



Brain Volume Evaluation and Lobar Segmentation for Pre-Clinical Cognitive Decline and Dementia

-Dr Shilpa Sankhe

The onset of dementia is insidious and gradual. It may take up to 3 years between the onset of symptoms of mild cognitive impairment, and the formal diagnosis of dementia. The presence of intellectual reserve in educated and intelligent professionals leads to still further delay in diagnosis. There is a definite need for an accurate, reliable and reproducible test that will provide an objective rather than subjective assessment of dementia.

Neural imaging by MRI is a powerful robust test for evaluation of the brain. Objective volumetric assessment of the cerebral cortex and hippocampal volumetry by computer aided diagnosis is especially valuable in the longitudinal interpretation of neuroparenchymal loss. Automated MRI brain segmentation software estimates whole brain, grey matter, cortical lobar and hippocampal volumes, as well as percentage volume change between two time points.

This volumetric assessment is colour coded, thereby providing lucid visual representation and quick interpretation

as well as visual assessment. Cortical grey matter is marked green in the frontal, blue in the parietal and red in the temporal lobe, while the hippocampi are coloured orange (Fig. 1).

These volumes are corrected for head size. The normal range and normative percentiles (based on Indian population) serve as a reference based on healthy controls and are used to classify subjects as follows;

1. Atrophy rate in line with normal atrophy rate*
2. Atrophy saturation of brain structure
3. Atrophy rate exceeding normal atrophy rate*

*based on age-and gender matched normative population

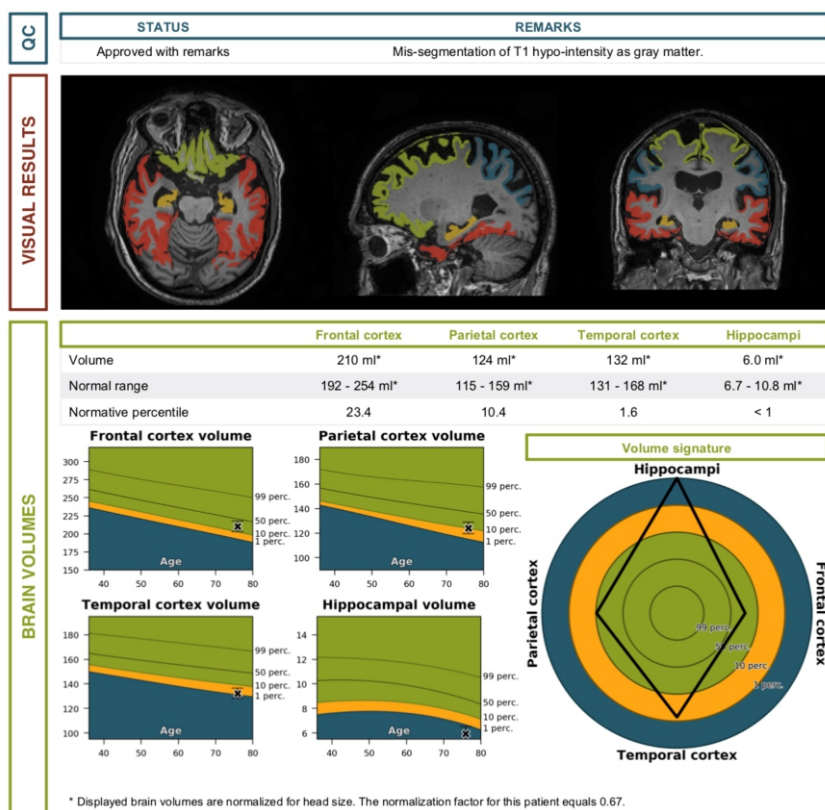


Fig. 1: Alzheimer's disease. Brain volumetry report of a 65-years old patient with suspected mild cognitive impairment (MCI) / Alzheimer's disease (AD). It shows generalised cortical atrophy with selective temporoparietal distribution. Note that hippocampi are maximally involved while the frontal lobe is least atrophied. The top figure gives visual representation while the bottom figure gives percentile volumes with normal age matched controls. This gives a clear diagnosis of AD.



At a glance:

- The brain volume signature may assist detecting deviations from normal, thus separating disease from normal brain aging.
- The substructure volumetry on a bull's-eye allows lucid depiction of changes and has demonstrated high accuracy as well as reproducibility.

- It also provides longitudinal assessment of lobar atrophy
- Thus, the gradual slope from normal healthy aging to mild cognitive impairment and dementia, whether Alzheimer's disease, frontotemporal or vascular dementia, can be assessed and a diagnosis made possible with higher accuracy, in an appropriate clinical setting.

The findings are depicted on a bull's-eye diagram which is called the Volume Signature. Dual time point studies are depicted on the same image (Fig. 2), providing ready assessment of volume loss and progression of the degeneration, or its stability. When no further loss of volume is identified, it is called atrophy saturation of that part.

In addition, the same volumetric assessment is used to quantify FLAIR white matter hyperintensities if vascular dementia is being considered and monitored.

Annualized volume change describes the percentage of brain volume change per year compared to the previous scan. The normal annualized volume change represents the average expected annual volume change for a healthy age- and gender-matched person (Fig. 2). Any change in excess of normal places a subject at greater and faster risk of progress to dementia.

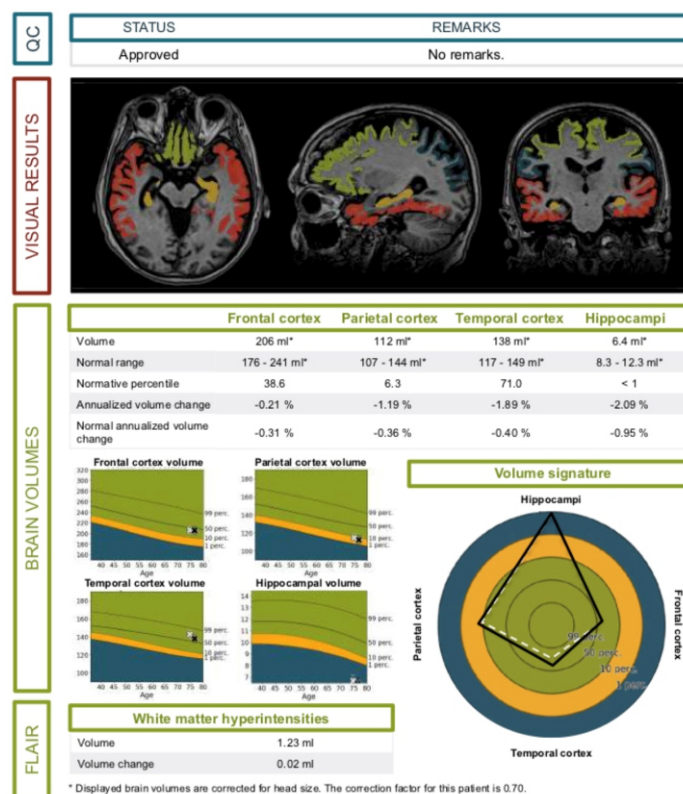


Fig. 2 (courtesy Icometrix): Mild cognitive impairment (MCI). Follow up brain volume and white matter lesions in a case of MCI showing progressive atrophy of temporal lobe, while the rest of the lobar volumes are more or less unaffected. Dotted white line shows previous volumes, while the black outline provides current volumes, thereby providing a "Volume signature". White matter hyperintensity (WMH) has progressed as expected for age.

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