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Background & Rationale

- Diffusion tensor imaging (DTI) is a noninvasive tool used to investigate structural changes in the brain by measuring the anisotropic water diffusion in neural fibers.
- Such technique may detect alterations that reflect brain lesions in regions that appear normal on conventional magnetic source imaging (MRI) scans.
- We **aim** to determine whether DTI can help localizing the epileptogenic zone (EZ) in children with drug resistant epilepsy (DRE).
- We **hypothesize** that diffusion parameters estimated inside the resected areas (i.e., confirmed to be epileptogenic) of seizure-free patients would differ from those inside mirrored areas in the contralateral hemisphere (i.e., used as control).

Methods

- We retrospectively analyzed data of **19 seizure-free children with DRE** (6 females, mean age: 12.7 years) who underwent neurosurgery (Engel I, follow-up: 12-48 months).
- Ground truth of successful estimation of the EZ was defined using resection volumes obtained by co-registering the pre- and post-operative MRIs (**Fig. 1**).
- For each patient, we mirrored the resection volume in the contralateral non-pathological hemisphere (**Fig. 1A**).
- For both resection and contralateral volumes, we extracted the following diffusion metrics: fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) (**Fig. 1B**).
- We then computed two unique mean and median values of each diffusion metric for each patient and compared these values between resection and the contralateral volume (*Wilcoxon signed-rank test*).

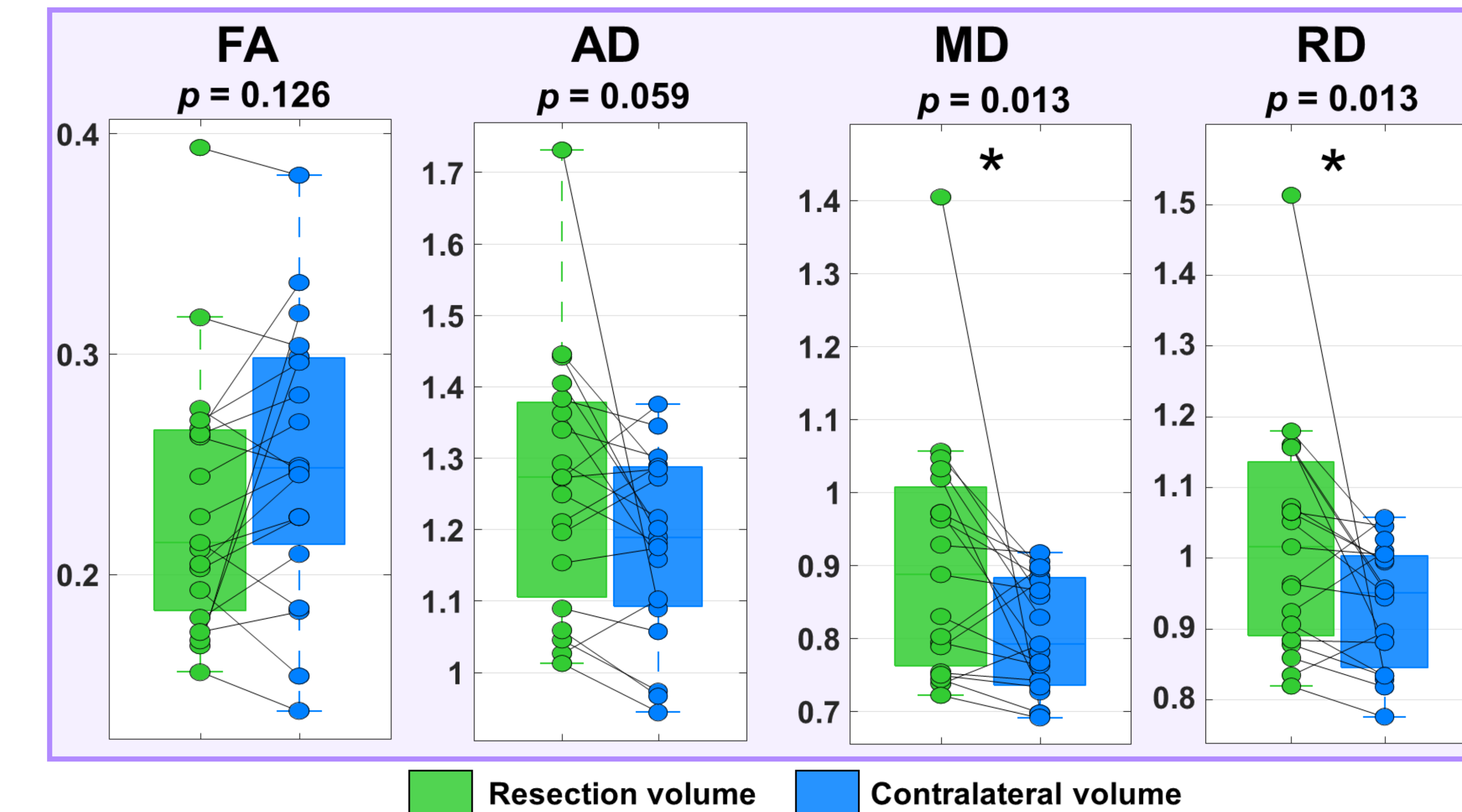


Fig. 3 DTI metrics for seizure-free patients. Fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) mean values for seizure-free patients computed inside resection vs. contralateral zone. *P*-values < 0.05 are displayed (*Wilcoxon signed-rank test*).

- For this cohort of 19 seizure-free patients, we observed that **diffusivity metrics** (i.e., AD, MD, and RD) **were more sensitive than FA** in detecting the diffusion abnormalities inside the resection zone.

Conclusions

- Our study shows that water molecule diffusion in neural fibers that reside in epileptogenic areas differs from homologous regions of the contralateral hemisphere.
- Our findings revealed that DTI can provide **information in localizing the EZ** in children with DRE.
- Combined with other neuroimaging noninvasive techniques, such as functional connectivity, **DTI is a powerful tool that may help the presurgical evaluation of children with DRE** by detecting pathological structural changes of brain networks associated with the epileptogenic focus.

Future studies

- Combining **DTI tractography** and **graph theoretical** approaches, future studies may investigate changes in the topological organization of whole-brain networks in patients with DRE and compare them with those of healthy control children.
- However, additional research studies with a larger number of patients are needed to implement the use of DTI and its usefulness in pediatric epilepsy surgery.

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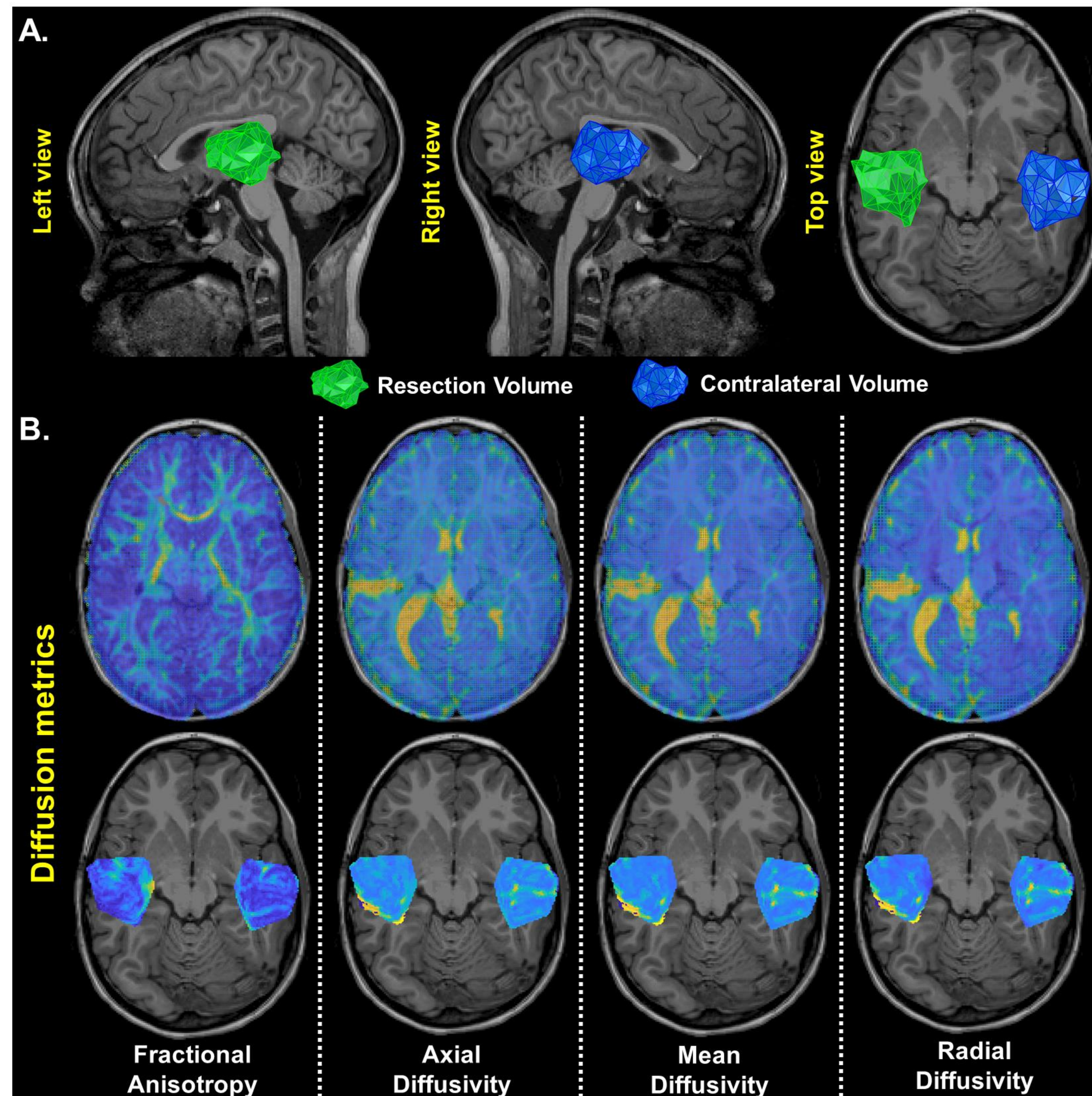


Fig. 1 Diffusion tensor imaging (DTI) metrics inside resection and at the contralateral areas of a seizure-free patient. (A) Resection zone (green) and mirrored contralateral volume (blue) on the MRI of a 7-year-old female seizure-free patient; (B) Fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) extracted from the whole-brain, resection and contralateral volumes.

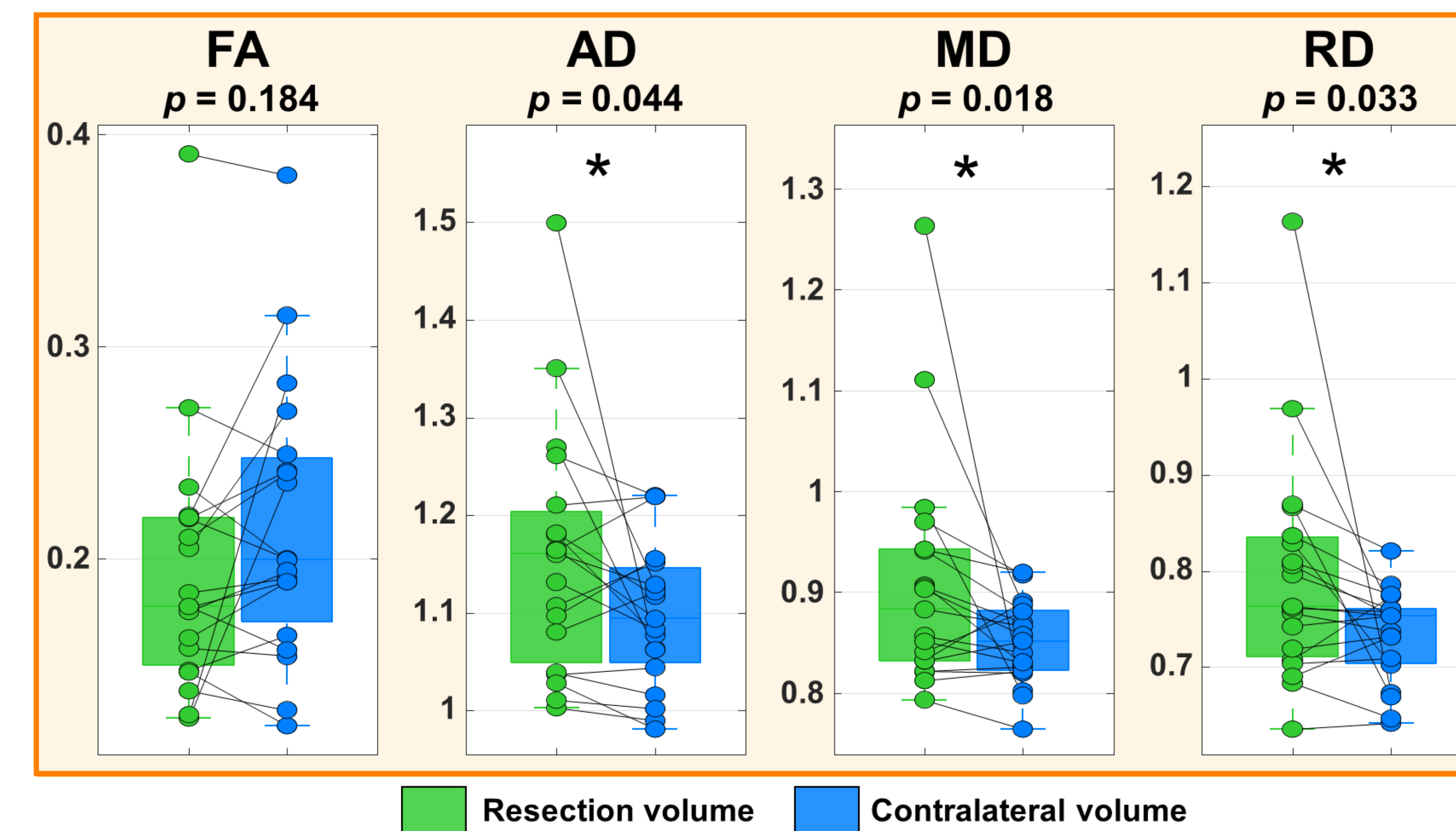


Fig. 2 DTI metrics for seizure-free patients. Fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) median values for seizure-free patients computed inside resection vs. contralateral zone. *P*-values < 0.05 are displayed (*Wilcoxon signed-rank test*).

Results

- We observed significantly higher median AD, MD, and RD inside resection compared to the contralateral zone (**Fig. 2**), as well as for mean MD and RD (**Fig. 3**).
- Contrarily, FA did not show significant differences between these two regions.
- Although FA was not significant, it showed increased median and mean values mostly inside the contralateral zone (i.e., non-pathological hemisphere) and decreased values inside the EZ (**Fig. 2 and Fig. 3**).