



Virginia Institute of Neuropsychiatry

Extended Volumetric Analysis based on NeuroQuant® data

Patient:

Location of MRIs:

Date of MRI: 06/06/2013

Date of report:

Region	LH Volume (% of ICV)	%tile rank	RH Volume (% of ICV)	%tile rank	Asymmetry Index %	%tile rank
Whole Brain Parenchyma	32.560%	0.5%*	31.283%	0.0%*	4.001%	100.0%*
Forebrain Parenchyma	27.228%	0.0%*	25.698%	0.0%*	5.783%	100.0%*
Cortical Gray Matter	12.478%	3.5%*	11.554%	0.4%*	7.690%	100.0%*
Cerebral White Matter	12.873%	6.0%	12.372%	1.2%*	3.966%	100.0%*
Lateral Ventricle	1.540%	89.5%	1.655%	94.6%	-7.226%	30.3%
Inferior Lateral Ventricle	0.101%	86.9%	0.144%	99.9%*	-34.536%	4.1%*
Total CSF	1.788%	90.4%	2.005%	95.8%*	-11.409%	28.7%
Caudate	0.253%	47.7%	0.247%	33.4%	2.030%	84.2%
Putamen	0.267%	7.2%	0.220%	0.4%*	19.163%	97.2%*
Pallidum	0.046%	17.1%	0.048%	12.8%	-3.723%	56.0%
Thalamus	0.681%	100.0%	0.628%	99.3%	8.119%	93.9%
Amygdala	0.085%	2.0%*	0.078%	1.8%*	8.816%	79.7%
Hippocampus	0.219%	8.3%	0.226%	9.4%	-3.351%	68.9%
Cerebellum	4.533%	89.7%	4.710%	97.8%	-3.832%	0.6%*
Brain Stem	0.799%	73.1%	0.875%	50.4%	-9.098%	85.0%

	L+R Volume (% of ICV)	%tile rank
Whole Brain Parenchyma (L+R)	63.842%	0.1%*

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Patient information

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Note: LH = left hemisphere. RH = right hemisphere. %tile = normative percentile. AI = Asymmetry Index.

“—” indicates that the data were unreliable due to segmentation error.

“*” indicates a normative percentile which was statistically and clinically significant, defined as any of the following:

- A parenchymal region $\leq 5^{\text{th}}$ normative percentile, consistent with atrophy
- A ventricular region $\geq 95^{\text{th}}$ normative percentile, consistent with atrophy of the surrounding parenchyma
- Asymmetry index $\leq 2.5^{\text{th}}$ or $\geq 97.5^{\text{th}}$ normative percentile, consistent with atrophy of the smaller structure
- Asymmetry index $\leq 5^{\text{th}}$ or $\geq 95^{\text{th}}$ normative percentile for cases in which there were other unilateral, homodirectional signs of head or brain injury, including:
 - scalp contusions or lacerations
 - cranial fractures
 - unilateral brain abnormalities identified by the attending radiologist which are consistent with or associated with parenchymal atrophy
 - a second asymmetry index $\leq 5^{\text{th}}$ or $\geq 95^{\text{th}}$ normative percentile and homodirectional with the first asymmetry index

Inspection for image segmentation quality: NeuroQuant[®] segmented (color-coded) DICOM images were inspected visually by D.E.R. The following segmentation errors were identified:

- None

Otherwise, the regions of interest were found to be accurately identified by the NeuroQuant[®] software.

Summary of positive findings: Abnormal volumes consistent with parenchymal atrophy were found in the following regions:

*The left and right whole brain parenchyma were abnormally small, and the right was abnormally smaller than the left.

*Both forebrain parenchyma regions were abnormally small, and the right was abnormally smaller than the left.

*Both cortical gray matter regions were abnormally small, and the right was abnormally smaller than the left.

*The right cerebral white matter region was abnormally small and abnormally smaller than the left.

*The right inferior lateral ventricle was abnormally large and abnormally larger than the left.

*The right total cerebrospinal fluid volume was abnormally large.

*The right putamen was abnormally small and abnormally smaller than the left.



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*Both amygdala were abnormally small.

*The left cerebellum was abnormally smaller than the right.

Methods for NeuroQuant Extended Analysis

Our methods have been published previously (Ross, Graham et al. 2012). Our normal control group consisted of 20 normal control subjects (10 men, 10 women) who were chosen from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database, as described in our previous publications (Ross, Ochs et al. 2012; Ross, Ochs et al. 2013). The IDs and dates of the MRIs were as follows:

ID	Date of MRI
002_S_1261	02/15/07
002_S_1280	02/13/07
011_S_0016	09/27/05
011_S_0022	10/10/05
020_S_1288	03/13/07
023_S_0058	12/12/05
023_S_0926	10/16/06
036_S_0672	07/21/06
037_S_0327	04/19/06
057_S_0934	10/04/06
067_S_0056	11/09/05
073_S_0089	01/26/06
098_S_0172	02/26/06
099_S_0090	01/11/06
099_S_0534	05/04/06
116_S_1249	03/01/07
128_S_0272	03/22/06
128_S_0522	05/19/06
130_S_0969	10/18/06
133_S_0525	07/10/06

The mean age of the normal controls was 68.3 years (SD 3.6 years; range 60.0-71.5). The standard NeuroQuant[®] analysis was done for each of the normal controls.



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The results were used to determine means and standard deviations for each of the 11 brain regions, left and right sides, and asymmetry indices.

For the extended analysis, the patient's data from the standard analysis were compared to the data from the normal controls in order to calculate normative percentile ranks (see above).

For further information regarding the use of NeuroQuant[®], see "Review of the Evidence Supporting the Medical and Forensic Use of NeuroQuant[®] in Patients with Traumatic Brain Injury" (Ross, Graham et al. 2012).

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References

- Ross, D. E., T. J. Graham and A. L. Ochs (2012). "Review of the Evidence Supporting the Medical and Forensic Use of NeuroQuant® in Patients with Traumatic Brain Injury." Psychological Injury and the Law **5**: 1-6.
- Ross, D. E., A. L. Ochs, J. M. Seabaugh, M. F. DeMark, C. R. Shrader, J. H. Marwitz and M. D. Havranek (2012). "Progressive brain atrophy in patients with chronic neuropsychiatric symptoms after mild traumatic brain injury: A preliminary study." Brain Injury **26**: 1500-1509.
- Ross, D. E., A. L. Ochs, J. M. Seabaugh and C. R. Shrader (2013). "Man vs. Machine: Comparison of Radiologists' Interpretations and NeuroQuant® Volumetric Analyses of Brain MRIs in Patients with Traumatic Brain Injury." Journal of Neuropsychiatry and Clinical Neurosciences **25**: 1-8.