Automated Detection of Paramagnetic Rim Lesions in Multiple Sclerosis on 3T Susceptibility-based MR Imaging

C Lou, P Sati, M Absinta, K Clark, JD Dworkin, AM Valcarcel, MK Schindler, DS Reich, EM Sweeney, RT Shinohara

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Perelman School of Medicine
University of Pennsylvania

The Department of Biostatistics, Epidemiology and Informatics

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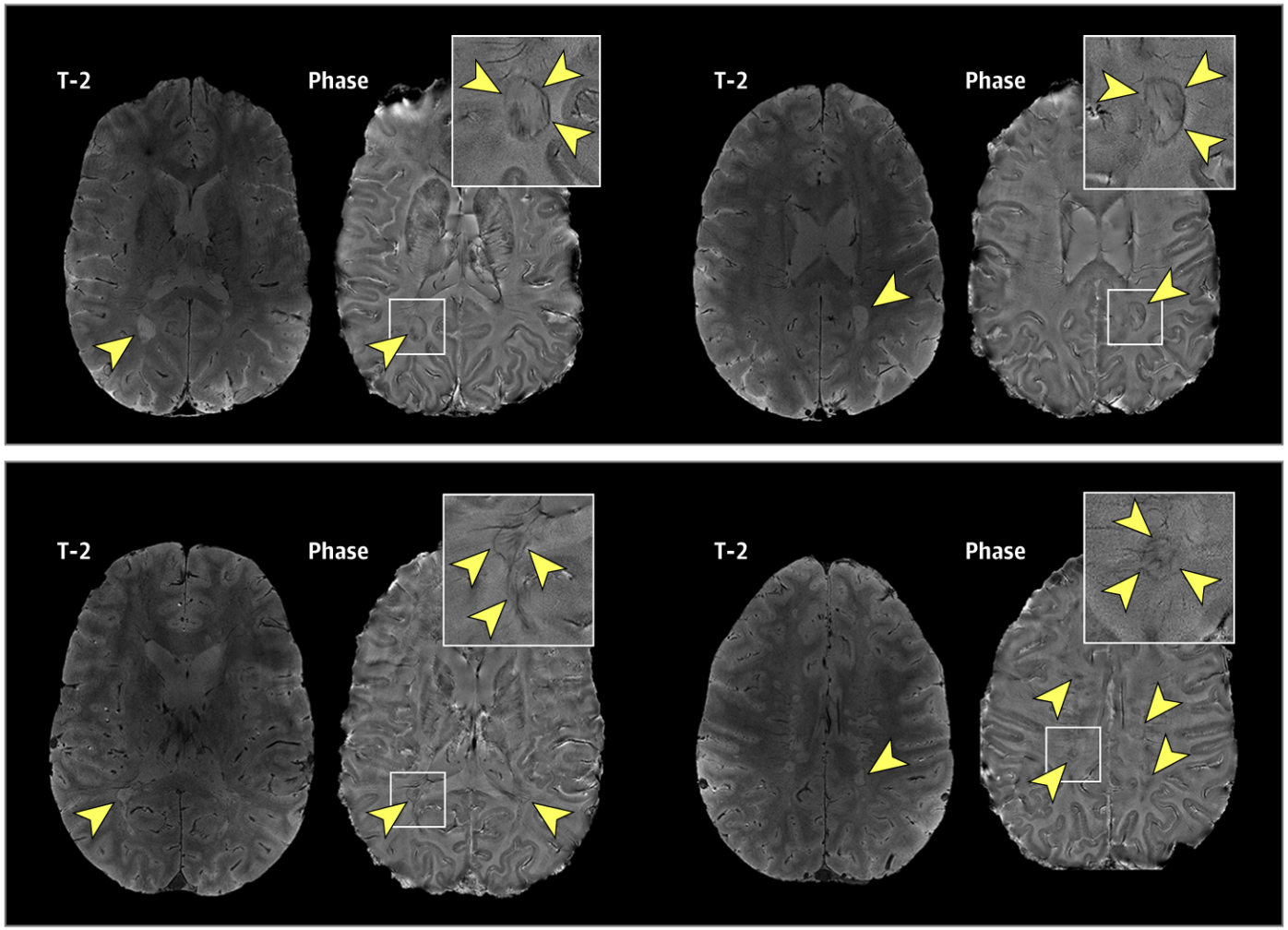
Multiple Sclerosis (MS)

- Demyelinating and inflammatory disease of the central nervous system
- Diagnosed and monitored with structural magnetic resonance imaging (MRI) through quantification of white matter lesions
- Paramagnetic rim lesions (PRLs) manifest with hypointense rim on susceptibility-weighted imaging (T2*-phase)
  - Presence is associated with greater disease burden



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Absinta et al. (*JAMA Neurology* 2019)

Methods

- 19 subjects with MS
  - 3T T1, FLAIR, and T2*-phase sequences
  - PRLs were visually identified and demarcated along the central vein
- Automated lesion identification:
  - Lesion segmentation, center identification, nearest neighbor labelling
- Automated lesion classification:
  - First-order radiomic features
    - Estimation of large number of quantitative features based on given ROIs
  - Random forest classification model

Table 1: Demographics of Study Sample

N	19
Age (mean (SD))	45 (12)
Male (%)	8 (42)
Phenotype (%)	
Primary progressive MS	3 (16)
Relapsing-remitting MS	11 (58)
Secondary progressive MS	5 (26)
Disease duration in years (mean (SD))	14.6 (9.1)
EDSS (median (range))	2.5 (1.0—7.0)
Treatment	
Untreated	5 (26)
glatiramer acetate	1 (5)
interferon beta-1a	4 (21)
dimethyl fumarate	6 (32)
fingolimod	1 (5)
natalizumab	1 (5)
rituximab	1 (5)

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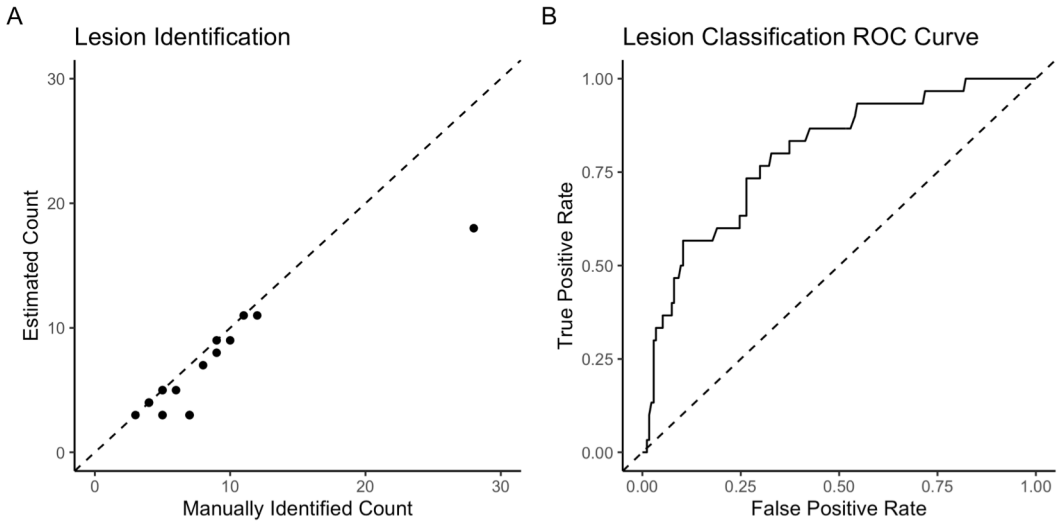
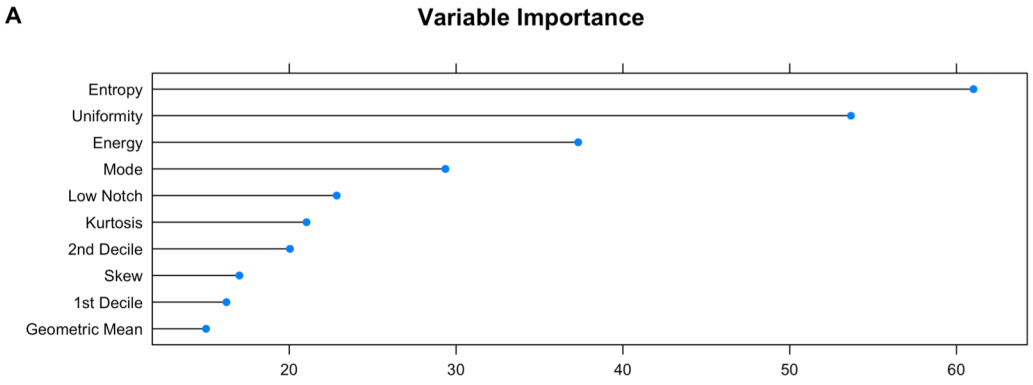
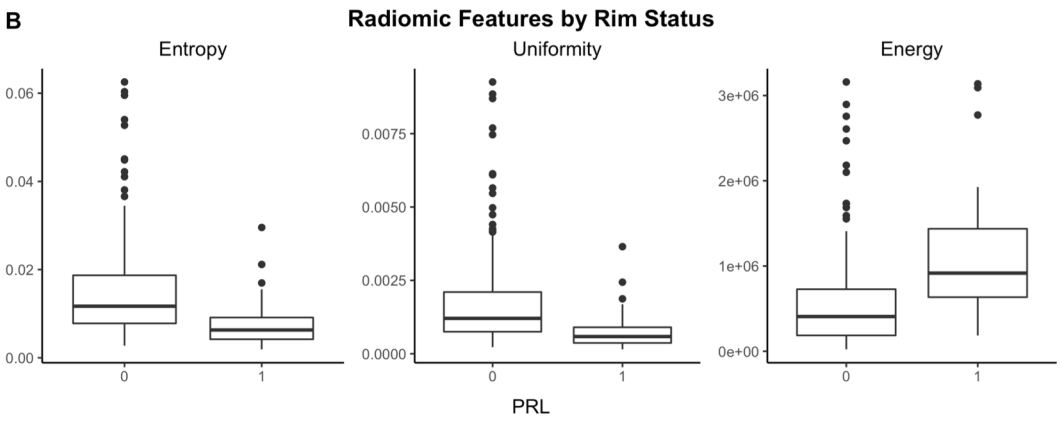
Results

- **Automated PRL identification count strongly correlated with manual PRL count: r = 0.91, 95% CI (0.79, 0.97)**
- **Classified lesions as PRLs with AUC=0.8 (0.67, 0.86)**
- **Important features for classification include entropy, uniformity, and energy**

Performance Measures	
Accuracy	0.82 (0.71, 0.86)
Positive Predictive Value	0.41 (0.16, 0.53)
Negative Predictive Value	0.92 (0.87, 0.97)
False Positive Rate	0.14 (0.08, 0.27)
False Negative Rate	0.43 (0.22, 0.72)
Sensitivity	0.57 (0.29, 0.74)
Specificity	0.86 (0.72, 0.92)







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The paramagnetic rim is an important imaging signal for identifying MS patients with potentially more burdensome disease. Radiomics enable automatic identification and classification of lesions with a paramagnetic rim.

Thank you!