

## Dynamic analysis of breast lesions: Can we use the wash-in phase instead of the wash-out phase?

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### Purpose:

To compare initial maximum slope as a heuristic parameter for differentiation of benign and malignant breast lesions on ultrafast TWIST acquisitions with diagnostic spatial resolution with conventional 3 timepoint analysis.

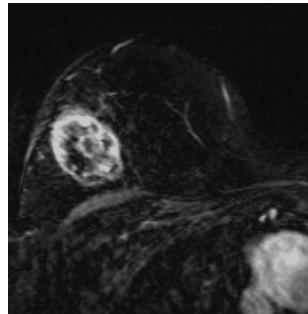


Fig 1. TWIST image of the right breast with large IDC. Note that the morphology of the lesion is clearly depicted

and 1-7-2011. High resolution VIBE acquisitions ( $0.9 \times 0.8 \times 1.0$  mm, TE 1.71ms, TR 5.50ms, FA 20°, FOV 360mm, GRAPPA 3, temporal resolution 80s) were interleaved with a series of 20 ultrafast TWIST acquisitions ( $1 \times 0.9 \times 2.5$  mm, TE 2.02ms, TR 3.96ms, FA 20°, FOV 360mm, central region 15%, sampling density outer zone 10%, GRAPPA 3, temporal resolution 4.32s) during the inflow of the contrast agent. For our analysis we included all patients with enhancing abnormalities that were at least two years stable (regarded as benign) and all enhancing lesions that were pathologically assessed (either benign or malignant). Consequently 42 consecutive patients with 43 enhancing abnormalities (21 benign and 22 malignant) were included. We measured the maximum slope of the relative enhancement versus time curve on the TWIST acquisitions and recorded curve type of the lesions on the VIBE acquisitions. ROC analysis was performed to compare diagnostic performance.

### Results:

The maximum slope of the relative enhancement versus time curve was significantly better in discriminating between benign and malignant disease than the curve type (Az 0.865 vs. Az 0.723,  $p = 0.036$ ) (fig 2). Cutoff values of 15%/sec and 3.15%/sec can be used to differentiate high-risk lesions (>85% malignancies) from intermediate and low-risk lesions (<10% malignancies), which is analogue to the relative risks of malignancy in classic wash-out, plateau and continuous curves, respectively.

We propose to use these cut-off values in a fixed grid of relative enhancement versus time, where relative enhancement (on the y-axis) of 1000% equals 87 seconds on the x-axis. In this grid an enhancement rate of 15%/sec gives an upslope angle of 60° while an upslope angle of 20° equals an enhancement rate of 3.15%/sec. We can then define a type 1 inflow curve as a curve with an angle of less than 20°, a type 2 inflow curve as a curve with an angle between 20° and 60° and a type 3 inflow curve as a curve with an angle of more than 60° (fig 3). This simplification yields an Az of 0.808, which is still better than classic curve type analysis.

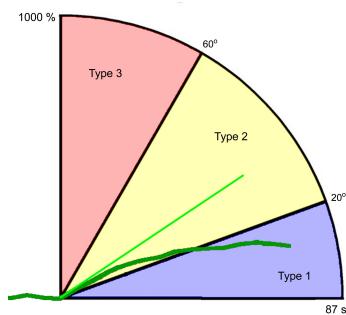


Fig 3. Inflow curve types. In green an exemplary curve as measured and the corresponding maximum slope (light green line, type 2).

### Introduction:

It was shown that using TWIST acquisitions<sup>1</sup> it is feasible to obtain whole breast MRI data with a diagnostic spatial resolution of  $1 \times 0.9 \times 2.5$  mm in less than 7 seconds<sup>2,3</sup>. Consequently imaging resolution is sufficiently high to assess morphology while it is fast enough to document the inflow of contrast in eventual lesions (fig 1). Since in conventional breast MRI the highest specificity is achieved by evaluating both morphologic and dynamic features of breast lesions we sought a simple way to use the inflow information for the differentiation of benign and malignant breast disease. Since pharmacokinetic modeling is not readily available everywhere, we propose the use of the upslope angle in a fixed grid of relative enhancement versus time as a novel heuristic discriminating parameter and compare this approach to the classic curve types derived from conventional 3 timepoint analysis<sup>4</sup>.

### Materials and Methods:

We performed a bi-temporal breast MRI protocol on a 3T MRI scanner (Siemens Magnetom Trio / Siemens Skyra) using a 16 channel bilateral breast coil (Siemens) in 568 consecutive patients who presented at our department between 1-12-2010

— Classic curve type (Az 0.723)  
- - - Initial maximum slope (Az 0.865)  
- - - Inflow curve type (Az 0.808)

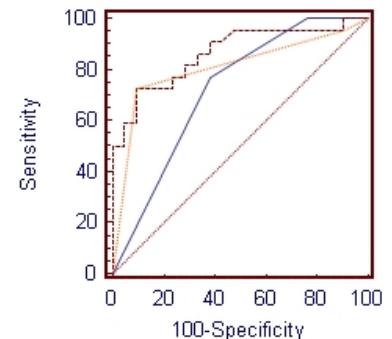


Fig 2. Results of ROC analysis

### Conclusion:

Initial maximum slope as derived from ultrafast TWIST acquisitions in breast MRI is a strong discriminator between benign and malignant disease that outperforms conventional dynamic analysis.

By using a fixed grid it becomes possible to define curve types based upon the upslope angle. This can easily be implemented in any radiological practice. Using the inflow information rather than the washout phase allows a serious decrease in scanning time (less than 2 minutes), thereby opening new possibilities for MRI screening.

### References:

1. Laub et al. Proc ISMRM 2007, 3058
2. Mann et al. Proc ISMRM 2011, 1016
3. Hermann et al. JMRI 2011 Oct;34(4):973-82
4. Kuhl et al. Radiology 1999 Apr;211(1):101-10