

Intercentre differences in multicentre brain MTR histogram studies can almost be eliminated by using body coil transmission

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Aims: 1. Define the factors that must be understood and controlled to eliminate intercentre differences in brain MTR histograms.

2. Test the hypothesis that matching MT pulses and using body-coil transmission will achieve this.

Introduction: In the brain, MTR values and histograms have been successful in characterizing widespread subtle changes caused by diffuse disease. Intercentre differences in MTR value have been analysed¹, as part of collaborations within the European Union, with the aim of carrying out multi-centre studies. Normal white matter values have a narrow range². The standardised EuroMT pulse has reduced intercentre differences³. An approximate correction for B₁ nonuniformity (NU) further reduces these^{4,5}. Factors affecting histogram generation⁶ are less well known. In a previous study⁷ histograms from 2 different manufacturers were very different, probably due to the differing coil configurations. Our earlier comparisons of birdcage head-coil vs body-coil showed a consistently higher peak height (PH) for the body-coil, implying superior B₁ uniformity. Here we summarise all MTR histogram factors. We hypothesise that the remaining uncontrolled factor, B₁ NU, could be controlled (without postprocessing) by using body-coil transmission (excitation); this is the default with a multi-array receive coil. This is intrinsically more uniform than a head-coil. Any remaining NU is caused by the subject (dielectric resonance and skin effect), not the transmission coil, and is not centre-dependent, although it does increase with B₀.

Six factors that must be controlled in a multicentre MTR histogram study:

1. Transmitter coil (body or head)
2. Imager stability and setup procedure
3. MT pulse (shape, duration, offset, FA)
4. MT pulse sequence (TR', TR, imaging FA, voxel dimensions)
5. Image registration and segmentation
6. Histogram generation (bin width and labelling, normalisation)

Methods: At 1.5T, an existing manufacturer's 3D MTR sequence was available at centre B, with TR=106ms, imaging FA=12°. The MTR pulse was a 5-lobed sinc, FA=620°, duration= 15 ms, gaussian apodisation (sd=0.5*pulse width), offset=1100 hz. Body-coil excitation was used, with a quadrature receive coil. The sequence was replicated with a different manufacturer at centre A, using a modified in-house sequence, and an 8-channel receive-only coil. Five different normal subjects were imaged at each centre. Whole brains were extracted from the skull, retaining CSF. Histograms from centre B had bins 1pu (pu=percent unit) wide, centrally labelled. Histograms from centre A were 0.1 pu wide. Histograms were fully normalised⁶ to take account of this. Peak location (PL) and peak height (PH) were measured.

Results: Group histograms from the 2 centres were very close (fig 1). Centre mean values of PL differed by only 1.3 pu (A: 34.7pu; B:36.0pu; p<0.01; fig 2), probably due to differences in auto-prescan procedure. PH showed no significant intercentre difference (p=0.32). At centre A, a single histogram from a birdcage coil was outside the range for body-coil histograms. The birdcage head-coil is relatively uniform, and we have observed much lower PH values for another head-coil design.

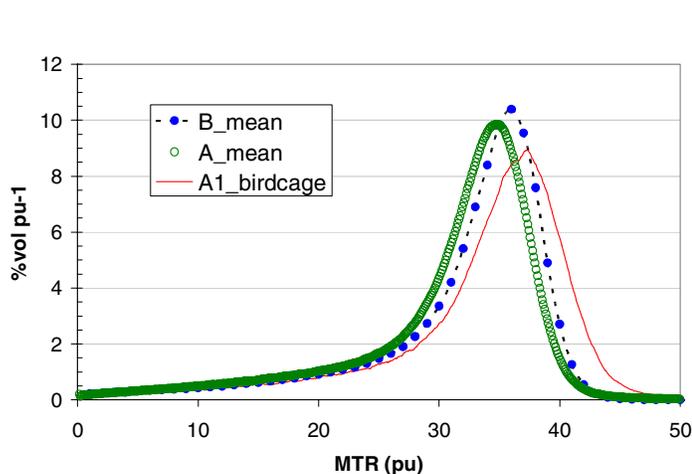


Fig 1: body-coil group histograms and single birdcage histogram

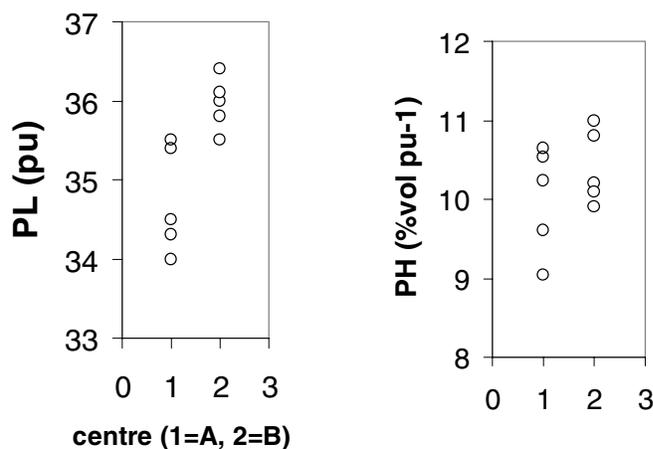


Fig 2: scatter plots of PL and PH

Conclusion: By controlling the MT pulse, the sequence, and the histogram generation, and by using body-coil excitation, inter-centre differences in MTR histograms can be almost eliminated. The small remaining difference could be incorporated as a site-effect in the statistical analysis.

References:

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