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Visual Outcomes after Anterior Temporal Lobectomy and transsylvian Selective Amygdohippocampectomy – A Quantitative Comparison of Clinical and Diffusion Data

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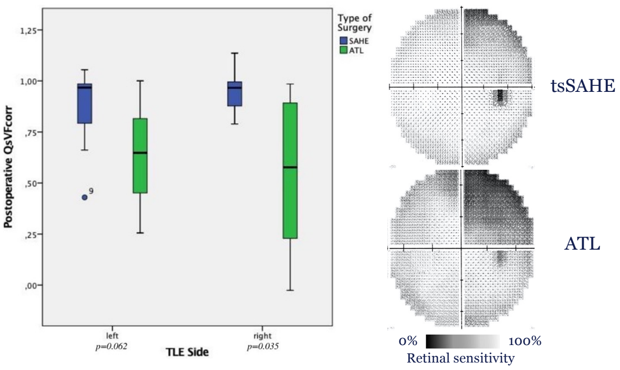
Objective

Anterior temporal lobectomy *(ATL)* and transsylvian selective amygdalohippocampectomy *(tsSAHE)* are effective treatment strategies for intractable temporal-lobe epilepsy but may result in visual field deficits *(VFDs)*. VFDs following epilepsy surgery are caused by damage to the optic radiation *(OpR)*. This imaging study aims to analyze visual outcomes after epilepsy surgery and to offer a quantitative structural explanation.

Patients and Methods

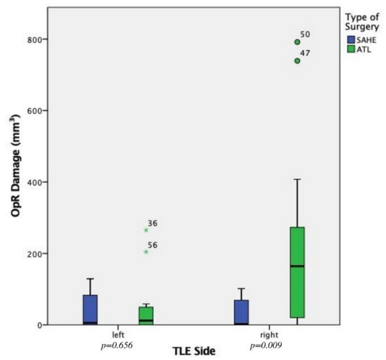
We studied 62 patients who underwent ATL *(n=32)* or tsSAHE *(n=30)*. Analysis was conducted in four steps, including the assessment of *(1)* perimetry outcomes [VFD incidences, VFD extent, group perimetry], *(2)* volumetric OpR-tractography-damages [preoperative tracts* warped to postoperative T1w to calculate volume overlap], *(3)* the relation of volumetric OpR-tractography-damages and VFDs [incidence prediction; regression analysis] and *(4)* microstructural changes [Fixel-Based-Analysis] within the OpR following epilepsy surgery. **tracts were extracted from structural connectomes between atlas ROIs (Thalamus [Freesurfer 2012], visual cortex [Glasser 2016]).*

Results 1 - Perimetry Outcomes



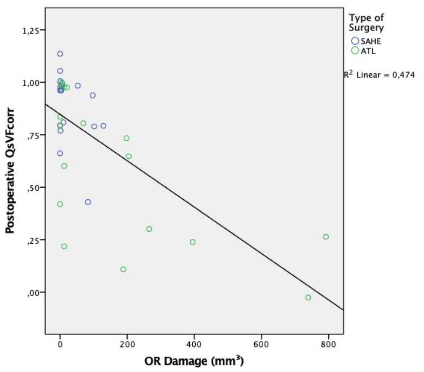
Altogether, postoperative **VFDs were more frequent after ATL** than after tsSAHE *(78.9% vs. 36.36%, p=0.011)*. Postoperative **retinal sensitivity was significantly lower after ATL** than after tsSAHE *(65% vs. 97%; p=0.002)*. This difference remained significant for right, however, not for left TLEs. **Group perimetry** visualized the **greater average VFD incidence and severity** observed among **ATL patients**.

Results 2 - OpR Tract damages



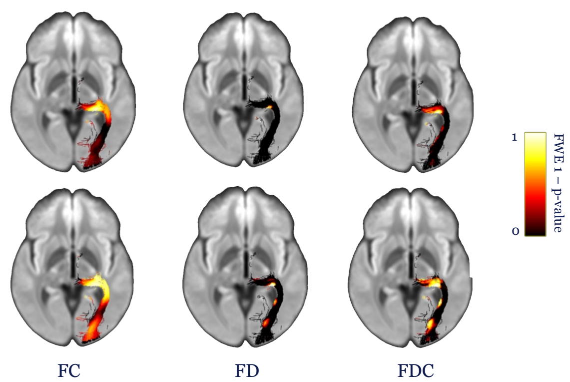
Concordantly with quantitative perimetry outcomes, **volumetric OpR damages were more severe among ATL patients** *(69.2mm^3 vs. 3.8mm^3, p=0.002)*. Group differences of volumetric tract damages remained significant when exclusively comparing right TLEs, however did not reach statistical significance in left TLEs.

Results 3 - OpR Tract damage and Perimetry



Volumetric OpR damages were able to reliably predict VFD occurrence with a sensitivity of 86% and a specificity of 78%. False-negative and false-positive rates did not differ between treatment groups. A linear regression model showed a **significant correlation of volumetric OpR damages and extents of postoperative VFDs** (R^2=0.47, p=0.0001).

Results 4 - Fixel-Based-Analysis



Fixel metrics obtained from Fixel-Based-Analysis *(Fiber Cross-Section [FC], Fiber Density [FD] and Fiber Density-Cross-Section [FDC])* were contrasted *PREOP > POSTOP* for both treatment groups. **Non-significant trends towards more extensive decreases of FC and FDC in patients undergoing ATL were observed**. In the context of this study, a decrease of Fiber-Cross-Section could be interpreted as a sign of tract atrophy, which seems to be the main pathophysiological mechanism of postsurgical tract damage, as Fiber-Density remained largely unaffected.

Conclusion

In the context of controversial visual outcomes following epilepsy surgery, this study provides clinical as well as multimodal neuroimaging evidence for a higher risk and greater severity of postoperative VFDs of epilepsy patients undergoing ATL compared to tsSAHE. Volumetric OpR damage is a feasible parameter to reliably predict this morbidity in both treatment groups and may ultimately support personalized planning of surgical candidates. Advanced diffusion analysis tools such as FBA offer a structural explanation of surgically induced visual pathway damage, allowing to non-invasively quantify and visualize tract affection on a microstructural level.

References

Fischl, B., *FreeSurfer*. Neuroimage. 2012
Glasser et al. *A multi-modal parcellation of human cerebral cortex*. Nature. 2016
Dhollander, T., et al., *Fixel-based Analysis of Diffusion MRI: Methods, Applications, Challenges and Opportunities*. NeuroImage. 2021

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