Investigation of the Precision of a Commercial Brain Volume Quantification Software

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INTRODUCTION

Alzheimer's disease (AD) is the most common cause of dementia and is rapidly becoming a global health issue. Brain atrophy rate from serial MRI studies has the potential to become an important biomarker for early diagnosis of AD [1-4]. Recently some FDA approved commercial hardware and software became available to automatically generate the volumetric measurements of various brain structures. It is unclear from the current literature and the vendor publication what the measurement precision is for this methodology. This study is aimed to evaluate the precision of this type of measurement across different types of scanners and over time. The results have shown significant variation that may impact the reliability and suitability of long term monitoring of AD patients.

MATERIALS AND METHODS

The MRI scans have been performed on a single healthy volunteer subject during a span of 3 months using the parameters specified by the NeuroQuant software manufacturer (Cortechs Labs, San Diago, CA). Nine scanners with field strength 1.5T and 3T were used. Typically a sagittal 3D T1-weighted MPRAGE type of sequence is used with the following parameters: 140-180 slices/slab, slice thickness of 1.2 mm, FOV=24 cm, full phase FOV, TR/TE/TI = 6.5-9.1ms/3.8-4.2ms/500-600ms, flip angle 8° (1.5T) / 10° (3T), bandwidth 15.63 kHz (1.5T) / 31.25 kHz (3T), imaging matrix 192^2 (1.5T) / 256^2 (3T), and one excitation (1 NEX). The types of scanners are HDx (2), MR450w (3), MR750 (2), MR750w (1) (GE Healthcare, Waukesha, WI), and Avanto (1) (Siemens Medical Solutions, Malvern, PA). The typical scan time is 8-10 min without parallel imaging (PI), and 5-6 min with parallel imaging. Sometimes scans were repeated on the some scanner to assess the short term repeatibility. The images were examined to be free of artifacts (motion or otherwise) before they were processed with the NeuroQuant platform which generates the volumetric data of various structures. A typical report contains the results for both left and right hemispheres. During the analysis the results from both sides are combined to reduce the complication from left-right segmentation inconsistency. These measurements were normalized to the nominal average values and the relative deviations were recorded and analyzed. With the short time interval between these scans, the variation due to the subject change and the MRI scanner hardware calibration drift is minimized.

RESULTS and DISCUSSION

The typical variation of measured Hippocampus volume is shown in figure 1. The standard deviation of the variation for all structures is listed in the table below. The structures that have smaller sizes, such as Inferior Lateral Ventricle and Pallidum, tend to have larger variations. The results here are from acquisitions without PI, though scans with ASSET factors of 1.75-2 do not seem to increase the variation significantly.

Structure	STD DEV	Max Variation
Forebrain Parenchyma	2.3%	7.2%
Cortical Gray Matter	2.2%	6.8%
Lateral Ventricle	1.7%	6.0%
Inferior Lateral Ventricle	9.1%	29.2%
Hippocampus	4.9%	13.1%
Amygdala	3.4%	14.7%
Caudate	6.6%	20.4%
Putamen	5.2%	16.9%
Pallidum	9.9%	32.7%
Thalamus	3.5%	13.0%
Cerebellum	2.6%	7.4%

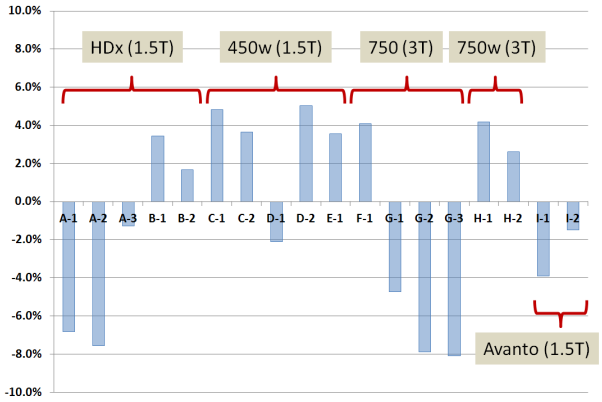

Fig 1 *Typical variation of Hippocampus volume measurements. The letters denote different scanners and the numbers denote single or multiple measurements. Types of machines are grouped and labeled accordingly. Parallel imaging was not used in these measurements*

CONCLUSIONS

We have observed significant variations of same scanner and across scanners. More studies are needed to understand these variations and it is critical to take this into account in routine clinical diagnosis for long term monitoring.

REFERENCES

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