

MRI Volumetry: What We Should Know?

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The present issue of JIMSA, contains two articles on a neglected, yet important aspect of MRI, that of volumetric studies of the human brain. The first is by Goel et al [1] on “Morphometric evaluation of brain in Parkinsonian diseases on 1.5 Tesla magnetic resonance imaging” and the other is “Quantification of hippocampal volume by MRI among patients of Temporal lobe epilepsy: A comparative study on adult Kashmiri population” by Bashir et al. [2]

MRI is now the standard imaging technique for all neurological disease. Disease assessment is mainly subjective or visual. Subtle changes in small structures like hippocampus or Amygdala may not be appreciated just by the human eye. Volumetry of the brain can be used to understand the nature and evolution of many diseases and allows objective assessment. The amount of White matter, Gray matter and CSF can be a biomarker for quantitative brain analysis.

The question is how to measure a particular part like hippocampus or pons on MRI. Manual segmentation techniques, are time consuming, tedious and produce inconsistent results. These limit use in daily clinical practise. However, with the advent of automated software and increasing use of Artificial intelligence algorithms, MR volumetry is increasingly being used to assess brain volumes in a range of clinical settings.

A significant amount of work is being done using MRI Volumetry to understand mechanism and tracking clinical progression of disease in conditions like Alzheimer’s, Multiple sclerosis, Epilepsy, Parkinsonian disease etc [3,4].

Differentiating various forms of Parkinson’s disease can be difficult in early stages both clinically and radiologically. Initial imaging findings are subtle and only potentially seen on MRI. With advanced disease, non-specific generalized minor cerebral volume loss can be demonstrated. Several studies have demonstrated that Multi system atrophy (MSA) is associated with a relatively greater pontine and Middle Cerebellar peduncle atrophy compared to that in PSP (progressive supranuclear palsy) and PD (Parkinson disease), whereas patients with PSP have a relatively greater midbrain and Superior cerebellar peduncle atrophy compared to MSA

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and PD. As single measurements of these structures have been shown not to adequately distinguish between neurodegenerative parkinsonian disorders, especially MSA and PSP, the ratio between midbrain/pons-ratio was found to be significantly smaller in patients with PSP compared to other groups and to differentiate better than the single measurement [5].

Patients of TLE often become refractory to medical treatment and are candidates for surgery and this makes radiological concordance and lateralisation essential. MRI is the modality of choice to evaluate the hippocampus in patients with Temporal lobe epilepsy (TLE). It requires a dedicated TLE protocol. Coronal volume and FLAIR sequences obtained perpendicular to the body of the hippocampus are the mainstay. This epilepsy protocol is now standard in evaluation of intractable epilepsy by MRI.

Hippocampal Volume loss and atrophy along with increase in T2 signal are the main diagnostic features on MRI. In patients, where there is bilateral disease, visual assessment of volume loss may not be feasible. 3D volumetric studies are more sensitive to subtle volume loss. The MRI negative TLE is a subset of patients where there is TLE without an epileptogenic lesion on visual inspection of MRI. This subset is shrinking with onset of higher strength magnets, 3 Tesla and now 7 Tesla systems [6-8].

Quantifying Hippocampal atrophy through MRI is important for lateralisation of focus and to select patients for any

presurgical invasive tests, if required. Automated volumetry has demonstrated atrophy in cases with visually normal MRI. There are several studies that validate the utility of hippocampal volumetry in temporal epilepsy, based on post operative correlate or ex vivo studies. Hippocampal asymmetries have discriminated patients with TLE from control subjects with high sensitivity (86.7 %-89.5%) and high specificity (92.2%-94.1%) [9].

MRI diffusion, spectroscopy and Perfusion MR, T2 Relaxometry are all being used in evaluation of patients with TLE prior to operative intervention, SPECT (Tc 99m HMPAO) and FDG PET are useful tools with abnormalities seen on both ictal and interictal scans.

There are considerable differences in hippocampal volumes in different populations [10], a fact that has been highlighted in the present study.

Both studies have used 1.5 Tesla MRI Systems. 3 Tesla systems are now the benchmark for evaluation of neurological disease specially for intractable epilepsy and complex movement disorders. Both studies have used manual methods for analysis, automatic techniques are now in focus and the only way forward if volumetry has to be included in clinical imaging. Both articles add to our awareness of what is possible on MRI. In patients with intractable epilepsy, MR Volumetry using automated techniques should be part of standard evaluation. Use of volumetry in clinical diagnosis and management of parkinsonian disorders remains to be validated.

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