INITIAL EVALUATION OF CORONARY CT ANGIOGRAPHY IMAGE QUALITY ON THE REVOLUTION CT SYSTEM

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**INTRODUCTION**

- BACKGROUND: CT Perfusion allows for the evaluation of myocardium in particular for the detection of ischemia and infarction. Previous studies have, however, described beam hardening artifacts within the myocardium, which may have an effect on identifying true perfusion defects. Larger or eccentrically located CT scanners may show promise in reducing myocardial heterogeneity but have been limited by cone beam artifacts and lower gantry rotation speeds. We sought to evaluate the performance of a new volume CT scanner (Revolution CT, GE Healthcare) enabled with novel wide cone recombination software (Volume HD reconstruction) and improved temporal resolution with regards to image quality and signal homogeneity.

**METHODS**

- **DESIGN AND SETTING**: Study Groups Prospective enrollment of 24 subjects was performed from May 2013 to November 2013. This study was approved by IRB. All 24 patients provided informed consent. Inclusion criteria were: 18 years or older not requiring acute care, without allergies to iodinated contrast media, and without renal insufficiency. Women less than 60 years of age confirmed to be non-pregnant.

- **All 24 patients had both a volumetric CCTA study (Revolution CT scanner) for research purposes after having undergone a prior clinical 64-slice CCTA (64-64 CT scanner). The 64-slice CCTA scan may have been performed at a prior time point within a few weeks or months. This made for an in person comparison of 24 subjects which formed our analysis.**

- **CCTA SCAN PROTOCOLS AND IMAGE RECONSTRUCTION**: The CT image data from the larger detector scanner were acquired in one heart cycle with a volumetric coverage of 16 cm (256 slice 6 cm x 0.625mm) (Revolution CT, GE Healthcare) and a gantry rotation speed of 0.28 sec/rotation. Images were then re-constructed with Volume HD reconstruction and next generation iterative reconstruction technology (ASIR-V Adaptive Statistical Iterative Reconstruction, GE Healthcare, Milwaukee, WI) (Table 1). Compared to past generations of iterative reconstruction, the version being validated in our analysis includes more advanced noise and object modeling.

- **All CT acquisitions with the Volumetric CT scan were axial prospectively triggered CCTA with different acquisition windows dependent heart rate. Motion correction software (SnapShot Freez, GE Healthcare) was selectively applied only if motion was present.**

- **Patients were given an injection of 60 cc of contrast in the first phase, followed by 20 cc of contrast and 30 cc of saline in the second phase and completed by 50 cc of saline. The contrast was calculated by multiplying dose-length product with the conversion factor for Cardiac CT examinations (0.034 mSv/mGy.cm).**

**QUANTITATIVE ANALYSIS (SIGNAL INTENSITY, NOISE AND CONTRAST)**

- **The post-processing analyses were performed on an offline three-dimensional workstation. Multiple planar reconstructions of the left ventricular wall at 5 mm thickness were created. Quantitative measures of image quality were performed in the myocardium, blood pool and aorta. Six Region of Interest (ROI) measurements were made across the myocardium in each of the Volumetric CT image sets as well as the 64-slice CT image sets (Figure 1).**

- **An ROI of the myocardial wall was obtained, which ranged between 0.1cm2 and 0.2cm2. These measurements were made in the following regions: base-anterior, base-inferior, mid-anterior, mid-inferior, apex-anterior, apex-inferior. The same technique was used to assess myocardial blood pool radiation dose was calculated by multiplying dose-length product with the conversion factor for Cardiac CT examinations (0.034 mSv/mGy.cm).**

- **Unlike the smaller ROI in the myocardial wall, a larger maximum ROI ranging between 1cm2 and 4cm2 was utilized to assess the most possible blood pool. ROI measurements ranging between 1cm2 and 2cm2 were made in the aorta in each of the Volume CT image sets as well as the 64-slice CT image sets.**

- **These measurements were obtained in one session by a single radiologist (RR, 3 years of post-fellowship experience) manually placing a circular region of interest at each anatomic site mentioned above. The signal to noise-ratio (SNR) was calculated by dividing the mean CT number within the ROI divided by the standard deviation from the mean value within the ROI.**

- **The variation in mean values across multiple ROI was quantified by the Coefficient of Variation (CV). This value is calculated by dividing the standard deviation of the mean CT numbers across multiple ROIs by the mean CT number. The CV metric normalizes relative contrast volume and specification differences from patient to patient, which do not reflect the performance of the scanner itself.**

**RESULTS**

- **Heart Rate The median heart rate of patients undergoing the Volume CT was 60 bpm ± 10 SD (range=49-86). The median heart rate for patients undergoing the 64-slice CT was 75 bpm ± 6 SD (range=48-65). A significant difference in heart rate between the Volume and 64-slice CCTA (p=0.036). Motion correction was applied at the time of the scan acquisition in 11 of 24 subjects. Radiation Dose Median effective dose for the Volume CT studies was 2.06 mSv ± 0.87 median SD and for the 64-slice CT images was 3.75 mSv ± 5.76.**

- **On the 64-slice platform, 8 patients had retrospectively gated scans and 16 had prospectively triggered CCTA. On the prospectively gated CAT scan, the retrospectively gated CATA was 11.46 ± 7.74 median ± SD and for the prospectively triggered CAT scan was 4.74 ± 1.28. As expected, there was a significant difference in the radiation dose between those who had retrospectively gated scans from prospectively triggered CCTA (p=0.002).**

- **Quantitative Analysis The distributions between the CV in the Volume and 64-slice CCTA were significantly different in each of the myocardium (0.097, 0.080-0.125 vs 0.138, 0.116-0.183, p=0.0012), blood pool (0.016-0.099 vs 0.024, 0.058, 0.047-0.075, p<0.001) and aorta (0.013, 0.008-0.19 vs 0.049, 0.033-0.077, p=0.001).**

- **Quantitative measures of Signal Intensity were statistically not significant at all the measured region of interest at the anterior and inferior wall at the base, mid and apical portion of the myocardium between Volume and 64-slice CT.**

- **Quantitative Analysis in image quality was observed at a per-patient as well as per segment level. Overall Likert score was 4.5±0.7 and 3.7±1.2 for Volume and 64-slice CCTA, respectively (p=0.001). Significant image improvement was calculated by dividing the mean CT number within the ROI divided by the standard deviation from the mean value within the ROI.**

- **The mean values across multiple ROI was quantified by the Coefficient of Variation (CV). This value is calculated by dividing the standard deviation of the mean CT numbers across multiple ROIs by the mean CT number. The CV metric normalizes relative contrast volume and specification differences from patient to patient, which do not reflect the performance of the scanner itself.**

**CONCLUSIONS**

- **CT Perfusion allows for the evaluation of myocardium in particular for the detection of ischemia and infarction. Previous studies have, however, described beam hardening artifacts within the myocardium, which may have an effect on identifying true perfusion defects. Larger or eccentrically located CT scanners may show promise in reducing myocardial heterogeneity but have been limited by cone beam artifacts and lower gantry rotation speeds. We sought to evaluate the performance of a new volume CT scanner (Revolution CT, GE Healthcare) enabled with novel wide cone recombination software (Volume HD reconstruction) and improved temporal resolution with regards to image quality and signal homogeneity.**