CORONARY CONTRIBUTIONS

883 Myocardial Perfusion and Viability by Magnetic Resonance Imaging

Wednesday, April 02, 2003, 10:30 a.m.-Noon
McCormick Place, Room S103

Flow-Function Relationships in Chronically Dysfunctional Myocardial Necrosis

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Background: The combined analysis of myocardial perfusion (MBF) and contraction allows to distinguish the various pathophysiological conditions that cause chronic ischemic dysfunction, i.e. chronic hibernation (perfusion-contraction mismatch) from chronic stunning (perfusion-contraction mismatch). Yet, prior work examining flow function relationships in humans with CAD was limited by a) not measuring subendocardial MBF, and b) not correcting for the confounding presence of necrosis. We thus used PET and Gd-DTPA first pass (FP) MRI measurements of MBF together with strain measurements by tagged MRI to quantitatively explore flow-function relationships in chronically dysfunctional human myocardium and correlated them to transmural extent of myocardial necrosis detected by delayed hyperenhanced (DH) MRI. Methods: Eleven patients (9 M, 60±10 years) with CAD and chronic contractile dysfunction (EF: 26±15%) underwent both PET and FPIDH-MRI and 13N-aminoethylcysteine PET. Transmural extent of DH, regional circumferential shortening strain (ECC) and absolute MBF and endo/epicardial ratio were measured quantitatively in 16 segments per patient. The relation between ECC and both transmural and endocardial MBF was examined in dysfunctional segments (~10% ECC) and correlated to transmural extent of DH.

Results: Non-infarcted (~25% transmurality) dysfunctional myocardium presented perfusion-contraction mismatch as indicated by a 75% reduction (to 24±13% of normal) of ECC vs. only a 22% (to 0.65±0.26 min/radio) reduction of transmural MBF. Endocardial perfusion was maintained (endo/epicardial ratio 1.2±0.24). With increasing amounts of necrosis, reductions between perfusion vs. contraction became increasingly matched. i.e. dysfunctional segments with >75% transmural extent of necrosis had a 47% reduction of MBF (p=0.01<0.05 vs. normal) for a similar severe reduction of 75% of ECC (to 5±3% shortening). Conclusions: Non-infarcted dysfunctional human myocardium mostly presents with perfusion-contraction mismatch, consistent with stunning. In contrast, dysfunctional myocardium presenting with perfusion-contraction mismatch is always associated with significant amounts of necrosis.

10:45 a.m.

883-2 Accurate and Objective Infarct Sizing by Contrast Enhanced Magnetic Resonance Imaging Defined in a Canine Myocardial Infarction Model

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Background: Myocardial infarct (MI) size by contrast enhanced MRI (CE-MRI) is defined by initial wash-in of Gadolinium-DTPA (Gd-DTPA) and requires subtraction of early small amount of blood pool signal to yield accurate MI sizing. CE-MRI often underestimates MI size due to signal contributions from adjacent normal myocardium. Methods: Nine dogs underwent 90 minutes of closed chest coronary artery occlusion, followed by reperfusion. CE-MRI was acquired 24 hours after reperfusion and compared with post-mortem TTC staining. Images were obtained 15 min after Gd-DTPA (0.2 mmol/kg) using inversion recovery gradient echo pulse sequence. MI size was measured by 3 types of methods: 1) Visual - arbitrary window and level chosen for best contrast between normal and infarcted myocardium (FWHM - Window and level were set to the full width at half maximum intensity). 2) Automatic methods - the inner and outer standard deviation (SD) of signal intensity from remote myocardium was determined and signal intensities below 1, 2, 3, 4, 5 and 6 SD the mean were considered as infarcted myocardium. Results: MI sizes by TTC staining was 26±7±9%, of left ventricular mass. Automatic methods using 1 and 2 SD correlated best with post-mortem data. Similar agreement coefficients by Pearson, Spearman and Kendall were confirmed by Bland-Altman plots. Conclusion: MI sizes by CE-MRI based on automatic method using 1-2 SD as cut-off point are the most accurate method compared with TTC. These results are crucial for the clinical implementation of MI size by CE-MRI.

ABSTRACTS - Noninvasive Imaging

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883-3 Infarct Size Needed to Cause Adverse Left Ventricular Remodeling in Humans: A Magnetic Resonance Imaging Study

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Background: Post-myocardial infarction (MI) left ventricular (LV) remodeling occurs in the setting of large myocardial infarctions. Current therapies such as emergent reperfusion, β-blockers and ACE-inhibitors have led to significant decreases in adverse remodeling. The accuracy of MRI in measuring LV volumes, geometry, and infarct size makes it a good technique for assessment of post-MI remodeling. Using MRI, we measured MI size in patients more than 2 months after the clinically recognized event to quantify the size of MI needed to result in adverse LV remodeling. Methods: Contrast-enhanced MRI was performed on 53 patients at least 2 months after acute MI. LV volumes and sphericity (an indicator of LV geometry derived from the LV long axis/short axis ratio) were measured using 3D MRI images of myocardium. Sphericity and MI size were determined using gadolinium-enhanced images with phase-sensitive reconstruction. Infarct size was measured using the 16-segment model of the American Society of Echocardiography. Results: Of the 53 patients, 24 had moderately to severely increased LV end-systolic volumes consistent with LV remodeling. There was a moderate to high linear correlation between MI size and LV end systolic volume (r = 0.69). Patients with >6 infarcted segments had significant differences in end-systolic volumes (<p<0.001), end-diastolic volumes (<p<0.001), and end-diastolic sphericity indices (<p=0.007) compared with patients with <6 segments. Remodeling as described by multiple indices was related to infarct size but not to location. Conclusions: The total amount of infarcted myocardium and the number of infarcted segments were related to LV remodeling so that patients with chronic MI into groups with and without adverse remodeling. Larger infarct size and infarctions in multiple locations were associated with adverse remodeling than infarct location (i.e. anterolateral vs inferior). Studies of post-MI LV remodeling should consider broader enrollment criteria than only patients with first, anterior MI.

11:15 a.m.

883-4 Diagnostic Value of Low Dose Dobutamine Stress in Addition to the Assessment of Late Enhancement for the Prediction of Functional Recovery

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Background: Magnetic resonance imaging techniques (late enhancement (LEH)) have been shown to yield a high value for the prediction of functional recovery of hibernating myocardium (HM). Stress imaging with low dose dobutamine by echocardiography (DSE) or magnetic resonance imaging (MR) has been successfully used in clinical routine to predict HM for years. The scope of this study was to determine the diagnostic value of LEH or DSE in addition to LEH for the detection of HM. Methods: In 25 consecutive patients with coronary artery disease (67±8 years, 4 female, ejection fraction 35±7%,), scheduled for revascularisation wall motion was evaluated semi quantitatively (16 segments) by echocardiography and magnetic resonance imaging (MRI) and dobutamine stress echocardiography (late enhancement; Gd-DTPA) was performed before revascularisation and the transmural extent of scar was assessed (25% steps). The analysis was based on 155 revascularized segments with wall motion abnormalities at rest. Kappa statistics were used to assess the additional value of the stress tests. Results: If the prevalence of functional recovery was intermediate in the LEH subgroups the additional diagnostic value of DSE or LEH was high. DSMH tends to be

9:00 a.m.
Comparative Diagnostic Value of Dipyridamole and Adenosine-Triphosphate Stress First-Pass Myocardial Perfusion Magnetic Resonance Imaging for Detection of Coronary Artery Disease

A whole-heart coverage MRI sequence, which is a hybrid of Fast gradient echo and Echo planar imaging, has recently been developed. Using this sequence, a first-pass myocardial perfusion MRI could be a good noninvasive modality for detecting coronary artery disease (CAD). To investigate comparative accuracy of dipyridamole and adenosine-triphosphate stress first-pass myocardial perfusion MRI for diagnosing CAD (>70% stenosis), we performed first-pass myocardial perfusion MRI in 256 patients with suspected CAD. Patients were allocated into dipyridamole or adenosine-triphosphate stress protocol, 194 patients (66±10 years) received dipyridamole stress and 62 patients (64±15 years) underwent adenosine-triphosphate stress. Using a 1.5 T cardiac MRI scanner (Philips Medical Systems, The Netherlands), which allows image analysis in less than 10 min, per slice and displays the results in color-encoded images. Visual interpretation of the color displays was performed by two independent observers and areas of relative underperfusion were reported. All SPECT studies were analyzed in the conventional manner using a subjective scale and results were compared to MRI. Taking SPECT as a reference method resulted in a sensitivity of 80%, specificity of 91%, positive predictive value of 68%, negative predictive value of 95%, and a total accuracy of 89%. In comparison, to X-ray angiography overall accuracy was 87% for MRI perfusion and 77% for SPECT to detect significant coronary artery disease with stenosis > 70%. Conclusions: Post-processing of first pass myocardial perfusion MRI imaging using a new semiautomatic software, which easily generates the results semi-quantitatively and displays it visually as color-encoded images has a high sensitivity and specificity for detection of perfusion defects in comparison to SPECT and a higher accuracy in detecting significant coronary artery disease. The post-processing method may accelerate the time-consuming analysis of MRI perfusion images thus enabling a more widespread clinical utility.

Methods: We enrolled 446 patients (mean age 61±12 yrs, 162 women) who had both coronary angiography and EXE. retrospectively. All subjects were classified into quartiles of peak heart rate.

Conclusion: Exercise related hypertension impacts negatively on the specificity of EXE. This effect is observed at a lower level of systolic BP at peak exercise in women than in men. Positive EXE results where BP ≥ 200 mmHg should be confirmed with another stress modality, especially in women.