Pushing old boundaries in breast MRI: non-fatsaturated dynamic imaging at very short TE

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Introduction

In non-fatsuppressed dynamic breast imaging, it is a well accepted recommendation to acquire data at or close to echo times that fulfil the in-phase condition for fat and water, such as 4.7ms at 1.5T, in order to avoid partial volume effects that lead to signal cancellation at fat/water interfaces. This has been described and analysed e.g. in [1,2] with the prescription of using either in-phase TE or "TE less than 1.2ms" resulting in a phase difference of below 90°. In a comparable parameter setting this would result in a decrease of 50% of the acquisition time due to the shorter TR of approx 8ms vs 4ms. With current gradient systems and fast imaging sequences meanwhile this has become possible without compromising the matrix size or the bandwidth. In this work we have set up an interleaved protocol approach to achieve a direct comparison of a minimum TE (minTE) acquisition within a clinical standard protocol.

Methods

Data were acquired on a 1.5T Siemens MAGNETOM Avanto using a Siemens breast array coil. The very short TE of 1.15ms was achieved using a gradient-echo sequence (VIBE) that allows asymmetric readout windows. Thus only an adjustable percentage of the gradient echo is sampled. The clinical reference protocol with in-phase TE was set up so that all scan parameters are identical with the minTE protocol, except for the echo asymmetry and the flip angle that was adapted to the TR. The spatial resolution was $0.8x0.8x2mm^3$ with a bandwidth of 445Hz, parallel imaging was used (GRAPPA acceleration factor of 2). This resulted in a acquisition time of 60s for the in-phase scans and 30s for the minTE scans, thus the actual temporal resolution for both techniques was 90s. Fig.1 shows the interleaved scan protocol that allows a direct comparison. Post-processing comprised subtractions, curve assessment and calculation of wash-in/wash-out maps using a commercial software (syngo BreVis) which provides a lesion volume calculation based on the contrast enhancement.

Results and Discussion

So far, six consecutive patients (age 31-92) were examined using the interleaved protocol. One advantage of the minTE approach is displayed in Fig. 2: because of the very short TE of 1.15ms, signal dephasing in the vicinity of metal clips (circled) is significantly reduced. In Fig. 3 an enhancing lesion is depicted in both scan techniques by color-encoding the wash-in/wash-out overlaid on the native image. Due to the asymmetric readout, there is slightly increased blurring in the minTE image (right). Considering the fact that the color-coded overlays represent two slightly shifted uptake curves, they are in very good visual agreement. In both cases, the software calculated identical values for the total lesion volume based on the number of pixels that exceed a defined enhancement. Therefore, it could be assumed that at such short TE remaining opposed phase artefacts would not lead to a misinterpretation of lesion characteristics or size. However, as displayed in Fig. 4, also at TE 1.15ms significant signal cancellation can occur. Therefore further studies are required.

Additionally it needs to be investigated how the saved acquisition time of 50% can be used optimally and whether the additional blurring would be an acceptable trade off or could be overcome by more sophisticated filtering. Another application of minTE protocols might be MR guided biopsy.

References

[1] Heywang-Köbrunner et al, Contrast-enhanced MRI of the breast, 2nd ed, Springer 1995 [2] Reichenbach et al, J Magn Reson Imag 2005, 21

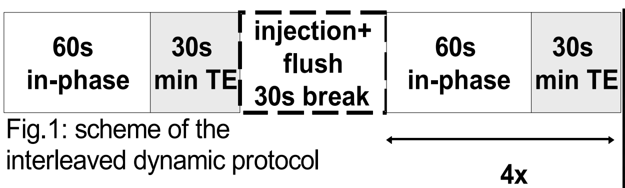

Fig.1: scheme of the interleaved dynamic protocol

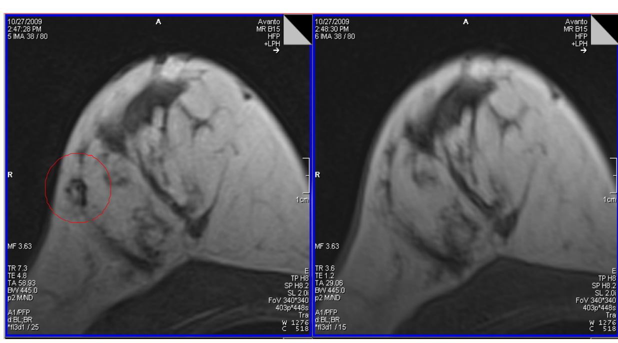

Fig.2: clip artifacts at in-phase TE (left), minTE (right)

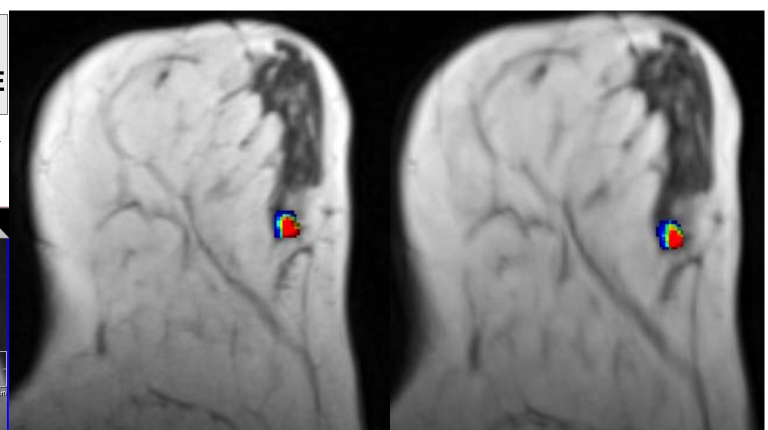

Fig. 3: left: time point 1 with overlay of wash-in/wash-out at minTE; right) time point 1 with overlay of wash-in/wash-out at in-phase TE

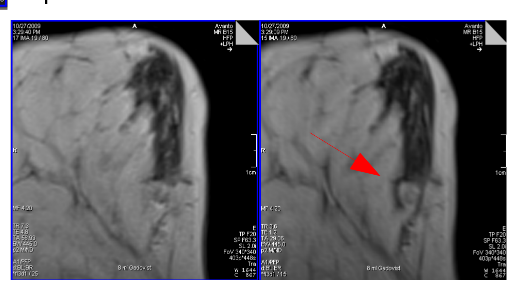

Fig. 4: time point 4 at in-phase TE (left) and minTE – remaining opposed phase cancellation at lesion boundary