ESTRO

Abstract

Title

Clinical evaluation of self-learning GAN based pseudo-CT generation software for low field pelvic MR

Authors

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Purpose or Objective

MR-guided radiotherapy (MRgRT) allows plan adaptation on the MRI of the day, offering new perspectives for pelvic cancer care. Recent developments on pseudo-CTs (pCT) and hybrid MRI linacs underlined the clinical feasibility and acceptance of MRgRT. However, the low field MR for ViewRay MRIdian® TrueFISP, with a limited field of view can affect the MR to pCT conversion with methods such as bulk electron density (ED) overwrite. These methods do not only introduce uncertainties due to assignment of mean EDs, but still require a planning CT. In this study an artificial intelligence-based pseudo CTs (AICT) is proposed and clinically evaluated to overcome these challenges and unlock the full potential of MRgRT for pelvic cancer care.

Materials and Methods

For the case of low field pelvis MR-based daily treatment adaptation, transfer learning was applied to an automatic synthetic-CT generation tool from unpaired pelvis MRIs that uses ensembled self-supervised GANs. Seventeen prostate cancer patients treated on the low field MR-Linac at three European cancer care excellence centers were selected for this evaluation. Planning CTs were deformably registered to the MRIs for each patient. Treatment plans were optimized on the planning CT with a clinical TPS fulfilling all clinical criteria and recalculated on the warped CT (wCT) and the pCT for image and dosimetric evaluation. For the analysis, wCTs and pCTs were compared based on a) mean absolute errors (MAE), b) DVH-parameters (D2%, D50%, D95%, D98% and Dmean) for the CTV and PTV, and c) dose distributions compared with global gamma criteria.

Results

The mean MAE for the whole body, rectum, bladder, and prostate are 58.45+/-113.86 HU, 63.49 +/- 89.85 HU, 26.12 +/- 25.52 HU and 34.08 +/- 51.06, respectively, demonstrating good image agreement between the wCT and the pCT. The pCT reproduced for all patients the dose distribution based on a gamma criterion of 2mm/2% with a mean pass rate greater than 99% (no threshold applied). The PTV DVH statistics reported were within 2% for all cases except 3 cases from center 3, which led to a slight increase in the DVH mean relative errors for this center (Table 1). On average, relative errors for all PTV and CTV DVH statistics were within 2%, which is below what is reported in the literature for bulk pCT for low field MRgRT.

Error % (mean ± std)	D98	D95	D50	D02	Dmean
Center 1	0.57 ± 0.34	0.56 ± 0.22	0.61 ± 0.2	0.57 ± 0.16	0.58 ± 0.2
Center 2	1.46 ± 0.74	1.6 ± 0.45	1.15 ± 0.3	1.18 ± 0.53	1.25 ± 0.33
Center 3	1.93 ± 0.69	1.92 ± 0.64	2.02 ± 0.86	2.04 ± 0.85	2.00 ± 0.82
Overall	1.26 ± 0.83	1.28 ± 0.78	1.24 ± 0.83	1.24 ± 0.86	1.24 ± 0.82

Table 1. DVH-parameter mean relative errors for D98%, D95%, D50%, D2% and Dmean for the different centers and over all cases.

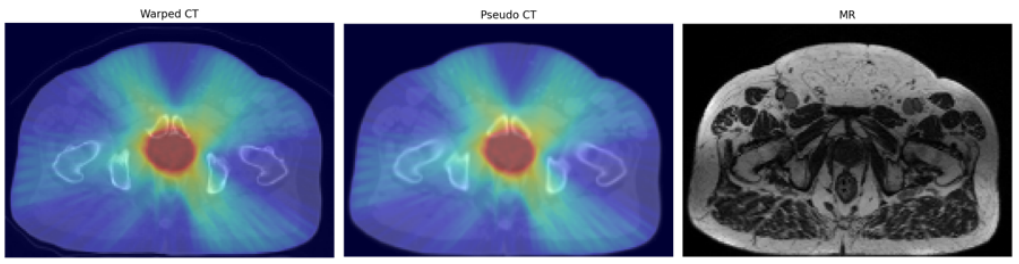

Figure 1. Example of dose distributions calculated on the warped CT and pseudo-CT for one patient. The MR used to generate the pseudo-CT is shown for reference.

Conclusion

This study demonstrated the feasibility of generating clinically acceptable synthetic CT using an AICT tool from low field MR. Results were comparable for sCT and CT images in both dosimetric and MAE evaluation. This tool which can be deployed in only seconds to generate an pCT image and bypasses the need for a planning CT, can be considered clinically acceptable whilst reducing imaging dose and registration issues. Future work will investigate the accuracy of using this pCT tool for MRgRT treatments of other anatomies.

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