Study shows ultra-low dose PET protocol eliminates need for CT, uses dose 50 times lower than current standard

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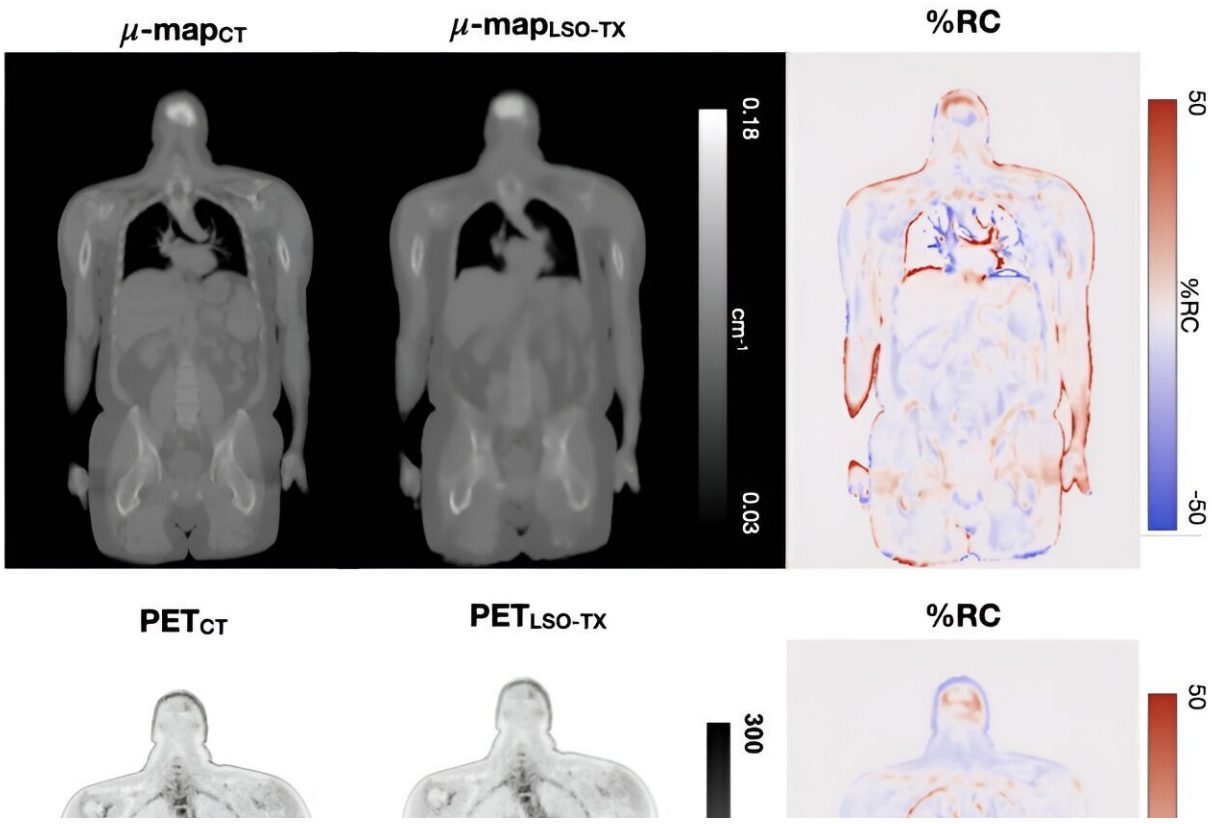

Top row: CT- and LSO-TX-based attenuation maps with their respective percentage relative change (%RC) map. Bottom row: PET images reconstructed using CT- and LSO-TX-based attenuation maps with their respective %RC map. Credit: Image created by H Sari et al., Bern University Hospital, Bern, Switzerland & Siemens Healthineers International AG, Zurich, Switzerland.

A new ultra-low dose imaging method used with long axial field-of-view PET scanners can obtain images with a historically low radiopharmaceutical dose—more than 50 times lower than the standard effective dose. Furthermore, the technique can generate quantitative PET images without the need for accompanying CT scans, greatly reducing the amount of radiation exposure to patients. This research was presented at the 2024 Society of Nuclear Medicine and Molecular Imaging Annual Meeting.

PET/CT examinations expose patients to ionizing radiation in two ways: the radiation dose resulting from the administered radiopharmaceutical and from the CT scan. Increased sensitivity and high timing resolution of long axial field-of-view PET scanners have enabled significant reductions in injected dose of radiopharmaceuticals. However, the advantages of low-dose PET examinations with such scanners can be hindered by the radiation dose linked to the CT scans conducted for PET attenuation correction.

"Recently, methods have been developed to utilize the background radiation from Lutetium-176 that is found in some PET scintillators as transmission source; this is known as LSO-TX. By combining LSO-TX information with joint reconstruction- and deep learning-based methodologies, CT-free attenuation maps can be generated," stated Hasan Sari, Ph.D., Senior Research Scientist at Bern University Hospital in Bern and Siemens Healthineers International AG in Zürich, Switzerland.

"In this work, we evaluated the performance of the LSO-TX-based attenuation correction method in ultra-low dose PET scans using a long axial field-of-view PET scanner."

Four subjects were administered a mean tracer activity of 7.9 MBq and underwent a 90-minute long PET scan using a long axial field-of-view

PET scanner. LSO-TX data were separately acquired and enhanced using a deep-learning based method. The patients also received low-dose CT scans. CT-based and LSO-transmission-based attenuation maps were generated and used to reconstruct PET images, which were then compared across different scan durations.

A very close visual resemblance was observed between CT- and LSO-TX-based attenuation maps, as well as between PET images reconstructed with the maps. By using the LSO-TX-based attenuation correction alone (no CT), the total effective dose in these scans was reduced to approximately 0.15 mSV while still preserving good quantitative accuracy and maintaining clinically feasible scan durations.

"This reduction in radiation dose is 50 times lower than the standard PET dose and is comparable to the dose received from a mammogram or a chest CT radiograph," noted Sari.

"Ultra-low-dose protocols have the potential to extend the use of PET scans beyond their current applications and could significantly enhance the utility of this modality in screening studies involving at-risk or healthy subjects, research studies, enhanced treatment response assessments with more frequent follow-up scans, and pediatric scans."

Long axial field-of-view scanners are commercially available with numerous installations worldwide. The CT-free attenuation correction method described in this abstract uses a special acquisition protocol that operates the scanner in a "research mode." The attenuation map is generated by processing the data offline using a research workstation.

According to Sari, Bern University Hospital is collaborating closely with the scanner vendor, Siemens Healthineers, to facilitate easier use of the proposed method. Further optimizations for this method are underway, including the application of artificial intelligence-based image

enhancement algorithms, which might further reduce scan durations.

More information: Abstract 241061: Sari et al. Ultra-Low-Dose PET Imaging in Long Axial Field-of-View PET Scanners with LSO Transmission-Based Attenuation Correction, *Journal of Nuclear Medicine* (2024).

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