7-Tesla GRE imaging of hippocampal subregion thickness is associated with symptom severity and neurocognitive deficits in Major Depressive Disorder

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Introduction

The hippocampus is involved in memory and emotional regulation, and is made up of subfields with different cytoarchitecture and different cortical and subcortical connections. Hippocampal volume is reduced in patients with Major Depressive Disorder (MDD), particularly in the CA1 subfield. We used 7T MRI gradient-echo imaging to examine the thickness of 2 regions within CA1, the cell-body layer stratum pyramidale (SP) and the synaptic layer stratum radiatum/stratum lacunosum-moleculare (SRLM) in MDD patients, and to test the hypothesis that decreases in these ultra-high field MRI measures of hippocampal thickness would be significantly associated with increases in clinical symptom severity and deficits in memory and attention neurocognitive measures known to involve hippocampal function.

Methods

Sixteen unmedicated MDD patients and 18 matched control subjects were scanned on a whole-body GE 7T scanner (GE Healthcare, Waukesha, WI) equipped with a volume transmit head coil and a 32-channel receive phased array coil (Nova Medical). 2D oblique coronal T2*-weighted gradient-echo images oriented perpendicular to the longitudinal axis of the hippocampus were acquired (20 degree flip angle, TR= 250 msec, TE = 15 msec, 1,024 x 768 matrix, 3 repetitions, 20-cm FOV, 2mm slice thickness). Three linear measurements were made of the thickness of the CA1-SLRM and of the CA1-SP on 2 adjacent slices at the level of the red nucleus on each side of the brain (Figure 1). The average thicknesses of the 6 measures per region were submitted to a general linear model analysis to test for group differences. Depression symptom severity was assessed with the Hamilton Depression Rating Scale (HAMD), and neurocognitive function was assessed with the Stoop, Hopkins Verbal Learning Test (HVLT), Symbol Digit Modality Test (SDMT), Trail-Making B Test, and WAIS digit span. These scores were tested for correlation with the average hippocampal subregion thickness measurements.

Results

There were no significant differences between the MDD and controls groups in hippocampal CA1 subregion thickness for any of the four regions. However, across both groups, there were significant correlations ($p<.05$) between R SRLM thickness and Stroop ($r=-.41$) and SDMT ($r=-.38$) performance, between R SP thickness and HAMD scores ($r=-.55$), and between L SLRM thickness, HAMD scores ($r=.41$) and Stroop performance ($-.41$). (Figure 2) In the MDD group alone, there were additional significant correlation between R SRLM thickness and HVLT ($r=-.60$), Stroop interference ($r=-.68$), and between R SP thickness and Trials B errors($r=.61$).

Discussion

This study identifies associations between the anatomy of specific subregions within the CA1 of the hippocampus and symptom severity as well as neurocognitive performance in Major Depressive Disorder. 7T imaging allows a new degree of specificity in identifying the hippocampal abnormality associated with depression.

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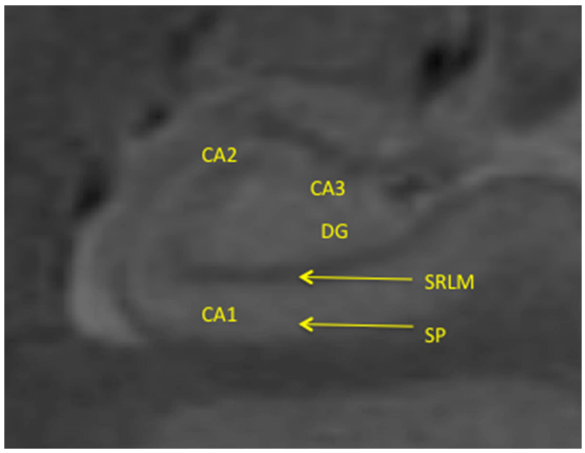

Figure 1. Hippocampal subregions visible with 7T GRE imaging.

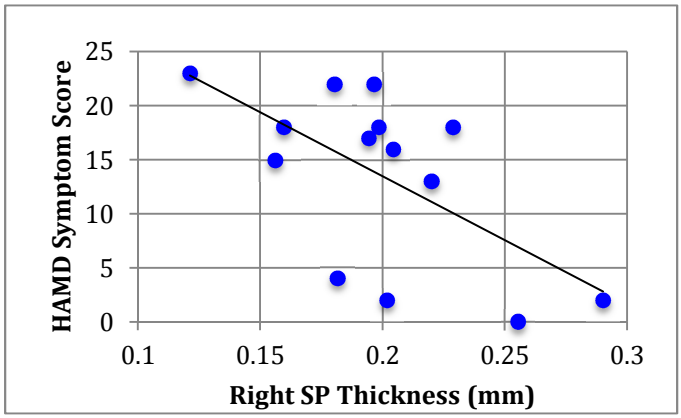

Figure 2. More severe depressions symptoms, indicated by higher Hamilton Depression Rating Scale (HAMD) scores were significantly correlated with Right SP CA1 subregion thickness in patients with Major Depressive Disorder.