

## **Radiation dose reduction in cardiovascular CT angiography with latest generation dose-saving scanner technology**

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## Purpose

The aim of the study was to evaluate the potential reduction in radiation dose associated with advances in scanner technology in cardiovascular computed tomography (CT) angiography and to identify the unique predictors of potential dose saving among a substantial set of scan and patient parameters.

## Methods and Materials

391 CT coronary angiograms (CTCA) performed in the clinical routine of our institution were randomly selected and retrospectively analyzed regarding the effective radiation dose (ED) applied to the patient. ED [mSv] was estimated from the dose-length product [mGy×cm] and an organ weighting factor [ $k=0.014 \text{ mSv} \times (\text{mGy} \times \text{cm}) \#1$ ]. 100 examinations were performed on a 16-slice single-source multi-detector CT (SSCT; Somatom Sensation 16, Siemens Healthcare, Germany), 199 examinations on a first generation dual-source multi-detector CT (DSCT; Somatom Definition, Siemens Healthcare, Germany) and 92 examinations on a second generation DSCT (Somatom Definition Flash, Siemens Healthcare, Germany) equipped with latest dose-saving technology. Image quality was assessed by two readers with an experience of more than 5 years in the reading of CT angiograms.

Continuous and categorical parameters were analyzed using t-Tests and Pearson product moment correlation as appropriate. Multivariate linear regression analysis was used to identify unique predictors of estimated dose. Statistical analysis was performed using the R software environment for statistical computing.

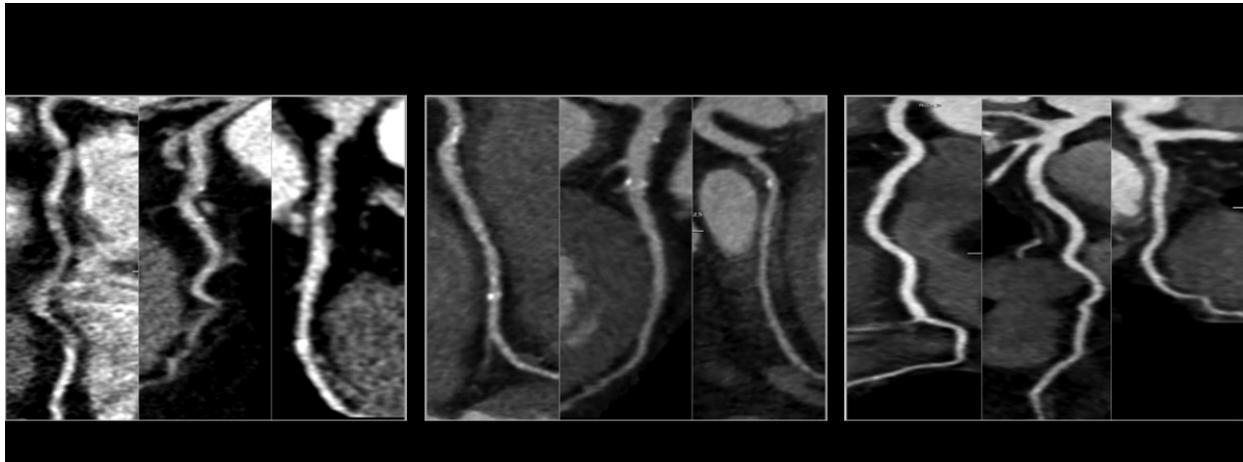
## Results

Mean ED for CTCA was  $10.57 \pm 2.76$  mSv on the SSCT scanner,  $6.96 \pm 3.59$  mSv on the DSCT standard scanner compared to  $1.19 \pm 0.66$  mSv on the Flash scanner (SSCT vs. DSCT t-Test:  $p < 0.001$ , DSCT vs. Flash t-Test  $p < 0.001$ ). Compared to SSCT, mean dose reduction with Flash was  $>88\%$  ( $>82\%$  compared to DSCT).  $72\%$  (66/92) of all examinations on the Flash scanner had an ED  $< 1$  mSv.

Using multivariate regression analysis the acquisition mode (Flash-Helix vs. Gated-Helix;  $-6.48$  mSv;  $p < 0.001$ ), the body mass index (BMI;  $0.24$  mSv per  $\text{kg}/\text{m}^2$  increase;  $p < 0.001$ ) and the total scan length along the longitudinal axis of the patients ( $0.41$  mSv per cm increase;  $p < 0.001$ ) were identified as unique predictors of estimated dose. In a subgroup of Gated-Helix acquisitions also the Hounsfield units (HU) measured with a region of interest in the lumen of the thoracic aorta were negatively correlated with estimated dose ( $R = -0.38$ ;  $p < 0.001$ ).

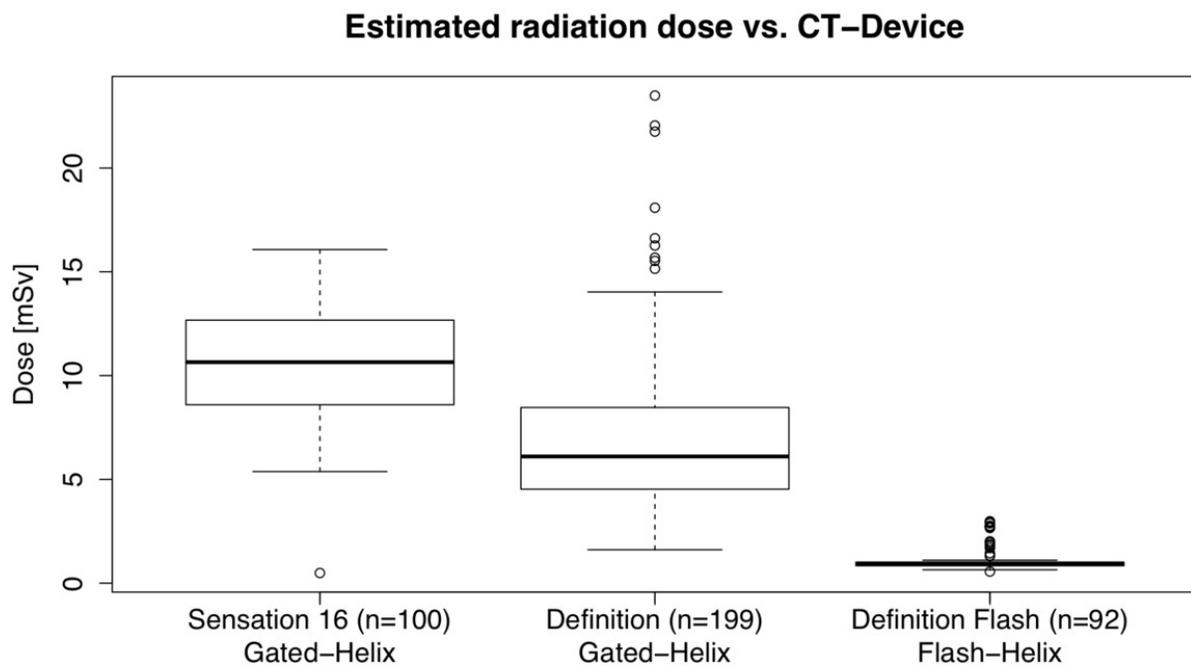
Regardless of the scanner, image quality was rated as diagnostic in all CTCAs. However, the average image quality was rated best on the Flash scanner.

**Images for this section:**



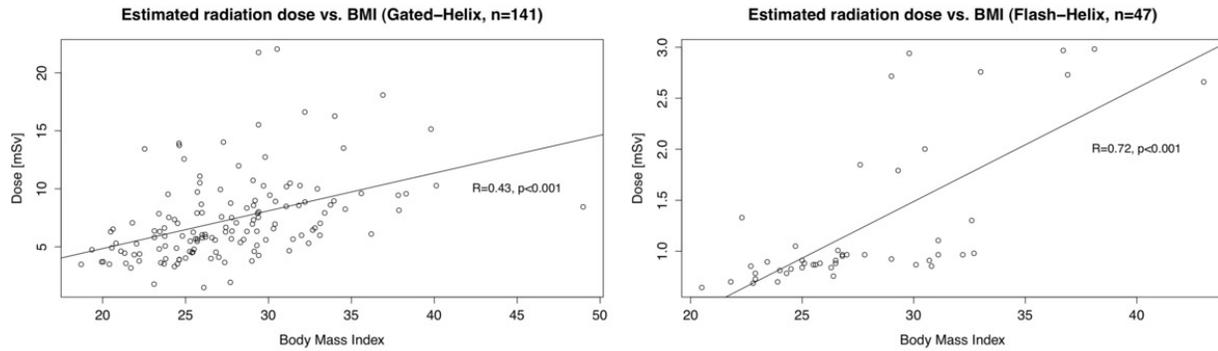
**Fig. 1:** Representative CTCA images acquired on three different scanner generations (3 male patients; >60 years; BMI: 27-28 kg/m<sup>2</sup>; HR: 52-59 bpm). Note the decrease in estimated dose associated with an increase in image quality.

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**Fig. 2:** Estimated radiation dose ranges grouped by CT-device.

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**Fig. 3:** Effect of patient BMI on estimated radiation dose grouped by acquisition mode.

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### Unique Predictors of Estimated Radiation Dose

Predictor	Dose change	p-Value
Flash-Helix vs. Gated-Helix	-6.48 mSv	<b>&lt;0.001</b>
Tube voltage, 100 kV vs $\geq 120$ kV	-1.20 mSv	0.15
BMI, 1-kg/m <sup>2</sup> increase	0.24 mSv	<b>&lt;0.001</b>
Patient age	0.01 mSv	0.54
Scan length, 1-cm increase	0.41 mSv	<b>&lt;0.001</b>
Definition Flash vs. Definition	-0.34 mSv	0.80
HU (Aorta), 1-HU increase	-0.002 mSv	0.43

\*\* 188 CTCAs, Somatom Definition and Somatom Definition Flash

**Fig. 4:** Unique predictors of estimated radiation dose as a result of multivariate regression analysis.

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## Conclusion

Latest dose-saving technology can yield drastic dose reductions in cardiovascular CT angiography shifting CTCA into the sub-mSv range while providing high diagnostic image quality.

## References

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