Évaluation des distorsions géométriques résiduelles en IRM dans le cadre des traitements stéréotaxiques intra et extra crâniens.

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Résumé

Introduction: Stereotactic radiotherapy is an external radiotherapy technique that delivers high doses to target volumes while minimizing the dose received by organs at risk (OAR). CT images serve as the reference images for dose calculation in radiotherapy, but MRI images are often necessary to define target volumes due to their superior spatial resolution and soft tissue contrast. However, despite vendor distortion corrections, residual distortions may still be present and could affect the spatial representation of anatomical images. Distortions can impact the contouring of target volumes and, consequently, the treatment plans, in particular for small targets. The aim of this study was to quantify residual gradient nonlinearity distortions for stereotactic treatments for brain and spine tumors and to evaluate their impact on dose distributions.

Material and Methods: The Cartesian3D BODY phantom was utilized to measure residual geometric distortions for quality assurance and to generate corrected RTstruct contours. A

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distortion map was obtained by comparing the centers of beads on the reference CT to their corresponding centers on MRI images acquired for the clinical sequences. (T1 3D Gradient Echo for brain and T1/T2 3D SPACE for spine). Twenty patients with multiple tumors located in the periphery of the brain, and five patients with spine tumors, were selected. Their MRI-contoured DICOM RTStructs were corrected by applying phantom-based 3D distortion maps through the Spin Up CartesianRT software. Differences between structures before and after the correction of the distortion were evaluated using the Dice score and the Hausdorff distance.

Results: In the worst case for brain tumors, the Dice index and Hausdorff distance were approximately 0.7 and 1.3 mm, respectively, when the distance from the magnet isocenter was 90 mm, resulting in dosimetric errors of around 10%. For spine tumors, distortion primarily affected the spinal cord due to its position at the edge of the field of view and its geometric shape.

Conclusions: Geometric distortions become a critical issue for structures located more than 6 cm from the magnet isocenter and can induce significant dosimetric impacts on target and OAR volumes. Therefore, MRI 3D distortion should be evaluated and taken into account during the treatment planning process and quality assurance program in radiotherapy.

Reference

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Mots-Clés: IRM, Distorsion géométrique, DICE, Hausdorff, impact HDV, contrôle qualité