Dual Source CT Coronary Angiography - Benchmark Diagnostic Reference Level and Compare Scanning Protocols with Patient Dose and Image Quality

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Objective

Two new dual source (DS) CT scanners were installed in 2017. We aimed at: (1) Benchmark SPH Diagnostic Reference Level (DRL) with national reference and local SPH 2013 study; (2) Compare image quality and effective dose (ED) in relation to heart rate (HR) in different CT Coronary Angiography (CTCA) protocols.

Materials and Methods

Sample collection was between 1st Jan to 15th June 2018.

For DRL, 481 samples were collected from SIEMENS SOMATOM Force and Drive. DRL was defined as 75th percentile of ED, a product of dose-length product (DLP) and conversion factor. Results were benchmarked[1,2,3].

For protocol comparison, 416 samples with regular HR were collected solely from Force. Patients were assigned to four available CTCA protocols (Fig. 1). Patients with persistent arrhythmias and history of bypass surgery were excluded from study. Image quality was reflected by repeat rate. Suboptimal CTCA image for repeat was inspected on site by radiologist.

Group	A	B	C
HR (beats/min) (bpm)	<65	65 to 75	>75
No of Samples	97	221	98
CTCA Scanning Protocol	Prospective high-pitch spiral (PS) / Prospective narrow-window sequential (PN)	Prospective narrow-window sequential (PN) / Prospective wide-window sequential (PW)	Prospective wide-window sequential (PW) /Retrospective spiral (RS)

Fig 1. Summary of CTCA Scanning Protocol Groups

Result

For DRL, SPH CTCA DRL (ED 9.2mSv, with calcium score) was comparable to national standard (existing lowest CTCA DRL at Netherlands[4]: ED 9.4mSv, with calcium score). Approximate 10% dose reduction was achieved from SPH 2013 (ED 10.1mSv, with calcium score) by SIEMENS 128 multi-slice CT.

For protocol comparison, in group A, mean ED (nil calcium score) was significantly 81% less in PS (0.96mSv) than PN (5.09mSv) ($p<0.005$), with repeat rate 11% and 1.5% respectively. In group B, mean ED was significantly 13% less in PN (6.04mSv) than PW (6.96mSv) ($p<0.05$), with repeat rate 1.7% and 6.1%. In group C, mean ED was significantly 41% less in PW (6.48mSv) than RS (10.89mSv) ($p<0.05$), with repeat rate 6.5% and 7.6% (Fig. 2).

	CT Coronary Arteries (Nil Calcium Score)					
Group	A (HR <65)		B (HR 65-75)		C (HR >75)	
Scanning Protocol (Acquired Phases)	PS (65%)	PN (50-75%)	PN (50-75%)	PW (35-75%)	PW (35-75%)	PS (35-75%)
Mean DLP /mGy.cm (Mean ED /mSv)	68.3 (0.96)	363.8 (5.09)	431.42 (6.04)	497.14 (6.96)	463.2 (6.48)	777.6 (10.89)
Repeat Rate (%)	11.0	1.5	1.7	6.1	6.5	7.6
Mean Comparison (unpaired t test)	p<0.005 (Significant diff.)		p<0.05 (Significant diff.)		p<0.05 (Significant diff.)	

Fig 2. Summary of Results

Conclusion

SPH DS CTCA ED was comparable to national DRL standard with 10% dose reduction from 2013. To achieve maximum dose reduction and image quality, patient should undergo PS at HR<65 bpm, PN at HR 65 to 75 bpm and PW at HR>75 bpm in regular heart rate.

Reference

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2. International Commission on Radiological Protection, Managing Patient Dose in Computed Tomography. ICRP Publication 87. Oxford: Pergamon Press (2001).
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4. Van der Molen, A. J., Schilham, A., Stoop, P., Prokop, M., & Geleijns, J. (2013). A national survey on radiation dose in CT in The Netherlands. Insights into imaging, 4(3), 383-390.