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Angaben zur Veröffentlichung / Publication details:

Groppa, S. A., V. Chiosa, D. Ciolac, Muthuraman Muthuraman, N. Koirala, A. Vataman, Y. Winter, M. Moldovanu, G. Gonzales-Escamilla, and S. Groppa. 2018. "Distinct cortical and subcortical structural alterations mirroring daytime related seizure occurrence [Abstract]." *Epilepsia* 59 (S3): S327. https://doi.org/10.1111/epi.14612.

Distinct Cortical and Subcortical Structural Alterations Mirroring Daytime-Related Seizure Occurrence

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Purpose: Investigating the daytime-related patterns of seizure presentation might provide important insights into the involved epileptogenic networks. However, the alterations of brain structural integrity linked to different profiles of seizure occurrence are still not clear. In this study we addressed the structural magnetic resonance imaging (MRI)-derived features of the involved cortical and subcortical substrates.

Method: In 13 patients (mean age ± standard deviation: 28±9 years; 9 male) with nocturnal seizures (NS), 12 patients (26±9; 3 male) with diurnal seizures (DS) and 10 healthy controls (HC) (28±4; 6 male) 3D 3T MRI was performed. Cortical and subcortical volumes (hippocampus, amygdala, thalamus) were extracted with the FreeSurfer processing stream and the between-group differences assessed with analysis of variance (ANOVA) and Bonferroni post hoc tests. There was no difference between the groups regarding age ($F_{2,32} = 0.26$, $p = 0.77$) and gender ($\chi^{\dagger} = 5.103$, df = 2, $p = 0.08$).

Results: NS group in contrast to DS group showed larger volumes of bilateral insula, superior temporal and orbitofrontal cortices ($p = 0.05$, corrected). In patients with NS cortical volumes of left postcentral and right middle temporal cortices were smaller in comparison to HC. Patients with DS in comparison to HC displayed reduced cortical volumes mainly in frontal, temporal and parietal lobes of the right hemisphere. Hippocampus analysis showed a significant group difference ($F_{2,32} = 3.643$, $p = 0.03$) with post hoc test indicating larger volumes in NS group (8208.6±1006.1) vs DS group (3859.1±508.1 $mm^{\ddagger}$, $p = 0.02$). For amygdala, ANOVA showed a similar significant group difference ($F_{2,32} = 4.341$, $p = 0.02$) with larger volumes in NS group (1797.3±323.2 $mm^{\ddagger}$) vs DS group (1500.5±246.2 $mm^{\ddagger}$, $p = 0.03$). There were no differences in thalamic volumes between the studied groups.

Conclusion: Despite epileptogenesis daytime-related seizures have distinct structural correlates. These alterations can assign protective or susceptibility properties linked to vigilance or sleep states that could be useful for therapeutic decisions.