Optimizing CCTA: Impact of Tailored CCTA Protocols on Radiation Dose, Image Quality, and Patient Eligibility

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Background

Coronary computed tomography angiography (CCTA) is highly dependent on patient variables [1]. Patient-specific protocols have demonstrated potential for dose reduction but can be difficult to create and manage [2]. The goal of this study was to create user-friendly, size and condition-specific protocols to improve CCTA image quality, reduce dose, and expand eligibility to patients with contraindications due to heart activity.

Impact

BMI-specific customizations and tailored phase windows led to a decrease in radiation dose, increased image quality, and expansion of eligible patients.

References

[1] Abbara S, Blanke P, Maroules C. SCCT guidelines for the performance and acquisition of coronary computed tomographic angiography: A report of the Society of Cardiovascular Computed Tomography Guidelines Committee JCCT, 2016; 10, 435-449

[2] Odigie-Okon E, Ogunleye O, Saxena R, Ganiyu S, Hassib M, Swanson D, Gaalema D. Radiation Dose Reduction in Coronary Computed Tomography Angiography. JACC Case Rep. 2025 Nov 12;30(36):105719.

Methods

Two CCTA protocols were created to replace multiple size and heart-rate dependent protocols on a wide-beam scanner: one for BMI ⩾25 and one for BMI <25. Within each protocol, 28 different profiles were established based on seven heart rate (HR) categories (from 30-200 beats/minute) and HR rhythm (stable, variable, irregular, and highly irregular). Before intervention, the whole heartbeat was often imaged to accommodate rapid/fluctuating heart rates due to high volume of inpatient and emergency patients. Custom phase windows were defined for specific HR/rhythm combinations to reduce radiation by retrospectively analyzing images and gathering feedback from technologists. New guidelines were established to specify contrast volume and injection rate based on BMI to improve bolus quality. Additionally, deep learning algorithms were utilized to further improve vessel detectability. $CTDI_{vol}$ was retrospectively tracked monthly.

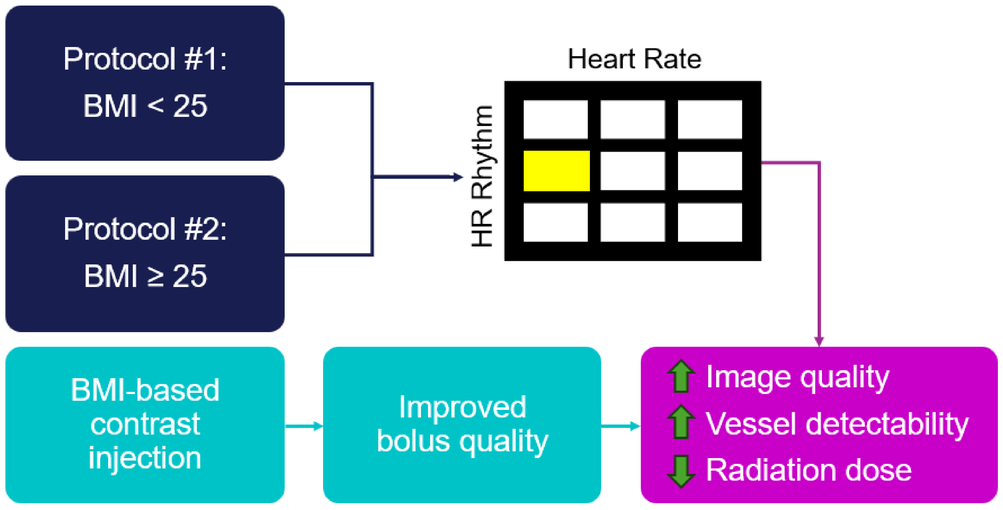

Figure 1: Improved CCTA workflow.

Average Heart Rate (BPM)

HR Rhythm	30	55	65	70	75	85	100	200
Irregular	Cardiac Axial 0.28 s/rot 35-45%, 100%, SSF 75-80%, 100%, SSF 1 beat, 20% HRV: 0.5 AG/SAM Center Phase	Cardiac Axial 0.28 s/rot 35-75%, 100%, SSF 70-80%, 100%, SSF 1 beat, 20% HRV: 0.8 AG/SAM Center Phase	Cardiac Axial 0.28 s/rot 35-80%, 100%, SSF 40-55%, 100% 1 beat, 20% HRV: 1.0 AG/SAM Center Phase	Cardiac Axial 0.28 s/rot 35-75%, 100%, SSF 70-80%, 100%, SSF 1 beat, 20% HRV: 1.0 AG/SAM SmartPhase, SSF	Cardiac Axial 0.28 s/rot 30-80%, 100%, SSF 200-400 ms, 100%, SSF 1 beat, 20% HRV: 1.0 AG/SAM SmartPhase, SSF	Cardiac Axial 0.28 s/rot 1 beat, 100%, SSF 40-55%, 100% 1 beat, 20% HRV: 0.0 AG/SAM SmartPhase, SSF	Cardiac Axial 0.28 s/rot 1 beat, 100%, SSF 40-55%, 100% 1 beat, 20% HRV: 0.0 AG/SAM SmartPhase, SSF	

Figure 2: Example parameters for irregular heart rhythm for various heart rate ranges.

Results

In the first month after implementation of the new protocols, $CTDI_{vol}$ decreased by 30%. Bolus quality improved, especially in high BMI patients. Patients with rapid HR or contraindications to beta blockers that previously were cancelled or delayed were successfully imaged. By embedding the HR/rhythm profiles within the protocol, fewer protocol decisions were required by technologists, leading to an increased comfortability with cardiac imaging on a multi-modality scanner.

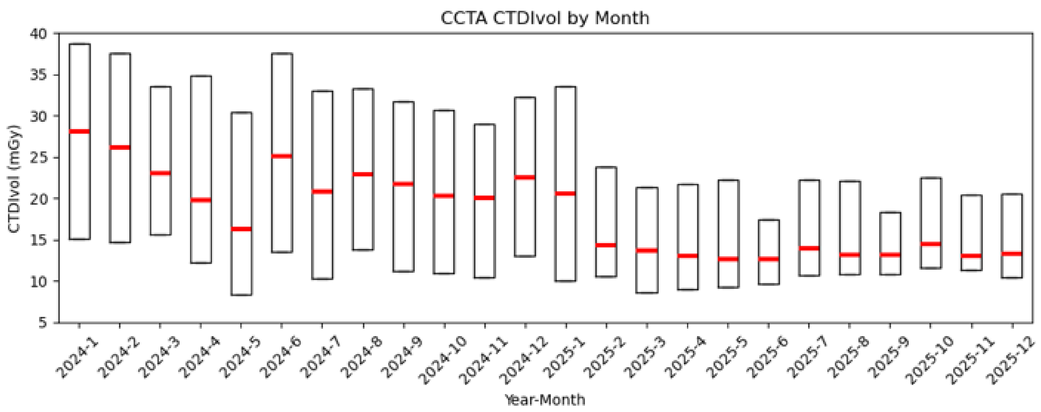

Figure 3: CTDIvol by month. Use of the new protocols began in February 2025.

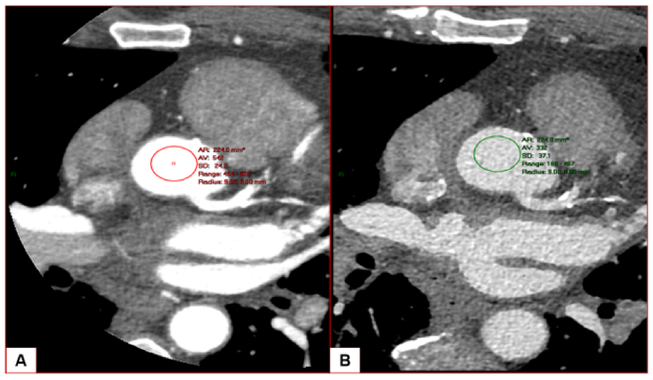

Figure 4 High BMI patient, using injection rate of A) 8 cc/sec and B) 6 cc/sec. The new BMI-based contrast injection showed an increase in bolus quality.

Conclusion

The use of tailored phase windows and BMI-based contrast administration improved image quality and lowered radiation doses, particularly for patients with irregular rhythms or high BMI. Replacing multiple rigid protocols with two dynamic protocols allowed imaging of challenging patients and increased comfortability among technologists.