

POTENTIAL FOR HIGHLY SPECIFIC PERFUSION IMAGING USING GADOTERIDOL AND K-EDGE SPECTRAL PHOTON- COUNTING CT

INITIAL EXPERIENCE

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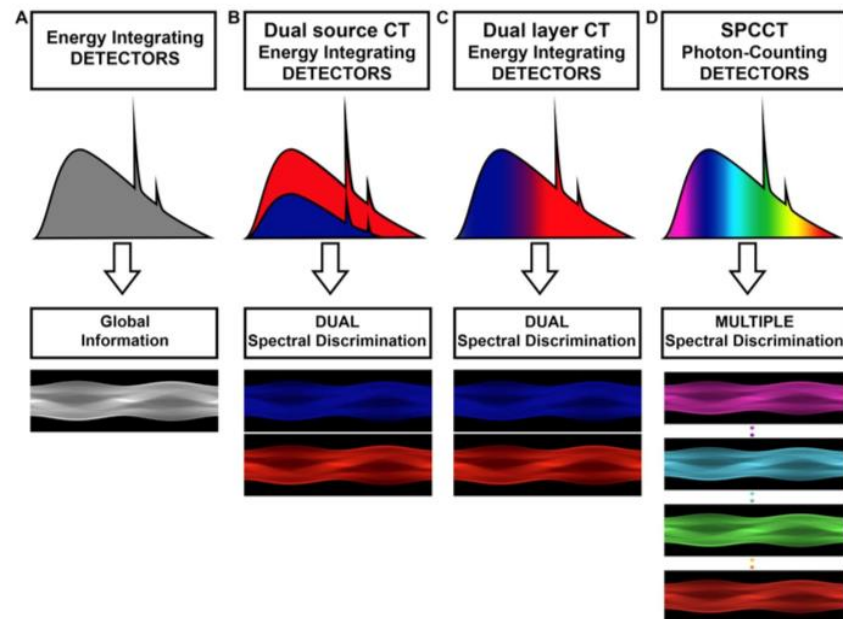
⁽²⁾ Hospices civils de Lyon

⁽³⁾ University of Turin

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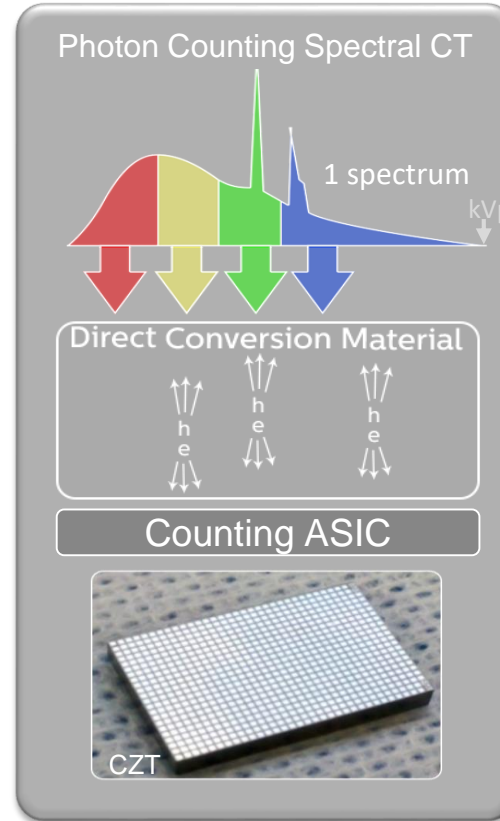
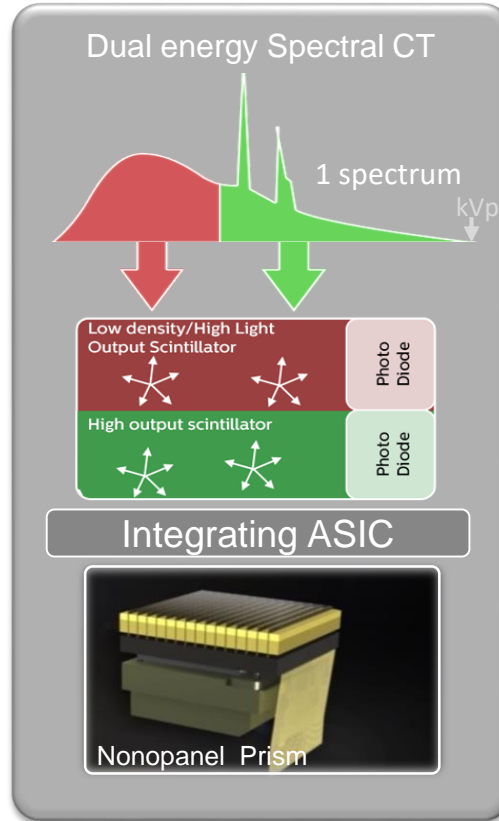
BACKGROUND

- Spectral photon-counting computed tomography (SPCCT) technology
 - New and promising imaging modality
 - Development of energy resolving detectors called photon-counting detectors ⁽¹⁾
 - **K-edge imaging**
 - **Dual contrast imaging**
 - Improved intrinsic spatial resolution ⁽¹⁾



⁽¹⁾ Si-mohamed et al. NIMAA. 2017

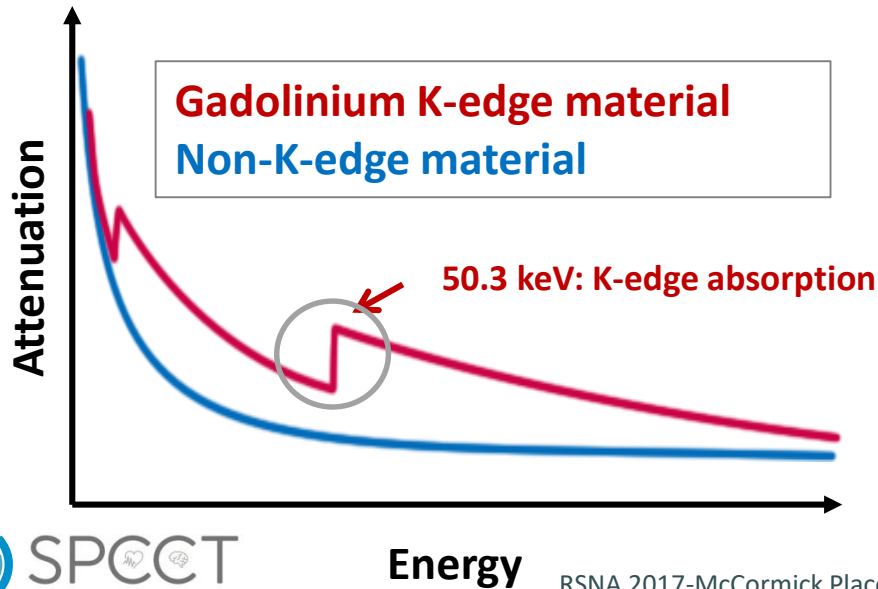
BACKGROUND



(1) Taguchi K, Iwanczyk JS. *Med Phys.* 2013
RSNA 2017-McCormick Place, Chicago

BACKGROUND

- Gadolinium atom
 - Candidate for K-edge imaging ⁽¹⁾



- Advantages:
 - Material specific K-edge imaging
 - Absolute quantification of specific materials

(1) Schlomka, J. P. *Physics in Medicine and Biology*. 2008

BACKGROUND

- Knowledge of gadolinium K-edge imaging
 - current sensitivity above 2 mg/ml
 - To achieve this concentration *in vivo* for perfusion imaging
 - large volume of standard Gd contrast agent needed, i.e. 2.5 ml/kg with a typical 0.5 M (279.3 mg/ml) formulation
 - => for a 70 kg patient: **175 ml**
 - To overcome this current limitation:
 - Preparation of a solution 1.25 M (700 mg/ml) of gadoteridol
 - => for a 70 kg patient: **70 ml**

OBJECTIVE

Objectif: To demonstrate the feasibility of K-edge perfusion imaging with gadoteridol by using spectral photon-counting computed tomography (SPCCT).

MATERIAL/METHODS

- Spectral photon-counting CT system
 - 5 bins photon-counting detectors set as 30, 51, 64, 72, 85 keV
 - Modified clinical base-Conventional X ray tube
 - Field of view of 160 mm
 - Gantry rotation time of 1 second
 - Spatial resolution: 250 μm
 - Parameters used: 100 mAs, 120 kVp



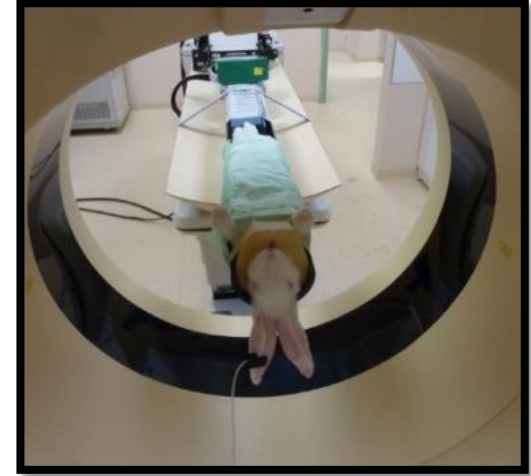
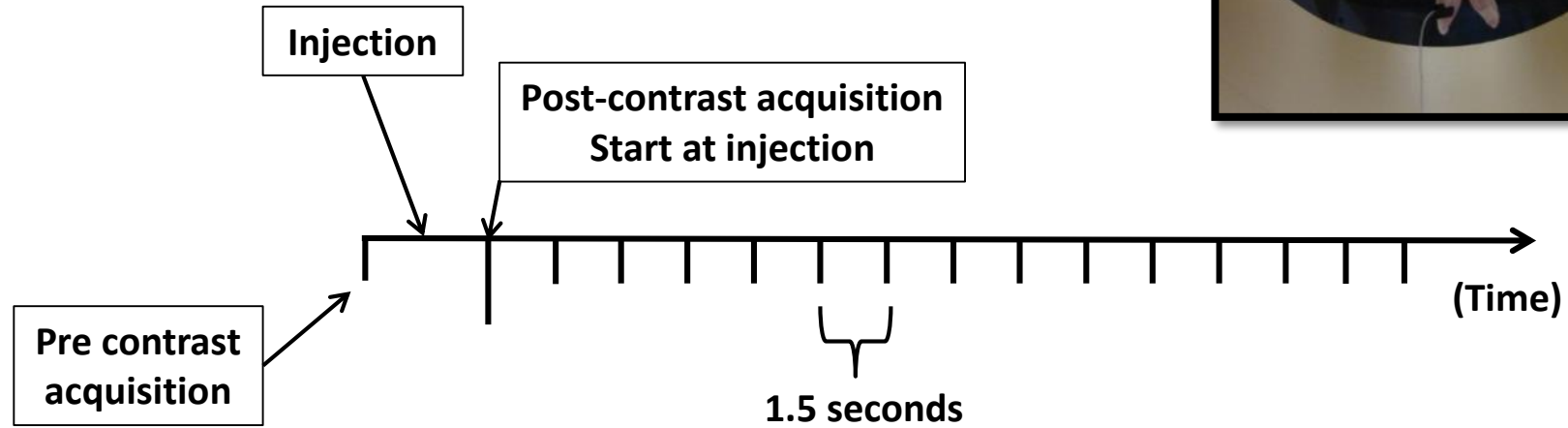
Philips Spectral Photon Counting CT
pre-clinical prototype UCBL, CERMEP, Lyon,
France

MATERIALS AND METHODS

- ≡ Highly concentrated gadoteridol based contrast agent
 - = Gadoteridol
 - Macrocyclic complex of 10-(2-hydroxypropyl)-1,4,7,10-tetraazacyclodecane-1,4,7-triacetic acid, with an empirical formula of $C_{17}H_{29}GdN_4O_7$
 - Molecular weight of 558.7
 - Low viscosity and low osmolality
 - Standard gadoteridol: 0.5 M
- ≡ Highly concentrated gadoteridol: 1.25M solution for injection contains 700 mg of gadoteridol

MATERIALS/METHODS

- 2 adults NZW rabbits (3.3 ± 0.1 kg)
- Injection of 3 ml (1 mmol/kg)
- Flow rate: 1 ml/s



MATERIALS/METHODS

- Image reconstruction:
 - Conventional images: HU units
 - Specific gadolinium images: mg/ml units

- Analysis:
 - Regions of interest:
 - lung
 - myocardium

RESULTS

CONVENTIONAL IMAGES

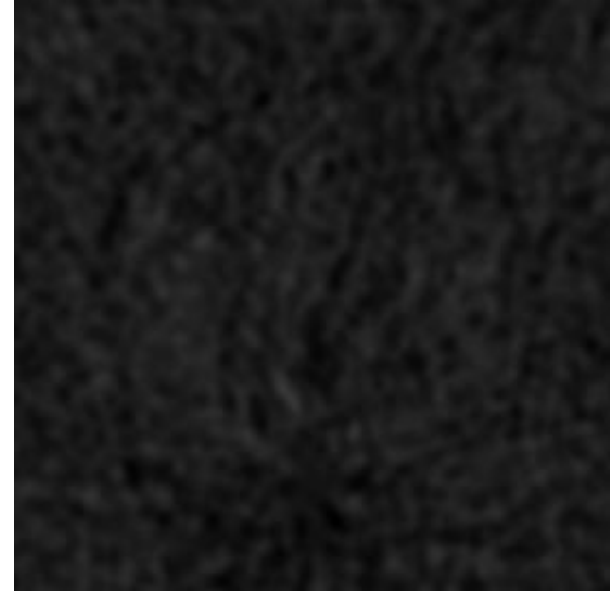


Mediastinal windowing

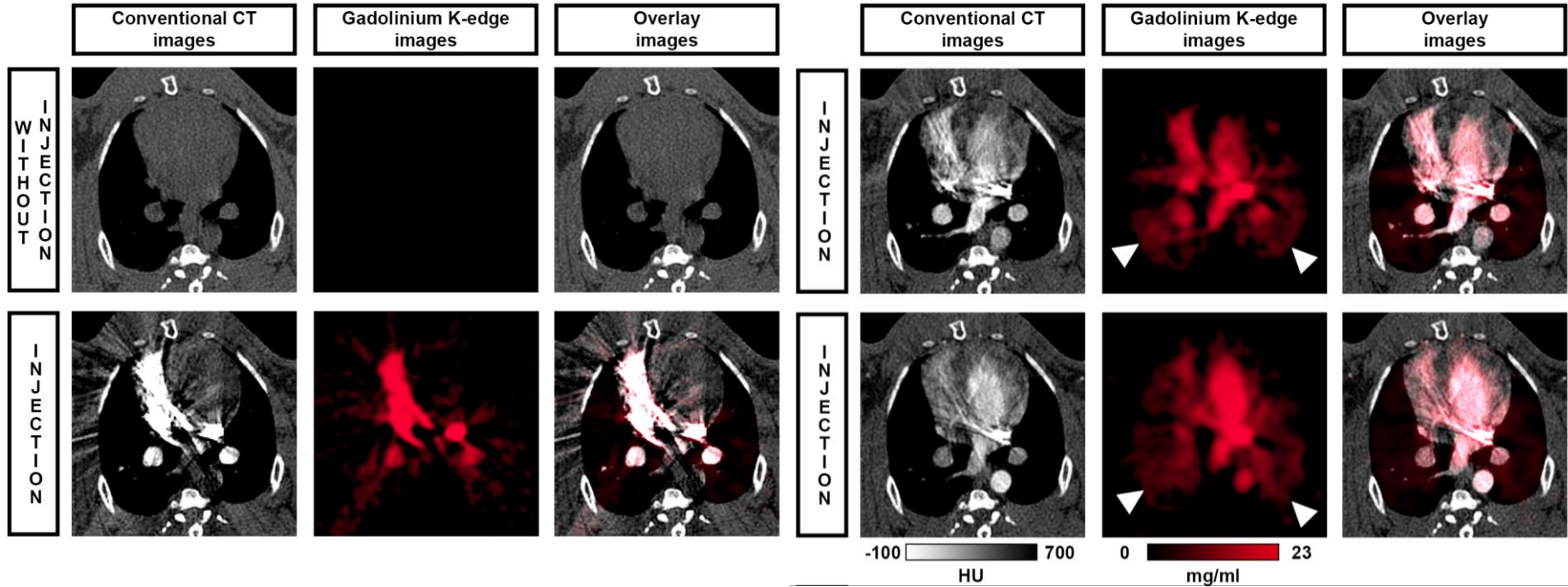


Parenchymal windowing

GADOLINIUM IMAGE

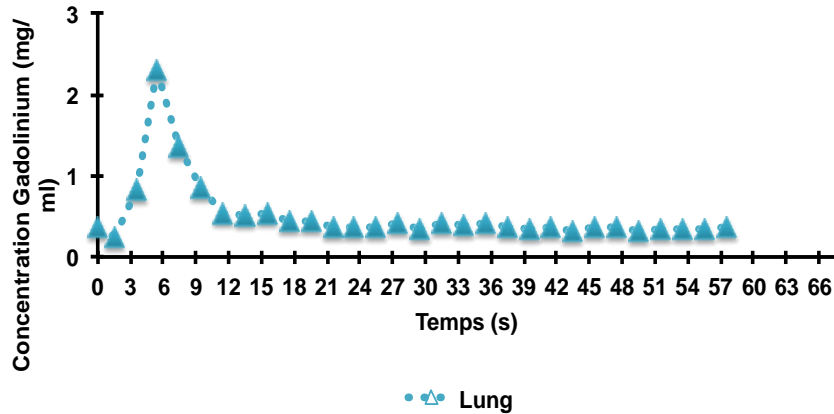


RESULTS

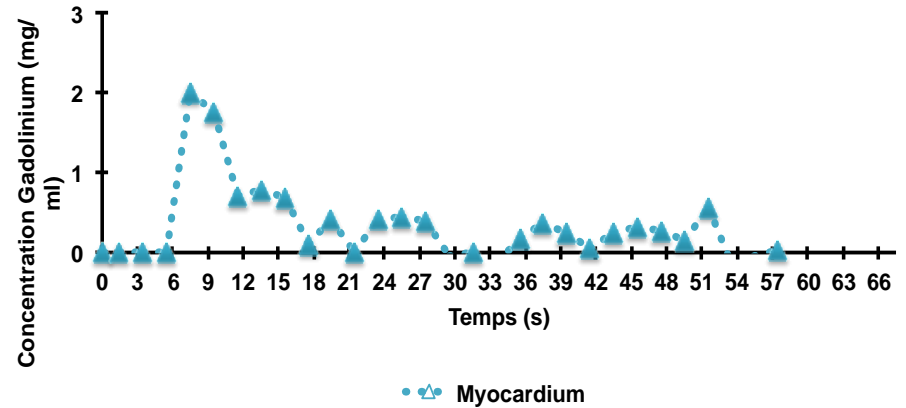


RESULTS

Lung perfusion



Myocardial perfusion



Evaluation of lung and myocardial perfusion



RESULTS

B.Table: Peak gadolinium concentrations in the regions of interest

Organs	Time to peak [s]	Mean [mg/mL]	SD [mg/mL]
Right ventricle	3.5	25.8	2.1
Pulmonary artery	3.5	11.6	1.2
Lung	5.5	2.3	1.1
Pulmonary vein	5.5	9.8	1.4
Left ventricle	7.5	10.2	0.3
Aorta	7.5	6.4	0.8
Myocardium	7.5	2.0	0.75



RESULTS

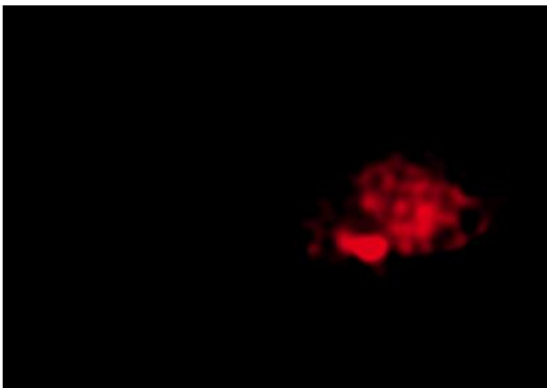
EXCRETION
RENAL

Conventional CT
images



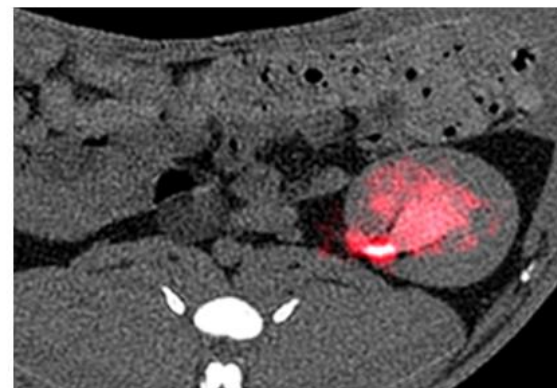
-100  300
HU

Gadolinium K-edge
images



0  5.7
mg/ml

Overlay
images

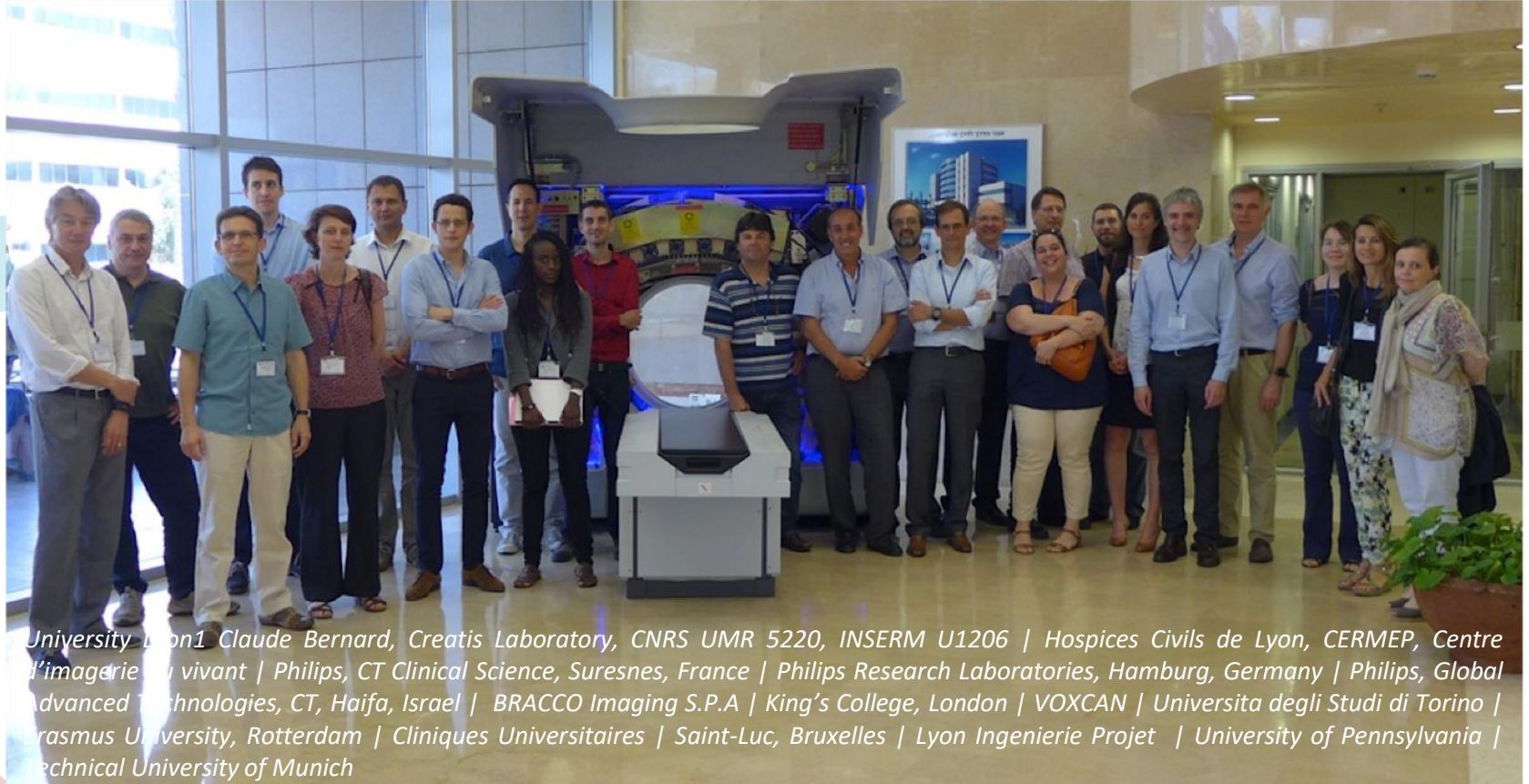


Visualisation of renal excretion as expected.

CONCLUSION

- Gadoteridol presents the potential of K-edge perfusion imaging using a spectral photon-counting CT, behaving like other gadolinium-based contrast agents
- K-edge imaging drastically increases the contrast to noise ratio
- Implications for patient care: Highly concentrated gadoteridol may be used a clinically compatible volumes to perform highly specific quantitative perfusion imaging with Spectral Photon-Counting CT (SPCCT)

THANK YOU FOR YOUR ATTENTION



University Lyon1 Claude Bernard, Creatis Laboratory, CNRS UMR 5220, INSERM U1206 | Hospices Civils de Lyon, CERMEP, Centre d'imagerie in vivo | Philips, CT Clinical Science, Suresnes, France | Philips Research Laboratories, Hamburg, Germany | Philips, Global Advanced Technologies, CT, Haifa, Israel | BRACCO Imaging S.P.A | King's College, London | VOXCAN | Università degli Studi di Torino | Erasmus University, Rotterdam | Cliniques Universitaires | Saint-Luc, Bruxelles | Lyon Ingenierie Projet | University of Pennsylvania | Technical University of Munich

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