

### 1169-153 Intra-Aortic Balloon Counterpulsation Improves Regional Systolic Function After Acute Myocardial Infarction: Randomized Experimental Magnetic Resonance Imaging Study

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**Background:** We investigated whether the favorable shift in the myocardial oxygen supply/demand ratio afforded by intraaortic balloon counterpulsation (IABP) translates into improved regional systolic function after acute myocardial infarction (AMI).

**Methods:** Fourteen dogs underwent 90-min coronary artery occlusion and reperfusion. Seven were randomized to IABP immediately after reperfusion. Five short-axis slices were acquired for each dog at 1h, 6h and 24h following reperfusion using both delayed-enhancement (DE) and tagged MRI. IABP was paused during image acquisition. The risk region was defined as regional blood flow <50% of remote by radioactive microspheres. Each slice was divided into 6 segments that were classified in 4 categories: transmural AMI (DE>50% area), subendocardial AMI (DE<50% area), risk region and remote area. Peak systolic circumferential strain (Ecc) was calculated for each segment.

**Results:** Among segments with transmural AMI there was no difference in Ecc between the IABP group and controls (1±3% vs 1±3% at 1h, 0±4% vs 0±3% at 6h and 0±3% vs 0±3% at 24h, NS for all) and no Ecc improvement over time. Among subendocardial AMI segments, at 24h after reperfusion, the IABP group exhibited higher Ecc values than controls (-2±4% vs -3±3% at 1h, NS, -2±4% vs -2±4% at 6h, NS and -6±3% vs -4±3%, P<0.01), and only the IABP group had a significant improvement in Ecc from 1h or 6h to 24h (P<0.001). Among risk region segments, both groups displayed significant systolic dysfunction at 1h, and recovered normal contractility at 24h. At 6h, however, the IABP group exhibited normal contractility while controls still displayed systolic dysfunction (-5±4% vs -5±3% at 1h, NS, -12±5% vs -6±3% at 6h, P<0.001 and -14±5% vs -13±4% at 24h, NS). Therefore, both groups showed a significant Ecc improvement over time in risk regions, but the improvement occurred earlier in the IABP group. Both groups displayed normal Ecc values in remote segments at all times (-13±5% vs -12±5% at 1h, -14±6% vs -13±5% at 6h, and -13±5% vs -13±5% at 24h, NS for all).

**Conclusion:** IABP has a direct beneficial effect on regional functional recovery of segments that are predominantly composed of stunned myocardium after reperfused AMI.

### 1169-154 Steady State Free Precession Perfusion Allows Visual Assessment for the Clinical Diagnosis of Ischemia

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Cardiac magnetic resonance imaging (MRI) is a powerful tool for the non-invasive examination of myocardial perfusion. Apart from the determination of wall motion the assessment of coronary perfusion at rest and during pharmacological stress is a very reliable method for the detection of myocardial ischemia. Semi quantitative analysis (assessment of the myocardial signal up-slope and the response of blood supply to stress) is too elaborate for the use in clinical routine. However, conventional techniques are hampered by artifacts and a poor signal-to-noise-ratio impeding visual assessment. Steady-state-free-precession (SSFP) sequences are a new technique with a better spatial resolution. The aim of this study was to assess diagnostic accuracy of SSFP.

**Methods:** 137 patients (mean 61 years, 85% male) with suspected coronary heart disease or suspected progression were examined by cardiac MRI (1.5T Philips Intera CV). All patients underwent coronary angiography. For the assessment of myocardial perfusion a SSFP-sequence with a slice selective saturation-recovery-prepulse (3 slice-coverage of left ventricle per heartbeat) was employed and pharmacological stress was performed by using adenosine (140µg/kg/min). The analysis was performed without knowledge of the angiographic findings.

**Results:** 85 of 94 patients with significant stenosis (>70% diameter stenosis) in invasive angiography showed stress related attenuated perfusion in MRI indicating ischemia (sensitivity 90%). Only 5 out of 38 patients with no significant stenosis in coronary angiography showed attenuated appearance of contrast in MRI (specificity 88%). Among those 2 patients had hypertension, 2 patients showed pathological exercise testing and 1 patient had no stenosis although presenting 2 lesions in scar imaging.

5/85 patients with a visible perfusion defect in MRI showed no relevant stenosis in angiography (positive correctness 94%). 9/38 patients with no attenuated perfusion in MRI showed a significant stenosis in coronary angiography (negative correctness 81%).

**Conclusion:** SSFP-sequences with visual assessment of perfusion defects allow a reliable detection of relevant myocardial ischemia from cardiac MRI.

### 1169-155 Gadolinium-Enhanced Magnetic Resonance Imaging in Patients With Left Ventricular Apical Ballooning Syndrome Identifies Acute Myocarditis as a Potential Etiology of This Syndrome

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**Background:** Gadolinium-enhanced cardiac MRI (Gd-MRI) is a new non-invasive diagnostic tool to identify patients with acute myocarditis. Left ventricular apical ballooning syndrome (LVABS) is a clinical condition of unknown etiology characterized by acute onset of abnormal apical wall motion in the presence of angiographically normal coronary arteries. To test the hypothesis that acute myocarditis may be the etiology of this syndrome, Gd-MRI was performed as described by Friedrich et al (Circulation 1998;97:1802) in 11 consecutive patients who presented to Massachusetts General Hospital between January 2000 and January 2002 with LVABS. **Methods.** The ratio of global enhancement of myocardium relative to skeletal muscle was calculated from T1-

weighted spin-echo images acquired before and after administration of 0.1mmol/kg of Gd intravenously. The Gd-MRI study was considered positive for myocarditis when this ratio was > 3.5. Because myocarditis can be a focal disease, we also calculated a regional relative enhancement ratio (RRER) within the area of abnormal wall motion. **Results.** All patients were female (mean age of 72 ± 11 years) who presented with acute onset of chest pain, ST segment elevation, extensive anterior and apical wall motion abnormalities, elevated cardiac enzymes and angiographically normal coronary arteries. Global MRI analysis was positive for myocarditis in 5/11 patients (45.5%, mean value of 4.8 ± 1.4 at 5 ± 2 days after admission). Regional MRI analysis identified 4 additional patients with myocarditis (mean RRER 4.1 ± 0.6). The mean left ventricular ejection fraction was 41 ± 12% at the time of admission, 52 ± 14% at the time of hospital discharge, and 70.2 ± 8% at 39 ± 43 days of follow-up. **Conclusion:** 1) LVABS is characterized by acute onset of chest pain associated with abnormal apical wall motion and myonecrosis in the presence of normal coronary arteries, followed by rapid improvement in LV systolic function. 2) Gd-MRI suggests that acute myocarditis is a possible underlying mechanism for the LVABS. 3) Because myocarditis can be a focal disease, regional Gd-MRI analysis adds sensitivity to global Gd-MRI analysis in this cohort of patients.

### 1169-156 Usefulness of Myocardial Delayed Enhancement Magnetic Resonance in the Diagnosis and Surgical Treatment of Endomyocardial Fibrosis

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**Background:** Endomyocardial fibrosis (EMF) is a rare restrictive cardiomyopathy, whose differential diagnosis includes cardiac diseases with apical obliteration. The treatment is fibrous tissue (FT) resection in symptomatic patients (pts). Myocardial delayed enhancement (MDE) magnetic resonance with gadolinium-based contrast (Gd) allows the detection of myocardial injury and fibrosis. Therefore, the aim of this study was to analyze the utility of MDE in patients with EMF.

**Methods:** We studied prospectively 24 pts (19 females, 58±11 years) with EMF, 4 (17%) with predominant right ventricular (RV) involvement, 12 (50%) with predominant left ventricular (LV) involvement and 8 (33%) with biventricular involvement. Six (25%) of these pts were submitted to resection of LV fibrosis and were analyzed by MDE pre- and post-operatively. MDE were performed in a 1.5TGE CVI magnetic. Images were acquired after 10-20 minutes of 0.2 mmol/kg of Gd bolus. We analyzed % LV FT (%FT)= LV FT/LV mass.

**Results:** All surgical cases were confirmed as EMF during surgery and by pathology. Data are shown in Table 1. Postsurgical LV fibrosis decreased significantly (Table 1 \*p<0.05, pre- vs. postsurgical).

**Conclusions:** MDE is useful to confirm the diagnosis of EMF by differentiating from apical thrombus, hypertrophy and tumor. MDE was able to detect and quantify the fibrous tissue in both ventricles pre- and postoperatively. Moreover, this technique provides the precise location of fibrous tissue crucial for surgical planning.

Table 1

Variable	RV fibrotic mass (g)	LV fibrotic mass (g)	% LV fibrotic mass (%)
LV EMF (n=12)	-	16±7	13±7
RV EMF (n=4)	13±12	-	-
Biventricular EMF (n=8)	12±9	22±14	17±8
Pre- (n=6)	-	19±6*	25±7*
Post- (n=6)	-	14±3*	11±3*

### 1169-157 Cardiac Magnetic Resonance Imaging in the Diagnosis of Sarcoidosis

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**Background:** Sarcoidosis has been reported to cause clinical symptoms due to cardiac infiltration in 5% of patients. Postmortem studies have revealed cardiac involvement in 20-50% of cases. Echocardiography, myocardial scintigraphy and myocardial biopsy suffer from low sensitivity, specificity or both. Cardiac magnetic resonance (CMR) imaging might be a valuable technique in the diagnosis of this condition.

We prospectively evaluated CMR findings in patients with various stages of sarcoidosis, and determined sensitivity and specificity as compared to the guidelines from the Japanese Ministry of Health and Welfare (1993) for the diagnosis of cardiac sarcoidosis (gold standard).

**Methods:** Breath-hold functional gradient echo, T1-weighted multislice CMR examinations acquired at 1.5 T with ECG-triggering were performed before and 10 minutes after the administration of 0.1 mmol/kg Gd-DTPA in 78 patients with various stages of sarcoidosis. Ventricular function, regional wall motion, wall thickness, and the presence and localization of Gd-enhanced lesions were assessed by two blinded observers. Additional evaluation included physical examination, 12 lead ECG, 24-hour Holter ECG, echocardiography, thallium-201 scintigraphy and coronary angiography, if coronary disease was suspected. The outcomes of the CMR studies were compared with the gold standard for the diagnosis of cardiac sarcoidosis.

**Results:** 78 patients (50 male, 28 female, mean age 46,1 years, range 29-72 years) with different stages of sarcoidosis (stage 0: 17, stage 1: 21, stage 2: 10, stage 3: 22, stage 4: 8) underwent diagnostic testing. 5 CMR studies were of insufficient image quality. In 8 patients (11%) the diagnosis of cardiac sarcoidosis was made according to the gold standard. In 6/8 patients CMR both observers found Gd-enhanced lesions with/without

regional wall motion abnormalities, in 51/65 both observers agreed on the absence of abnormalities on the CMR study. (sensitivity 75% and specificity 78%) The lesions were most frequently located in the septal and anterolateral wall.

**Conclusions:** Functional and delayed enhanced CMR enables valuable detection and localisation of cardiac sarcoidosis.

#### 1169-158 **Magnetic Resonance Imaging Can Reliably Identify Heart Iron Overload in Patients With B-Thalassemia Major**

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**Background:** Patients with b-thalassemia major depend on continuous blood transfusions for survival. As a consequence, iron overload occurs in all organs including the heart. Heart biopsy is the only way to detect heart iron deposition, but it is invasive and not easily repeatable. We applied magnetic resonance imaging (MRI) for the assessment of myocardial iron deposition in patients with b-thalassemia and compared the results with cardiac biopsy data.

**Methods:** Twenty-five consecutive thalassaemic patients, NYHA II-III, were studied using a 0.5 T system, ECG-gated, with TE=17-68 msec. T2 relaxation time of the interventricular septum was calculated assuming simple monoexponential decay in one square centimeter regions of interest. Heart biopsy was performed within a week after the MRI study.

**Results:** Seven of the 25 patients had heart biopsy indicative of low iron deposition (Group A) and the remaining 18 patients had heart biopsy indicative of high iron deposition (Group B). T2 relaxation time of the heart (T2H) was in agreement with heart biopsy in 86% of the patients in Group A vs. 78% of the patients in Group B (overall agreement 80%). Similarly, serum ferritin levels were in agreement with heart biopsy in 28% vs. 88%, respectively (overall agreement 72%). In Group A, MRI was in better agreement with biopsy compared to ferritin (86% vs. 28%, p<0.05).

**Conclusions:** Heart T2 relaxation time appears in agreement with cardiac biopsy, both in high and low iron deposition, and is a useful non-invasive index for serial evaluation in b-thalassemia.

#### 1169-159 **Myocardial Infarct Age Determined by Contrast-Enhanced Cine Magnetic Resonance Imaging**

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##### **Background**

In patients with acute chest pain and resting wall motion abnormalities, differentiating acute myocardial infarction (AMI) and chronic myocardial infarction (CMI) can have important therapeutic implications. Contrast-enhanced cine magnetic resonance imaging (CEC) has been shown to sensitively diagnose microvascular obstruction (MO), a signature of AMI that is rarely seen in CMI. The present study was designed to determine if CEC can distinguish between AMI and CMI.

##### **Methods**

In 43 patients with enzyme-documented AMI treated by reperfusion, we performed CEC within 36 hours of admission, and repeated this examination after 3 months. CEC imaging was performed approximately 1 minute after 0.20mmol/kg of I.V. gadolinium-DTPA contrast. Nine 8mm short-axis slices and two long-axis slices acquired, using an-EKG gated, segmented k-space true-FISP pulse sequence. At 10 minutes post-injection, after an inversion time scan for optimum myocardial nulling, an inversion-recovery turbo-FLASH delayed hyperenhancement (IR-DE) study was done in identical slices. MO was defined as discrete endocardially-based hypoenhancing regions that became all or partially enhanced on IR-DE. All studies were read by two blinded observers.

##### **Results**

Microvascular obstruction on CEC was seen in 35/43 (81%) of patients with AMI, and in only 4/43 (9%) after 3 months. The presence of MO on CEC 81% sensitive and 91% specific for AMI.

##### **Conclusions**

The presence of microvascular obstruction on contrast-enhanced cine MRI is a sensitive and specific predictor of acute MI. Its absence suggests chronic MI.

#### 1169-160 **Systolic and Diastolic Strain Rates by Tagged Magnetic Resonance Imaging Distinguishes Regions With Different Degrees of Myocardial Injury After Acute Myocardial Infarction**

**Clerio F. Azevedo**, Luciano C. Amado, Dara L. Kraitchman, Bernhard L. Gerber, Nael F. Osman, Carlos E. Rochitte, Thor Edvardsen, Joao A. Lima, Johns Hopkins Hospital, Baltimore, MD

**Background:** Myocardial injury after acute myocardial infarction (AMI) is a regional and heterogeneous process that affects both systolic and diastolic function. Using tagged MRI, we evaluated regional systolic and diastolic function in areas with different degrees of myocardial injury after AMI and assessed whether both measures combined would allow us to better characterize and distinguish these regions.

**Methods:** Fourteen dogs underwent 90-min coronary artery occlusion followed by reperfusion. Five short-axis slices were acquired for each dog within the first 24h of reperfusion using 3 techniques: tagged MRI, first-pass perfusion and delayed-enhancement (DE). Regional blood flow <50% of remote by radioactive microspheres during coronary artery occlusion was used to define risk region. Each slice was divided in 6 segments that were classified in 4 categories: transmural AMI (DE>50% area, n=95), subendocardial AMI (DE<50% area, n=82), risk region (n=80) and remote area (n=163). For each segment, circumferential systolic strain (Ecc), systolic strain rate (SSr) and early diastolic strain rate (DSr) were calculated.

**Results:** Transmural AMI segments displayed depressed systolic contractility compared to subendocardial AMI segments (P<0.01), and both showed reduced systolic and diastolic regional function compared to remote areas (Ecc = -2.5±0.5% and -6.0±0.6% versus -13.1±0.5%, SSr = -0.11±0.10s<sup>-1</sup> and -0.82±0.12s<sup>-1</sup> versus -2.15±0.08s<sup>-1</sup> and DSr = 1.26±0.09s<sup>-1</sup> and 1.50±0.08s<sup>-1</sup> versus 2.99±0.10s<sup>-1</sup>, for transmural and subendocardial AMI segments versus remote areas, P<0.001 for all). In contrast, risk region segments only exhibited diastolic impairment (DSr=1.62±0.09s<sup>-1</sup>, P<0.001 versus remote), but not systolic dysfunction (NS versus remote). Importantly, after controlling for segmental infarct extension, the presence of microvascular obstruction ("no reflow") was related to further impairment of systolic and diastolic regional function (P<0.05 for both). **Conclusion:** Regional systolic and diastolic functional assessment using strain rate analyses provides for superior characterization and distinction of regions with different degrees of myocardial injury after AMI.

#### POSTER SESSION

### 1170 Nuclear Blood Flow Studies

Tuesday, March 09, 2004, 3:00 p.m.-5:00 p.m.

Morial Convention Center, Hall G

Presentation Hour: 4:00 p.m.-5:00 p.m.

#### 1170-141 **Initial Results Regarding the Safety, Tolerability, and Hemodynamic Effects of CVT-3146, a Selective Adenosine A2A Agonist, in Patients Undergoing Pharmacologic Stress SPECT Myocardial Perfusion Imaging**

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**Background:** CVT-3146 is a selective A2A adenosine receptor agonist shown to induce coronary hyperemia and potentially procure less adverse effects due to its limited stimulation of receptor subtypes not involved with coronary vasodilation. Thus, CVT-3146 may be an effective pharmacologic stress agent.

**Methods:** We studied 36 subjects (27 men, 9 women; 67±10 years) with two doses of CVT-3146 [400 mcg (n=18), 500 mcg (n=18)], administered by IV bolus, as part of a pharmacologic stress SPECT myocardial perfusion imaging protocol.

**Results:** Adverse effects (AE) occurred in 26 subjects (72%), including chest discomfort (33%), headache (25%), and abdominal pain (11%), with a similar incidence for both doses. Flushing, dyspnea, and dizziness were more frequent in the 500-mcg group (44%, 44%, and 28%, respectively) than in the 400-mcg group (17%, 17%, and 11%, respectively). Most AEs were mild to moderate (96%) and resolved within 15 minutes without treatment (91%). One serious AE occurred, with exacerbation of a migraine headache, requiring hospitalization. ST and T wave abnormalities developed with CVT-3146 in 7 and 5 subjects, respectively. No 2nd or 3rd degree AV block was noted and there were no serious arrhythmias. Peak hemodynamic effects were noted at 4 minutes for systolic blood pressure (-5.9±10.7 mmHg) and within 2 minutes for heart rate (+21.9±10.4 beats per minute). Systolic BP did not fall below 90 mmHg with either dose. The mean change in HR response was higher for the 500 mcg dose than for 400 mcg. Thirty minutes after CVT-3146, BP changes deviated <2% from baseline but HR remained above baseline by 8.6%.

**Conclusion:** CVT-3146 is well-tolerated and has acceptable hemodynamic effects. Minimal differences were noted in BP and HR responses between the 400 mcg and 500 mcg doses, but AEs were more frequent at the higher dose. CVT-3146 appears safe and well-tolerated for bolus-mediated pharmacologic stress SPECT myocardial perfusion imaging.

#### 1170-142 **Differential Vasodilatory Effects of CVT-3146, an A<sub>2A</sub> Adenosine Receptor Agonist in Various Vascular Beds in Anesthetized Dogs**

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CVT-3146 is a novel selective A<sub>2A</sub> adenosine receptor agonist being developed as a pharmacologic stressor for radionuclide myocardial perfusion imaging. Previously it has been shown in awake dogs that CVT-3146 causes coronary vasodilation without significantly affecting either total peripheral resistance or renal blood flow. The goal of this study was to determine the differential effects of CVT-3146 on blood flow velocity in various vascular beds. The effect of CVT-3146 on the blood flow velocity in the canine left circumflex coronary artery (LCX), brain arterial vasculature (BA), forelimb artery (FA) and pulmonary artery (PA) of comparable diameters were quantified as the average peak blood flow velocity (APV) using intravascular Doppler transducer-tipped catheter. CVT-3146 (1.0 µg/kg) given as an intravenous bolus, transiently enhanced blood flow which was site specific: APV increased 3.1±0.2, 1.4±0.1, 1.2±0.1, and 1.1±0.01 fold in the LCX, BA, FA and PA, respectively manifesting a site-potency rank order of LCX >>BA>FA>PA (figure). The effect of CVT-3146 on blood flow velocity was short lasting; reaching a peak in less than 30 sec and dissipating in less than ten minutes. Increased blood flow velocity was associated with a small transient increase in heart rate (16 bpm)