No significant differences in baseline hemodynamic parameters (including LV ejection fraction) were found between group I and II except for systolic aortic pressure ($102 \pm 12.3$ vs $143.1 \pm 27.7$ mmHg, $p < 0.002$), pulse pressure ($39.1 \pm 12.5$ vs $88.1 \pm 21.9$ mmHg, $p < 0.000$), LV volume (LV end-diastolic volume index $85.4 \pm 29.7$ vs $141.1 \pm 29.4$ ml/m$^2$, $p < 0.001$) and aortic valve gradient. PCr/ATP ratios were as follows:

| Group | PCr/γ ATP | PCr/α ATP | PCr/β ATP |
|---|---|---|---|
| I | 2.28 ± 2.09 | 0.78 ± 0.62* | 1.01 ± 0.62* |
| II | 2.80 ± 1.75 | 1.34 ± 0.60* | 1.59 ± 0.49* |
| III | 2.98 ± 1.78 | 1.74 ± 0.51* | 2.01 ± 0.30* |

*$p < 0.05$

Positive correlation was revealed between Pcr/α ATP or Pcr/β ATP and systolic aortic pressure ($r = 0.60$, $p < 0.014$ and 0.009, respectively) as well as pulse pressure ($r = 0.50$, $p < 0.036$ and $r = 0.53$, $p < 0.023$, respectively) in all patients.

In conclusion, detection of significant impairment of HEP metabolism in aortic stenosis only and relationship of these changes to aortic, and therefore to coronary perfusion pressure appear to reflect imbalance in myocardial oxygen/supply ratio rather than deterioration of LV function itself.

## 929-63 Dobutamine Stress Cine Magnetic Resonance Imaging versus PET for Detection of Myocardial Viability

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To identify viable myocardium before coronary revascularization, we prospectively submitted eleven patients ($60 \pm 7$ yrs; 11 M) with previous Q-wave myocardial infarction to $^{18}$FDG-Positon Emission Tomography and low-dose (5 to 10 μg/kg/min) dobutamine cine-MRI. $^{18}$FDG uptake >60% was considered indicative of viable tissue. Quantitation of systolic wall thickening/thinning (SW) was performed by use of a computer software allowing automatic detection of epicardial and endocardial outlines, at rest and under 5, 7.5 and 10 μg/kg/min of dobutamine. Heart slices of both $^{18}$FDG-PET scans and dobutamine cine-MRI were divided in 8 segments, matched and analyzed by observers blinded to clinical data. Sixty-five segments were considered viable by $^{18}$FDG-PET; in this subgroup, rest SW thickening averaged $47 \pm 5\%$ and improved by $43 \pm 8\%$ under low-dose dobutamine. In the remaining 23 segments considered non viable by PET, rest SW thickening averaged $14 \pm 7\%$* (*$p < 0.05$ vs viable segment group) and further worsened by $-13 \pm 8\%$* during low-dose dobutamine stress (*$p < 0.05$ versus viable segment group). Positive predictive value of low-dose dobutamine stress cine-MRI for assessment of myocardial viability was 84%. These data suggest that quantitative assessment of regional wall motion by dobutamine cine-MRI may help discriminate viable from non viable myocardium as defined by $^{18}$FDG-Positon Emission Tomography.

## 929-64 Global Cardiac Function Using Active Contour Models with Fast Breath-hold MRI

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Fast MR imaging techniques now permit rapid acquisition of gated cardiac images spanning the entire ventricle through most of the cardiac cycle. Quantitative global function analysis requires extraction of the myocardial borders in the images. However, manual analysis is tedious and time consuming while fully automated techniques are limited because of image artifacts and poor blood/myocardial contrast in certain regions, especially with fast-imaging techniques. We have developed a fast, interactive, semi-automated method for defining the myocardial borders. We present the initial results of this method using MR images of static phantoms, dog hearts, and normal volunteers.

Ten healthy adult volunteers (ages 18–34) were imaged with a clinical 1.5 Tesla MRI system (GE) using a fast gradient-echo ECG-gated pulse sequence which acquired 8–12 cardiac phases from end-diastole (ED) past end-systole during a breath-hold. 12–15 short-axis (SA) images were acquired from the pulmonary valve to the LV apex. The imaging parameters were: FOV = 24–26 cm, flip angle = 33°, slice thickness = 6 mm, slice spacing = 2 mm, TR/TE = 7.2/2.6 msec.

Analysis was done with our customized software (SPAMMVU) using our contour tracking routine. This method models each contour as an analytic function (with an associated effective strain "energy") that is attracted to edges in the image, but can be manipulated by the user to outline regions with poor contrast or to avoid artifacts. Internal stiffness of the model results in smoothing and fast outlining. Typical analysis takes less than 20 minutes vs. 1–2 hours for a manual method.

Volumes were computed using Simpson's rule. Measured volumes of static phantoms had less than 5% error compared to truth. Errors in calculated LV mass of dog hearts by MRI were less than 10% compared with actual *ex vivo* weight. LV mass of normal volunteers was determined at ED and ES. Linear regression analysis of ED LV mass vs. ES LV mass yields an excellent correlation ($R^2$ of 0.94). A similar analysis of LV stroke volume (SV) vs RV SV yields an $R^2$ value of 0.85.

Our semi-automated contour extraction program provides a fast, reproducible, and accurate method for quantifying cardiac global function from MR images.

## 929-65 Mechanisms of Hyperenhancement by Contrast Enhanced Magnetic Resonance Imaging are Related to Injured Myocardial Mass in Patients with Acute Myocardial Infarction

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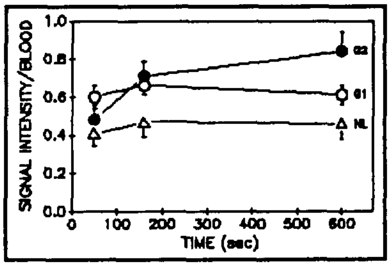
The extent of injured myocardium is directly related to infarct size after acute myocardial infarction (AMI). Myocardial hyperenhancement during ultrafast contrast enhanced magnetic resonance imaging (CEMRI) reflects ischemic injury and its mechanism; extracellular volume expansion with or without washout impairment may be related to the magnitude of ischemic injury; edema formation with or without cell death. To investigate the relationship between the extent of myocardial injury and the mechanism of myocardial hyperenhancement by CEMRI we studied 19 patients after AMI. Spoiled GRASS, TR = 6.5 ms, TE = 2.3 ms, 4 short-axis images were analyzed, and the ratio of signal intensity in myocardium to blood from injured (IN) and normal (NL) regions was obtained at 50 secs, 160 secs and 600 secs. after I.V. contrast (gadoteridol 0.1 mmol/kg). Percent injured myocardial mass was calculated as the ratio of hyperenhanced myocardium to total LV mass by planimetry. Patients were divided into two groups according to the mechanism of signal hyperenhancement. Group 1 (N = 9) was defined by a parallel upwards displacement (ANOVA $p < 0.002$) of the injured myocardium/blood ratio over time relative to normal myocardium consistent with pure extracellular expansion. Group 2 (N = 11) had upwards displacement (ANOVA $p < 0.001$) with significant slope (ANOVA $p < 0.001$) consistent with impaired washout (see Figure). Injured mass was greater in Group 2 ($31.9 \pm 6.4\%$) than in Group 1 ($15.9 \pm 5.0\%$, $p < 0.001$).

In conclusion, the mechanism of myocardial hyperenhancement is related to the extent of ischemic injury after AMI, with greater injury associated with the presence of washout impairment, suggesting cell death. These relationships may be explored to assess myocardial viability after AMI by CEMRI.




## 929-66 Validation of a New Method for Calculating Continuous Transmural Distributions of Strain in the Ventricles Using Magnetic Resonance Tagging

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Magnetic resonance imaging (MRI) tagging provides information about deformation at many intramural points in the ventricular wall and thus offers the potential to characterize the transmural pattern of deformation. We have developed a method to calculate continuous transmural distributions of finite strains across the ventricular wall from the deformation of the MR "tag lines". The purpose of this study was to quantify the error in this technique by comparing strains computed with our method to a "gold standard" solution. Seven dogs underwent cine MRI with tagging, generating dark grid patterns of presaturations on the images. Deforming tag lines were tracked using an automated algorithm. A parametric representation of tag line deformation was developed. Strains were calculated in a local region bounded by five to six tag lines by constructing a local mapping from the region on the undeformed image to the same region on the deformed image. The mapping was defined by fitting a polynomial "surface" to the measured deformations of the tag lines and by employing a smoothing term to control the trade-off between fidelity of the data and surface and the smoothness of the