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Krypton-enhanced ventilation CT with dual-energy technique: feasibility study in animals

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We assumed that krypton is sufficiently radio-opaque enough to allow extraction and quantification of the gas with the dual energy CT (DECT). The purpose of this study was to assess the feasibility of krypton-enhanced ventilation CT using dual energy technique in normal animals and to determine the proper krypton dose for ventilation CT.

The study was approved by our institutional animal experimental committee. A total of 5 New Zealand white rabbits were used. Baseline DECT of the chest was first performed. After then, animals were ventilated using krypton (a mixture of krypton and oxygen) for 3 minutes. The dose of krypton increased from 20%, 30%, 40%, 50%, 60%, to 70%, and the DECT was performed at the end of krypton inhalation. Two radiologists reviewed the images in consensus reading. The CT number was measured at 80 kVp, 140 kVp, and weighted average 120 kVp at each dose of krypton. Wilcoxon's signed rank test was used for evaluation of change in CT number with increasing krypton dose. Krypton extraction was performed through a workstation, and the result was displayed on a color map. Visual assessment of the homogeneity of the krypton map was also performed.

Mean CT numbers (HU) according to krypton dose were as follows: base, −757.8 ± 38.0, −765.8 ± 38.3, and −762.2 ± 38.0; 20%, −748.8 ± 37.7, −762.9 ± 40.5, and −757.6 ± 38.9; 30%, −736.5 ± 37.0, −757.5 ± 35.1, and −749.7 ± 36.4; 40%, −725.1 ± 35.5, −748.2 ± 35.7, and −739.3 ± 35.1; 50%, −715.6 ± 34.0, −740.1 ± 32.9, and −730.7 ± 32.5; 60%, −704.7 ± 34.0, −732.7 ± 35.3, and −722.0 ± 35.3; and 70%, −695.4 ± 34.7, −723.7 ± 35.8, and −713.1 ± 34.0 (for 80 kVp, 140 kVp, and weighted average 120 kVp, respectively). For 80 kVp, CT numbers significantly increased per increase of krypton dose (all $p < 0.01$). But significant changes were observed between 30% and 40%, 40% and 50%, and 50% and 60% for 140 kVp ($p < 0.05$, respectively), and between 20% and 30%, 30% and 40%, 40% and 50%, and 50% and 60% ($p = 0.018$) for 120 kVp ($p < 0.05$, respectively). For the krypton color map, observers determined homogenous enhancement for the 50%, 60%, and 70% krypton dose, but not for the 20%, 30%, and 40%.

It is feasible to study lung ventilation function using DECT after krypton inhalation in animals. The 50% or 60% krypton dose might be appropriate for ventilation imaging.