Continuous Moving Bed MRI with Golden Angle Radial Sampling .

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INTRODUCTION

Continuous moving bed MRI (COMBI) is a high throughput imaging technique that has been employed in rapid whole body fat–water quantification[1], MR angiography[2] and diffusion weighted imaging[3] among other applications. Existing COMBI implementations include a variety of 2D and 3D cartesian methods[4]. As an alternative to cartesian methods, radial COMBI with linear angle (LA) increments has also been presented with targeted gains in image resolution per unit time and motion immunity[5]. In dynamic radial acquisitions such as in the case of COMBI, a golden angle (111.25^o azimuthal step) sampling pattern can potentially provide benefits over linear sampling schemes in retrospective profile binning flexibility for arbitrary slice thickness reconstruction[6]. In this abstract, we introduce GA radial COMBI and compare it to LA COMBI at different reconstructed slice thicknesses in a phantom setup at 3 Tesla (3T).

METHODS

Whole-body COMBI was implemented on a Philips Achieva 3T scanner (Philips Healthcare, Best, The Netherlands) with a 2-channel receive body coil. Scan control modifications allowed table motion during a scan with inputs of extended Z direction field of view, one of three table speeds (20, 90, 180 mm/s) and the standard in-plane imaging parameters. Radial COMBI was implemented as a continuous radial scan such that the total number of profiles (N) equaled

$$N = Full\ zFOV\ (mm)/(Table\ Speed(mm/s) * Repetition\ Time(s)\ )$$

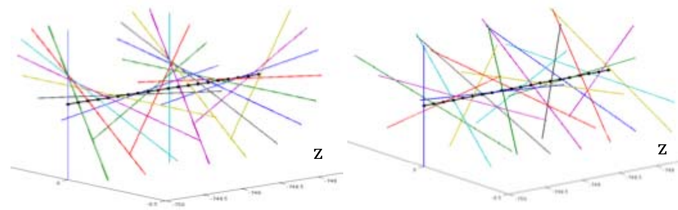

Figure 1: Linear and Golden Angle sampling patterns in COMBI

Fast low angle shot gradient echo (FLASH) imaging was performed on a phantom setup, which included the American College of Radiology MRI phantom. The imaging parameters were as follows: Full zFOV = 1500 mm, table speed = 20 mm/s, in-plane FOV = 400 x 400 mm^2, resolution = 1.56 x 1.56 x 8 mm^3, TR/TE = 2.7/1.15 ms, readout matrix size = 256, angle increments of 180^o/readout-length for LA and 111.25^o for GA (Figure 1). Complex images were reconstructed offline using projection reconstruction in MATLAB (Mathworks Inc, MA, USA). A 1-pixel-shift equivalent phase ramp was applied in k-space to account for profile shifts in the image domain. To evaluate the benefit over LA sampling, both volumes were reconstructed with slice thicknesses of 13.8 mm (full 256 profiles), 10 mm (185 profiles) and 8 mm (148 profiles) at 5 mm intervals.

RESULTS

Figure 2 shows sum of squares magnitude images of the phantom setup. A single axial slice through the ACR phantom is displayed for 13.8,10 and 8 mm slice thicknesses for LA and GA acquisitions. LA images show higher levels of undersampling artifacts with decreasing slice thickness, as expected. GA slices have significantly lower artifact levels in comparison to LA. GA image quality and SNR decreases when using fewer profiles, but GA results are much higher quality compared to LA images. Reformatted coronal GA images show excellent image quality over the full 1500 mm extended FOV.

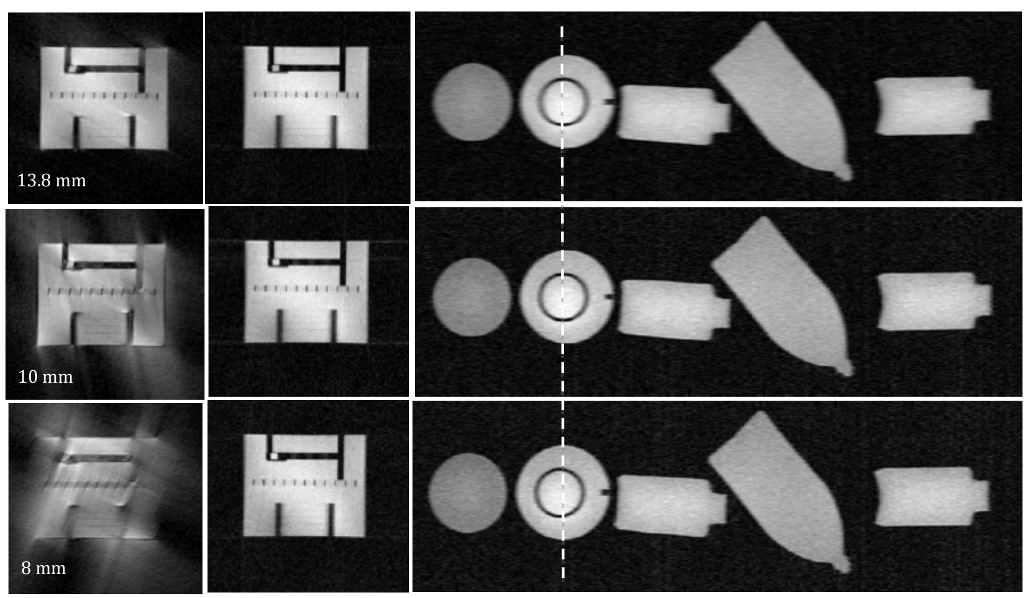

Figure 2: LA and GA COMBI reconstructed images at 13.8, 10 and 8 mm slice thickness.

DISCUSSION

GA sampling produces excellent image quality even with 58% of the full 256 profiles effectively producing a table speed of ~11.5 mm/s without hardware modifications. Flexibility afforded by GA sampling in a COMBI acquisition enables a rapid and robust “one size fits all” approach to whole-body scanning, which will likely prove to be valuable in many continuous moving bed MRI applications.

REFERENCES

1. Kullberg, J et al. JMRI 30. 185 (2009). 2. Kruger, DG et al. *MRM* 47. 224 (2002). 3. Han,Y et al. *MRM* 65.1557 (2011). 4. Börnert et al. JMRI 28. 1 (2008) 5. Shankaranarayanan, A et al. *MRM* 50.1053 (2003). 6. Winkelmann S et al. *IEEE TMI* 26.68 (2007).

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