Semi-automated method for improved reproducibility of apparent diffusion coefficient measurements in breast lesions

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Target Audience

Radiologists, medical physicists and MR technologists

Introduction

Diffusion weighted imaging (DWI) has shown promise for improving the accuracy of magnetic resonance imaging (MRI) for diagnosing suspicious breast lesions. On average, malignant lesions display a lower apparent diffusion coefficient (ADC) than benign lesions, making ADC a potentially useful parameter for discriminating benign and malignant lesions [1-3]. The low spatial resolution and image quality of DWI can limit interobserver reproducibility of ADC measurements, particularly in small lesions and irregularly shaped non-mass-like enhancements (NMLE). To address this challenge, we developed a semi-automated method for selection of lesion pixels based on DWI thresholding. Because lesions are typically hyperintense on DWI, a threshold of the DWI image can enable discrimination of lesion pixels from normal parenchyma [4]. The purpose of this study was to compare inter-observer variability of ADC measurements obtained with this semi-automated approach against the standard manual region-of-interest (ROI) method.

Methods

After IRB approval, we retrospectively reviewed 31 breast lesions (16 malignant, 15 benign) with a BIRADS 4 or 5 assessment. All scans were performed on a Philips 3T Achieva scanner using a gadolinium enhanced T1 weighted DCE sequence, and a six direction ss-EPI diffusion tensor imaging (DTI) sequence (b= 0, 800 s/mm^2). Measurements were performed by three observers, including one experienced breast radiologist. Observers first measured each lesion using the standard approach by manually drawing an ROI circumscribing the lesion on the b=800s/mm^2 diffusion weighted image. A measurement was also made of the normal parenchyma tissue in the contralateral breast by the same method. Measurements were repeated using the semi-automated tool: An ROI was defined around the lesion, and then a threshold of the DWI image was adjusted to mask the surrounding parenchyma. Unmasked pixels within the ROI were included in the measurement. ADC values for each measurement method were compared by paired t-test for each observer. Inter-observer reproducibility was assessed by concordance correlation coefficient (CCC) and Bland-Altman analysis [5].

Results

For all observers, paired t-test revealed no significant difference between measurements by manual and semi-automated methods (p≈0.4). For lesions, the CCC for semi-automated was 0.97 (95% CI: 0.94-0.99), and the CCC for manual was 0.81 (95% CI: 0.64-0.93). The mean difference in CCC was 0.16 (95% CI: 0.05-0.33) and the 95% CI excluded a difference of zero, indicating higher reproducibility using the semi-automated method, as illustrated by Bland-Altman analysis (Fig. 1). For normal breast tissue, the CCC for semi-automated was 0.62 (95% CI: 0.16-0.82), and the CCC for manual was 0.48 (95% CI: 0.15-0.75). The difference was 0.14 (95% CI: -0.05-0.47), but since the 95% CI included a difference of zero, we could not confirm any improvement in reproducibility using the semi-automated method for normal tissue measures.

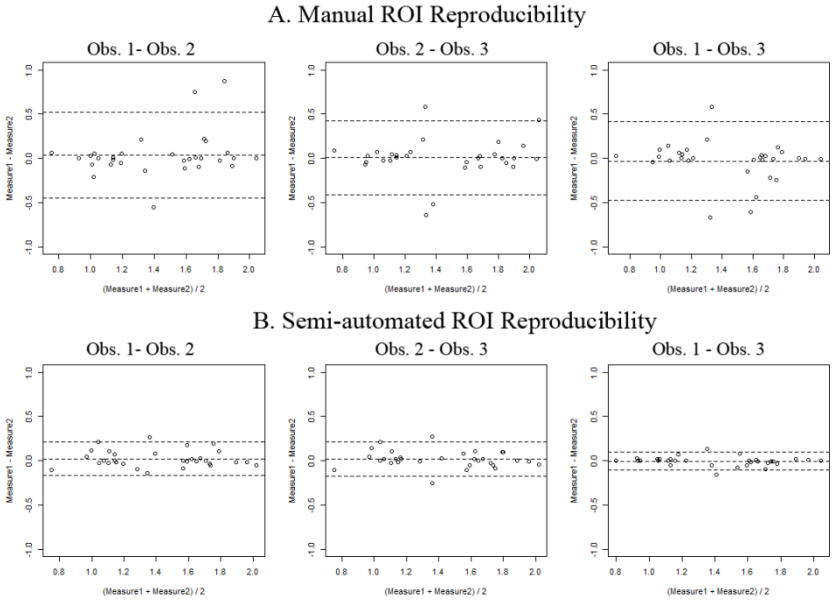

Figure 1. Bland-Altman analysis of interobserver reproducibility of lesion ADC measures using: A. Manual ROI selection. B. Semi-automated ROI selection.

Discussion

Our results show that lesion measurements obtained by the semi-automated pixel selection method based on threshold of the DWI image are more reproducible than measurements obtained by a manually drawn ROI. In addition, paired t-test showed no bias in ADC measures using the semi-automated vs. manual method. Given that the semi-automated method was also observed to be faster than drawing by hand, it may provide a superior method for analyzing large datasets, and support use of ADC measures in routine clinical practice.

References

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