Feasibility Study of Multicentric Diffusion Tensor Imaging for Identifying New Organs at Risk in Intracranial Stereotactic Radiotherapy

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A transborder study between France and Germany

This multicentric study aims to evaluate the feasibility of performing Diffusion Tensor Imaging (DTI) across different centers with varying MRI systems, using the same protocol, to ensure consistent dosimetric planning results. The goal is to confirm whether DTI-based organ-at-risk (OAR) identification can be standardized for intracranial stereotactic radiotherapy (SRT) planning.

Material and methods

DTI imaging protocols were harmonized between CHR Metz-Thionville, France (Siemens SOLA 1.5T MRI) and UKS Homburg, Germany (Siemens SKYRA 3T MRI), Figure 1. NIST Diffusion phantom (Caliber MRI), DTI resolution, and fiber-crossing phantoms (ImagingHQ), as well as data from four healthy volunteers, were used to assess the reproducibility of diffusion metrics, spatial resolution, and fiber tract extraction methods. Longitudinal validity was evaluated through acquisitions performed at three time points, approximately six months apart, between December 2023 and November 2024. Using synthetic CT (MR-Box, Therapanacea), dosimetric treatment plans derived from DTI OARs were compared between centers (FiberTracking 2.0 and Elements 4.0, Brainlab). All DTI exams were corrected for MR distortion (Cranial Distortion Correction, Brainlab).

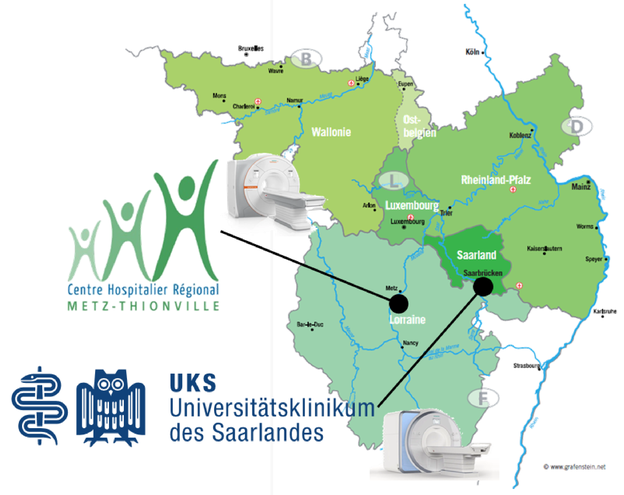

Figure 1. Transborder position of both the UKS (3T MRI scan) and CHR Metz-Thionville (1.5T MRI scan)

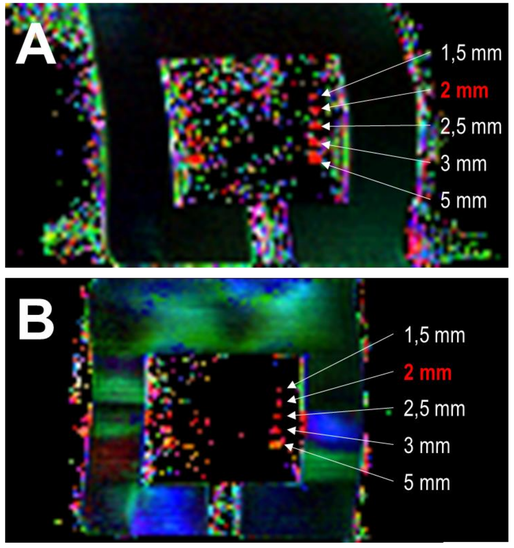

Figure 2. Results of the spatial resolution characterization with the DTI resolution test object on the (A) and (B) the 3T and 1.5T MRI scanners respectively

Results

Phantom measurements were highly reproducible, with ADC values showing an absolute deviation ≤ 2%, and consistent spatial resolution (Figure 2) and fiber-crossing tracking. All fiber bundles were similar both between sites and over time with an overlap of ~95% when a 2 mm margin was applied between exams (Figure 3). Planning studies produced comparable dosimetric results in terms of PTV coverage and fiber bundle sparing.

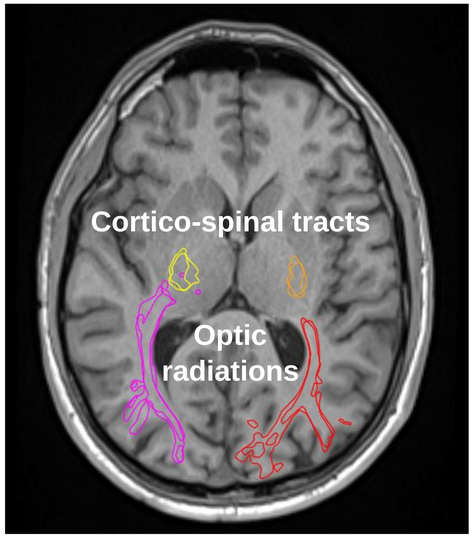

Figure 3. Axial view of some fiber tracts from both sites

Conclusion

This study establishes the groundwork for using DTI to protect white matter tracts in SRT planning, ensuring consistency and reproducibility in multicenter settings.