simple Technique to Reduce Scatter in Myocardial Perfusion Imaging

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Background- Bowel scatter degrades image quality in 99m Tc-sestamibi myocardial perfusion imaging (MPI). Iodinated oral contrast (IOC) absorbs X-rays and has been used to outline bowel in x-ray imaging. However IOC also absorbs gamma rays. This study tested our hypothesis that IOC given during MPI would absorb gamma rays from 99m Tc-sestamibi in the bowel thereby reducing scatter and improving cardiac SPECT images.

Methods- Twenty consecutive patients undergoing 99m Tc-sestamibi MPI were randomized to receive either IOC or no contrast (controls). Patients had one-day rest-stress MPI using the adenosine stress protocol. All study subjects had their 1st stress images done 45 minutes after the stress test. Then the subjects in IOC group were given the iodinated oral contrast to drink over 30 minutes and then had their 2nd set of stress images. The control subjects waited 30 minutes and then had their 2nd set of stress images. Images were analyzed using image quality parameters of the scatter counts from a scatter win-

dow set at 118±6 KeV, image variability and image contrast. The differences between the IOC and the control groups were compared using the Students t-test.

Results- Age, gender, ethnicity, weight and tracer dose were similar between the both groups. The image quality parameters results are given in table.

	Groups	1 st image	2 nd image	Change
Scatter counts	Controls	8.0 ± 3.0	6.8 ± 2.8	1.05 ± 0.4
	IOC	8.4 ± 3.0	6.4 ± 2.3	2.0 ± 1.6
	p-value	0.75	0.7	0.02
Image contrast	Controls	72 ± 11	68.8 ± 13	-3.2 ± 7.8
	IOC	73.9 ± 15	81.6 ± 13	7.7 ± 8.2
	p-value	0.7	0.043	0.007
Image variability	Controls	17.8 ± 3.5	19 ± 2.9	-1.3 ± 1.4
	IOC	17.7 ± 3.8	14.8 ± 3.5	2.9 ± 1.9
	p-value	0.9	0.008	0.0001

(Counts are in millions, mean ± SD)

Conclusion- The use of iodinated oral contrast improved image quality. This simple, safe and inexpensive clinical technique can improve 99m Tc-sestamibi MPI.

ORAL CONTRIBUTIONS

875 Three-Dimensional Echocardiography

Tuesday, March 19, 2002, 4:00 p.m.-5:00 p.m.

Georgia World Congress Center, Ballroom II

4:00 p.m.

875-1 Multi-Threshold Flow 3-D Color Doppler Reconstruction of Velocity of the Flow Acceleration Region for Quantification of Mitral Regurgitation: A Chronic Animal Model Study

Xiaokui Li, Michael Jones, Xiang-Ning Li, Arthur D. Zetts, Rosemary A. Rusk, Yoshiki Mori, Crispin H. Davies, Gordon K. Mack, David J. Sahn, Oregon Health & Science University, Portland, Oregon, NHLBI, Bethesda, Maryland.

Background: Since mitral regurgitant orifice geometry is often quite complex, in this study we employed a scanline based digital color 3D reconstruction method that allows visualization of the flow convergence (FC) at any chosen velocity from the digital data processed offline. **Methods:** Mitral regurgitation (MR) was created in 4 sheep by chordal interruption 3-4 months before the study. During open chest study, an electromagnetic (EM) flow probe was sutured onto the mitral annulus ring to simultaneously record the transmitral flow data and was balanced against an aortic EM flow meter. Raw velocity scanline data were obtained for 180° (6° increment) rotations with a 7MHz TEE probe placed epicardially under 12 flow conditions (peak flow rate 30-130 ml/sec) obtained by volume loading, nitroprusside and angiotensin administration. The 3D data were transferred to a Silicon Graphics system to develop a multi-threshold computation to digitally reconstruct spatial FC surface for any selected velocity threshold. Direct FC surface tracings were made by computing 10-20 slices across the convergence zone. **Results:** For MR peak flow rate, there was good correlation between 3D and EM data (r=0.92, SEE=8.73 ml, p<0.05). Each measurement took 1-2 minutes. Measurements could also be integrated at 5-8 points during the heart cycle to provide the regurgitant volume. **Conclusions:** This 3D multi-threshold method could provide accurate estimation of mitral regurgitant flow clinically despite varying geometries.



875-2

Geometric Differences of Mitral Valvular Apparatus Between Ischemic and Dilated Cardiomyopathy With Significant Mitral Regurgitation: Real-Time Three-Dimensional Echocardiography Study

Jun Kwan, Takahiro Shiota, A. Marc Gillinov, Deborah A. Agler, Jian Xin Qin, Yong Jin Kim, James D. Thomas, The Cleveland Clinic Foundation, Cleveland, Ohio.

Background: The aim of this study was to elucidate the geometric differences of mitral valve (MV) apparatus in patients with ischemic MR caused by posterior infarction (IMR) and functional MR due to idiopathic dilated cardiomyopathy (DCM), compared to normal control (NL) using real-time 3D echocardiography (RT3DE). **Methods:** Fourteen patients (9: posterior infarction 5: posterior and anterior infarction) with IMR, 13 patients with DCM and seven NL were studied. RT3DE volumetric images of MV apparatus were digitally transferred into a personal computer. Three different imaging long axis planes [Medial (M), Central (C) and Lateral (L)] of MV were generated at mid-systole by 3D computer software (TomTec). Commissure-commissure (CC) and septo-lateral (SL) distances were measured. Angles between annular plane and both posterior (α) and anterior mitral leaflet (β) were measured in all three planes [(Mα, Cα, Lα) (Mβ, Cβ, Lβ)]. **Results:** In medial and central planes, α and β of both IMR and DCM significantly increased compared to NL. In lateral plane, α of both groups significantly increased, while β of IMR was not significantly different from NL.

	CC(cm)	SL(cm)	Mα(°)	Cα(°)	Lα(°)	Mβ(°)	Cβ(°)	Lβ(°)
NL	2.8±0.1	2.4±0.1	32±5	32±6	34±4	21±3	23±5	23±3
IMR	3.1±0.1**	2.7±0.2***	64±8**	58±9**	55±7**	40±5**	32±8*	25±6**
DCM	3.2±0.2**	2.9±0.2**	60±8**	60±7**	59±7**	37±6**	35±6**	33±7**

*: p < 0.05, **: p < 0.01 compared with NL. *: p < 0.05, **: p < 0.01 compared with DCM **Conclusion:** Mitral annulus dilated more toward SL direction in DCM than IMR. Geometric change of MV in DCM was relatively symmetrical showing tethering of both leaflets from medial to lateral side while it was asymmetrical in IMR, showing no significant tethering of anterior leaflet laterally.

4:30 p.m.

875-3

Detection of Proximal Functional Occlusion of Three Major Coronary Arteries by Contrast-Enhanced Transesophageal Doppler Echocardiography

Masami Nishino, Shiro Hoshida, Shinichiro Suna, Masayuki Taniike, Yasuyuki Egami, Yoshihiro Takeda, Ryu Shutta, Masayoshi Kawabata, Hideo Tanahashi, Jun Tanouchi, Yoshio Yamada, Osaka Fossil Hospital, Sakai, Osaka, Japan.

Backgrounds: Recently, transthoracic Doppler echocardiography (TTDE) has been useful for detecting coronary flow at the distal left anterior descending artery (LAD), and however, it is very difficult to detect the proximal LAD coronary flow, also left circumflex (LCX) and right coronary artery (RCA) flow using TTDE. It is clinically more important to evaluate proximal coronary lesions as compared to distal lesions. On the other hand, usefulness of Levovist to enhance various Doppler signals has been reported. Thus, in this study, we investigated whether transesophageal Doppler echocardiography (TEDE) using Levovist can evaluate coronary lesion of the proximal sites in LAD, LCX, and RCA. **Methods:** We studied consecutive 43 patients with suspected coronary artery disease who underwent TEDE with 5-MHz multiplane transesophageal probe after sedation by intravenous injection of a small amount of propofol. Within one week after TEDE, diagnostic coronary angiography was performed in each patient. Using TEDE, color Doppler flow mapping was detectable in 100% at proximal LAD, 79% at proximal LCX, and 72% at proximal RCA before and it was detectable in 100% at each coronary artery after injection of Levovist (300 mg/ml in 2ml). Coronary angiogram revealed proximal LAD occlusion in two patients, proximal LCX occlusion in three patients, and proximal RCA occlusion in two patients that were all accompanied with collateral flow. In these 7 patients, contrast enhanced TEDE detected abrupt disappearance of color Doppler flow with retrograded distal flow (which supplied by collateral flow from the other coronary arteries) clearly, and these positions of abrupt disappearance of color Doppler flow correctly located the occlusion along the vessel that were shown by coronary angiogram. However, TEDE without Levovist could not detect abrupt disappearance of color Doppler flow or retrograded flow in the two occlusion lesions of LCX and in the two lesions of RCA. **Conclusion:** Contrast enhanced transesophageal Doppler echocardiography can detect proximal LAD, LCX and RCA functional occlusion with collateral flow accurately.

4:45 p.m.

875-4

Spatio-Temporal Brushlet Denoising Improves Real Time Three-Dimensional Calculation of Right Ventricular Function in Primary Pulmonary Hypertension Patients

Deborah R. Gersony, Elsa D. Angelelli, Josh Donis, Clarito Dimayuga, Robyn J. Barst, Rola Saouaf, Marco R. Di Tullio, Andrew F. Laine, Shunichi Homma, Columbia University, New York, New York.

Background: Assessment of right ventricular (RV) function is clinically relevant in the follow-up of patients with primary pulmonary hypertension (PPH). No single echocardiographic approach has gained wide acceptance as being both reliable and accurate. We compared 2-dimensional (2D) and real-time three-dimensional (RT-3D) echocardiographic imaging to magnetic resonance imaging (MRI). Comparison was made both