

Hippocampus Volumetry and Shape Analysis in mTLE With (TLE-MTS) and Without (TLE-no) Evidence for Mesial Temporal Sclerosis

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Background

Mesial temporal lobe epilepsy (mTLE) due to mesial-temporal sclerosis (MTS) is characterized by neuronal loss and astrogliosis. 90% of patients with evidence for MTS on MRI, i.e. increased T2 signal and/or volume loss (TLE-MTS) become seizure free after temporal lobe resection but only 50% without MTS evidence on MRI (TLE-no). The reason for the higher failure rate of surgery in TLE-no is not known. However, subtle changes of the shape indicating a mild hippocampal malformation need not necessarily to be associated with volume loss. Therefore, the aims of this study were first: to use automated hippocampal volumetry to distinguish TLE-MTS and TLE-no from controls and second to determine if measurement of hippocampal shape changes provided additional information for seizure localization, especially in TLE no.

Patients and Methods

The study population consisted of 22 TLE-MTS (13 right TLE, 9 left TLE; age 35.6 ± 9.3 years) 10 TLE-no (5 right TLE, 5 left TLE; age 43 ± 9.5 years) and 17 controls (age 29.5 ± 5.8 years).

The subjects were scanned on a 1.5 Vision™ (Siemens Inc. Iselin, NJ) using a magnetization prepared rapid gradient echo (MP-RAGE) sequence with TR/TE/TI = 13.5/7/300 ms, 15° flip angle, 1.0 x 1.0 mm² in plane resolution and 1.4 mm slice thickness. The hippocampus was manually marked using a commercially available high dimensional brain mapping tool (Surgical Navigator Technology Inc., Boulder CO) (1) automatically segmented and the volume (HV) in mm² calculated. HV was corrected for head size using the intracranial volume. For shape analysis the subjects were divided in two groups: 1. TLE-MTS and controls and 2. TLE-no and controls. A high dimensional matrix consisting of 6000 to 7000 triangulated vertices was superimposed onto the surface of the segmented hippocampus and a pooled covariance matrix was computed. To compare hippocampal shape characteristics between patients and controls the dimensionality of the covariance matrix was reduced using Principal Component Analysis (PCA).

Two factor ANOVA tests with repeated measures on one factor were done to test for HV differences. One factor ANOVA tests were performed to test for differences of PCA between groups. Post hoc comparisons were done with two-tailed t-tests and corrected for multiple com-

parisons with Holm's Test. Pearson Correlation Coefficients were calculated to test for correlations between the hippocampal volume and the hippocampal PCA measurements.

Results

In TLE-MTS, ipsilateral hippocampi were smaller than contralateral and hippocampi of controls. There was no difference between the HV of controls and TLE-no. (cf. Table 1).

The comparison of shape characteristics showed that PCA2 was different between the ipsilateral hippocampus of MTS-TLE (right hippocampus: $F(2/36) = 41.42, p < 0.00001$; left hippocampus $F(2/36) = 16.45, p < 0.00001$) compared to contralateral and controls. There was a correlation between hippocampal volume and PCA2 on both sides (r right = 0.56, $p < 0.0005$; r left = 0.74, $p < 0.00001$). There were no PCA differences between TLE-no and controls.

Table 1. Hippocampal Volume (HV) in Controls, TLE-MTS and TLE-no in mm²

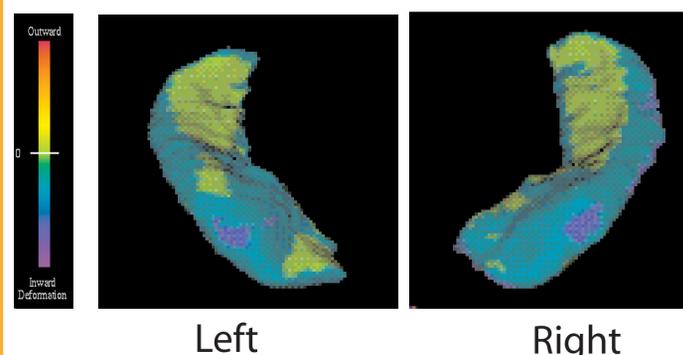
Group	Right HV	Left HV
Controls	1913.1 ± 240.5	1828.5 ± 154.4
TLE-MTS right	1529.9 ± 188.0 **	1995.3 ± 202.2
TLE-MTS left	2048.4 ± 188.6	1245.1 ± 227.0 **
TLE-no right	1860.8 ± 256.4	2016.0 ± 348.5
TLE-no left	1644.6 ± 188.2	1803.0 ± 262.0

TLE-MTS right, TLE with MRI evidence for mesial temporal sclerosis (MTS) and seizure origin in the right hippocampus; TLE-MTS left, TLE with MRI evidence for MTS and seizure origin in the left hippocampus; TLE-no right, TLE without MRI evidence for MTS and seizure origin in the right hippocampus; TLE-no left, TLE without MRI evidence for MTS and seizure origin in the left hippocampus.

* $p < 0.05$ compared to contralateral

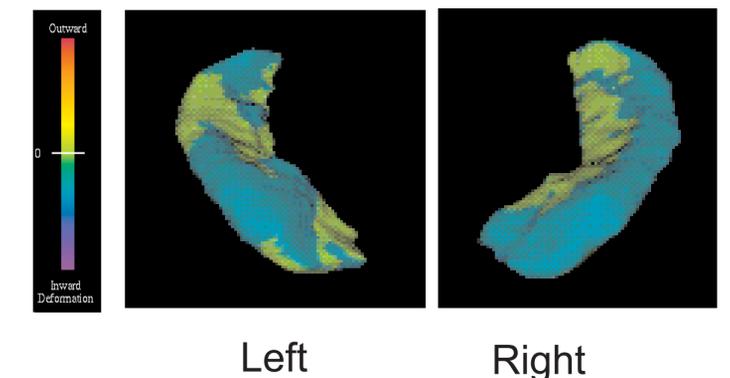
° $p < 0.05$ compared to controls

Figure 1



Comparison of the hippocampus of TLE-MTS with healthy controls. The blue areas demonstrate a surface displacement and corresponding volume loss.

Figure 2



Comparison of the hippocampus of TLE-no with controls. There is no evidence for deformation or volume loss.

Conclusion

In TLE-MTS the epileptogenic hippocampus was smaller than the non-epileptogenic hippocampus and the corresponding hippocampus of controls, similar to many previous reports. The volume loss of the epileptogenic hippocampus was associated with shape changes affecting primarily the head of the hippocampus (Figure 1). Contrary to TLE-MTS, there is no evidence for a volume loss and/or deformation of the epileptogenic hippocampus in TLE-no when compared to healthy volunteers (Figure 2). These results indicate that measurement of hippocampal shape does not provide additional information to measurement of volume in TLE.

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References:

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