Abdominal Imaging with Extended Field of View in Rectal Cancer Using a Continuously Moving Table: A Feasibility Study

G. Sommer[1], U. A. Ludwig[1], H-P. Fautz[1], O. Schäfer[2]

[1]Diagnostic Radiology - Medical Physics, University Hospital Freiburg, Freiburg, Germany, [2]Diagnostic Radiology, University Hospital Freiburg, Freiburg, Germany

Introduction

Follow up diagnosis in rectal cancer requires the determination of numerous parameters like local tumor recurrence, lymph node involvement and metastatic spread. While MRI has established as a widely used standard for local T- and N-staging, solitary metastases in the upper abdomen or the lungs are mostly assessed with CT which is more time efficient and more sensitive for lung metastases compared to standard MRI approaches [1], [2]. In recent years fast imaging techniques with a continuously moving table made it possible to cover large volumes of interest also with MRI in a very time efficient manner [3], [4], [5], [6]. This study is to gain initial experience about the applicability and usefulness of these methods as a tool for extending the field of view and the diagnostic coverage of standard pelvic or abdominal MRI examinations. For this purpose two MRI sequences with continuous table motion were implemented in a standard pelvic imaging protocol for rectal cancer follow up and tested on ten patients. The sequences were designed to cover the whole abdomen in down to one minute with only one breath hold required. The results were evaluated in an individual case analysis concerning quality and diagnostic scope of the images.

Method

Ten patients with known and treated rectal carcinoma were examined during follow up diagnostics for the question of local tumor recurrence or metastatic spread. As part of the standard examination procedure all patients underwent stationary T1- and T2-weighted MR imaging of the pelvis (Seq. 1 and 4 in Tab. 1). In order to extend the examined field of view towards coverage of the whole abdomen, the protocol was complemented by two additional sequences with continuous table motion: After T2-weighted imaging of the pelvis (Seq. 1), a TSE-sequence (Seq. 2) with STIR-fat suppression was performed. With this a FOV_z of 72 cm from the upper lung to the pelvis was acquired in 3:30 min during free breathing at a constant table velocity of v_{table} = 4 mm/s. The second additional sequence (Seq. 3) was applied after administration of contrast agent before performing standard contrast enhanced T1-weighted imaging of the pelvis (Seq. 4). This GRE-sequence covered a FOV_z of 55 cm from the lower lung to the pelvis (see Fig. 1g) in 1:10 min with a constant table velocity of 9 mm/s. To achieve optimum image quality in the liver, the patients were pleased to hold their breath for 20 seconds during the examination, which corresponded to 18 cm of the FOV_z. The additional sequences extended the protocol by 4:52 min including 0:12 min for a second localizer. All measurements were performed on a 1.5 T whole body system (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany) featuring a multi channel array of local surface coils (Tim system, Siemens medical solutions, Erlangen, Germany) and an automatically moving patient table.

Patient positioning and preparation		3:30 min
1)	Stationary T2-weighted imaging of the pelvis	
	TR: 4960 ms, TE: 126 ms, 512 matrix, sagittal slices, thickness 6 mm	2:35 min
	TR: 6530 ms, TE: 126 ms, 512 matrix, oblique slices, thickness 4 mm	3:20 min
2)	Moving table STIR imaging from lung apex to pelvis	3:30 min
	TR: 2622 ms, TE: 98 ms, 384 matrix, transverse slices, thickness: 5 mm	
Administration of i.v. contrast agent (Multihance™, 20 ml)		1:00 min
3)	Moving table T1-weighted imaging from liver to pelvis with partial breath hold	1:10 min
	TR: 95 ms, TE: 2.5 ms, FA: 70°, 320 matrix, transverse slices, thickness 5 mm	
4)	Stationary T1-weighted imaging of the pelvis	4:57 min
	TR: 8.3 ms, TE: 3.14 ms, FA: 25°, 512 matrix, oblique slices, thickness 2.5 mm	
Total measurement time		~20:00 min

Tab.1: Examination protocol with sequence parameters and required measurement times

Results

In seven out of ten patients the complementary sequences showed relevant diagnostic findings which provided additional information outranging the standard local examination of the pelvis: Four patients showed liver metastases, in two patients lung metastases (size 4 to 8 mm) could be found. Bony metastases outside the pelvis were revealed in three patients. Additional findings were hydronephrosis, pleural effusion, enchondroma and multiple cysts in the liver and kidney. While the GRE sequence with partial breathhold (Seq. 3) provided good and reliable results in all examinations, the free breathing STIR-TSE in some cases showed motion related signal dropout in the upper abdomen.

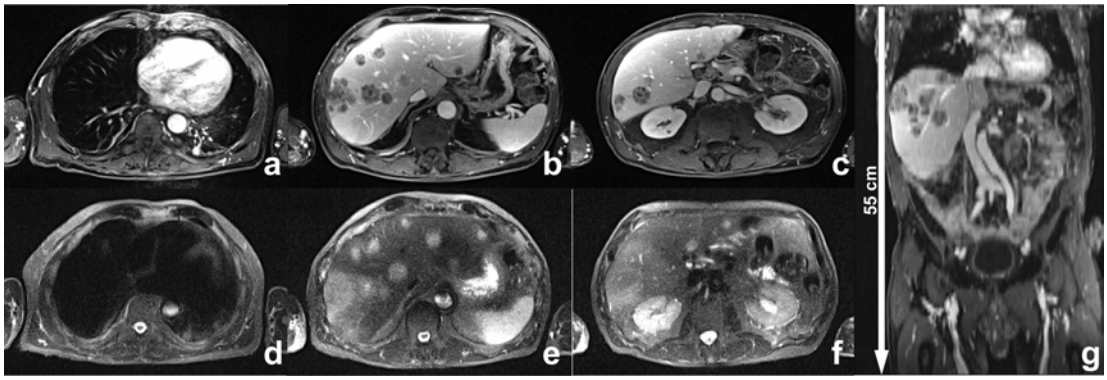

Fig. 1: Example images from one of the examined patients. Left: original axial slices used for diagnosis showing multiple metastases in the liver. (a-c): CE T1-weighted GRE with fat sat. (d-f) STIR-TSE. Right: reformatted coronal whole FOV_z overview from Seq. 3 (g). The arrow indicates the direction of data acquisition.

Discussion

Fast imaging sequences with a continuously moving table allow for performing examinations of the whole abdomen in high image quality and with only one breath hold required. In less than 5 additional minutes for the two complementary sequences, the amount of information obtained in our study could be considerably increased. Though the given individual case results are not statistically significant, further evaluation of the presented techniques as a tool for extending the spatial and diagnostic range of standard MR imaging protocols seems highly advisable. The free breathing STIR technique did not provide satisfying results in all cases and should possibly be modified towards a one-breath-hold approach.

References

[1] Bipat S et al. Rectal Cancer: Local Staging and Assessment of Lymph Node Involvement with Endoluminal US, CT, and MR Imaging--A Meta-Analysis. *Radiology* 2004; **232**(2): 773-783.

[2] Saunders TH et al. New techniques for imaging colorectal cancer: the use of MRI, PET and radioimmunoscintigraphy for primary staging and follow-up. *Br Med Bull* 2002; **64**(1): 81-99.

[3] Barkhausen J et. al. Whole-body MR-imaging in 30 seconds with real-time true FISP and a continuously rolling table platform: feasibility study. *Radiology* 2001; **220**: 252-256.

[4] Kruger DG et al. Continuously moving table data acquisition method for long FOV contrast-enhanced MRA and whole-body MRI. *Magn Reson Med* 2002; **47**: 224-231.

[5] Fautz H-P et al. Sliding Multi-Slice (SMS): A new technique for minimum FOV usage in axial continuously moving table acquisitions. *Magn Reson Med* 2006; **in press**.

[6] Ludwig UA et al. 2D Axial Moving Table Acquisitions with Dynamic Slice Adaptation. *Magn Reson Med* 2006; **in press**.