Computed Tomography: Techniques and Applications

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 circumflexes (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.

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 (MDCT) 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) 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 < 0.05). 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 = 29). 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). Consistent motion free coronary imaging, using 16 MDCT and adaptive multi-cycle reconstruction algorithms, can be obtained for heart rates up to 80 bpm.

16-Slice Computed Tomography for Coronary Angiography: Do We Need Optimal Cardiac Phase?

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Background. The optimal cardiac phase for 16-slice MDCT coronary angiography is unknown. We sought to determine if tissue Doppler imaging (TDI) of the left ventricle could improve detection of the optimal phase for reconstruction of the coronary vessels.

Methods: TDI was performed in 107 patients for 20 seconds during baseline (at heart rate 70±12 bpm). The mean heart rate was 75±12 bpm. The left anterior descending, left circumflex and right coronary arteries were reconstructed at 10% increments (0-90%) of the cardiac cycle. TDI was performed in the left ventricle at 80% of the cardiac cycle. The correlation coefficient between TDI and R-R interval was assessed.

Results: The mean heart rate was 75±12 bpm. The mean heart rate was 75±12 bpm. The correlation coefficient between TDI and R-R interval was assessed.

Conclusions: The correlation coefficient between TDI and R-R interval was assessed. The optimal cardiac phase for 16-slice MDCT coronary angiography is at about 80% of the R-R interval.