

# Texture Analysis of MRI of Juvenile Myoclonic Epilepsy Patients

M. S. Oliveira<sup>1,2</sup>, L. E. Betting<sup>2,3</sup>, F. Cendes<sup>2,3</sup>, and G. Castellano<sup>1,2</sup>

<sup>1</sup>Neurophysics Group, State University of Campinas (Unicamp), Campinas, SP, Brazil, <sup>2</sup>CInAPCe (Cooperação Interinstitucional de Apoio a Pesquisas sobre o Cérebro), São Paulo State, Brazil, <sup>3</sup>NeuroImage Laboratory, State University of Campinas (Unicamp), Campinas, SP, Brazil

## Purpose

To investigate the thalamus of patients with Juvenile Myoclonic Epilepsy (JME) using texture analysis, a quantitative neuroimaging technique, applied to their cerebral MR images.

## Introduction

JME is the most frequent subsyndrome of the idiopathic generalized epilepsies (IGE). Magnetic resonance (MR) imaging is not routinely performed in IGE patients. Visual analysis of the MRI usually is normal or minor abnormalities may be observed (1). The cortico-thalamic circuitry is a key neuroanatomical pathway involved in the pathophysiology of JME (2, 3). By using quantitative MRI analysis, previous investigations of the thalamus were able to detect subtle abnormalities in the volume of this structure in patients with IGE (4, 5). The goal of this work was to apply texture analysis to MR images of JME patients and control subjects, in order to find out if there are tissue differences between the thalami of these groups, which are not perceived by standard visual analysis. Texture analysis has already been validated and applied to several areas of medicine, including the study of hippocampal sclerosis in patients with temporal lobe epilepsy (6).

## Methods

**Subjects:** 24 patients with JME (16 women, mean age: 30.00 ± 9.24, range: 19-50) and 20 healthy volunteers (10 women, mean age: 30.55 ± 8.46, range: 22-52) were investigated. The project was approved by the Ethical Research Committee of our institution, and all subjects gave their written informed consent.

**MRI scanning protocol:** The MRI data, obtained with a 2 T scanner (GE Elscint Prestige, Haifa, Israel), consisted of T1 weighted images with 1 mm isotropic voxels, acquired with a spoiled gradient echo sequence (flip angle = 35°, TR = 22 ms, TE = 9 ms, matrix = 256×220, FOV = 23×25cm<sup>2</sup>). All the images were submitted to visual analysis by two imaging experts. Patients with abnormalities on the MRI exams were not included in this study.

**Image processing:** The thalami (left and right) were manually segmented in 5 slices in the axial view. Texture analysis was performed for each segmented region of interest (ROI) in the selected slices, using the MaZda program (7). The texture approach used was the Gray Level Co-occurrence (GLC) matrix. Twenty GLC matrices were computed (for distances 1 to 5 pixels and directions 0°, 45°, 90° and 135°), from which 220 texture parameters (8) were extracted for each ROI. Since the ROI size was different for each slice, a weighted average of the 220 texture parameters was computed for every thalamus. This set of parameters was further used to calculate an average over the different GLC directions, giving 55 parameters for each thalamus (left and right) per subject. These parameter sets were analyzed statistically using the Mann-Whitney test.

## Results

The statistical analysis showed differences between the texture parameters of JME patients and controls only for the right thalamus. The differences in texture came from the parameters computed from GLC matrices for distances from 3 to 5 pixels. Table 1 shows the results obtained, giving the GLC matrix (distance), the texture parameter and the corresponding p-value.

## Discussion

The analysis of texture parameters was able to detect differences between the thalamus of JME patients and controls. This observation supports the participation of this structure in the pathophysiology of JME. The thalamic functionality is complex and not completely understood. The present investigation disclosed a thalamic abnormality that confirms a disruption in this system. Previous investigations did not demonstrate neuronal loss in the thalamus of patients with JME (9). The abnormalities observed in the texture analysis performed in here may be more closely related to axonal and neurotransmission changes. This hypothesis is in line with the genetic profile described in some families with IGE and with previous investigations using quantitative MRI and magnetic resonance spectroscopy (4, 10, 11). Furthermore, only abnormalities in the right thalamus were observed. This finding was not previously described and may be related with the heterogeneity observed in the IGE phenotype. Therefore, further investigations of this structure in patients with JME are needed.

## References

1. Betting LE et al (2006). MRI reveals structural abnormalities in patients with idiopathic generalized epilepsy. *Neurology* 67:848-852.
2. Gloor P (1979). Generalized epilepsy with spike-and-wave discharge: a reinterpretation of its electrographic and clinical manifestations. *Epilepsia* 20:571-588.
3. Meeren HK et al (2002). Cortical focus drives widespread corticothalamic networks during spontaneous absence seizures in rats. *J Neurosci* 22:1480-1495.
4. Betting LE et al (2006). Voxel-based morphometry in patients with idiopathic generalizes epilepsies. *NeuroImage* 32:498-502.
5. Chan CH et al (2006). Thalamic atrophy in childhood absence epilepsy. *Epilepsia* 47:399-405.
6. Bonilha L et al (2003). Texture analysis of hippocampal sclerosis. *Epilepsia* 44:1546-1550.
7. Szczypiński PM et al (2009). MaZda – A software package for image texture analysis. *CMPB* 94:66-76.
8. Haralick RM (1979) Statistical and structural approaches to texture. *Proceedings of the IEEE* 67:788-804.
9. Meencke HJ, Janz D (1984). Neuropathological findings in primary generalized epilepsy: a study of eight cases. *Epilepsia* 25:8-21.
10. Helbig I et al (2008). Navigating the channels and beyond: unraveling the genetics of the epilepsies. *Lancet Neurol* 7:231-245.
11. Mory SB et al (2003). Thalamic dysfunction in juvenile myoclonic epilepsy: a proton MRS study. *Epilepsia* 44:1402-1405.

**Acknowledgments:** We thank CNPq and FAPESP for financial support.

**Table1:** Significant texture parameters obtained for the right thalamus in the comparison between JME patients and controls.

Distance (d)	Texture parameter	Mean ± sd (controls)	Mean ± sd (patients)	p-value (<=)
3	Contrast	22.746 ± 2.607	25.078 ± 3.244	0.015
3	Inverse Difference Moment	0.227 ± 0.013	0.218 ± 0.013	0.05
3	Difference Variance	8.154 ± 0.900	8.962 ± 1.159	0.02
3	Difference Entropy	0.987 ± 0.023	1.004 ± 0.024	0.015
4	Contrast	27.264 ± 3.127	30.192 ± 4.200	0.025
4	Difference Variance	9.351 ± 1.108	10.307 ± 1.390	0.015
4	Difference Entropy	1.013 ± 0.024	1.029 ± 0.025	0.05
5	Sum of Squares	15.103 ± 2.225	16.396 ± 2.501	0.05