How to reduce dose in Cardio CT

SOMATOM Definition AS Family *syngo* CT 2011A

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General

Coronary CT Angiography (CTA) is one of the more challenging CT acquisitions in your daily practice. The main reason is cardiac motion, which usually requires additional scan data, of which only a fraction is deemed motion free and can be used for image reconstruction. This can result in high radiation dose exposure if no preventive measures are taken.
The tips below apply to all cardiac modes:

Use 100 kV tube voltage for all patients up to 80 kg/175 lbs (or BMI 25 kg/m^2). Use 120 kV for heavier patients. Enable CARE Dose4D for all patients. Reference values for voltage and current are: 370 mAs/rot at 100 kV, 320 mAs/rot at 120 kV*

Use the axial images from the calcium scoring scan for an optimization of the scan range in the upcoming CTA. Easily save up to 15% dose!

Position the patient in the iso-center of the scanner to guarantee optimal use of the cardiac shaped filter.

Remove all metal objects from the patient and ensure a tidy layout of the ECG cables.

Rule of thumb dose ranking (low to high) :

1. Adaptive Cardio Sequence – low dose at steady heart rate!
2. Cardiac Spiral – for the more challenging patients!
3. Bi-Segment Spiral – for patients with very high heart rates!

* Depending on your institute's preference, these values may be adapted.

Adaptive Cardio Sequence

A wide variety of patients are suitable for the Adaptive Cardio Sequence. The scan window within the diastolic phase of the cardiac cycle can be extended to enable scans for patients up to 70 bpm. The variability should not exceed 5 bpm. ECG Pulsing is also possible, allowing a functional evaluation based on sequence data.

The stack overlap is fixed to 10% in a 3D Sequence which enables a near-optimal dose utilization in comparison to any cardiac standard spiral scan.

Watch for ectopic beats in the ECG of the patient. The Adaptive Cardio Sequence reacts automatically, however the total examination time might be prolonged and influence your contrast media requirement.

A functional evaluation is also possible in sequence mode. Simply extend the scan window on the trigger card to 20% – 90% and set the pulsing menu to “auto”.

In case of a scan repetition due to an ectopic beat, you can interactively select the desired data at reconstruction time in the ECG (trigger card).

It is possible to disable the reconstruction stack overlap in all scan modes.

This is done on the trigger card, Recon Menu, e.g. “quick 150 ms* TrueStack”.

*Temporal resolution might be different, depending on the licence.

Cardiac Spiral

The well established Cardiac Spiral mode is your fallback for the more difficult patients. It can handle a high degree of heart-rate variability and allows ECG editing in challenging cases.

Always enable the available options for dose control, such as CARE Dose4D, CARE kV, pitch adaptation, Adaptive ECG-Pulsing and MinDose. Disable only if clinically necessary!

The spiral pitch is completely determined by the heart rate of the patient. This is the main inherent dose disadvantage of the Cardiac Spiral.

Always use MinDose if there is no functional evaluation required. On average you can save around 20% of dose compared to the normal ECG pulsing setting.

In the case of bypass patients, which would generate a rather long scan, you can switch to the ECG-gated Chest Pain protocol. It allows you to scan the complete bypass grafts with 50% reduced dose compared to a conventional ECG-gated spiral scan.

Challenging patients with a very high variability e.g. 40 – 80 bpm can be scanned in end-systole by pulsing in milliseconds (e.g. 250 ms – 450 ms). The reconstruction has to be in milliseconds as well in the BestPhase settings.

Bi-Segment Spiral

Use the Cardiac Bi-Segment Spiral for patients with heart rates above 70 bpm. The main difference to the normal Cardiac Spiral is a rather reduced pitch value.

The reduced pitch value of this mode yields an estimated up to 40% increase in dose compared to the Cardiac Spiral. Use only if clinically necessary in patients with high heart rates.

A very strong variation in the heart rate (>10 bpm) does not work well with a Bi-Segment reconstruction, as the adjacent cycles do not fit nicely. Add an extra mono segment reconstruction for crosscheck of your Bi-Segment images.

The low pitch value can result in a longer examination time. Be sure to adjust your contrast protocol accordingly.

Try to derive your reconstructions from positive millisecond values (e.g. + 320 ms or + 600 ms) instead of percent in the case of higher heart-rate variations. This should improve the matching of the cardiac cycles and therefore improve the image quality.

If you derive a standard mono segment reconstruction, it is highly recommended to use the TrueStack option. It prevents images with very large stack overlap.

Reconstruction

Carefully chosen reconstruction settings are mandatory for good clinical images with high quality.

Optimize the field of view according to the size of the heart in the case of coronary reconstructions and ensure the organ of interest to be nicely centered.

Suitable settings are B26f or B36f kernel, 0.75 mm slice thickness and 0.4 mm reconstruction increment. In the case of stents or a high calcium burden, do an extra reconstruction series with a B46f kernel and 0.6 mm slice thickness and 0.3 mm increment. If available, use Iterative Reconstruction kernels instead!

For functional analysis, reconstruct with a B26f kernel, 1 mm slice thickness and a 0.7 mm increment, 256 matrix and in 10% intervals.

For quantitative evaluation, the kernels B22f or B23f have to be used. B23f includes a dedicated iodine beam hardening correction algorithm.

Iterative Reconstruction is a very powerful tool that allows the reduction of dose while maintaining image quality. If your system is equipped with Iterative Reconstruction, use the kernels I26f, I36f and I46f instead of the B-kernels. The reference values for the tube current can be lowered by approximately 30% if you apply Iterative Reconstruction.

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