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Evaluating the perfomance of PET/CT Gemini TF64 for dynamic 4D PET/CT imaging for radiotherapy treatment planning using the CIRS 008A thorax phantom

The availability of tools for visualize, control, and track patient specific respiratory motion could improve the accuracy in radiation therapy for thorax and abdomen tumor lesion. If smaller treatment fields are used, there is the possibility of target may move out of the treatment field resulting in an under dose to the target and surrounding normal will be exposed.The goal of this work is the evaluation of the tools for dynamic 4D imaging of the PET/CT Phillips Gemini TF64 system installed at INOR for radiotherapy treatment planning of tumors located in thoracic and abdominal cavities which could be influenced by respiratory motion.The performance of PET/CT Philips Gemini TF64 system was previously verified by following the recommendations given in the documents IAEA 1393 and 1557. The CIRS 008A Dynamic Thorax Phantom was used during the tests for simulation of three-dimensional target motion controlled by the CIRS Motion Control Software Model 008PL.The influence of CT acquisition parameters and reconstruction for three simulated respiratory cycles (20bpm/15mm, 10bpm/15mm and 15bpm/25mm) on the gated image quality, geometric accuracy of detection and delineation of moving target with different sizes (10, 20 and 30 mm)were studied. The results using 4D CT and non-gated CT were compared with those obtained using CT acquired without target motion.Three refillable spherical inserts with diameters similar to those used for CT acquisitions were built and adapted to CIRS thorax phantom in order to evaluate the dynamic 4D PET and 4D CT performance of PET/CT Gemini TF 64 system. These in-house made inserts were filled with a Ga-68 radioactive solution(18.5MBq/cc)containing radiologic contrast media. PET/CT acquisition without target motion were used as reference.The effect on SUV measurement for moving target of three types of attenuation correction images used for reconstructions: (a) the free-breathing CT for all PET phases, (b) the average CT for all PET phases and (c) 4D CT for phase-matched attenuation correction were compared. The results obtained matched with those reported in similar experiences using phantoms. Larger targets provide higher registration accuracy than small targets. Different respiratory cycles affect the registration accuracy. Increasing the respiratory amplitude will decrease the accuracy. Nevertheless this is the first experience in our country performing these studies the experiments and their results are the starting point for discussion to establish methodologies for commissioning other imaging systems with 4D imaging tools in Cuba, QC/QA program and acceptance limits.

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