Quantifying White Matter Lesions in Multiple Sclerosis: A Multiple Technique Comparison

J. Thorpe [1], S.E Hobbs[2] , E. Gordon[3] , P. Tran[3] , N. Evangelou[2] , P.S Morgan[2]

1. Nottingham University Hospitals NHS Trust, Medical Physics, Nottingham, United Kingdom
2. University of Nottingham, School of Medicine, Nottingham, United Kingdom
3. Qynapse, Paris, France

Scan for presentation

Introduction

Measurement of total white matter (WM) lesion volume is important for the treatment and diagnosis of multiple sclerosis (MS). Manual delineation is time consuming and susceptible to operator dependant variability. Semi and fully automated methods have been developed and widely used in research, but direct comparisons are limited.

Aims

To quantify variability across WM lesion volumes from two semi-automated software packages JIM 7.0 (Xinapse Systems, Northants, UK) and 3D Slicer, wuith one fully-automated FDA-cleared and CE-marked method QyScore®

Method

Total lesion volume was calculated for 44 MS research patients (mean age=53 (range 36-65), 16M/28F, 16 Primary Progressive/ 28 Secondary Progressive) using JIM, 3D Slicer, and QyScore®

Comparisons between software were performed by calculating linear regression and using the Bland-Altman method.

Visual assessment of the results from a subset of the cases was conducted by experienced image analysts to identify sources of discrepancy with neuroradiologist review pending.

Results & Discussion

Mean (std) lesion volumes were 11.38 (8.00), 18.39 (12.65), and 26.38 (18.06) ml for 3D Slicer, QyScore® and JIM respectively. Average user-input time (minutes) was <2 for QyScore® and >30 for both JIM and 3D Slicer.

JIM & QyScore®

Bland-Altman analysis showed a percentage bias of +38% (167% CI) between JIM and QyScore®. Visual assessment suggests this is largely driven by erroneous grey matter inclusion using JIM. In the most discrepant cases QyScore® produced the most representative WM segmentations. An additional consideration with semi-automated software is user dependency.

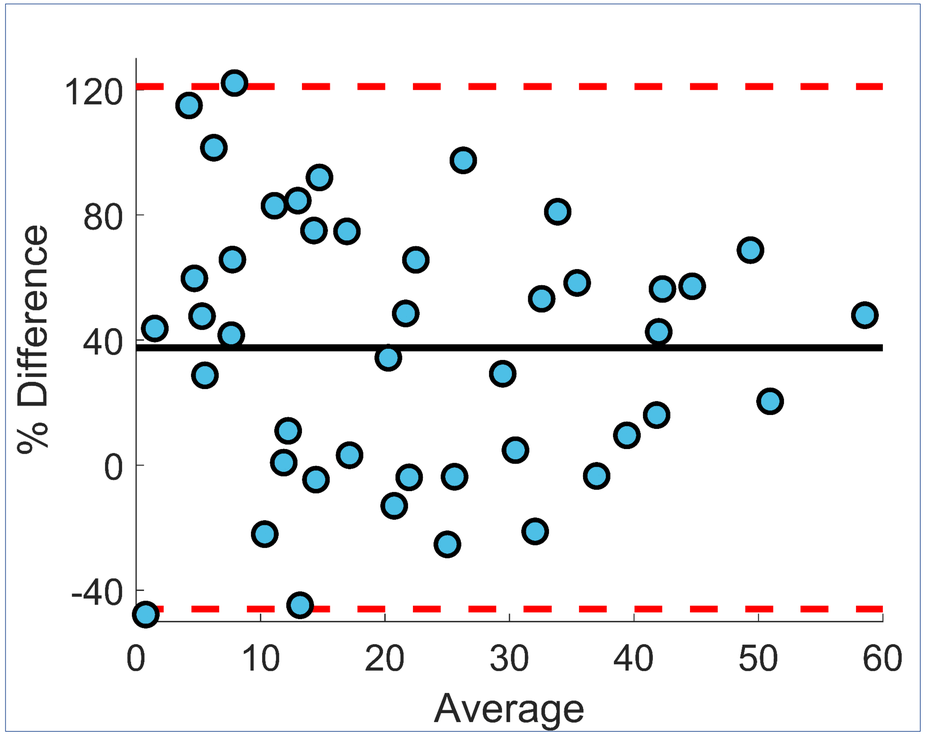

Figure 1. Bland-Altman Plot for JIM – QyScore® with a percentage bias of 38% and a confidence interval of 167%.

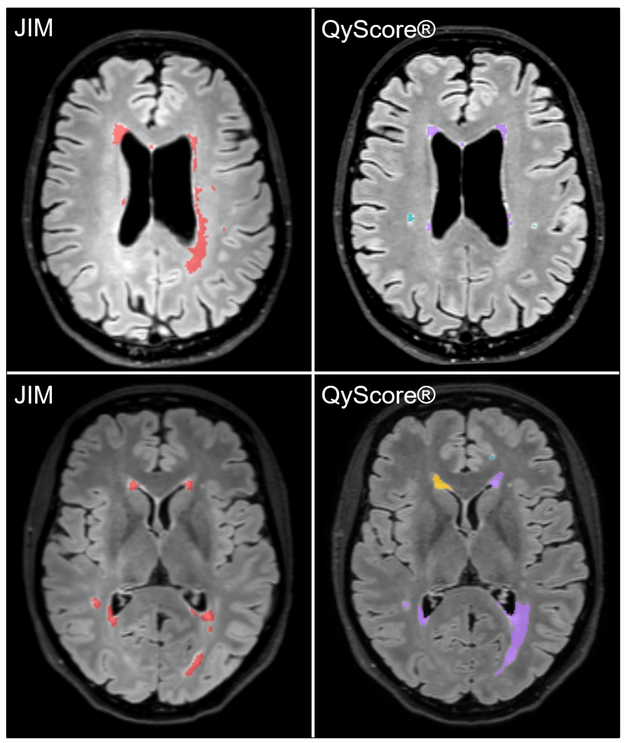

Figure 2. Comparison between MS lesions in T2W FLAIR by JIM and QyScore®

3D Slicer & JIM/QyScore®

Correlation coefficients were calculated with greater similarity found between 3D Slicer and QyScore® in determining relative lesion volume compared to JIM.

Bland-Altman analysis indicated significant discrepancy between all three methods with the difference between regression and bias results highlighting the challenges in delineating WM lesions across a typical pathological range.

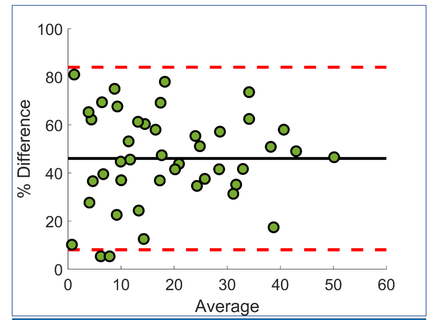

Figure 3. Bland-Altman Plot for QyScore® - 3D Slicer with a percentage bias of 46% and a confidence interval of 78%.

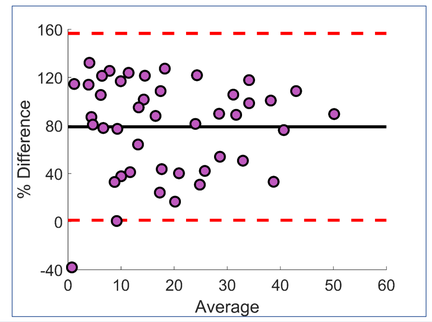

Figure 4. Bland-Altman plot for JIM - 3D Slicer with a percentage bias of 79% and a confidence interval of 155%.

Conclusions: The method used for quantification of WM lesions significantly impacts lesion volumes and should remain consistent longitudinally. Ongoing work to better characterise this variability is important to give precision and efficacy in MS clinical decision-making. Metrics evaluated by QyScore® are fast, accurate and reproducible, whilst the semi-automated methods required considerably more user input, particularly for more severe cases, also resulting in the greater potential for inter-rater variability and operator error.