Development and external validation of automatic diagnostic aid for multiple sclerosis using a radiomics analysis of white matter on clinical and quantitative MRI

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Conflict of interest disclosure

Elizaveta Lavrova: *nothing to disclose*
Dr. Henry Christian Woodruff: Shareholder: Oncoradiomics
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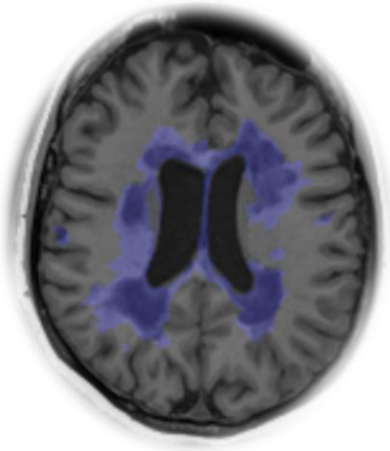
Introduction



Background

Brain lesion load is related to multiple sclerosis development in patients with clinically isolated syndrome

Unmet clinical need

Rapid automatic check for white matter abnormalities

MRI advantage

Has an appropriate contrast (compared to CT)

MRI disadvantage

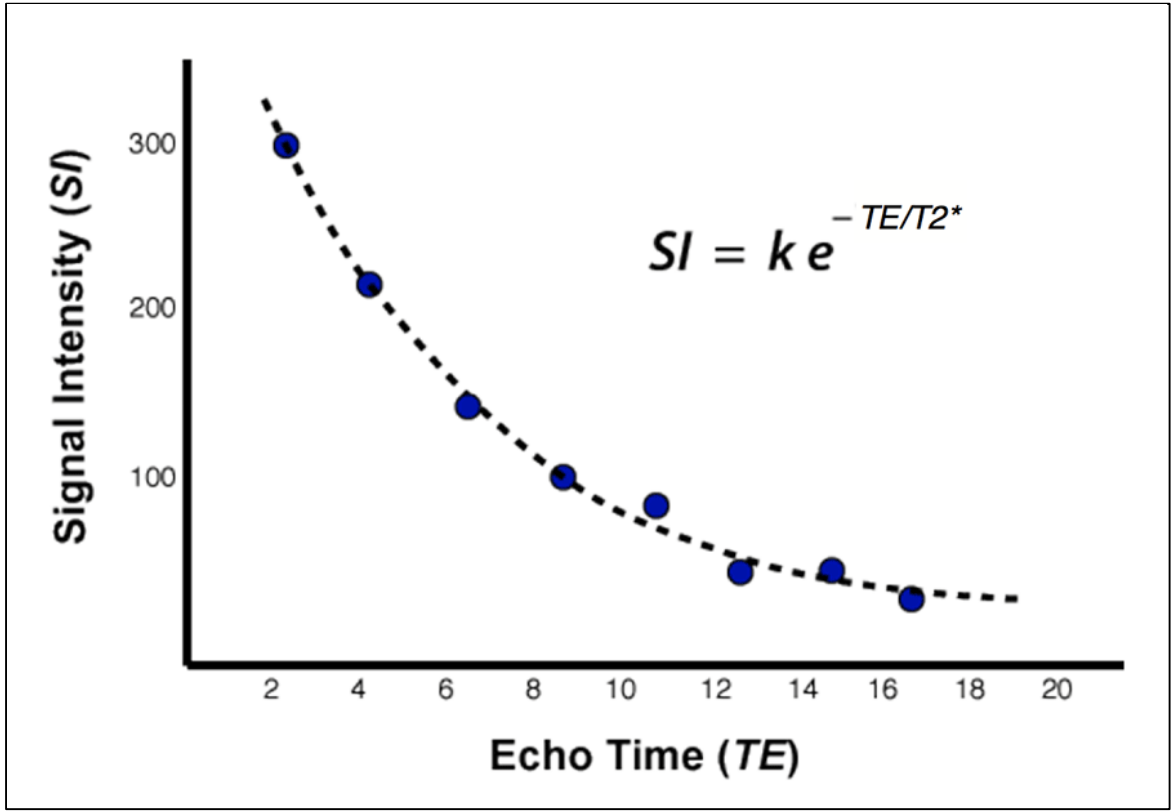
Is expressed in arbitrary units (not robust/stable/reproducible)

Hypothesis

MRI-based WM radiomics features are able to distinguish between healthy and MS-affected brain

Introduction

qMRI



Tabelow K., et al. (2019). hMRI – A toolbox for quantitative MRI in neuroscience and clinical research. Neuroimage, 194(2019), 191-210.

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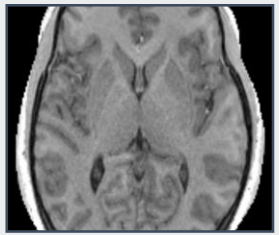
THE D LAB
Decision Support For Precision Medicine

Materials and methods

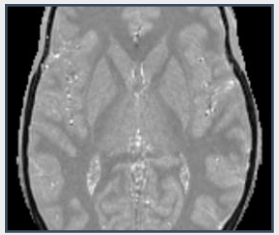
MS qMRI dataset

CHU Liege, Belgium
3T MRI (1×1×1 mm^3)
Siemens Prisma & Allegra
36 non-MS, 35 MS (relapsing-remitting & progressive)
45.7 ± 11.9 y.o., M/F = 0.73



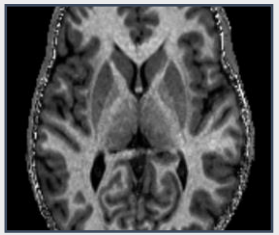
T1w

Visual contrast



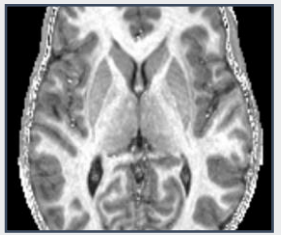
Proton density (PD)

Free water



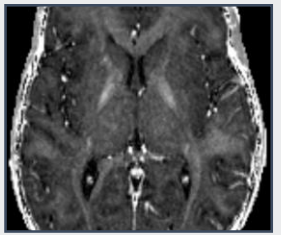
Magnetization transfer (MT)

Axonal myelination



Inversed T1 (R1)

Axonal myelination



Inversed T2 (R2*)

Iron accumulation

qMRI maps

Lommers, et al. (2019). Multiparameter MRI quantification of microstructural tissue alterations in multiple sclerosis. NeuroImage: Clinical, 101879.

Materials and methods

Data for external validation

	CC-359	MICCAI 2016 MSSEG Challenge
Subjects	167 non-MS	10 MS
Sites	Campinas (Sao Paulo, Brazil); Calgary (Alberta, Canada)	CHU Rennes (Rennes, France); CHU Lyon (Lyon, France)
Equipment	1.5 T and 3 T Siemens (53), Philips (54), GE Healthcare (60) MRI scanners	3 T Siemens Magnetom Verio (5); 3 T Philips Ingenia (5)
Voxel resolution [mm^3]	1×1×1	1×1×1 (Siemens) 0.74×0.74×0.85 (Philips)
Age, mean ± STD	52.7 ± 7.3	40.5 ± 10.8
Gender, M/F	0.96	1.00

Souza, et al. (2018). An open, multi-vendor, multi-field-strength brain MR dataset and analysis of publicly available skull stripping methods agreement. NeuroImage, 170, 482-494

Commowick, et al. (2018). Objective evaluation of multiple sclerosis lesion segmentation using a data management and processing infrastructure. Scientific reports, 8(1), 13650

Materials and methods

Radiomics pipeline

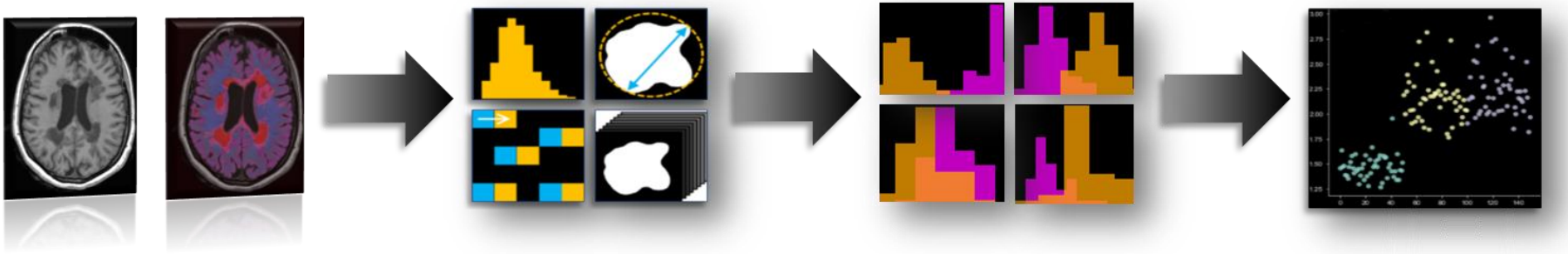
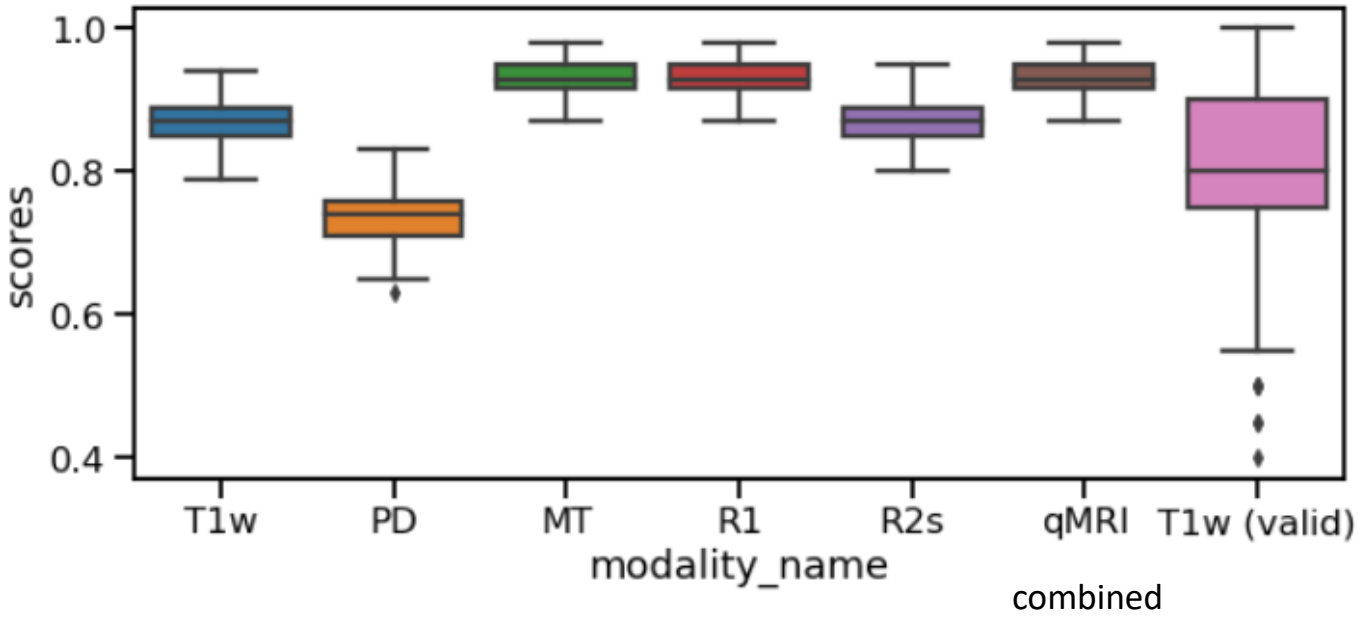


Image pre-processing and segmentation	Features extraction from WM	Features selection	Machine learning classification
Unified segmentation (SPM12)	92 features/ROI (pyradiomics)	Recursive features elimination 6 features/ROI	Logistic regression

Results

Binary classification accuracy scores



combined features = (PD + MT + R1 + R2*) features

Conclusion

Limitations

- For interpretation and generalization of results, more data is needed!
- External validation for qMRI is needed → (+ longitudinal) data is needed

Conclusion

- Utility of Radiomics/qMRI approaches in automatic MS diagnosis is indicated
- White matter MRI-based features: future potential in early MS prognosis

Ethics committee approval / Funding

Ethics committee approval

The study was approved by the local ethic committee (approval B707201213806).
Written informed consent was obtained from all participants.

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