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Abstract Title: Evaluation of a Patient-Specific Deep Learning Model for CBCT-Based Synthetic CT in Proton Therapy

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Background / Aim:

This study aims to assess the feasibility of an in-house solution for generating synthetic computed tomography (sCT_{ptpl}) images from cone beam computed tomography (CBCT) images. Image and dosimetric qualities of sCT_{ptpl} were evaluated and compared with that of the DIR-based synthetic computed tomography algorithm from MIM Maestro (sCT_{mim}).

Methods:

Our in-house model employed a deep convolutional neural network approach. It was patient-specific and trained on a paired dataset consisting of a simulation CT (CT_{sim}) and a CBCT from the same patient, generating sCT_{ptpl} images with high shape consistency that closely match the input CBCT images.

We modeled three site-specific phantoms (head, thorax, and abdomen) and quantified image quality using mean absolute error and structural similarity index with mask threshold to assess conversion accuracy. Proton plan dose was recalculated to evaluate the dose distribution using 3D gamma analysis (2mm/2%).

Results:

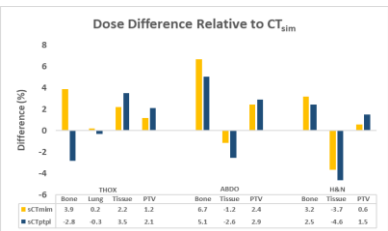

Fig 1: Structure based percentage mean dose difference is < ±6% compared with original plan dose.

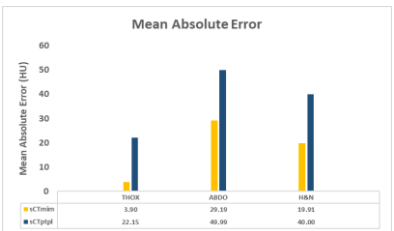

Fig 2: Mean absolute error is generally lesser than 50 HU.

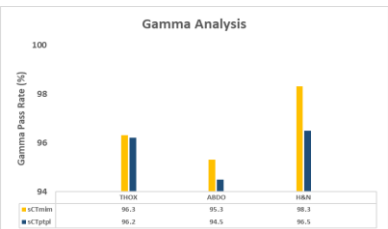

Fig 3: Qualitative analysis of dose distribution shows reasonable agreement for all site-specific phantom.

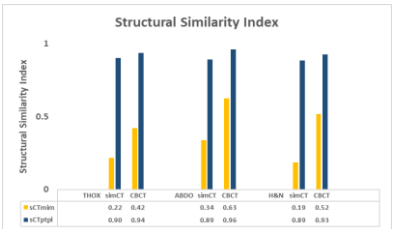

Fig 4: Image quality degradation shows high perceptual similarity in sCTptpl than sCTmim.

Conclusion:

Our in-house CBCT based synthetic CT solution, using a patient-specific deep learning model, is feasible for generating images with high shape consistency that closely match the input CBCT, while maintaining a reasonably low MAE.

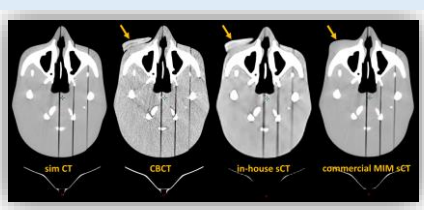

Fig 5: Visual comparison between sCTptpl and sCTmim of a H&N phantom.