**Introduction**: MRI-based treatment planning is a key step in the achievement of MRI-only treatment, without the use of CT. Its major interest is that there is no need to perform a CT scan, thus eliminating target localization errors induced by CT-to-MRI registration. For that purpose, we developed an atlas-based method to construct a pseudo-CT (pCT) from the MR image of the patient for Cyberknife treatments of head and neck patients.

**Methods**: Our method is based on the method of Gudur et al. [1]. Our atlas consists of an aligned pair of CT and MR images of the same patient. A set of 23 brain tumor (test) patients were retrospectively analyzed. The MR image of the atlas and the MR image of each test patient were non-rigidly registered, and the resulting deformation field was used to map the atlas onto the MR image of the test patient. To construct the pCT from the MR image of the test patient, every pixel (“pixel of interest”) of the deformed atlas CT image was replaced by a HU weighted sum of the most similar intensity-based neighbors. The neighbors selected were those whose intensities in the deformed atlas MR image differed from the intensity of the pixel of interest in the MR image of the test patient by less than +/-5%. To evaluate our results, for each test patient, we calculated the dose distributions with our in-house Monte Carlo algorithm using the estimated pCT and the true CT (tCT), and we compared the coverage of the planning target volume (PTV) focusing on the following dose-volume histogram (DVH) parameters: D98, D95, D50, D05, D02 and Dmean (35 PTVs in total).

**Results**: The Wilcoxon signed-rank test was conducted for each DVH parameter, and showed that there is no statistically significant median difference in target coverage between the pCT and the tCT (p-value > 0.05 for all DVH parameters). For each DVH parameter, the probability density function was estimated and the percentage of values within +/- 2% and +/-3% was calculated from the cumulative density function (Table 1).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Range | D98 | D95 | D50 | D05 | D02 | Dmean |
| -2%/2% | 74% | 75% | 87% | 81% | 83% | 85% |
| -3%/3% | 89% | 90% | 99% | 97% | 97% | 98% |

Table 1: Percentage of tCT/pCT relative dose difference values that fall within +/- 2% and +/- 3% for each DVH parameter.

**Conclusions**: The proposed atlas-based pCT construction method was assessed on a dosimetric basis. We found that the percentage of relative dose differences between the pCT and the tCT within +/-3% was higher than 97% for D50, D05, D02 and Dmean parameters, and higher than 89% for D98 and D95 due to wider difference distributions. Our study showed promising results which favor the use of the proposed method in clinical routine and a study on its transfer to other anatomical locations.

**Reference:**

[1] M. Gudur et al. A unifying probabilistic Bayesian approach to derive electron density from MRI for radiation therapy treatment planning. Phys. Med. Biol. 2014; 59(21):6595-6606