

Reduced Volume of Basal Ganglia Nuclei and Thalamus in Major Depressive Disorder

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Experimental Objective -- to investigate volumetric differences in the thalamus and basal ganglia between healthy controls (HC) and patients with major depressive disorder (MDD).

METHODS

Image Acquisition

Two GE scanners were used to acquire whole brain images. (GE Healthcare, Waukesha, WI)

Scanner 1: 3 Long-bore Tesla GE Signa

Tests were done using a 3D, single-channel head coil. A Magnetization Prepared-Rapid Gradient Echo (MP-RAGE) sequence was used (TE = 2.98 ms, TR = 7.5 ms, TI = 725 ms, voxel size = 0.9 × 0.9 × 1.2 mm)

Scanner 2: Short-bore 3 Tesla GE

Tests were done using an 8-channel head coil. An Inversion Recovery-Prepared Fast Spoiled Gradient Recalled Echo (IR-fSPGR) sequence was used (TE = 20 ms, TR = 2000 ms, voxel size = 3.4 × 3.4 × 3.0 mm)

SUBJECTS

Reliability Analysis N = 25

Twenty-five subjects (N=25, 15 female) imaged on both Scanner 1 and Scanner 2 (Nine subjects in the depressed phase of MDD, three in the remitted phase of MDD, and thirteen healthy controls). All subjects aged 18-65 years.

Group Analysis: N = 325

Patient characteristics appear in the table below, all subjects are aged 18-65.

All subjects had been un-medicated for at least 2 weeks prior to the study (4 weeks for fluoxetine).

Healthy subjects had no personal or family history of psychiatric disease.

Subjects with depression met DSM-IV criteria for major depressive disorder, and were in the depressed phase at the time of scanning.

	MDD (females)	HC (females)
Scanner 1	93 (52)	148 (84)
Scanner 2	38 (21)	46 (28)
Total	131 (73)	194 (112)

VOLUMETRIC ANALYSIS

FIRST (FSL toolbox, FMRIB, Oxford, UK) was used to segment sub-cortical regions automatically, including the accumbens, amygdala, caudate, hippocampus, pallidum, putamen and thalamus.

A qualified rater inspected the segmentations, rating each structure individually between 'a' and 'f', with 'a' indicating a difference ≤ 5% and 'f' ≥ 50% between the automatically derived boundary and the structure boundary as observed by the rater. Only segmentations rated 'a' or 'b' were used.

The reliability analysis examined correlations between measurements acquired on the two scanners, while the group analysis compared the volumetric data between the patient groups.

STATISTICAL ANALYSIS

Intra-class correlation coefficients (ICC) and Pearson correlation coefficients were calculated to compare volumes collected on the two scanners. ANOVA was used to compare control and depressed subjects in SPSS (SPSS, Chicago, IL), with scanner used as a covariate. In the group analysis groups were matched for age and gender prior to statistical comparisons for each structure independently, with only segmentations graded 'a' and 'b' used. The separate ratings and group matching produce a different subject size (N) for each structure.

Reliability Analysis

Results for the reliability analysis appear below, for each region, only segmentations graded 'a' or 'b' were included in the analysis, thus N is reported separately for each structure. Correlations between volumes derived from both scanners were high (p < 0.005, r > 0.5) for the right accumbens, and bilateral caudate, pallidum, putamen, and thalamus. Intra-class correlation coefficients were similarly high, with ICC > 0.75 for bilateral caudate, pallidum, putamen, and thalamus.

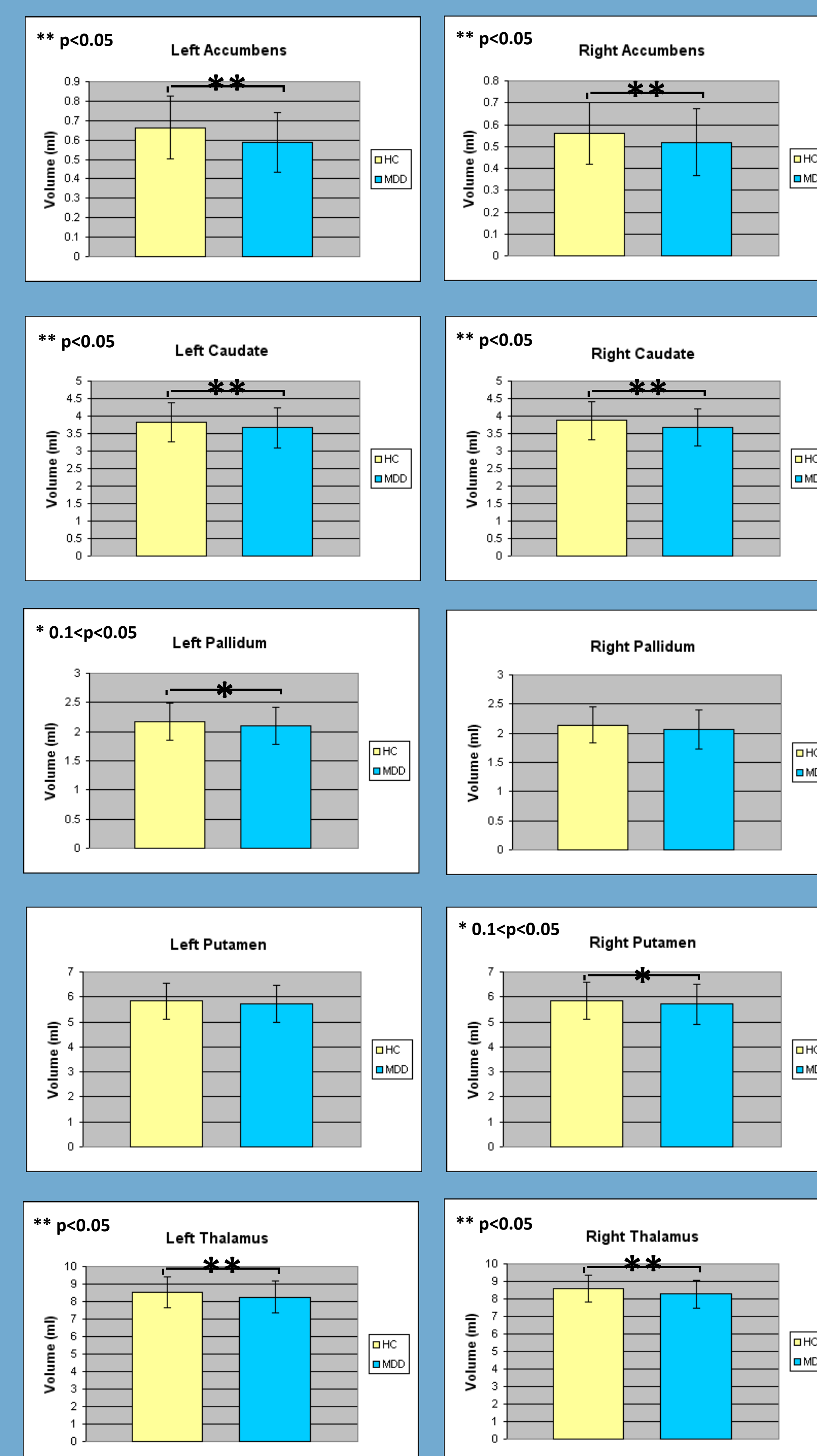
Structure	N	Intraclass	Pearson	p
Left Accumbens	18	0.573	0.402	0.098
Right Accumbens	13	0.510	0.749	0.003
Left Amygdala	10	0.411	0.285	0.424
Right Amygdala	11	0.669	0.524	0.098
Left Caudate	19	0.912	0.864	< 0.000
Right Caudate	16	0.888	0.808	< 0.000
Left Hippocampus	4	0.623	0.460	0.540
Right Hippocampus	3	0.971	0.944	0.215
Left Pallidum	18	0.759	0.642	0.004
Right Pallidum	19	0.872	0.780	< 0.000
Left Putamen	21	0.876	0.804	< 0.000
Right Putamen	21	0.862	0.782	< 0.000
Left Thalamus	20	0.830	0.712	< 0.000
Right Thalamus	19	0.834	0.716	0.001

Group Analysis

Based on the results from the reliability analysis, we chose to examine bilateral accumbens, caudate, pallidum, putamen, and thalamus. Subjects (N=325) were pooled across the two scanners.

RESULTS SIGNIFICANT AT p ≤ 0.05:

Left Accumbens (F = 12.278, 0.001)
 Right Accumbens (F = 4.393, 0.037)
 Left Caudate (F = 7.198, 0.008)
 Right Caudate (F = 8.176, 0.005)
 Left Thalamus (F = 6.467, 0.012)
 Right Thalamus (F = 11.494, 0.001)



CONCLUSIONS

Our findings indicate smaller bilateral accumbens⁵, caudate^{3,4} and thalamus^{1,2} volumes in MDD compared to HC populations. These structures are known to affect mood regulation and reward processing, which are some cognitive and behavioral attributes associated with depression. Our results are consistent with previous MDD findings of functional abnormalities in these regions.

References

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