

# Do we need suspended breathing with real-time axial continuously moving table MR imaging?</I>

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## Introduction

In recent years interest has increased in whole-body magnetic resonance (MR) imaging with continuous table movement. Advantages are that there are no artifacts at the borders of the scan volumes and their transitions; furthermore, this technique may be advantageous in shorter, more open magnets with smaller homogeneous imaging volumes even for localized imaging. The most basic form of moving table imaging is real-time, 2D axial imaging, which can be performed for instance with EPI [1]. First applications included tumor detection with a steady state free precession with balanced gradients sequence (SSFP) [2]. Recent work has enabled the recording of exact table position during table movement, which allows sagittal and coronal reformations of the axial images [3]. Although the imaging times of these real-time 2D sequences theoretically allow free breathing, until now patients have been requested to suspend breathing to ensure uniform coverage in the z-direction to avoid gaps/overlaps due to z-axis compression and expansion during breathing. In this context, the purpose of this work was to investigate the influence of respiration on the image quality of a SSFP sequence, especially focusing on potential deformation of structures and length measurements in the z-direction.

## Materials and Methods

Scanning was performed on a 1.5 T Siemens Avanto system (Siemens Medical Solutions, Germany), which provides 32 receiver channels and a matrix of dedicated phased-array surface coils. A reconstruction algorithm for 2D axial moving table datasets (single slice acquisition at the isocenter of the magnet) was incorporated into a standard Siemens reconstruction program. This algorithm records the slice position and passes these values via the slice orientation data parameters to the final images. This experiment was performed on five healthy male volunteers (22 to 31 years old) using a SSFP sequence with TR=2.4/ TE= 1.1ms and a z-coverage of 1800mm. From a previous study in phantoms, we found a set of 3 optimal parameter combinations, which are shown in Table 1. These 3 sequences were evaluated under suspended breathing for 30 seconds during acquisition of abdomen and thorax (Fig. 1a), as well as without a breath hold. The volunteers were asked to breathe with normal amplitude and frequency for the non breath hold exam. The overall image quality was assessed, and the deformation in the z-direction was evaluated between anatomic landmarks (aortic arch – left renal artery, liver size in medioclavicular line). For control of measurement uncertainties, z-distances between other structures in the body in regions not susceptible to breathing were performed and expressed in % of the absolute values. Furthermore, two radiologists investigated how well the lung arteries, ascending aorta as well as the vertebral bodies were depicted in the three different sequences.

## Results

As shown in Fig. 1, there were no significant deformations in the images except for fast motion artifacts in the heart region. Slow motion artifacts (breathing) could not be noted. The image quality with suspended respiration (Fig. 1a-c) (mean quality value 2.25) was equal to that without breath hold (Fig. 1d-f). The difference concerning depiction of anatomic structures was not significant. The difference for the measurements of z distances was below 2%, which is in the range of measurement uncertainty as verified in non-moving structures in the same coronal reformations. The best performance was obtained with the two 6mm slice thickness series (a, c, d, f); the 4mm slice thickness sequence (b, e) showed less sharp contours of the assessed structures.

## Conclusion

Single slice axial SSFP imaging during table movement can be used with normal respiration, making it conceivable to examine patients who are uncooperative. Potentially, even higher resolutions are possible if the need for a 30 second breath hold is not required any more. Further effort should be undertaken to optimize shimming during table movement and to develop other real-time 2D sequence types with alternative image contrasts. Finally, for an optimal MR protocol, a fast type of fat saturation should be available (which depends on whole-body shimming). MR thus could be used in more diseased patients with the advantage of reducing the total examination (in room) time, of reducing breathing artifacts and by eliminating the need for suspended breathing, which can be bothering even in less diseased patients.

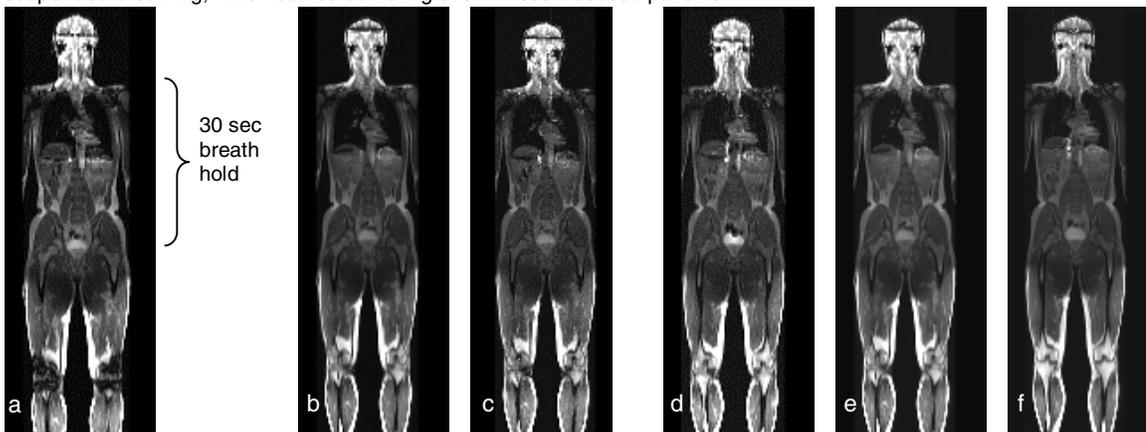


Fig. 1, Tab. 1: Parameters for the three different SSFP sequences. (a-c: non-breath hold, d-f: breath hold).

	Slice thickness	Table velocity	Matrix	Single slice acquisition time (s)	Total acquisition time (min)	Voxel size (mm)	Slice overlap
Fig. 1a, 1d	6 mm	22 mm/s	256	0.27	1:21	1.6x1.6x6	No
Fig. 1b, 1e	4 mm	20 mm/s	192	0.20	1:28	2x2x4	No
Fig. 1c, 1f	6 mm	20 mm/s	192	0.18	1:28	2x2x6	2 mm

## References

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