

Comparison of MS lesions seen with 7T iron sensitive phase and 3T post Gadolinium T1 imaging

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Introduction

Assessment of the inflammatory process in Multiple Sclerosis is of significance for monitoring disease activity and making treatment decisions. Gadolinium (Gd) enhancement is currently the only way to clinically assess inflammation. Gd enhancement, however, reflects the local integrity of the blood-brain barrier and Inflammation cannot be detected if the barrier is still intact. Consequently, many lesions seen with other sequences are not depicted on Gd-enhanced MRI [1]. On the other hand, it is known that iron is accumulated in macrophages at the sites of inflammatory lesions [2, 3]. In this study, iron sensitive imaging at 7T is evaluated as a surrogate measure of inflammatory activity and compared to standard Gd-enhanced T1-weighted images.

Methods

Twelve patients with Multiple Sclerosis (6 SPMS [mean age = 57.8 years], and RRMS with known disease activity [mean age = 31.3 years]) were imaged using a 7T scanner (Philips Achieva, Cleveland, OH) before and after the standard clinical 3T session. IRB approval and informed consent were obtained from all participants. At 7T, phase images were calculated from complex susceptibility-sensitive images (TR = 23 ms, TE1 = 3.6 ms, TE2 = 10-15 ms, FA = 5°) using high pass filtering. Late post gadolinium 7T T1-weighted MPRAGE (TS = 4550 ms, TI = 1800 ms, TR = 4.1 ms, TE = 1.6 ms, TFE factor = 360, FA = 8°) were obtained after the routine 3T exam which included FLAIR, pre-, and post-Gd T1w-SE. All images were registered to one another using FSL (Oxford, UK), involving a 2.5-fold interpolation of the 3T data in the slice direction. Lesions were located in four representative slices on FLAIR and then compared to the visible lesions in the registered phase images and 3T post-Gd T1w-SE.

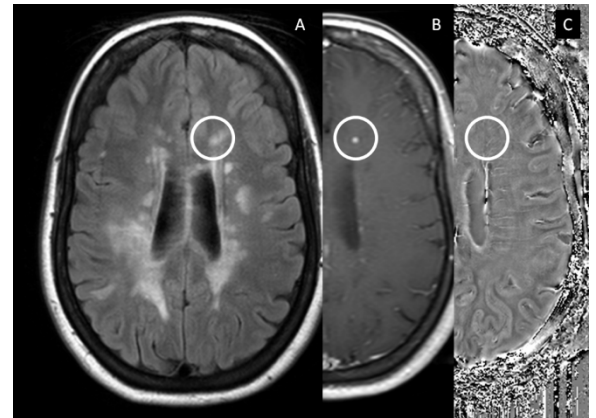


Figure 1: A lesion depicted in FLAIR (A) and post Gd-MPRAGE (B) is not visible in the phase image (C). This suggests that Gd-enhanced and iron-sensitive imaging depict lesions with different mechanisms of lesion formation.

Results and Discussion

A total of 14 Gd-enhancing lesions were seen in 4 of 6 RRMS patients. None of these lesions were seen on the iron-sensitive phase images. In the RRMS patients, lesion counts were higher than in SPMS and iron-containing lesions were more prevalent in RRMS (37.2%) than in SPMS (12.1%). Furthermore, RRMS patients had also relatively fewer T1w-SE lesions (34.6% of all counted lesions) than in SPMS patients (48.0%).

Conclusion

Relapsing-remitting Multiple Sclerosis is characterized by periods of lesion activity followed by a dormant state in which the patient experiences few, if any, neurological symptoms. In this pilot study, it is shown that iron-sensitive phase imaging provides a complementary indicator of lesion activity to post-Gd T1-weighted imaging. This suggests that Gd-enhancement and iron-sensitive imaging depict different underlying mechanisms of lesion formation. Lesion counts in RRMS patients with very active disease compared to patients with stable SPMS suggest that iron-sensitive imaging may be a more sensitive marker for inflammation in MS than Gd-enhancement. This is consistent with recently published studies indicating that MS lesions seen in 7T phase images persist for long time periods [4].

References

[1] Lee MA, et al., 1999, Pitt et al, Archives 2010, [3] Pitt et al ECTRIMS 2011, [4] Pelletier, et al. #602 ISMRM 2011

Table 1: Lesion Counts in SPMS and RRMS

| Dx | Mean Age | Iron lesion total | FLAIR total | FLAIR and iron | FLAIR not iron | Iron not FLAIR | Percent iron positive FLAIR | Gd-enhancing | T1-SE Lesions | Percent T1-SE |
|------|----------|-------------------|-------------|----------------|----------------|----------------|-----------------------------|--------------|---------------|---------------|
| SPMS | 57.8 | 152 | 149 | 18 | 131 | 3 | 12.1% | 0 | 73 | 48.0% |
| RRMS | 31.3 | 309 | 293 | 109 | 184 | 16 | 37.2% | 14 | 107 | 34.6% |