

# Comparison of Breath-hold versus Free-breathing versus Respiratory Triggered and Navigator Triggered Diffusion Weighted Imaging of the Liver

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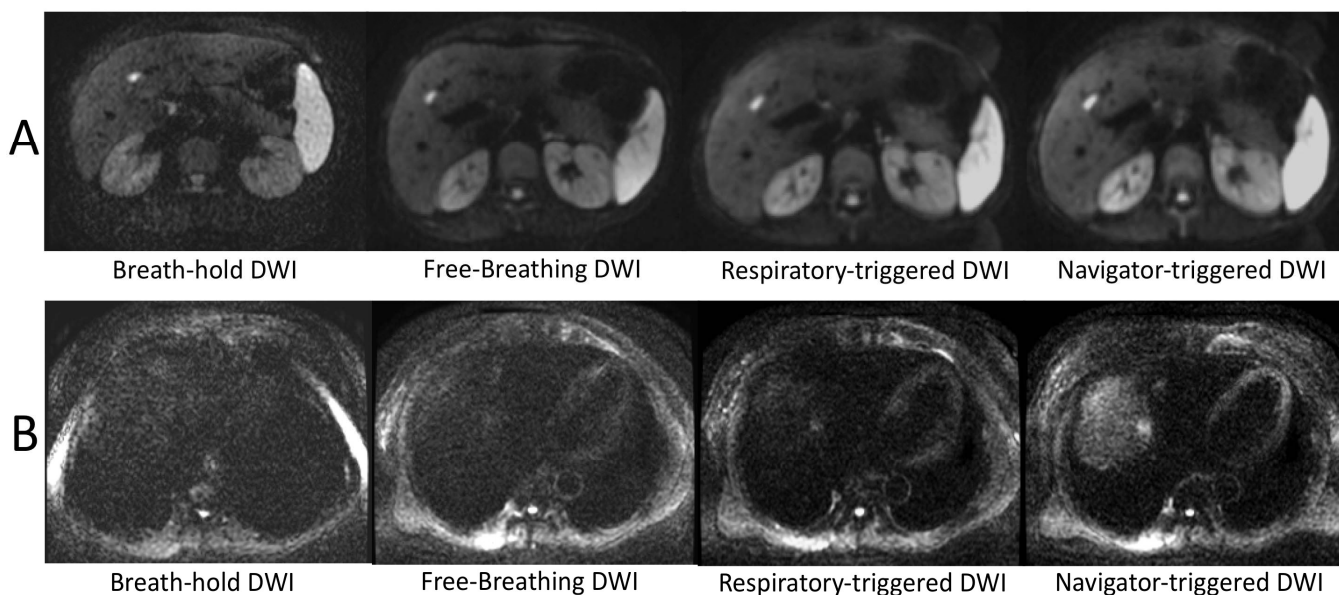
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## Introduction:

Diffusion-weighted imaging (DWI) is now routinely used in abdominal MRI examinations. In clinical practice, either breathhold DWI (BH-DWI) or one of several non-breathhold DWI techniques are used. The non-breathhold techniques include free-breathing (FB-DWI), respiratory-triggered DWI (RT-DWI) and Navigator-triggered DWI (NT-DWI). Advantages of non-breathhold techniques compared with breathhold DWI are the possibility to increase signal-to-noise ratio by acquiring multiple signal averages. However, respiratory-gated DWI suffers from a prolonged examination time, while free breathing DWI may suffer from image blurring. Several of these techniques have been compared against each other (1, 2). To our knowledge, however, a direct comparison of all of these four commonly used DWI techniques has not yet been reported. In this work, our aim was to prospectively evaluate and compare the subjective image quality of BH-DWI, FB-DWI, RT-DWI and NT-DWI in patients with liver lesions.

## Methods:

We prospectively enrolled 30 patients who had a known liver lesion. Patients were evaluated with axial BH-DWI, FB-DWI, RT-DWI and NT-DWI (low flip angle 2D cylindrical RF navigator pulse positioned on the right hemi-diaphragm), using b-values of 0 and 500 s/mm<sup>2</sup>, in addition to standard sequences, on a 1.5T magnet (GE Healthcare, Signa HDxt) and an 8-channel phased array coil. The following scan parameters were identical for all four methods: Matrix size 128 x 128, slice thickness 6 mm, spacing 1 mm, TE 81.4 ms, acceleration factor 2. TR was 3000 for BH-DWI and FB-DWI and variable (1000-17000) for RT-DWI and NT-DWI. NEX was 4 for all techniques except BH-DWI (NEX=1). Scan time was approx. 30 s for BH-DWI, 100 s for FB-DWI and 2-3 min for RT-DWI and NT-DWI. Three board certified radiologists (with approx. 25, 10, and 1 year experience, respectively) independently and blindly evaluated BH-DWI, FB-DWI, RT-DWI and NT-DWI b=500 images for overall image quality, overall image sharpness, overall qualitative SNR, overall artifacts, and quality of depiction of the spleen, kidneys, and spinal cord as reference structures. The reviewers evaluated lesion conspicuity, definition of lesion border, definition of internal lesion architecture, and whether lesion depiction was degraded by artifacts. A six point scale was used (0=nondiagnostic, 1=very poor, 2=poor, 3=acceptable, 4=good, 5=excellent). Pairwise differences between DWI methods were tested with paired Wilcoxon tests; a Bonferroni-adjusted p-value < 0.0009 was taken as significant. Pairwise agreement between readers was assessed with a linearly weighted kappa statistic. Confidence intervals were computed by 2000-sample bootstrap. Statistical analyses were performed with Stata Release 9.2 (StataCorp LP).



Two example cases of quality differences between the four examined DWI techniques. **Case A:** Example of improved signal-to-noise ratio of non-breathhold techniques over breathhold technique in a patient with a liver hemangioma. **Case B:** Example of a "difficult" liver lesion located at the dome of the liver, a location that is prone to being degraded by diaphragmatic motion artifacts. The lesion is not depicted by BH-DWI and FB-DWI, but is depicted by RT-DWI and NT-DWI. Image quality was best for NT-DWI with the least amount of image degradation.

## Results:

Both NT-DWI and RT-DWI were better than BH-DWI in all ratings ( $p < 0.0001$ ). There was no significant difference between NT-DWI and RT-DWI. NT-DWI was significantly better than FB-DWI ( $p < 0.009$ ) in the following categories: lesion conspicuity, artifacts affecting lesion depiction, and depiction of the spinal cord. RT-DWI was significantly better than FB-DWI ( $p < 0.0002$ ) in the following categories: overall quality, overall artifacts, lesion conspicuity, lesion border, and depiction of liver, spleen and spinal cord.

**Conclusions:** To our knowledge this is the first direct comparison of BH-DWI, FB-DWI, RT-DWI and NT-triggered DWI in the same study. The results demonstrate a clear superiority of NT-DWI and RT-DWI over BH-DWI for both overall image quality parameters and liver lesion conspicuity. The results also demonstrate superiority of NT-DWI and RT-DWI over FB-DWI in the majority of the examined image quality criteria.

## References:

1. Kandpal H et al. AJR Am J Roentgenol. 2009;192(4):915-22. 2. Taouli B et al. J Magn Reson Imaging. 2009;30(3):561-8.