

Diffusion Tensor Imaging and Tractography in Epilepsy Surgery Candidates

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This thesis is based on the following papers:

- I. Visual field defects after temporal lobectomy - comparing methods and analysing resection size**
Nilsson D, Malmgren K, Rydenhag B, Frisen L. Acta Neurol Scand 2004; 110(5):p 301-307
- II. Intersubject variability in the anterior extent of the optic radiation assessed by tractography**
Nilsson D, Starck G, Ljungberg M, Ribbelin S, Jönsson L, Malmgren K, Rydenhag B. Epilepsy Res. 2007 Oct;77(1):11-6.
- III. Bilateral diffusion tensor abnormalities of temporal lobe and cingulate gyrus white matter in children with temporal lobe epilepsy**
Nilsson D., Go C., Rutka J. T., Snead III. O. C., Raybaud C. R., Rydenhag B., Mobbitt D, Widjaja E. Submitted
- IV. Preserved structural integrity of white matter adjacent to low-grade tumors**
Nilsson D., Rutka J. T., Snead III. O. C., Raybaud C. R., Widjaja E.
Childs Nerv Syst, 2008. 24(3): p 313-320



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Abstract

In selected patients with medically refractory epilepsy, surgical treatment can render the patients seizure free or significantly reduce seizure frequency. Temporal lobe resection (TLR) for temporal lobe epilepsy (TLE) is the most commonly performed epilepsy surgery procedure. A visual field defect (VFD) due to injury to the optic radiation (OR) may occur after TLR. DTI-based tractography (TG) can be used to visualize white matter tracts such as the OR non-invasively. DTI evaluates the structural integrity of brain tissue by measuring water diffusion and provides information on the directionality and magnitude of diffusion motion and can be used to assess the effects of seizures on the brain parenchyma.

First, we evaluated the frequency of VFD after TLR in patients with TLE and investigated if the extent of lateral TLR correlated with the frequency of VFD in 50 patients. We found that quadrantanopia due to injury to the OR occurred in 50% of patients and that there was no association between the extent of lateral resection and VFD. The second aim was to use TG to assess the anatomical location of the OR and the interindividual variability in the anterior extent of the OR. The OR was assessed in seven normal controls and two patients with previous TLR. TG could depict the OR in all cases and demonstrated a considerable variability in the anterior extent of the OR. The mean distance from the temporal pole to the anterior edge of Meyer's loop was 44 mm bilaterally (range 34-51 mm). TG demonstrated a disruption of the tract depicting Meyer's loop in one patient with quadrantanopia. Next, we used DTI to study the effects of seizures on the diffusion properties in temporal lobe and cingulate gyrus white matter in eight children with TLE. We found bilateral changes in the diffusion properties which may reflect effects of frequent seizures on the white matter. The presence of bilateral alterations in diffusivity precluded seizure lateralization. Finally, we used DTI and TG to quantitatively assess the structural integrity of white matter tracts adjacent to low-grade brain tumors causing seizures in 11 children. We found preserved structural integrity of the white matter as indicated by preserved DTI indices of the white matter adjacent to the tumor and also displacement of the white matter tracts adjacent to the tumor in 10/11 children.

TG provides a non-invasive means of evaluating the major white matter tracts which is important for presurgical planning to improve and individualize the preoperative risk analysis and prevent neurological deficits. However, limitations of the technique must be considered before it is used routinely and prospective studies using TG to assess the OR in TLE patients before TLR are needed to determine its clinical value. DTI may contribute to the multimodal evaluation in medically refractory epilepsy with information on the effects of focal seizures on the brain. However, longitudinal studies are needed to clarify these effects in more detail and to decide if this information may be useful to guide selection of epilepsy surgery candidates.

Key words: epilepsy, epilepsy surgery, temporal lobe resection, optic radiation, diffusion tensor imaging, tractography