AI-POD

Trustworthy AI Tools for the Prediction of Obesity Related Vascular Diseases

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DELIVERABLE D2.2

COMPREHENSIVE PHOTON-COUNTING CT PROTOCOL

Lead beneficiary	USZ
Author(s)	All clinical sites: H. Alkadhi (USZ), U. Attenberger (UKB), C. Loewe (MUW), J. Ferda (CU), M. Froelich (UHEI), H. Bosmans (KUL)
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EXECUTIVE SUMMARY

The prospective study part of WP2 requires a standardized imaging protocol that yields the highest possible diagnostic gain from each imaging examination with photon-counting detector CT, and which allows the collection of homogenous and quantitative information over all involved clinical sites.

INTRODUCTION

For obtaining the highest diagnostic yield from the imaging examination, and to allow for homogenous standardized protocol over the various clinical sites, a standardized, comprehensive CT protocol for the photon counting detector CT system was developed by USZ, including feedback loops from the other clinical sites (UKB, MUW, CU, UHEI, KUL) and from CT physicists from Siemens Healthineers, the latter being the developers of the photon-counting detector CT system used in this study. The protocol will deliver high spatial and high temporal resolution images at the lowest possible radiation dose, is tailored to obese patients and enables quantitative cardiac CT analysis. Image information will include i) non contrast-enhanced coronary calcium scoring images (Agatston scoring), ii) arterial contrast-enhanced coronary CT angiography images for defining the presence and extent of coronary artery stenoses, iii) atherosclerotic plaque composition, and iv) pericoronary adipose tissue characterization, and v) a late contrast enhancement phase for myocardial iodine distribution and extracellular volume quantification (ECV). The latter is possible by making use of the inherent spectral capabilities of the photon counting CT system measuring the energy bins of the incoming photons at various predefined keV thresholds.

This comprehensive assessment of both, coronary atherosclerosis and myocardial tissue will also allow for the identification of possible interaction between atherosclerosis related (=ischemic) changes and structural heart disease (fatty tissue accumulation, secondary cardiomyopathies, and more).

SECTION 1

The following tables summarize the photon-counting detector CT protocol for comprehensive cardiac imaging.

SECTION 1.1

1st phase: Calcium Scoring – non-enhanced, electrocardiography (ECG)-gated

Tube voltage	IQ level	Scan mode	%-phase	Monoenergetic keV level	Kernel	QIR level	Slice thickness	Increment
120	20	sequential	75	70	Qr36	off	3 mm	1.5 mm

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SECTION 1.2

2nd phase: Coronary CT angiography – contrast-enhanced, ECG-gated

Tube voltage	IQ level	Scan mode	% phase	monoenergetic keV level	kernel	QIR level	Slice thickness	Increment
140	65	sequential	heart rate dependent (from 75%-75% at low/regular heart rates to 30%-80% at higher/irregular heart rates)	65	Bv40	3	0.4 mm	0.2 mm

Image reconstructions as follows:

- BestDiast,
- BestSyst,
- Multiphase according to the ECG-pulsing window,
- VSSP in the best phase showing least motion,
- BestDiast with a Bv48 kernel (QIR 3, 0.4/0.2 mm),
- Chest (large FoV, including all soft tissue) with a soft tissue kernel, and
- Lung (large FoV, including the lungs) with a lung kernel.

SECTION 1.3

3rd phase: Late enhancement phase – late contrast-enhanced, ECG-gated

Tube voltage	IQ level	Scan mode	% phase	monoenergetic keV level	kernel	QIR level	Slice thick-ness	Increment
140	65	sequential	heart rate dependent (similar to coronary CTA: from 75%-75% at low/regular heart rates to 30%-80% at higher/irregular heart rates)	65	Qr40	3	1.5 mm	1 mm

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			additional reconstruction	Iodine	Qr40	3	1.5 mm	1 mm
			additional reconstruction	SPP	Qr40	3	1.5 mm	1 mm

The data acquisition of the late enhancement phase should start 5 minutes after the administration of the contrast media.

SECTION 2

The following table summarizes the contrast media protocol for the comprehensive photon-counting detector CT protocol in patients with a body mass index (BMI) > 30 kg/m^2.

Contrast media protocol	Iodine Flux	Flow rate	Iodine
1st contrast media phase	≥ 2 (mgI/s)	≥ 5.5 ml/s	≥ 35 g

The contrast media type differs from site to site, therefore minimum iodine flux and flow rate is provided.

For example, USZ will use in patients with a BMI > 30 kg/m^2 a contrast media concentration of 370 mgI/ml, a flow rate of 6 ml/s, and will administer a total volume of 100 ml contrast media. The iodine flux is then 2.2 gI/s, the injection time 17 s, and the iodine dose is 37 gI (for calculations see e.g. https://mdct.net/dose-flux-calculator/).

This 1st contrast media injection phase will be followed by a saline flush of 30 ml NaCl 0.9% at the same flow rate as the contrast media phase.

CONCLUSION

The protocol developed in task 2.2. of WP2 is based on the >2 clinical experience of the various clinical sites involved in this project, and taking into account the existing literature and scientific evidence on photon-counting detector CT. It shall enable a robust and standardized acquisition of image information in obese patients for enhancing the diagnostic yield of each examination and in each individual patient.

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