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EUROPEAN CONGRESS OF MEDICAL PHYSICS

September 1-4, 2016

Eugenides Foundation
Athens-Greece

Hippocampal analysis, using Diffusion Tensor Imaging (DTI) and Surface Based Analysis (SBA), to assist in Temporal Lobe Epilepsy (TLE) research.
Preliminary results.

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Paper Number: PP 048



ΠΑΝΕΠΙΣΤΗΜΙΟ ΘΕΣΣΑΛΙΑΣ

Introduction

Epilepsy is the fourth most common serious neurological disorder and TLE (Temporal Lobe Epilepsy), the most frequent form of refractory focal epilepsy.

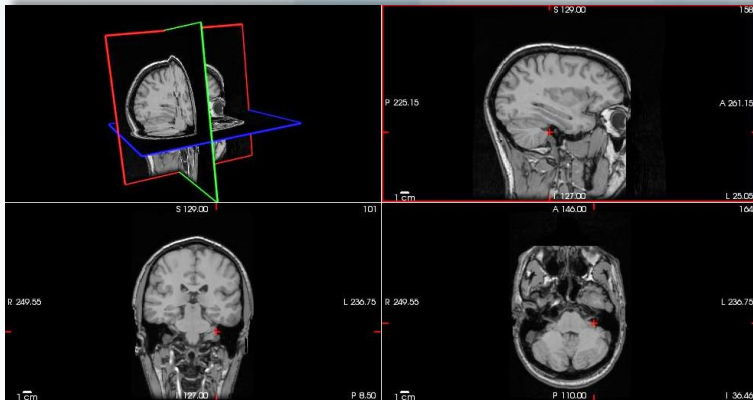
MRI Epilepsy protocols have been already established in many centers in order to facilitate the detection and localization of the seizure focus.

Purpose

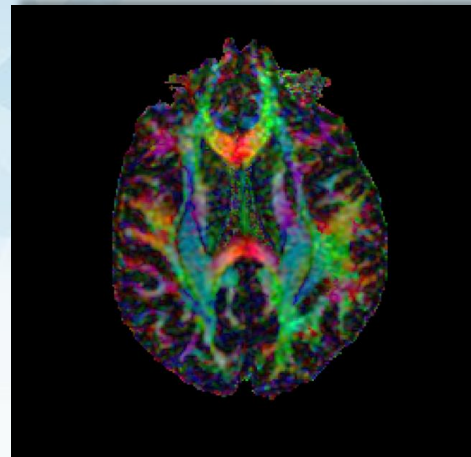
In this study we sought to investigate the contribution of advanced MRI Techniques, combined with Surface-Based Analysis (SBA) to the underlying pathophysiology of epilepsy.

Methods (1/2)

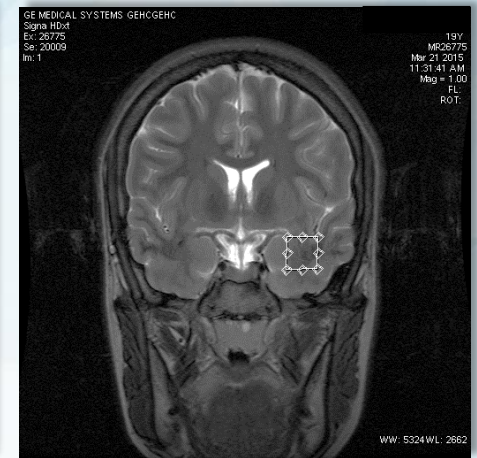
3D MRI, DTI and MR Spectroscopy data were acquired from a group of 35, 19 years old, healthy adults (12 males/23 females), at a GE Signa HDxt 3.0T scanner.



3D MRI



DTI



Single Voxel MRS,
TE=35ms

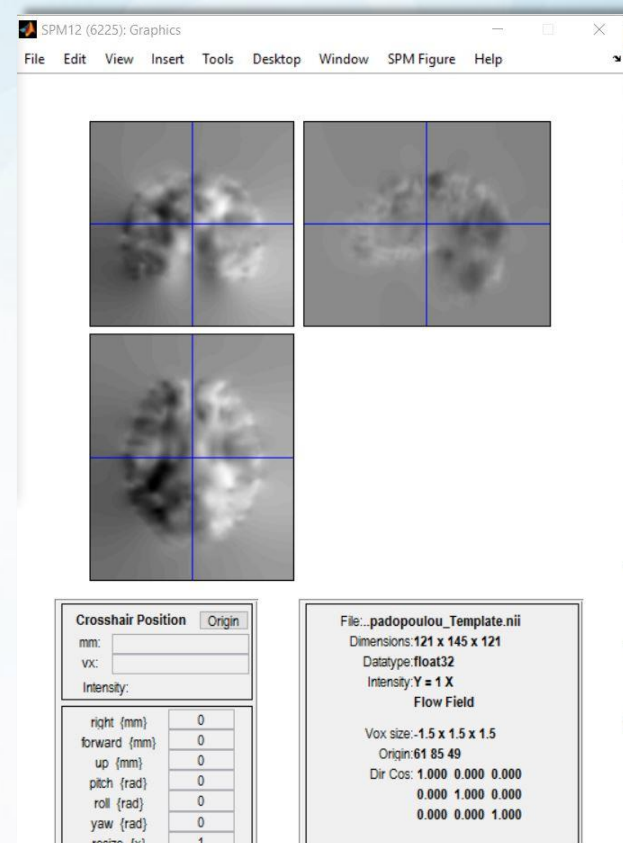
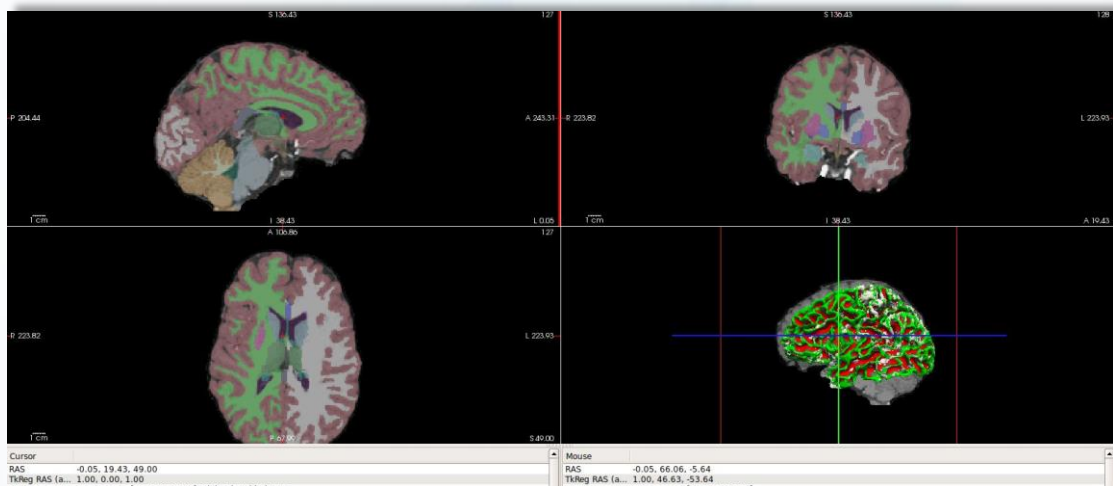
DTI metrics, such as Fractional Anisotropy (FA), Mean Diffusivity (MD) and Eigenvalues λ_1 , λ_2 , λ_3 were derived from **GE Functool** (GE Milwaukee, USA) and **ExploreDTI** (courtesy of Alexander Leemans*).

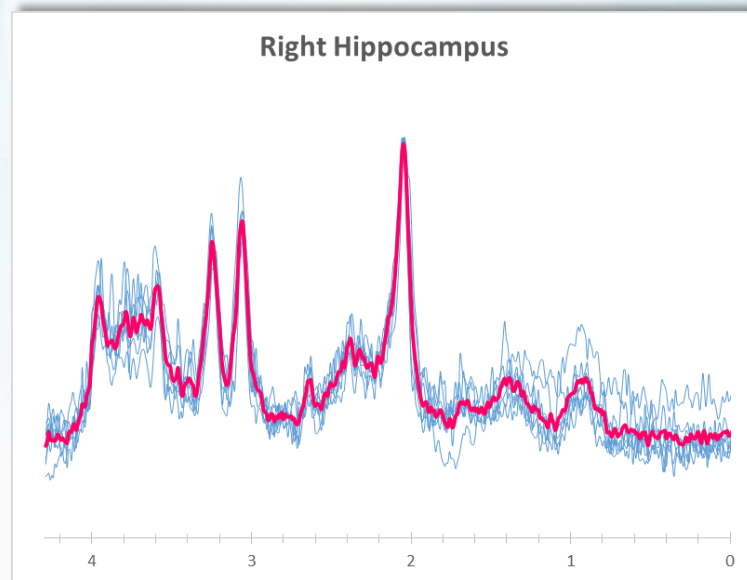
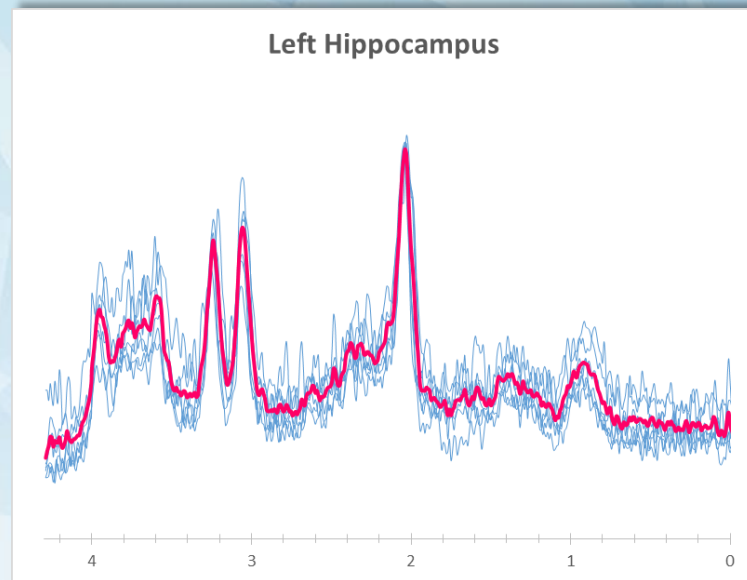
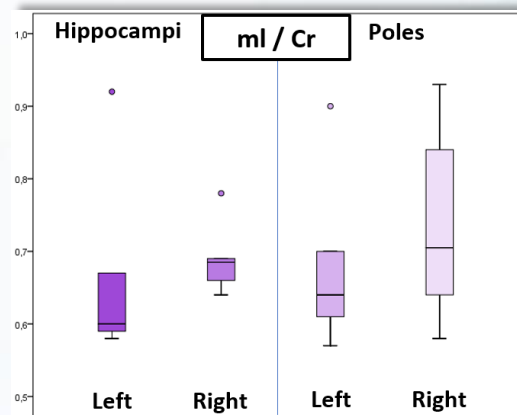
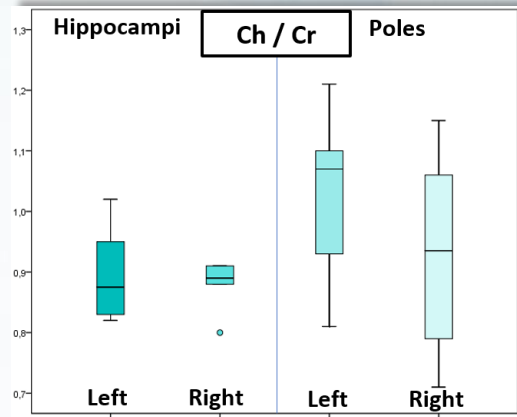
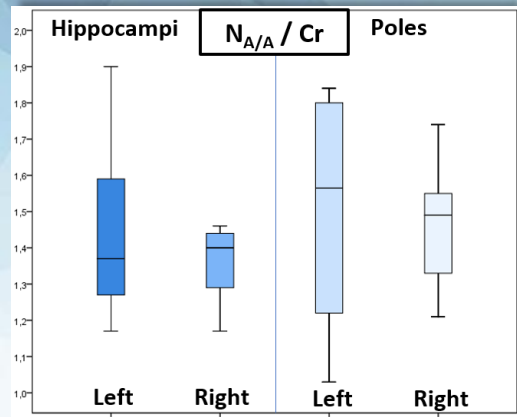
Statistical Analysis was performed using **IBM SPSS**.

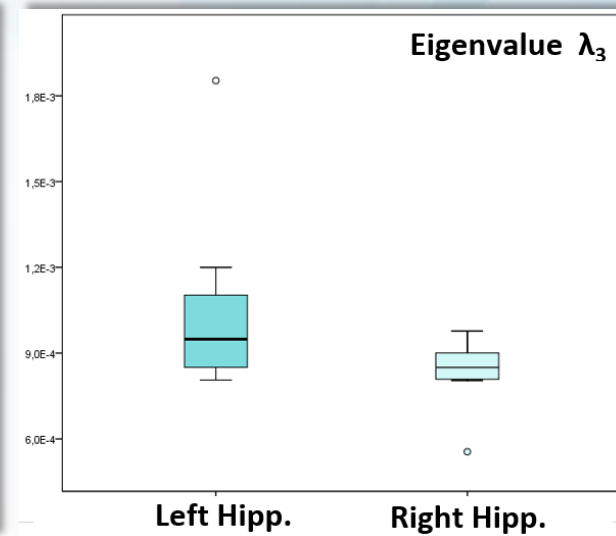
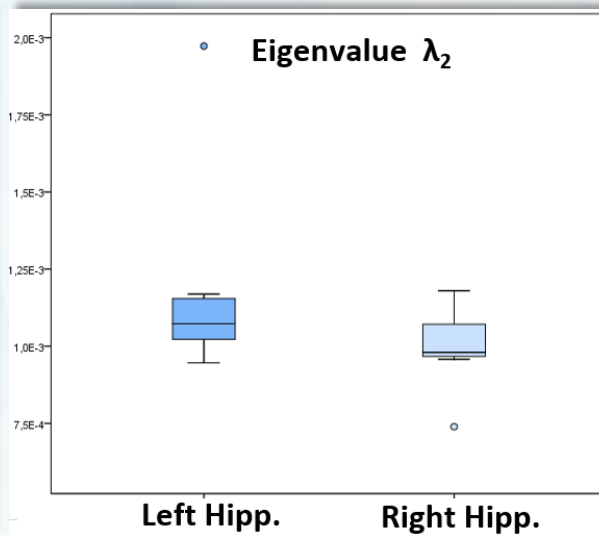
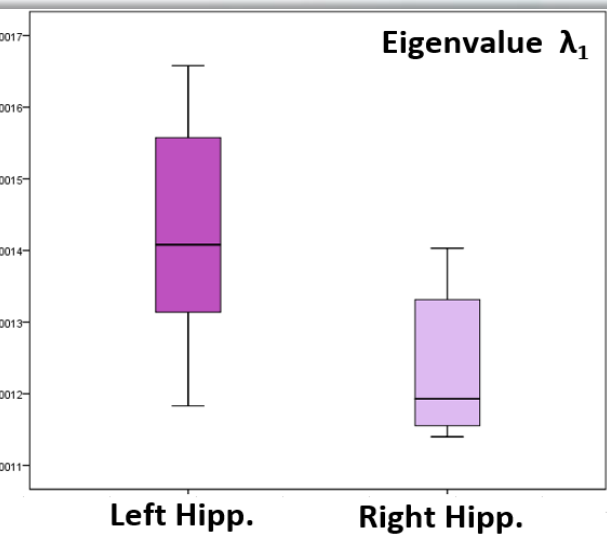
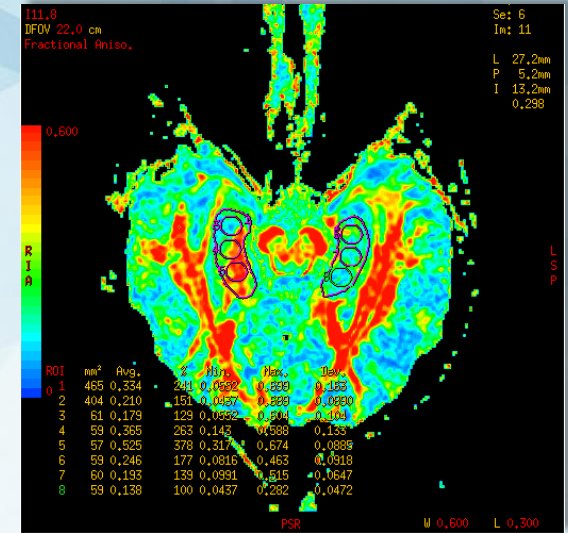
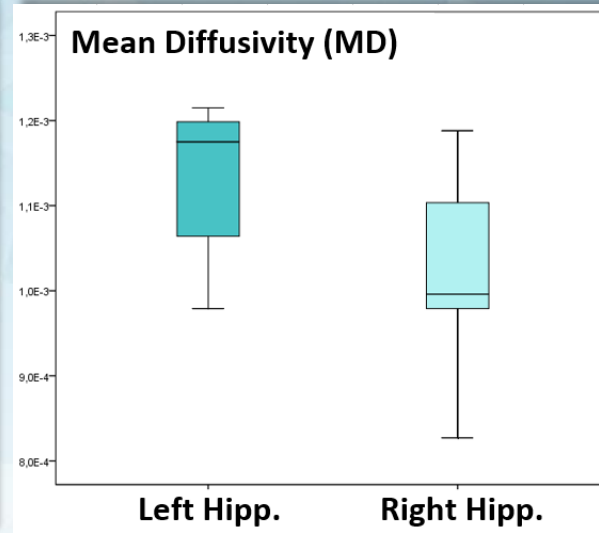
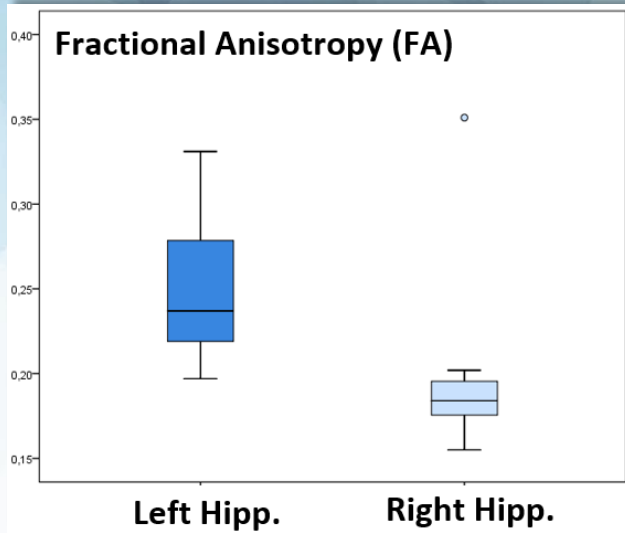
Methods (2/2)

Hippocampal volumes were measured using a Surface-Based Analysis (SBA) software, deriving morphometric measures from geometric models of the cortical surface. (**FreeSurfer** -Laboratory for Computational Neuroimaging, Athinoula A. Martinos Center).

The Intracranial Volume (ICV) was calculated using the Statistical Parametric Mapping software package. (**SPM**-Version 12.0, UCL, UK).







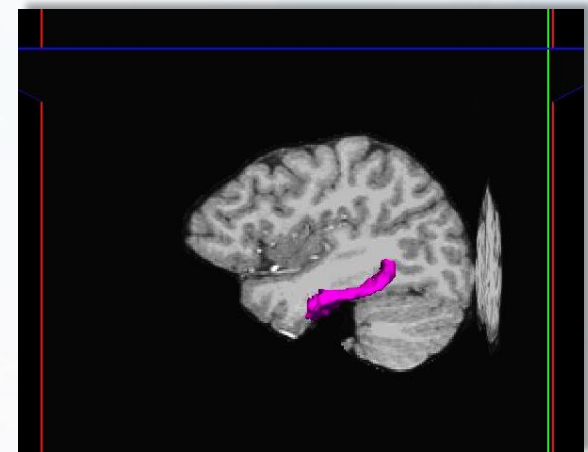
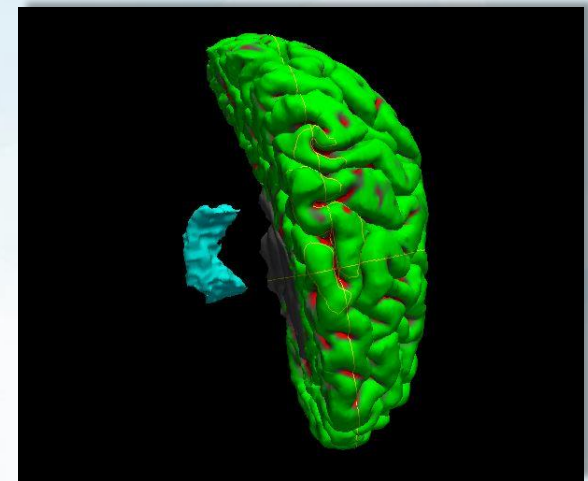
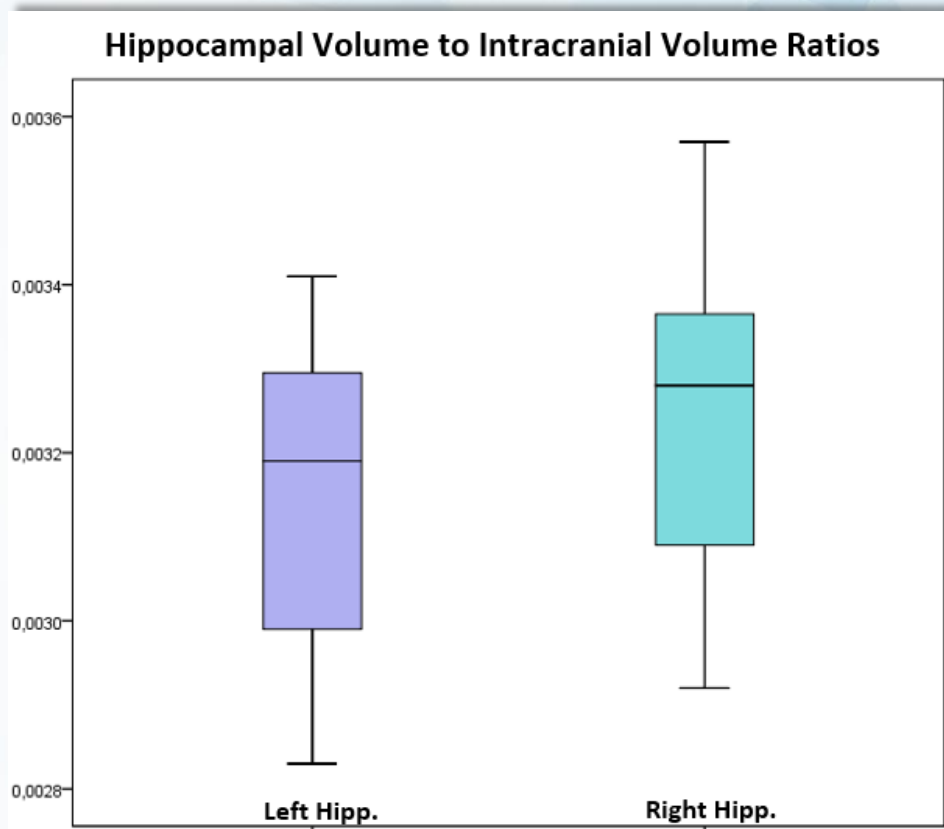
MD and $\lambda_1, \lambda_2, \lambda_3$ in $10^{-3} \text{ mm}^2 \text{ s}^{-1}$

Results (3/4)

Hippocampal Volume and ICV

Hippocampal volumes were measured on T1-weighted MRI using FreeSurfer, while Intracranial Volume (ICV) using SPM12.

Proportion method was used for the head-size correction →
Tissue (Hippocampus) to ICV ratio.



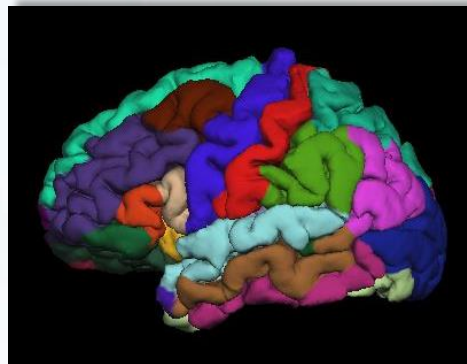
Summary of Results

Left Hippocampus			Right Hippocampus		
Mean Metabolite Ratios					
NA/A /Cr	Ch/Cr	ml/Cr	NA/A /Cr	Ch/Cr	ml/Cr
1,48	0,92	0,70	1,39	0,89	0,70
DTI Metrics					
Average FA		SD FA	Average FA		SD FA
0,251		0,0875	0,204		0,0771
Average MD		SD MD	Average MD		SD MD
0,001128		0,000255	0,001025		0,000252
Average λ_1		SD λ_1	Average λ_1		SD λ_1
0,001427		0,000314	0,001244		0,00033
Average λ_2		SD λ_2	Average λ_2		SD λ_2
0,001192		0,000262	0,000996		0,000252
Average λ_3		SD λ_3	Average λ_3		SD λ_3
0,001074		0,000249	0,000829		0,000221
Average Hippocampal volume to ICV Ratio					
LH/ICV			RH/ICV		
0,00314			0,00324		

Conclusion (1/2)

Surface-Based Analysis software such as FreeSurfer and Statistical Parametric Mapping software such as SPM12 are powerful tools for the analysis and visualization of structural neuroimaging data.

Hippocampal volume reduction could be detected by automated segmentation via FreeSurfer in patients with TLE compared to the hippocampal volume measurements of the healthy adults.



Conclusion (2/2)

Using extracted data for hippocampal volume, Mean Diffusivity, FA, DTI eigenvalues and MRS, from the group of healthy volunteers, we generated a normative database in order to facilitate potential differentiation between physiological and pathological hippocampus.

In conclusion, our initial results indicate a strong contribution of advanced MRI combined with SBA towards the optimization of TLE diagnosis.