

# T2 WM HYPERINTENSITY MAPPING AND QUANTIFICATION WITH FSL

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## Purpose

T2 White Matter Hyperintensities (WMH):

- Are a defining feature of Multiple Sclerosis
- Are also important in other areas such as Traumatic Brain Injury (TBI) and normal aging
- WMH volumes (or T2 Lesion Volumes; T2LV) are an important biomarker for summative effect on disability
- Improvements in acquisition (e.g. high resolution 3D T2 FLAIR) have improved detection
- And many methods developed for segmentation/volumetrics

Current segmentation methods often:

- Require time-consuming human intervention
- Are proprietary
- Require multiple images

We aim to develop a segmentation method that:

- Is fully automated
- Is freely available
- Requires only a single image

## Acquisition

- Siemens Trio 3T MR scanner
- 12 channel head coil
- FLAIR T2-weighted 3D TSE with variable flip angle
- 1mm isotropic resolution
- Saggital prescription
- 7 minute scan time
- TI=2.2s, TE/TR=388ms/6s, GRAPPA=2

## Segmentation

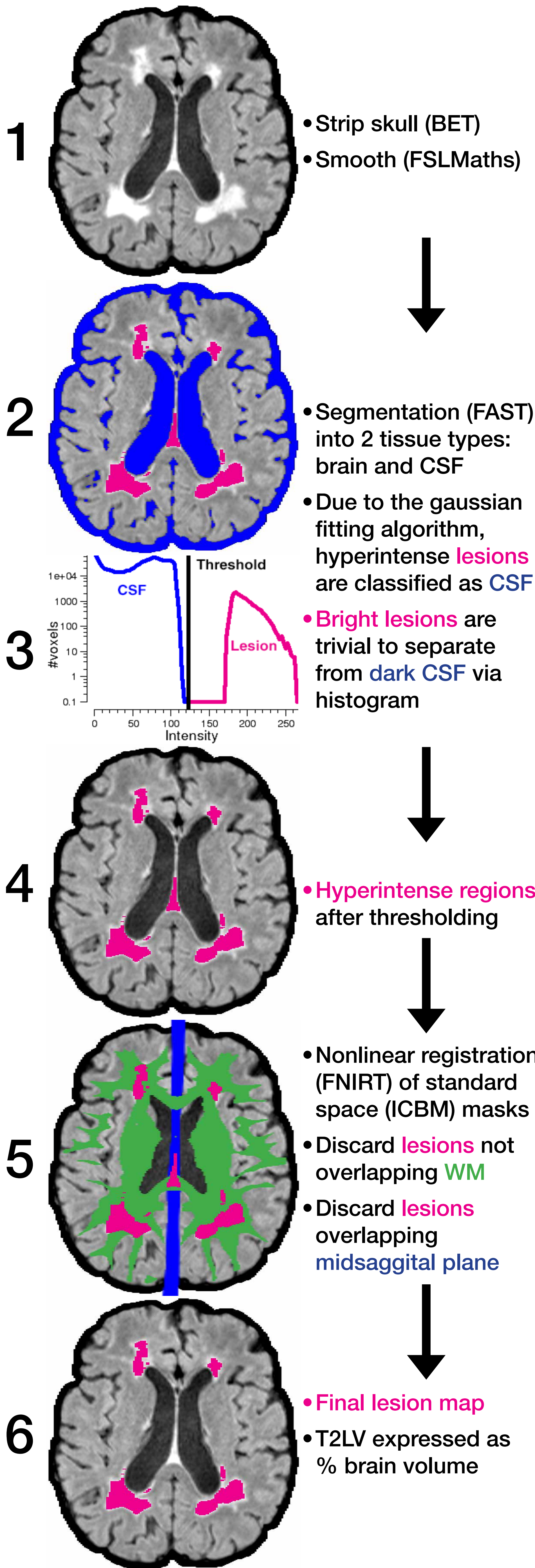
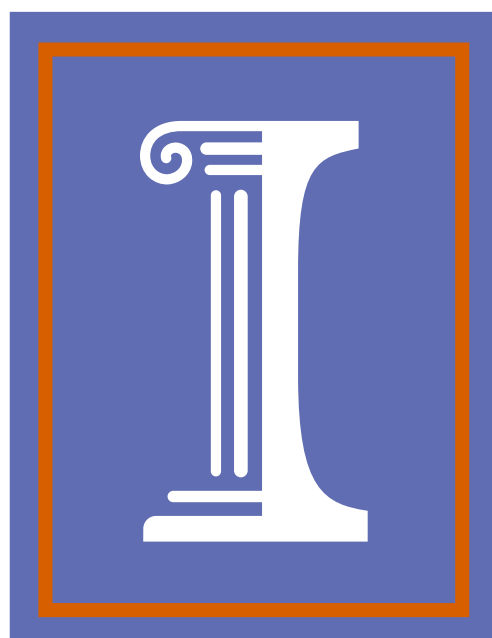
We combined various programs within FSL in an intuitive way, explained as a flow chart in the center panel.

[FSL: fMRIB Software Library, fMRIB, Oxford, <http://fsl.fmrib.ox.ac.uk/fsl>]

## Validation

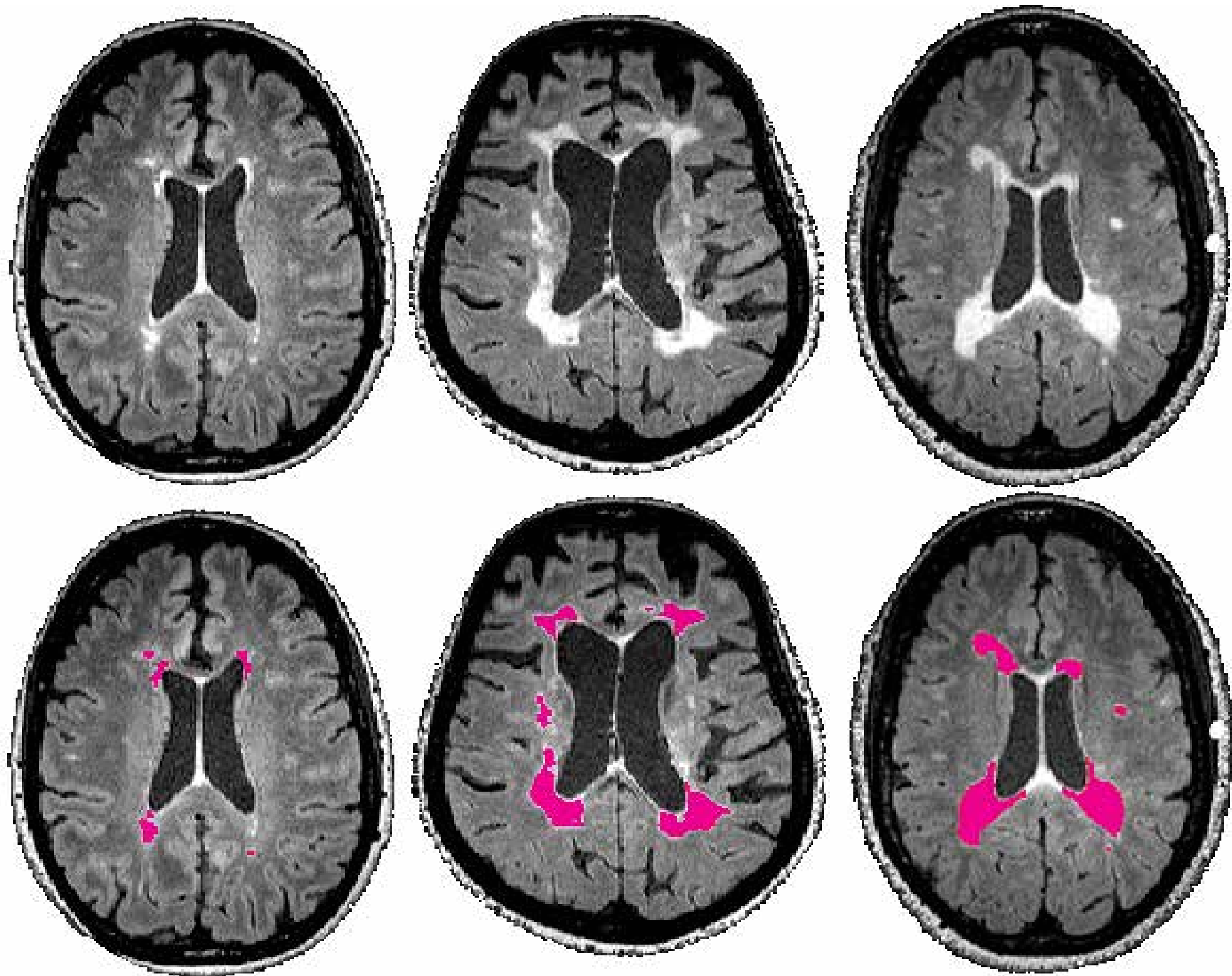
We scanned and segmented images from 53 MS patients  
We validated the ability of our method to predict the degree of clinical disability by calculating Pearson correlations between T2LV and 2 measures of clinical disability

- Expanded Disease Status Scale (EDSS), a composite measure of global disability
- Symbol Digits Modality Test (SDMT), a measure of cognitive processing speed



## Results

Our method ran successfully, without human intervention, on all 53 subjects



Representative input images and output *lesion maps*  
Average run time 3.6 hours/subject

- 2.5 hours of this was nonlinear registration

## Statistics

- T2LV normally distributed after a log transform
- EDSS and SDMT were normally distributed
- 1 subje excluded as an outlier, with an SDMT of 102 (mean+3.8 SD)

- Descriptive statistics

N=52	Min	Max	Mean	SD
T2LV (% Brain Volume)	0.01	4.01	0.86	1.01
Age (Years)	25	64	51.0 <sup>a</sup>	8.4 <sup>a</sup>
EDSS (Score)	0.0	7.5	5.5	2.84
SDMT (# Correct)	20	77	46.06	12.16
<sup>a</sup> For EDSS, median and interquartile range are reported instead of mean and SD				

- T2LV vs. EDSS:  $r=.344$ ,  $p=.013$
- T2LV vs. SDMT:  $r=-.499$ ,  $p=.000$

## Conclusions

We have produced a lesion mapping that is:

- Intuitive
- Fully automated
- Freely available
- Based on FSL, an already popular and widely-understood toolkit

We have validated our method by demonstrating *clinical relevance*

To the best of our knowledge...

- This is the *first* fully-automated method to require only a single image.
- This is the *first* fully-automated method to be validated against clinical significance.

We hope our method will *lower costs* of lesion mapping and enable better *reproducibility* across studies of T2 hyperintense lesions in MS and other conditions.