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Technical implementation and evaluation of a curvature correction software for spinal SBRT.

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Purpose

Stereotactic body radiotherapy (SBRT) is a treatment option for spinal metastases, involving the prescription of high doses which require an increased precision in the target delineation. Several sets of images are often used to identify and contour the targets and organs at risk, including different modalities (PET, MR). The position of the patient varies between these images and the CT used for radiotherapy planning. Elements Spine SRS (Brainlab, Munich) includes a ‚Curvature Correction' module that elastically deforms to provide an improved fusion before segmentation. The aim of this study is to evaluate the effectiveness of this curvature correction tool.

Materials and Methods

Retrospectively 92 CTs were selected from patients who underwent RT for spine tumors between 2019 and 2022 and had available at least a previous CT scan of the same region. Rigid fusions were performed between the pairs of CT (RT and previous) on Elements, followed by curvature correction. Automatic segmentations were generated from the resulting images. To evaluate the deformation on the corrected vertebrae, individual fusion was performed for each vertebra and a Dice coefficient computed between the original and corrected contours. To evaluate the performance of the curvature correction, the corrected image was rigidly fused using the spine as a ROI. Dice coefficients and mean dose to agreement (MDA) were computed for all vertebrae.

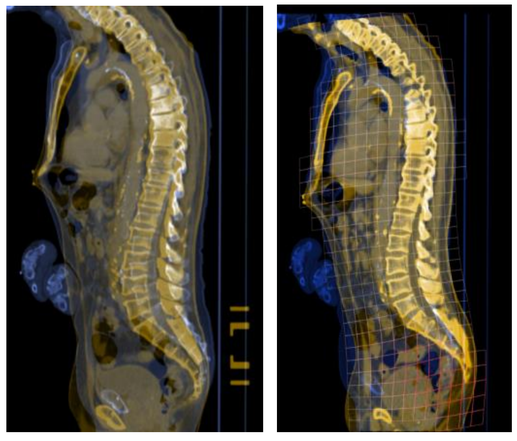

Fig. 1 – Fusion of two datasets before (left) and after (right) curvature correction on Elements Spine SRS.

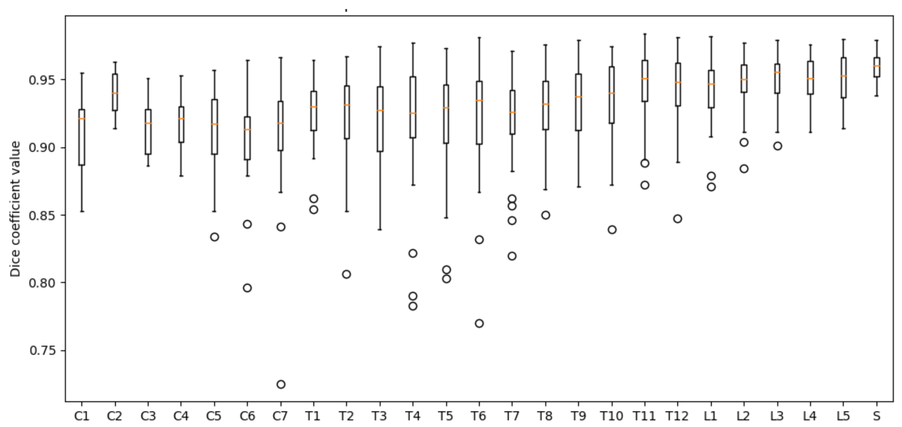

Fig. 2 – Dice score evaluation of the agreement between uncorrected and corrected vertebrae.

Results

Correction and segmentation was considered successful in 76 datasets. Disease-related anatomical anomalies (collapsed vertebrae, etc.) was identified as an important source of correction failure. Deformation analysis showed no Dice scores below 0.7, with median dice ranging between 0.95 (T11) and 0.92 (C5). Lowest segmentation agreement was found in the vertebrae on the edges of the CT. Mean dice coefficient for alignment correctness was 0,82 (SD 0,08) ranging from 0,83 (C6) to 0,93 (L4) and mean MDA 0,82mm (SD 0,77), ranging from 0,47mm (SD 0,06) (C1) to 1,08mm (SD 2,47) (L5). Largest misalignments are observed on the extremes of the region analyzed.

Conclusion

Acceptable general alignment was found between corrected and reference datasets with excellent agreement between vertebrae segmentations. Distance from ROI and anatomical anomalies were identified as source of misalignment or correction failure. Future work involves the validation of the tool with multimodality datasets including MR and PET.