MRI T2 Hypointensity Load and Gray Matter Loss in Patients with Huntington's Disease

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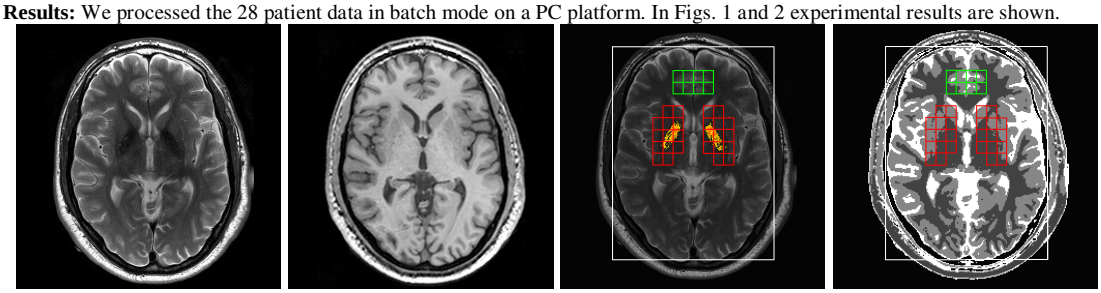
Synopsis: We investigate two MRI features computed in the Basal Ganglia (BG) of Huntington's disease (HD) patients. One feature is the hypointensity load in T2-weighted (T2-w) images, and the other one corresponds to gray matter (GM) loss detected in T1-weighted (T1-w) images. We automatically select BG regions [2] given by a set of grid cells which define the region-of-interest (ROI). The T2-w hypointensity load within the ROI is computed by comparing image brightness with a threshold determined based on ROC curve analysis. The tissue segmentation was implemented based on a K-harmonic means clustering algorithm. We tested these two features on 28 subjects, 14 HD patients and 14 controls. We found out that, on average, the percentage of hypointense pixels in the BG is 3.95 times higher for HD patients compared to the controls. Also, the HD patients have 87 % less GM compared to controls, and about 8 % more white matter (WM), significant at p = 0.05 in t-test.

Introduction: The T2-w hypointensity load in the BG of patients is associated, although not exclusively, with iron load [1]. One goal here is to verify if there is a significant difference in T2-w hypointensity load in the BG between controls and HD patients. We know that for HD patients the neural degeneration of cells in the BG and in the frontal lobes results in the degeneration of the indirect (inhibitory) pathway of the BG; one side effect of this is the abnormal iron load in the BG. The other goal is to check if there is a GM loss in the BG of HD patients compared to controls. In order to compare these features in the BG between HD patients and controls, we use the following representation. First, we use a per slice a uniform grid, analogously to the Talairach-Tournoux brain atlas grid, to define the ROI as a sub-set of grid cells. Second, the T2-w hypointensity load per cell is defined as the percentage of hypointense pixels. Third, we build up a vector, of these hypointensity loads, one for each ROI slice and per patient. Finally, we combine these vectors into a matrix – the hypointensity load matrix. This allows us to make cell-based comparisons. Similar matrices are build for the T1-w GM and WM percentages. This matricial representation is advantageous because: (i) it allows an instant visualization of the differences in feature values, on the cell level, and (ii) it allows us, in combining row/column values, to compare feature values for specific sets of cells in the ROI.

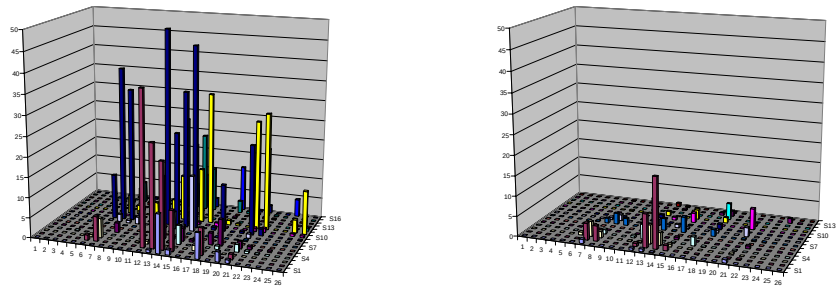
Method: We processed a total 28 patients (mean age 45.1 $\pm$ 3.16), a total of 12 women and 16 men that were screened for HD. MRI was performed on a Philips Intera 3 Tesla whole body scanner. The images are specified by (TR/TE1/TE2: 3000/27/120 ms, FLIP: 90^0) with a FOV 220 mm, 3.6 mm slice thickness, no slice gap and 1024^2 matrix (T2-w) and 256^2 (T1-w). The steps to automatically compute the T2-w hypointensity are as follows. First, we select BG structures. This is realized in three steps: (i) brain volume vertical alignment using mid-sagittal information, and bias field correction, (ii) selection of the volume-of-interest (VOI) [2] based on ventricle shape analysis; the VOI is a collection of slices containing the BG, (iii) ROI computation. Second, we normalize MRI T2-w images as in [2]. Third, we classify pixels as hypointense by determining if the image brightness in the normalized image is larger then a threshold that is computed by ROC curve analysis. After this, we compute the per ROI cell hypointensity load. In our implementation we use a total of 26 cells; these cells can be sequentially sub-divided, thus leading to a simple data structure. The tissue (GM, WM, and CSF) segmentation is done by a K-harmonic means clustering algorithm [3].

Results: We processed the 28 patient data in batch mode on a PC platform. In Figs. 1 and 2 experimental results are shown.



(a) **(b)** **(c)** **(d)**

Fig. 1: (a) original T2-w image, (b) original T1-w image, (c) the automatically computed T2-w hypointense pixels, highlighted in yellow/orange; the ROI is given by the 26 cells in red, (d) the tissue segmentation map: dark gray corresponds to WM, light gray corresponds to GM, and white corresponds to CSF.



(a) **(b)**

Fig. 2: An example of the T2-w hypointensity load matrix for a VOI slice. The T2-w hypointensity matrix for 26 ROI grid cells and 14 HD patients in (a) and controls in (b). In the horizontal direction we have the 26 grid cells, and in depth we have the 14 subjects, one per row. We can clearly observe the larger hypointensity load per cell for HD patients compared to the controls.

Conclusion: We presented a method and a representation for T2-w hypointensity load and T1-w GM (WM) loss. This was implemented on a set of 14 HD patients plus 14 controls. The results indicate clearly that for HD patients there exists an increase in hypointensity load and a GM loss compared to controls.

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[2] A. Ekin, R.S. Jasinschi, A.J. Van Der Grond, M.A. Van Buchem, and A. Van Muiswinkel, ISMRM 2006.

[3] A. Ekin, R.S. Jasinschi, A.J. Van Der Grond, M.A. Van Buchem, and A. Van Muiswinkel, EUSIPCO 2005.