AUTOMATED MRI LESION ANALYSIS AND REPORTING AS A COMPUTER-ASSISTED RADIOLOGY TOOL FOR DETERMINATION OF MCDONALD CRITERIA

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BACKGROUND

- Dissemination in **space** (DIS) and **time** (DIT) are core components of the **2017 revised McDonald criteria**, the current diagnostic standard of Multiple Sclerosis
- **Regulatory-approved automated methods** to quantify, count and localize the lesions could **reduce the time** and cost of radiological review, performed visually by trained neuroradiologists and decrease the variability in MRI lesion quantification in clinical practice

OBJECTIVES

To demonstrate:

1. Reliable **white matter lesion quantification**, in comparison with manual tracing and **six other state-of-the-art** automated methods, of an automated 3D T2-FLAIR segmentation method (WHASA-3D) [1]
2. How **QyScore® automated reports** can inform the DIS and DIT radiological components of the 2017 revised McDonald criteria

MATERIALS & METHODS

IMAGING DATA

Database	MRI sequences Scanner (n)	Clinical status	Age (mean +/- SD)	Sex proportion (F : M)	Manual segmentation
LITMS [2]	2D-T1, 3D-FLAIR Siemens TrioTim 3T (30)	24 RRMS, 2 SPMS, 1 PPMS, 2 CIS, 1 unspecified	39 +/- 10	23 : 7	**3** experts to form consensus
MICCAI 2016 [3]	3D-T1, 3D-FLAIR Siemens Verio 3T (5)	MS	35 +/- 10	1 : 4	**7** experts to form consensus
	3D-T1, 3D-FLAIR Philips Ingenia 3T (5)		46 +/- 9	4 : 1	

1 – WHASA-3D METHOD & PERFORMANCE ASSESSMENT

- **WHASA-3D** is based on non-linear diffusion filtering and watershed segmentation to increase contrast between white matter hyperintensities (WMH) and surrounding tissues, followed by a subject-specific selection based on intensity and location characteristics
- This algorithm is included in **QyScore®**, an FDA-cleared and CE-marked computer-assisted radiology software that provides a fully automated volumetric measurement of brain structures and WMH quantification
- Performance was assessed in comparison with consensus and with **six other state-of-the-art** automated WMH segmentation methods: LST-LGA [4], LST-LPA [5], Lesion-TOADS [6], lesionBrain [7], BIANCA [8] and nicMSlesions [9] with **Absolute Volume Error** (AVE in mL) and **Dice** score on the LITMS dataset
- WMH segmented **volumes** and **Relative Volume Error** from WHASA-3D were also computed for each expert and consensus from the MICCAI2016 dataset to assess the inter-rater variability

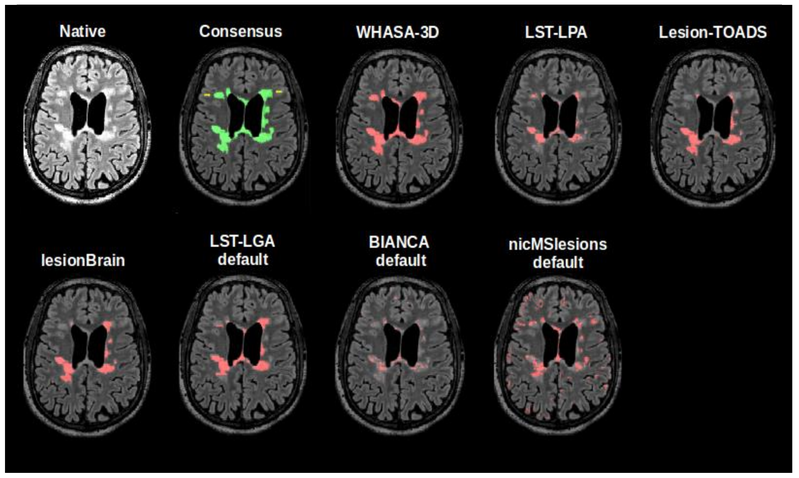
2 - QYSCORE® MS REPORT

- **Volumetric** measures of the brain and substructures in comparison to a large normative database of cognitively healthy individuals
- **Spatial localization** of WMH (periventricular, juxtacortical, infratentorial and deep white matter lesions)
- Visualization of **WMH longitudinal** changes (increased, decreased or static)

RESULTS

1 – WHASA-3D RESULTS

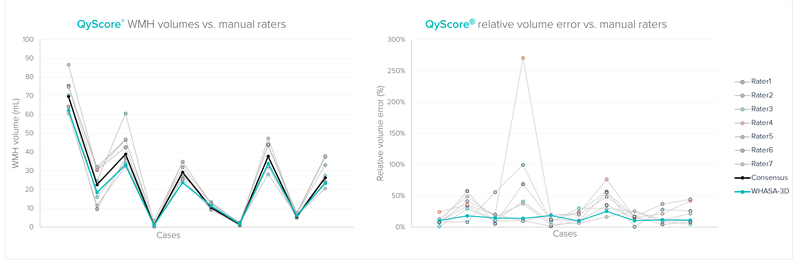
The Figure shows an example MS 3D T2-FLAIR image and superposed segmentations from the consensus reference (LITMS data), WHASA-3D and the six comparator state-of-the-art methods with their default settings. Yellow arrows shows areas of WMH that are correctly detected by WHASA-3D but either missed or underestimated by other methods.



The table shows Dice scores (spatial overlap) and AVE in the comparison among WHASA-3D and all the other methods with default parameters [1] **p-value < 0.001 Wilcoxon tests

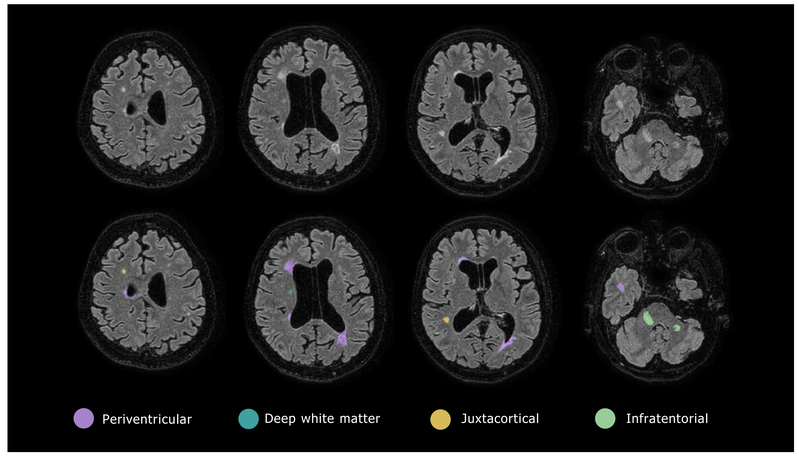
Median	QyScore® WHASA-3D	LST-LGA	LST-LPA	lesionBrain	Lesion-TOADS	BIANCA	nicMSlesions
Dice	0.66	0.41**	0.49**	0.45**	0.43**	0.24**	0.19**
AVE (mL)	1.9	7.9**	7.9**	7.0**	4.3**	11.4**	17.5**

The Figure below displays the **Inter-rater variability reduction** with WHASA-3D relative to human raters. This study was performed on 10 cases from the MICCAI2016 dataset. Individual manual segmentation from 7 experts and combined consensus were used as comparison. The WHASA-3D segmentation is less variable than human raters across raters and cases.

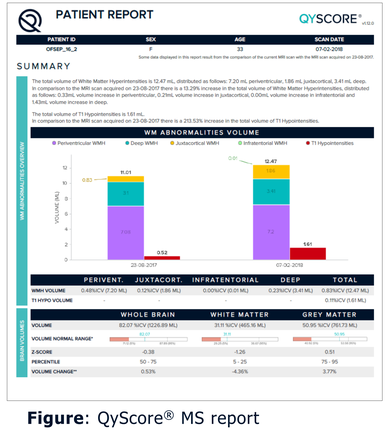


2 – QYSCORE® MS REPORT

- Automated segmentation of WMH according to their spatial **localization**



- Visualization of WMH **longitudinal changes**



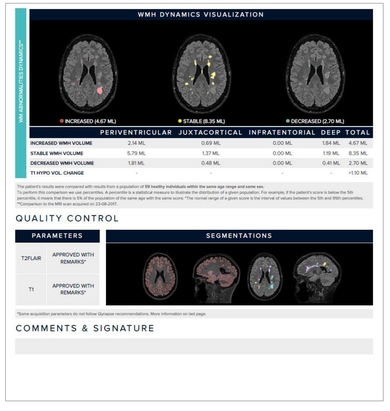


Figure: QyScore® MS report

CONCLUSION

- The availability of **reliable**, **automated** algorithms and **reporting tools** for the assessment of DIS and DIT could facilitate and increase confidence in the diagnosis and monitoring of MS patients' status and evolution
- Future work will assess the utility of these tools in clinical practice

[1] Tran, P. et al. (2022)
[2] Lesjak, Ž. et al. (2018)
[3] Commowick, O. et al. (2021)
[4] Schmidt, P. et al. (2012)
[5] Schmidt, P. (2017)
[6] Shiee, N. et al. (2010)
[7] Coupé, P. et al. (2018)
[8] Griffanti, L. et al. (2016)
[9] Valverde, S. et al. (2019)