[SY10] Breast Symposium

SY10-04

Radiomics and Quantitation in Breast MR: Pitfalls and Insights

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MR based radiomics is a rapidly growing field that utilizes multivariate analysis of shape, texture and histogram features extracted from imaging data to characterize regions of interest. Radiomics analysis has been primarily performed to determine lesion malignancy but has also been employed to assess or predict response to treatment. The extraction of multiple features and the meaningful application of radiomics is dependent on the use of large datasets, ideally involving hundreds of cases. Because of this requirement, studies often involve patient data acquired over multiple MR scanners of varying field strengths provided by different vendors with subsequent slight changes in acquisition parameters. Care must then be taken to ensure data is appropriately managed with regards to normalization and standardization before analysis. This presentation will discuss these issues and potential methods of data normalization.

Texture features can be calculated using various well-established methods including techniques based on assessing co-occurring pixel pairs (Haralick parameters), the frequency of pixel runs of a set length and intensity (run length matrices derived parameters), and the frequency of pixel clusters of various sizes and intensities (size zone matrices derived parameters). However, because all these features are highly sensitive to the pixel intensity distribution within an image it is unclear how repeatable and reproducible they are. This is of critical importance when assessing feature value alterations over time, and potentially attributing noted changes to treatment effects. Due to this high sensitivity to the pixel intensity distribution it is accepted that data needs to be decimated (reducing the gray level representation) prior to analysis to improve robustness. Unfortunately, the optimal number of gray levels is unknown. This issue, alongside appropriate means to deal with extreme image intensity values, will also be explored.

Traditionally MR data, such as T1w and T2w images, is not standardized and thus does not easily facilitate longitudinal studies assessing treatment induced changes based on signal intensity. Robust quantification of absolute values of T1, T2 and ADC is therefore highly desirable. Previously, quantification has been hampered by the compromises in data acquisition that are required to enable clinically acceptable acquisition times. The gold standard for T2 mapping is the basic spin-echo imaging technique. However, accurate multi slice T2 maps would require a total scan time that can be measured in hours rather than minutes, which is clearly unfeasible. Compromise approaches involving the use of multi spin-echo based sequences with considerably shorter acquisition times have been proposed. Unfortunately, because of the generation of indirect and stimulated echoes it is no longer appropriate to model the signal evolution as a mono-exponential decay controlled by the T2 value of the tissue of interest, often leading to under or overestimation. Echo modulation curve generation and MR fingerprinting are recent developments enabling the production of accurate parameter maps in clinically acceptable imaging times and these will also be discussed.

Keywords : Breast, Cancer, Radiomics, Quantitation

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Ultrafast DCE MRI

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MRI diagnosis of breast lesions depends on information on morphology and kinetics through dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) based on BI-RADS. Conventional kinetic analysis requires time intensity curves using pre-contrast and initial- and delayed-phase images, normally takes as long as 8–10 minutes. Other challenges of the current DCE-MRI include false positive by hypervascular benign lesions and marked BPE among younger populations.

Ultrafast DCE (UF-DCE) MRI is an attempt to extract both morphologic and kinetic information **in the very early post-contrast period.** Most of the recent studies used state-of-the-art accelerated image acquisition and reconstruction techniques, such as view-sharing or compressed sensing (CS), to achieve high spatial and high temporal (4-8 seconds) resolution. Detailed information on the up-slope of the time-intensity curve (TIC) is obtained, while maintaining sufficient image quality to evaluate morphology.

In order to evaluate “very early phase” time-intensity curve obtained by UF-DCE, new kinetic information is necessary. Several semi-quantitative parameters have been proposed. The **maximum slope (MS)** is defined as the slope of the tangent (%/seconds) along the steepest part of the curve. Malignant lesions show steeper upslope –large MS. **Time to enhancement (TTE)** is a parameter reflecting the inflow of contrast in lesions. Enhanced timing of **tumor-related artery and vein – their interval (AVI)** can be a direct parameter for cancer-related vascularity.

Several studies showed that UF-DCE MRI helps to diagnose hypervascular benign lesions. Another potential benefit is improved conspicuity of hypervascular lesions for patients with marked background enhancement. It should be noted, however, that hypo-vascular malignant lesions (invasive lobular carcinoma or ductal carcinoma in situ) are difficult to recognize on UF-DCE. Our preliminary results suggested that MS, TTE, and AVI can be used to evaluate kinetics in breast lesions with clinical performance equivalent to that of conventional kinetic analysis.

Along with kinetic information, image quality of UF-DCE is important in diagnosing breast lesions. Contrast and sharpness may be affected by reconstruction technique and scan-timing. Optimal parameters of reconstruction scan timing needs further investigation.

In conclusion, UF-DCE MRI of the breast is an emerging technique. For the best use of this new technique, it is important to understand several new kinetic parameters and technical aspects of UF-DCE MRI.

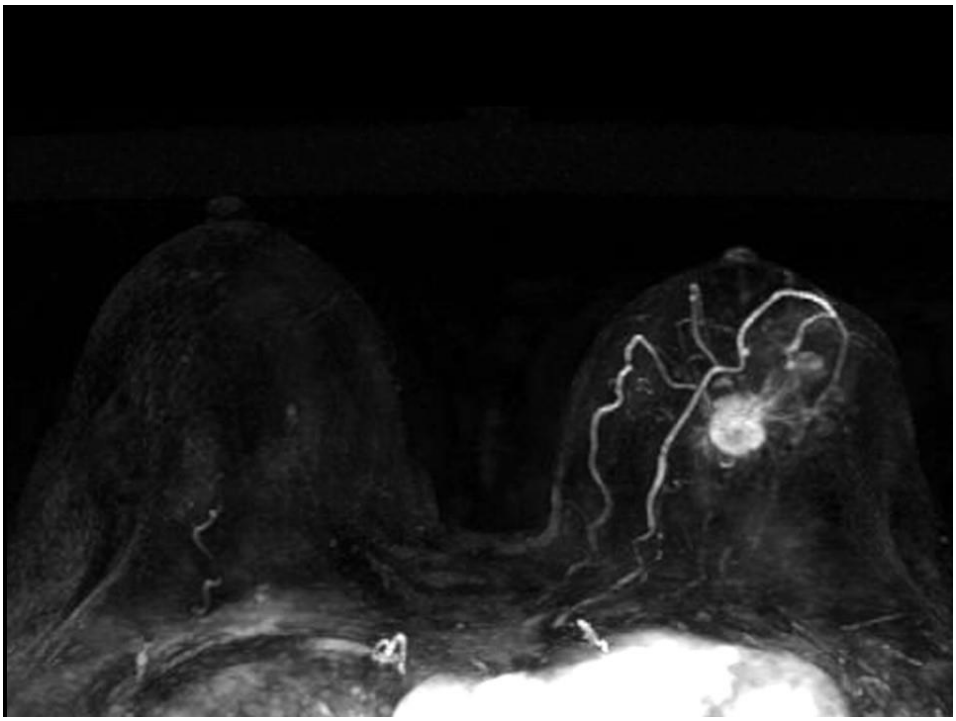

Figure 1. Representative image of UF-DCE MRI (MIP)

Keywords : Breast, MRI, Ultrafast, Dynamic, Compressed sensing

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SY10-06

Abbreviated Breast MRI

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Breast magnetic resonance imaging (MRI) has been increasingly utilized due to its high sensitivity and superior ability to detect cancers compared with mammography and ultrasound, including screening for high-risk cases. Although mammography has been the most cost-effective method of breast cancer screening to date, the ability of mammography to detect cancer is reduced significantly when the breast tissue is dense. Similarly, ultrasound, which is readily available, has become the primary supplemental imaging modality but breast screening ultrasound has many limitations, including time, cost, and a low positive predictive value (PPV). Several limitations such as higher cost, longer examination time, longer interpretation time, and low availability, have hindered the wider application of MRI, especially for screening of average-risk women. To overcome some of the limitations and increase access to MRI screening, an abbreviated breast MRI protocol has been introduced. Abbreviated breast MRI is becoming popular and challenges the status quo. This lecture aims to present an overview of abbreviated MRI, discuss the current results & considerations, and introduce ongoing prospective trials.

Keywords : BREAST, MRI