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MLS analysis of INSIDE in-beam PET images for the detection of morphological changes in patients treated with protontherapy.

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Anatomical changes occurring during proton therapy treatment are considered a relevant source of uncertainty in delivered dose. The INSIDE in-beam Positron Emission Tomography scanner, installed at the National Oncological Center of Hadrontherapy (CNAO), performs in-vivo range monitoring to obtain information about morphological changes in the irradiated tissue. Our purpose is to assess the sensitivity of the INSIDE PET system in detecting anatomical changes using inter-fractional range variations methods.
Eight proton treated patients, enrolled during the first phase of the INSIDE clinical trial at CNAO, were considered. Range variations along the beam direction were estimated using the Most-Likely Shift (MLS) method, which was for the first time applied to in-beam PET images. It was tested on a simulated patient, for which notable anatomical changes occurred, and validated on six patients without and two with anatomical changes. In order to establish the efficacy of the MLS method, we made a comparison with the previously used Beam Eye View (BEV) method. The sensitivity of the INSIDE in-beam-PET scanner in detecting range variation was evaluated by the standard deviation of the range difference distributions for each patient. The range differences obtained were superimposed on the CT scan as colorized maps, which indicate where an anomalous activity range variation was found.
For patients showing no morphological changes, the average range variation standard deviation was found to be 2.5 mm with the MLS method and 2.3 mm with the BEV method. On the other hand, for the two patients where small anatomical changes occurred, we found larger standard deviation values. In the simulated patient case, the standard deviation gradually increases according to the increasing anatomical changes. The changes detected with our range analysis were localized in the same zones as the one observed with the control CT scans.

Collaboration

INSIDE collaboration

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