Does Cardiac Multislice Computed Tomography Change the Indication for Invasive Angiography in Symptomatic Patients With Suspected Coronary Artery Disease?

Ralph Haber, Janine Titus, Elke Boehme, Andreas Czernik, Barbara Richrath, Jürgen Buck, Peter Steinbrügler, Klinik München-Pasing, 81241 Munich, Germany

Background: Noninvasive coronary angiography with multislice spiral CT (CTA) produces impressive images, however, it is unclear, whether this new technique adds additional information that may change the indication for invasive coronary angiography (Inva-A) alone.

Methods: We therefore studied 118 consecutive symptomatic patients with suspected CAD and an indication for Inva-A according to standard criteria (angina and signs of ischemia in bicycle stress test, stress echocardiography and/or scintigraphy). Patients with known CAD or acute coronary syndrome were excluded. In all patients both Inva-A and CTA (Philips MX8000) multislice spiral CT, scan time 250ms, slice width 1.6mm, 120cc of contrast medium, 4cc/sec, retrospective gating) were directly compared by two independent investigators using the AHA 15-segment model (a total of 1.534 segments were studied). Each patient received metoprolol 100mg pos., patients with a calcium score (CS)>1000 were excluded (12 patients). The results are presented unpolished without exclusion of segments with poor image quality. Significant stenosis (SS) was defined as >50% lumen obstruction.

Results: Of 126 patients with CS<1000 52/61 patients with Inva-A correctly identified SS in 16/17 cases with no or only insignificant stenoses in Inva-A (specificity 72%). The major reason for impaired sensitivity were motion artifacts and severely calcified plaques masking SS. Specificity was impaired mainly by misclassification of nonobstructive plaques in Inva-A as SS. Calcium scoring alone was less reliable: of 20 patients with CS=0, five had SS in Inva-A and Inv-A, whereas 25/37 patients (67%) without SS revealed an age related elevated CS.

Conclusion: CTA with multislice spiral CT, but not calcium scoring alone, is a highly valuable additional test in symptomatic patients with suspected CAD to reduce the number of catheter procedures by up to 35% with minimal risk for the patient.

Self-Gating in Pediatric Cardiac Magnetic Resonance Imaging

Tiffanie R. Johnson, Orlando Simionetti, Andrew Larson, Mark A. Fogel, Children’s Hospital of Philadelphia, Philadelphia, PA, Siemens Medical Solutions, Malvern, PA

Background: Cardiac magnetic resonance (MR) uses the electrocardiogram (ECG) to synchronize image data acquisition. In 5% of cases, a reliable ECG cannot be obtained. The ability to perform cardiac MR without ECG would make MR more robust, and is a technical advance in the field.

Methods: A new method of using motion-induced changes in the image data to retro-spectively synchronize the data to the cardiac cycle has been developed. To determine if this “self-gating” method of cine MR can be substituted for the ECG, we performed cardiac MR with this new sequence on 20 pts (1.2-20.2 yrs) with congenital heart disease (CHD). Diagnoses included Fontan operation, pulmonary stenosis/regurgitation, tetralogy of Fallot, pulmonary atresia with intact ventricular septum, and Rastelli repair. Shortening fraction, fractional area change, and blood vessel diameter in both ECG and self-gated techniques were measured. The paired t-test and regression analysis were used.

Results: All self-gate sequences were successful. For all linear and area measurements there was no significant difference between the ECG and self-gated images (n=218, P=0.507), and correlation was excellent (r=0.986). Patients with right ventricular outflow obstruction had a statistically significant difference in measurements performed between the ECG and self-gated images could be identified (Power = 99%). (Figures)

Conclusion: Cardiac MR in CHD can be successfully performed without the use of the ECG. The new self-gating technique provides accurate information, makes the modality more robust, and is a technical advance in the field.

Magnetic Resonance Imaging Predictors of the Hemodynamic Severity of Aortic Coarctation

James Nielsen, Andrew J. Powell, Kimberlee Gauvreaux, Edward Marcus, Tai Geva, Children’s Hospital, Boston, MA

Background: MRI is increasingly utilized for anatomic assessment of aortic coarctation (Coarc) but its ability to predict the hemodynamic severity of the obstructive lesion has not been studied in detail. The goal of this study was to identify independent MRI variables predictive of hemodynamically significant Coarc as determined by cardiac catheterization (Cath).

Methods: Patients who fulfilled the following criteria were included: 1) MRI assessment of native or recurrent Coarct with contrast-enhanced 3D MRA of the aorta and phase velocity encoded cine MRI flow measurements in the ascending and proximal descending aorta (DoA); 2) Cath with hemodynamic evaluation of Coarc; 3) DoA with native and native minus post-Coarc index <2.2 L/min/m² by Cath were excluded. Patients were divided into 2 groups based on peak Coarc gradient by Cath: 1) ≤20 mm Hg (n=12); 2) >20 mm Hg (n=19). Logistic regression analysis was used to calculate odds ratios (OR) and areas under the receiver-operator characteristic (ROC) curve to determine MRI predictors of Coarc gradient ≥20 mm Hg and multivariate logistic regression was used to develop a rule for predicting the probability of Coarc gradient ≥20 mm Hg.

Results: By logistic regression analysis, the following variables predicted Coarc gradient ≥20 mm Hg: 1) smallest aortic cross-sectional area indexed to body surface area (AoCSA) (OR 1.71 for 10 mm²/m² decrease, p=0.005, ROC=0.87); 2) heart rate (HR)-corrected DoA flow duration (OR 1.27 for 0.01 sec² increase, p=0.012, ROC=0.86); 3) HR-corrected DoA flow fall time (OR 1.32 for 0.01 sec² increase, p=0.009, ROC=0.86); 4) HR-corrected DoA mean flow deceleration (MDec) (OR 1.68 for 100 ccs/m² increase, p=0.018, ROC=0.84). By multivariate analysis, AoCSA (OR 1.62, p=0.02) and DoA HR-corrected MDec (OR 1.66, p=0.005) were independent predictors of Cath gradient ≥20 mm Hg. The combination of AoCSA and DoA HR-corrected MDec predicted Coarc severity group with 96% sensitivity, 82% specificity, and ROC area of 0.94.

Conclusion: The combination of anatomic and flow data obtained by MRI provides a sensitive and specific test for predicting of Cath gradient ≥20 mm Hg. These findings should be prospectively validated.

Magnetic Resonance Imaging Predictors of the Hemodynamic Severity of Aortic Coarctation

Jin Chul Paeng, Dong Soo Lee, Joo Hyun Kang, June-Key Chung, Myung Chul Lee, Seoul National University College of Medicine, Seoul, South Korea

Background: With increasing therapeutic application of stem cells to diverse heart disease, in vivo imaging method of cellular differentiation is required. We developed a transgenic mouse model to image the differentiation into cardiomyocyte.

Methods: Alpha-myosin heavy chain (α-MHC) promoter is a specific gene expression regulator for differentiated cardiomyocyte, and sodium/voldeide symporter (NIS) is one of promising reporter genes, which takes up radioactive iodine. A DNA construct comprising human NIS gene driven by a murine α-MHC promoter was synthesized. The DNA construct was tested in rat myoblast cell lines for the uptake of iodine. Lineage-specific vectors of the construct were microinjected into fertilized eggs of FVB mouse strain and positive founders were identified by PCR typing. To test the adequacy of the transgenic mouse model, in vivo image was acquired using ¹³¹I and gamma camera. Also the uptake was poor.
Noninvasive Detection of Angiogenesis With a 
αvβ3 Integrin Following Hindlimb Ischemia

Jing Hua, Brian N. Bourke, James Song, Conroy Chow, Mehran M. Sadeghi, Patti Cavatere, Xiaoyue Hu, Neda Jahanesh, Lawrence W. Dobrucki, Niels VanRoyen, Marvi Mendizabal, Ivo Buschmann, Albert J. Sinusas, Yale University, New Haven, CT

Background: The αvβ3 integrin is over-expressed in angiogenic vessels, and represents a potential target for non-invasive imaging of angiogenesis.

Methods: We evaluated a technetium-99m labeled peptide, NC100692 (NC), targeted at αvβ3 integrin for imaging in an established murine model of angiogenesis induced by hindlimb ischemia. Mice (n=23) underwent a surgical right femoral artery occlusion (OC) and contralateral sham operation. NC (1.35±0.15 mCi, i.v.) was injected (INJ) in control mice or at different times after OC (3d, 7d, 2wk and 8wk), and in vivo pinhole planar imaging performed at 75 min after INJ. 90 min after NC INJ, tissue from hindlimb (HL) proximal (P) and distal (D) to OC was excised for gamma well counting (GWC), and for quantitative immunohistochemical staining of lectin D to OC. HL muscles were divided into 3 groups for GWC; 1) P upper (U) HL, 2) DUHL, and 3) lower (L) HL. Regional activity on ischemic (I) HL was normalized to non-ischemic (NI). ROI's were drawn on in vivo images in region distal to OC, and UNI ratios calculated.

Results: Relative NC activity by GWC was significantly increased in DUHL and LHL at 7d after OC. On in vivo pinhole images increased focal NC activity was seen distal to OC at 3d and 7d. Lectin staining confirmed increased angiogenesis in LHL at 3d and 7d post OC.

Conclusions: NC selectively localized in regions of increased angiogenesis, and was detectable by non-invasive imaging. NC could potentially be used for non-invasive serial “hot spot” imaging of angiogenesis.

*p<0.05 vs control

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Assessment of Myocardial Perfusion and Metabolism in Normal and Diabetic Rats by MicroPET Imaging

Piaar Herren, Jooyoun Kim, Terry Shall, Carmen Dence, Jason S. Lewis, Robert John Gropler, Michael J. Welch, Washington University School of Medicine, St. Louis, MO

Background: Small animal positron emission tomography (microPET) imaging has the potential to accurately phenotype various rodent models of cardiovascular disease. We are currently developing and validating techniques to measure myocardial perfusion and metabolism in rodents that utilize radiotracers and compartmental kinetic models validated in animal models and applied to humans. We investigated whether differences in cardiac metabolism could be detected with these techniques.

Methods: Zucker diabetic rats (D) (n=5) and lean controls (L) (n=5) (age:100 ± 27 days) were studied under fasting conditions in one imaging session. The following measurements were obtained; myocardial blood flow (MBF, mL/g/min) and myocardial oxygen consumption (MVO2, umol/g/min) with 11C-acetate; myocardial glucose uptake (MGU, mL/g/min) and utilization (MGU, mL/g/min) with 11C-glucose; and fatty acid uptake (MFAU, mL/g/min), utilization and oxidation (MFAO, MFAU both in mmol/min) with 11C-palmitate.

Results: Heart rate, MBF and MVO2 were not different between L and D. When compared to L, D had higher plasma glucose (16.8 ±3.3 vs 31.6 ±1.8 mmol/L, p<0.001), free fatty acid (894±519 vs 1665±510 nmol/mL, p<.05) and insulin levels (27.2± vs 61±5 μIU/ L, p<.001). Despite higher plasma glucose and insulin levels observed in D, MGU was comparable between L and D (6.09±0.34 vs 0.86±0.042); however due to higher plasma glucose levels, MGU (MGU x plasma glucose) tended to be higher in D (1125±271 vs 250±61271 nMolas). In contrast, when compared to L, MFAU (0.38±0.11 vs 0.51±0.04, p<.05) was higher in D. MFAU (306.12± 843.24± p<.01) and MFAO (230±83 vs 503±205, p<.05) were higher in D.

Conclusions: The results of this study are consistent with the well-known metabolic changes that take place in the diabetic heart such as its reliance on fats as source of energy as well as the observation that derangement of fatty acid metabolism precedes that of glucose metabolism. This study demonstrates the feasibility of using microPET imaging to phenotype myocardial metabolism in rodent models of cardiac diseases to identify biologically relevant models to human disease.

Noon

Percutaneous Endarterectomy for Repair of Vascular Trauma: Early Experience


Background: Percutaneous valve repair is an increasingly attractive alternative to valve replacement, but still requires thoracotomy, cardio-pulmonary bypass, and intraoperative echocardiographic monitoring. Successful valve repairs using the edge-to-edge surgical technique (Alfieri) have been reported. This paper presents the initial experience with echocardiography in performing the percutaneous endovascular repair.

Methods: The endovascular Mitral Repair System (EvalveTM Redwood City, CA) uses a steerable guide catheter to position a two-armed, V-shaped device, to approximate the leaflet tissue near the midline of the valve. The delivery of Evalve has 5 essential steps that require echo guidance: 1) trans-septal cross, 2) alignment of the delivery system perfectly perpendicular to the mitral valve plane and in the center of the coaptation line 3) alignment of the approximation implant device with the open arms perpendicular to the coaptation line 4) - closing of the arms and approximation of the tips of the mitral valve and 5) release of the implant device.

Results: We used a combination of trannsesophageal echo (TEE) and transthoracic echo (TTE) to guide the entire procedure in 5 cases, the first performed in humans. TEE was used only during steps 1, 2, 4 and 5. TTE imaging was performed 1 day and 3d post procedure. The myocardium of transgenic mouse showed intense uptake of 131I (7.1-fold of control) when compared to L, D had higher plasma glucose (16.8 ±3.3 vs 31.6 ±1.8 mmol/L, p<.001), free fatty acid (894±519 vs 1665±510 nmol/mL, p<.05) and insulin levels (27.2± vs 61±5 μIU/ L, p<.001). Despite higher plasma glucose and insulin levels observed in D, MGU was comparable between L and D (6.09±0.34 vs 0.86±0.042); however due to higher plasma glucose levels, MGU (MGU x plasma glucose) tended to be higher in D (1125±271 vs 250±61271 nMolas). In contrast, when compared to L, MFAU (0.38±0.11 vs 0.51±0.04, p<.05) was higher in D. MFAU (306.12± 843.24± p<.01) and MFAO (230±83 vs 503±205, p<.05) were higher in D.

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Noon

Early Experience With Percutaneous Aortic Valve Implantation in Patients With Severe Nonoperable Aortic Stenosis

Hélène Etcherenrodt, Christophe Tron, Fabrice Bauer, Catia Agatiello, Laurent Sebagh, Danielle Nussmovici, Alain Cribier, Charles Nicolle Hospital, Rouen, France, Percutaneous Valve Technologies, Fort Lee, NJ

Background: To offer a therapeutic option to end-stage non-operable patients (Pts) with calcific aortic stenosis (AS), we developed a percutaneous heart valve (PHV) made of three-leaflets equine pericardium mounted in a stainless steel balloon expandable stent.

Methods: The PHV is crimped on a 22 mm diameter-balloon catheter advanced over a 0.035 extra-stiff guidewire through a 24 Fr introducer, and delivered by balloon inflation. This PHV was extensively tested in vitro and in animals before being implanted in 6 Pts (5 male; 75 ± 12 yrs). Results. All Pts had severe calcific AS (0.5 ± 0.1 cm²), were in NYHA class IV and were declined for surgery due to cardiac (cardiogenic shock in two, low ejection fraction, previous bypass surgery, porcelain aorta) and/or extracardiac reasons (subacute leg ischemia; previous or evolving cancer; renal failure; stroke; age > 90 yrs). Under local anesthesia and mild sedation, the antegrade trans-septal route was chosen. A 0.51±0.04* control endovascular repair. 2) Endovascular mitral valve repair appears feasible in human with severe mitral regurgitation.

Noon