Synchronization strategies in T2-weighted MR imaging for detection of mouse liver metastasis

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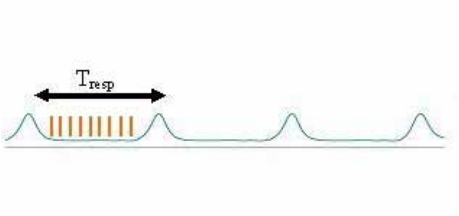
Introduction: To detect liver metastasis in clinical practice, respiratory-triggered T2-weighted MR images is the sequence of choice. In mice, T2-weighted contrast imaging at high field requires a TR longer than the usual mouse respiratory period. Moreover, with conventional acquisition strategies the number of acquisition slices is limited by the respiratory period, leading to an insufficient liver coverage. To circumvent these limitations, we proposed a novel acquisition strategy.

Method: The experiments were performed *in vivo* at 7T on a Biospec system (Bruker, Ettlingen, Germany), using a cylindrical volumetric coil with a 32 mm internal diameter for both RF emission and reception. Mice were imaged while under isoflurane anesthesia, and body temperatures were preserved with a water-flow heating apparatus. A respiratory sensor, placed on the abdomen, and a pressure sensor (DCXL01DN, Honeywell) detected movement due to respiration and heart beats. Pressure sensor was interfaced with ECG Trigger Unit HSB-T (Rapid Biomedical, Würzburg, Germany), to use the adapted functionalities of this trigger unit.

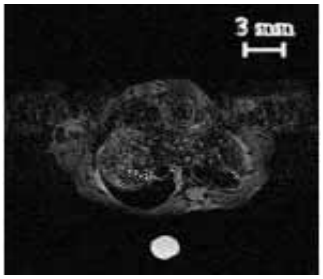
The conventional procedure consisted of T2-weighted imaging synchronized with the respiratory motion. All slices are acquired on each respiratory cycle: 0.5 s < Tresp < 1.5 s (Fig. 1a). To realize true T2-weighted images (with minimal T1 effects), we developed an acquisition strategy with TR spanning over several respiratory cycles. Furthermore, acquisition was synchronized to both respiration and cardiac movement to reduce motion artifacts, especially in the ventral liver region (Fig. 2a).

Results: Fig. 1b and 2b show axial images of the same liver region, acquired using conventional and proposed acquisition strategies respectively. Fig 1b depicts important heart motion artifacts. As depicted in Fig. 2b, the motion artifacts are reduced with the second strategy, especially in ventral liver region. The TR is longer and the slices are acquired over 3 respiratory periods. Comparing Fig. 1c and Fig. 2c, it is obvious that proposed acquisition strategy allows better lesion visualization. However, total acquisition duration depends of heart beat cycle.



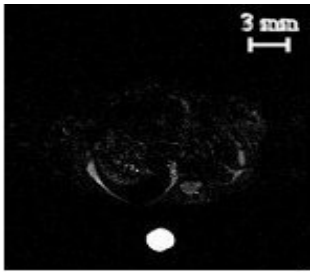
a

Figure 1: (a) Scheme of conventional acquisition strategy for T2-weighted contrast images



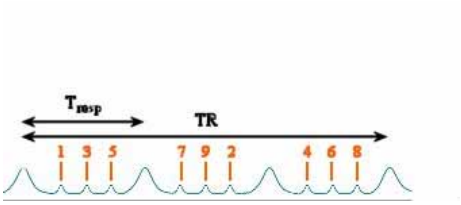
b

Figure 1 (b) Example of image (TR=T_{resp}) TR/TE = 2000/20 msec



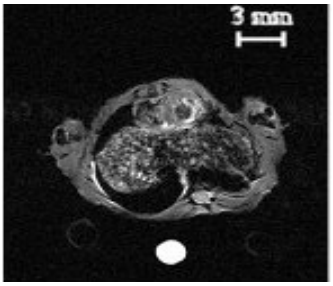
c

Figure 1: (c) Example of image (TR=Tresp) TR/TE = 2000/60 msec



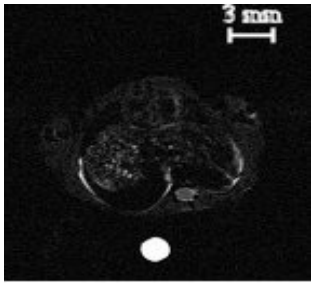
a

Figure 2: (a) Scheme of original acquisition strategy with cardiac and respiratory triggering for T2-weighted contrast images



b

Figure 2: (b) Example of image (TR = 3×Tresp) TR/TE = 6000/20 msec obtained on same location and on same mice as Fig. 1b



c

Figure 2: (c) Example of image (TR = 3×Tresp) TR/TE = 6000/60 msec obtained on same location and on same mice as Fig. 1c

Conclusion: When all slices are acquired within on respiratory cycle, the slice number is limited and the duration between two consecutive slices is decreased, favoring cross talking. With the conventional strategy the T2 contrast is not freely controlled. The suggested strategy enables true T2-weighted imaging with minimal movement artifacts and minimal inter-slice crosstalk, regardless of the respiratory period and the number of slices. Total acquisition duration could be speed up by interleaving, within one heart cycle, additional slices acquired in the caudate part of the liver.

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