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Quantitative Susceptibility Mapping of Ring Lesions in Relapsing Remitting Multiple Sclerosis

Rebecca White

Wayne State University, fv2761@wayne.edu

Chad Coffman

Wayne State University, chad.coffman@med.wayne.edu

Karthik Subramanian

Wayne State University

Sagar Buch

Wayne State University

E. Mark Haacke

Wayne State University

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INTRODUCTION

Recent evidence exists that shows a correlation of changes in magnetic susceptibility in multiple sclerosis (MS) lesions over time with the patient's expanded disability status scale (EDSS) and disease severity.

Our goal was to evaluate the presence of and changes in susceptibility and volume of white matter lesions (WML) and particularly for ring-like lesions (RLs) over a two-year time period in a series of relapsing remitting (RR) MS subjects.

OBJECTIVES

- Identify relationships between white matter properties and EDSS scores in relapsing remitting MS patients
- Recognize the temporally steady nature of quantitative susceptibility mapping (QSM) –enhancing ring lesions with respect to volume, susceptibility, and intensity

METHODS

- A total of 43 MS subjects were included in the study. All subjects went through MR imaging at baseline and 41 subjects underwent follow-up scans.
- All subjects were imaged on a 3T Siemens VERIO (Erlangen, Germany). The imaging protocol included T2 fluid attenuated inversion recovery (FLAIR), T1-weighted imaging acquired pre and post contrast, [T2-weighted](#) turbo spin-echo (T2 TSE) and susceptibility weighted imaging (SWI), all collected in a transverse mode.
- Regions-of-interest (ROI) were drawn around ring lesions using SPIN and were copied over to the co-registered FLAIR, T1 and T2 images to verify their presence in the other modalities.
- The mean susceptibility, peak intensities and volume were recorded for each lesion at both time points.

FIGURES

Figure 1: Ring lesion appearance in different modalities: (A) magnitude, (B) phase, (C) SWI, (D) QSM, (E) FLAIR, (F) T2 TSE, (G) pre-contrast T1WI and (H) post-contrast T1WI.

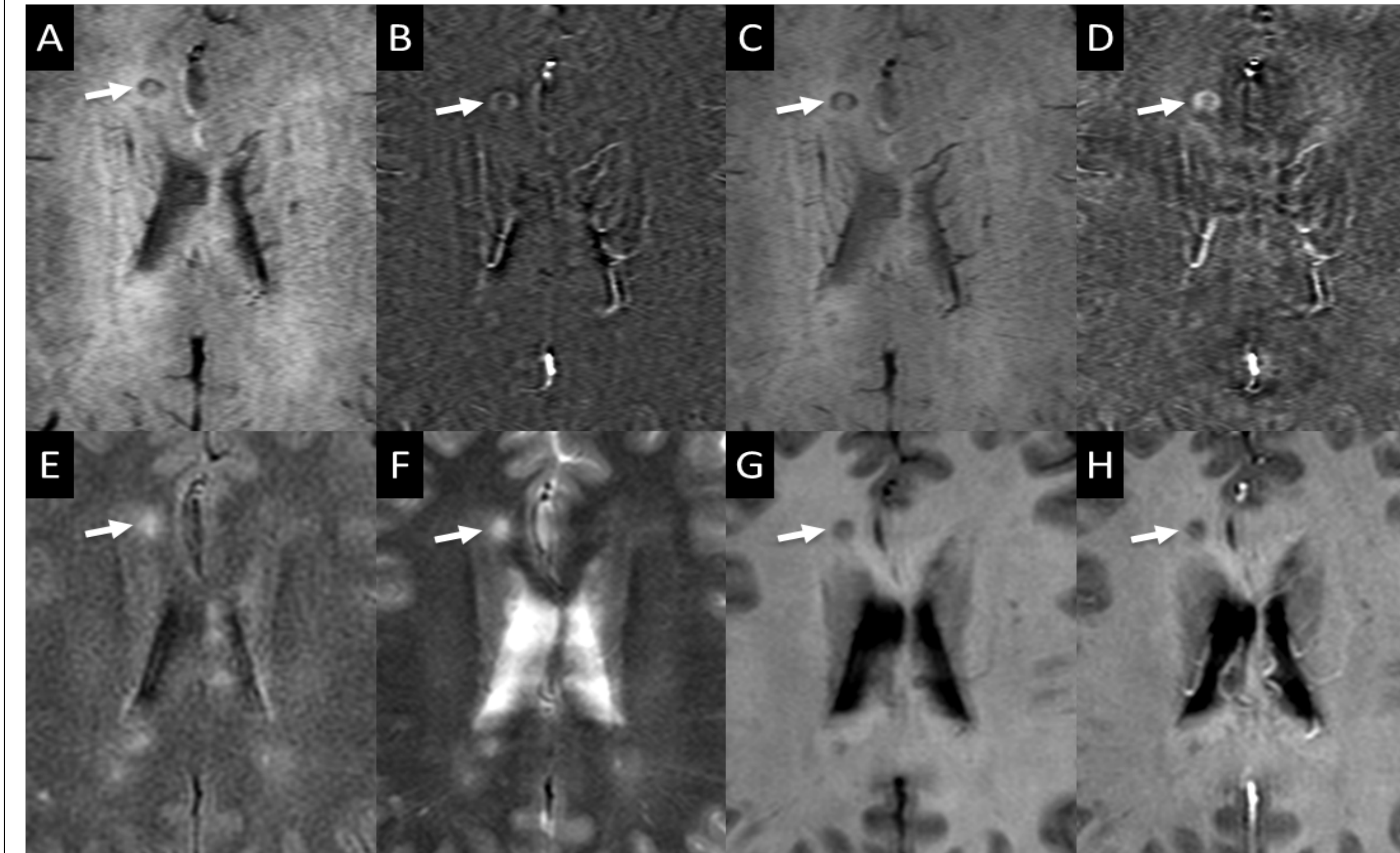
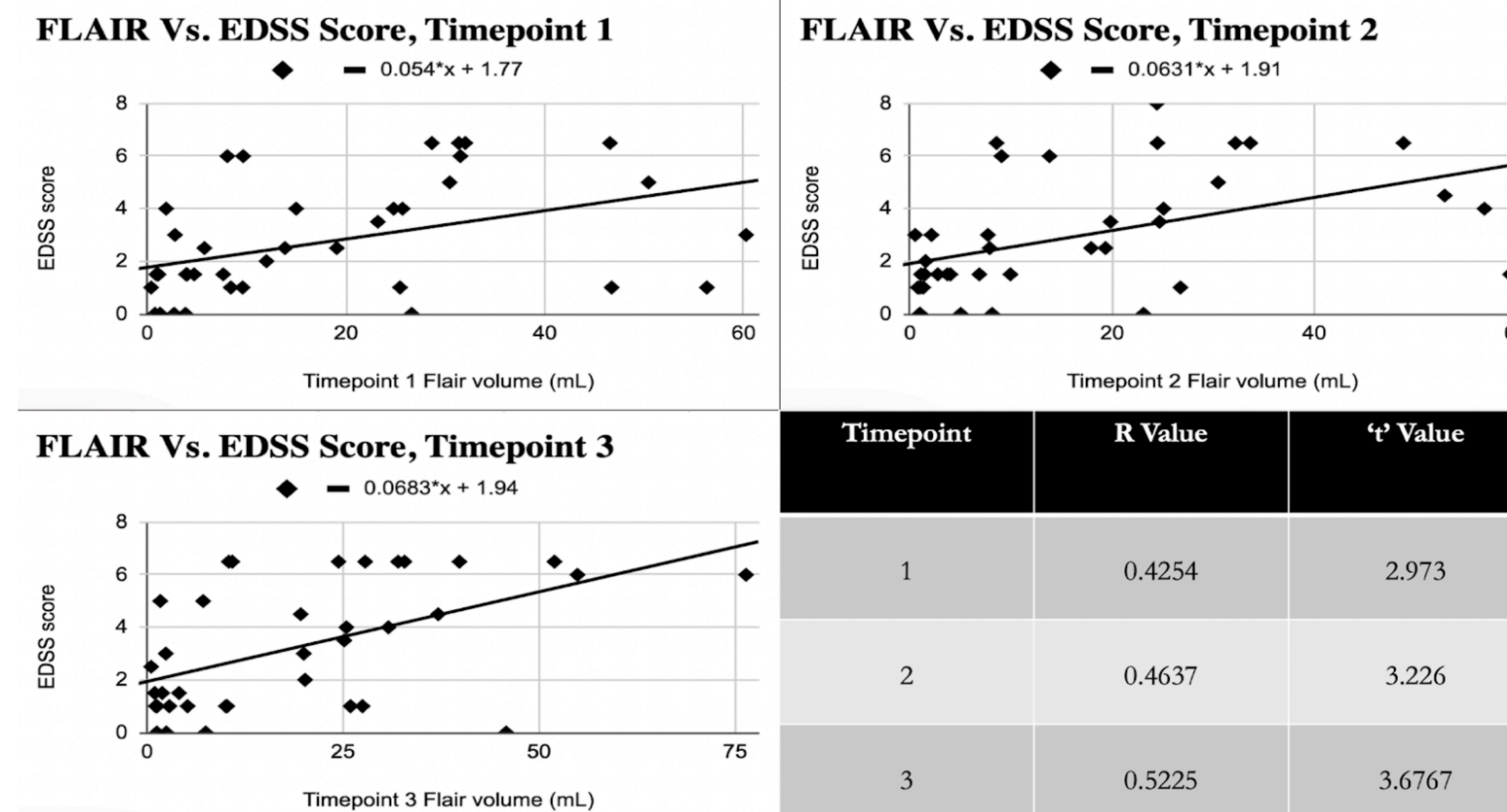


Figure 2: EDSS as a function of the total volume of FLAIR-positive lesions.



RESULTS

- The number of ring lesions had a weak positive correlation with EDSS, yet ring lesion volume showed no such relationship.
- Measurements of both the entire annular ring and its brightest section in QSM remained constant over time (p=.232).
- With respect to imaging modalities, only FLAIR lesion volume positively correlated with EDSS. This includes ring and non-ring lesions.
- Volume, diameter, and absolute value of T2 lesion intensity did not significantly change over the three time points (p > .386).

DISCUSSION

- With respect to RLs, the mean and standard deviation of T2 intensity changed very little over time, and the magnetic susceptibility as seen in QSM changed only slightly over the two year time scale. To assess how RLs change may require a much longer time period to properly assess.
- Our data did not support the hypothesis that RL magnetic susceptibility seen in QSM would correlate with disease severity.
- Eight RLs enhanced in a ring-like shape in T1 post-contrast and SWI but disappeared in subsequent timepoints. We hypothesize that the annular shape seen in these images was artifactual, and a result of Gadolinium contrast leakage.
- A larger cohort study over a longer period, with original unfiltered phase images, could help further unveil the strength of the relationships elucidated in this investigation.