POSTER SESSION

1075 Computed Tomography: Techniques and Applications

Monday, March 08, 2004, 9:00 a.m.-11:00 a.m.
Morial Convention Center, Hall G
Presentation Hour: 10:00 a.m.-11:00 a.m.

1075-157 Selection of Optimal Phase for 3-D Computed Tomography Reconstruction of Coronary Arteries Using an Automatic Vessel Tracking System

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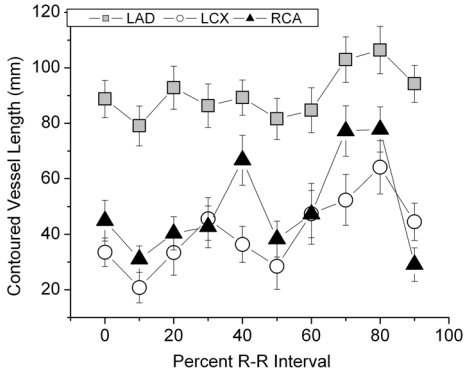
Background. Multi-detector CT (MDCT) is an evolving technology for non-invasive coronary angiography (CTA). Selective imaging during phases of the cardiac cycle that yield the best coronary definition should reduce interpretation time and radiation dose.We used an automatic vessel tracking system to identify factors associated with variation in the quality of CTA, including artery assessed, cardiac phase, R-R variability and heart rate. The software tracks contrast-enhanced vessels along their course using an algorithm based on level sets. The tracked vessel length is proportional to image quality and provides a quantitative measure of the adequacy of coronary visualization. Twenty-five patients aged 59±12 years, 71% male, with a heart rate of 64±14 underwent CTA using 16-slice MDCT at 400 or 500 msec rotation time. Results. The average tracked vessel length in mm was 91±32 in the left anterior descending, 50±25 in the right coronary artery and 41±29 in the circumflex ($p<0.001$). Tracking length was related to cardiac phase ($p<0.001$ ANOVA), with greatest tracking at 80% of the RR interval in all vessels (figure). Tracking length was also greater in patients with lower R-R variability and heart rate. Conclusion. The proximal coronaries are well visualized by CTA. Sampling and analysis at 80% of the RR interval provides optimal image quality for all three major epicardial vessels. Concentrated sampling and analysis at this time interval may reduce radiation exposure and interpretation time.



1075-158 Optimal Reconstruction Protocol for Noninvasive Coronary Angiography With 16-Slice Multidetector-Row Computed Tomography

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Background: Motion artifacts limit diagnostic quality of coronary arteries even with state-of-the-art multidetector-row computed tomography. Mid-diastole (MD) is the preferred phase for image reconstruction because of less cardiac motion but coronary arteries have biphasic movement pattern with slower velocities at MD and end-systole (ES). We evaluated the influence of systematic inclusion of ES and the most efficient reconstruction protocol needed for optimal image analysis.
Methods: Coronary imaging was performed using a contrast-enhanced ECG-gated protocol (120 kV, 500mAs, 12x0.75 collimation, and 120 cc contrast agent at 3 cc/sec). The images were reconstructed at 10% increments (10-90%) of the RR interval. Each reconstruction was evaluated blinded to the cardiac phase and each artery left main, left anterior descending [LAD], left circumflex [LCX] and right coronary artery [RCA]) was graded quantitatively as unacceptable (1), acceptable (2), good (3) or the best (4) based on the degree of motion artifact. Multiple combinations of reconstructions were compared to determine the optimal protocol.
Results: From 50 patients (38 males, heart rate 58.2±14), 438 reconstructions and 1756 arteries were analyzed. Overall, 60% was most likely to give the best reconstruction for each artery. In 44% of the patients the best reconstruction for at least one artery (RCA 36%, LCX 20%, LAD 22%) was located in ES (20-30% of the RR interval). This group had a higher mean heart rate (67.9±10 vs 59.6±8.8, $p=0.005$). There was no correlation between heart rate and score quality except when the worst reconstructions (10-40-90%) were excluded ($r=-0.33$). Combinations of 3 or 4 reconstructions covering both ES and MD showed higher scores than any combination covering only MD ($p<0.001$) and also yielded an 80% reduction in the number of non-evaluable arteries (from 5% to 1%, $p=0.02$). The best combination in this study was 20-30-60-70%.
Conclusion: The combination of ES and MD reconstructions significantly reduces the number of non-evaluable coronary arteries (especially the RCA) and may increase the diagnostic accuracy of the technique. A protocol including 4 different reconstructions is the most efficient.

1075-159 Individualized Cardiac Phase Selection by Tissue Doppler Imaging Improves Image Quality in Multislice Computed Tomography of the Coronary Vessels

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Background: Multi-Slice Computed Tomography (MSCT) of the coronary vessels is hampered by motion artifacts, where the right coronary and left circumflex arteries are most often compromised.
Hypothesis: With the future goal of reducing radiation and improving image quality we sought to determine if tissue Doppler imaging (TDI) of the the atrio-ventricular grove could improve detection of the optimal phase for reconstruction of the coronary vessels.
Methods: We studied the coronary vessels in 27 subjects (including 7 with known coronary disease, 3 heart transplant patients, 3 patients with valvular disease and one with an anomalous coronary). TDI echocardiography was done to determine an optimal phase within the cardiac cycle where tissue velocity in the atrio-ventricular grove was at zero. Contrast enhanced MSCT (Mx800IDT, Phillips Medical Systems) was done of the coronary vessels. Curved multi-plane reconstruction (MPR) of the right coronary artery was done in each subject in three different phases; 50%, 75% and the TDI determined phase. These MPR phases were examined for quality (adequate or inadequate) and ranked internally (1=best, 2=medium, 3=worst) for each subject.
Results: The average heart rate was 69±16 beats/min (range 42-115). The average TDI phase was 70.7±2.4 % (range 42-90). The quality of the TDI determined phase MPR images was deemed adequate in 81% of subjects compared to 70% and 41% with reconstructed phases 75% and 50%, respectively ($P<0.01$ by Chi-square). The TDI determined MPR images had the best average rank, 1.6±0.1 compared to 2.0±0.1 and 2.4±0.1 with reconstructed phases 75% and 50%, respectively ($P<0.001$ by ANOVA). The TDI determined phase was better than one or more of the other phases in 96% of the subjects ($P<0.0001$ by Chi-square).
Conclusion: Over a wide range of heart rate coronary artery reconstruction, based on individual specific TDI, increases the likelihood of gaining adequate image quality when compared to standard phase reconstruction. Prospective gating based on TDI might decrease the amount of radiation needed for MSCT angiography.

1075-160 16-Slice Computed Tomography for Coronary Angiography: Can We Do It at Higher Heart Rates?

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Background: The potential of 16 multi-detector row computed tomography (MDRCT) paired with adaptive multi-cycle reconstruction was assessed for coronary artery imaging at higher heart rates.
Methods: Fifty patients underwent coronary CT angiography (heart rate range 45-103). Raw helical data and ECG tracings were saved in a combined dataset. Retrospectively ECG-gated images were reconstructed at pre-selected heart phases (50% and 80% window center in relation to cardiac cycle). The reconstruction algorithm used a 3D voxel based approach with cardiac phase weighting function. The relationships between heart rate, heart phase reconstruction window and image quality were analyzed. Image quality for motion free images was referenced against coronary catheterization in a secondary evaluation step.
Results: A significant negative correlation was observed between heart rate and image quality ($p < .05$). Motion artifact free images were available in 88% (N=44) of the patients. Consistent motion free images were achieved at or below a heart rate of 80 bpm (N = 39). Highest ranked image quality is achieved below 75 bpm. Segmental analysis reveals 97% of the segments (≥ 1.5 mm according to conventional angiography) assessable below 80 bpm. Premature ventricular beats and rate contained arrhythmia did not impede diagnostic access to the coronary arteries in 83% (N=10, arrhythmia detected in N =12).
Conclusion: Consistent motion free coronary imaging, using 16 MDRCT and adaptive multi-cycle reconstruction algorithms, can be obtained for heart rates up to 80 bpm.

1075-161 Multislice Spiral Computed Tomography Coronary Angiography of the Entire Coronary Tree

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Background: multislice spiral computed tomography (MSCT) is a promising technique for non-invasive coronary angiography, but clinical application is still limited due to insufficient image quality, caused by motion artefacts and calcifications.
Methods: MSCT coronary angiography was performed in 128 patients (112 male, aged 58±12yrs) with angina pectoris using a 16-row MSCT scanner. Patients with a pre-scan heart rate ≥65 b.p.m. received 100 mg metoprolol one hour before the scan. An intravenous bolus injection of 100 ml of contrast material was administered, and all data were acquired during a breath hold of <20s. The left main, left anterior descending, left circumflex and right coronary artery, including ≥2.0mm side-branches, were independently evaluated by two observers for the presence of ≥50% diameter stenosis. The consensus MSCT-reading was compared to reference quantitative coronary angiography.
Results: the mean heart rate was: $58\pm8 min^{-1}$. Non-invasive MSCT coronary angiography was successfully performed in 127 patients. Two-hundred-sixty of all available 1384 coro-