

Spatial distribution of T2 values in the Hippocampus of Alzheimer's Disease and Control subjects

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Introduction

Hypointense regions in T2-weighted images are thought to indicate increased iron storage [1]. Higher field strengths enhance iron-dependant contrast [2] making 3T MRI a useful tool to probe specific regions of the brain seeking to study the spatial distribution of T2 values[3]. The presented study details a method of qualitatively examining the spatial distribution of T2 values in the hippocampal region in an age-matched population of AD and Controls.

| | N | Age(yr) | CDR | MMSE |
|---------|----|---------|-----------|----------|
| AD | 24 | 70±7 | 0.84±0.39 | 22.9±4.2 |
| Control | 20 | 68±8 | 0.02±0.07 | 29.5±1.0 |

Methods

44 age-matched subjects have undergone 3T MRI examinations. All subjects have

Figure 1: Population Statistics

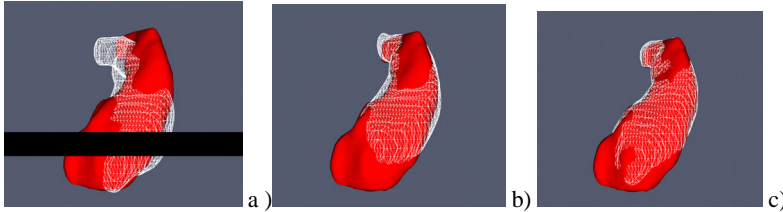


Figure 2: Subject hippocampus (white wireframe) is deformed to the baseline subject hippocampus (red surface). As segmented, the two structures exhibit poor registration a), better after rigid registration in b), and good agreement after the TPS deformation c).

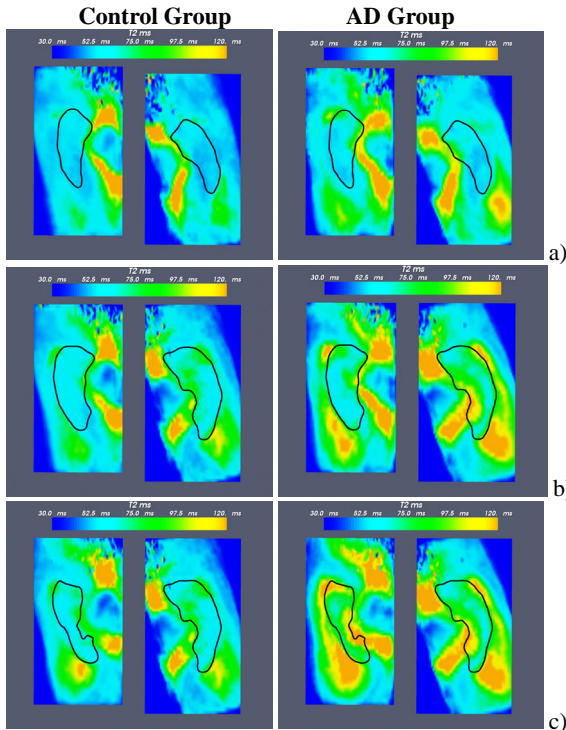


Figure 3: Spatial distribution of T2 values. Three regions of the hippocampus were studied, the subiculum (inferior region a), a middle transverse plane b), and a superior transverse plane c). The Control group is the left column; the AD group is the right column. The color bar ranges from 30ms to 120ms.

3. Alyassin A et al. Brain iron analysis of high field MR images. 11th ISMRM, Toronto, 2003; p 891
4. Grabil et al. Brain Research 971:95 (2003);
5. G McKhann et al. Clinical diagnosis of Alzheimer's disease. NINCDS-ADRDA Workshop. 1984;34:939-944.

consented in accordance with the IRB approved protocol. Dual spin-echo images (TE 18 and 80ms, TR 5s, 20cm FOV, 2mm slice thickness) were acquired using at 3T (General Electric, Waukesha, WI). The subjects are classified as Controls and probable AD patients [4]. Figure 1 shows population demographics. The hippocampus region was hand-segmented for each subject. One subject was randomly chosen as the baseline. For each subject, the hippocampus surface points were identified and rigidly registered to the hippocampus surface points from the baseline subject using the iterative closest point algorithm. After rigid registration, the point correspondences between the subject points and the baseline points are used to define a thin plate spline (TPS). The TPS is a spatial transformation that warps points from the subject reference frame into the baseline reference frame. The transformations are applied to the label map using nearest-neighbor interpolation and to dual echo images using a cubic spline interpolation. Figure 2 illustrates the deformation procedure. The resulting deformed hippocampi have nearly the same shape as the baseline subject and are transformed into a common frame of reference. For each group, an average T2 value was computed for each voxel in the region of the hippocampus.

Results and Discussion

The deformed hippocampus label maps for Control group had 89.0% overlap with the baseline subject's hippocampus label map. The AD group had 82.9% overlap. The spatial distribution of average T2 values for each group is shown in Figure 3. Each image shows the T2 distribution from the same axial slice through left and right hippocampus; the black outline is the intersection with the baseline hippocampus surface. The top of the image is anterior, bottom is posterior, image left and right are patient right and left respectively. Displayed T2 values range from 30ms(blue) to 120ms(red). Three different transverse slices through the hippocampus are shown for the Control (left column) and AD (right column) groups: row a) is through the subiculum or inferior portion, row b) is through the mid-plane, and row c) is through the superior region. The three regions demonstrate the heterogeneous distribution of low- and high-T2 values in the hippocampus. The subiculum region of the AD group has areas of decreased T2. In the other regions, the AD group shows higher T2 values compared to the Control group.

Conclusions

We have presented a method to deform the hippocampus region to calculate average T2 value volumes used to qualitatively compare an age-matched Control and AD group. The average T2 images shows marked increase in high T2 values for the AD group appearing on the peripherals of the hippocampus and distributed similarly to the Control group's image. These regions of high T2 values are thought to indicate increased CSF in more advanced stages of the disease [5]. In the subiculum region, areas of decreased T2 values were observed.

References

1. Drayer B. et al. MRI of brain iron. AJR Am J Roentgenol. 1986;147
2. Schenck JF. MRI of brain iron. J Neurol Sci. 2003;207:99-102