MEASUREMENT OF BODY FAT COMPOSITION IN CHICK EMBRYOS USING A 7T MRI

Qun Zhao[1,2], Houchun H Hu[3], Qingying Meng[1], Forrest Goodfellow[2,4], and Steve Stice[2,4]

[1]Bioimaging Research Center, University of Georgia, Athens, GA., United States, [2]Regenerative Bioscience Center, University of Georgia, Athens, GA., United States, [3]Dept. of Radiology, Phoenix Children's Hospital, Phoenix, AZ, United States, [4]Department of Animal & Dairy Science, University of Georgia, GA., United States

Target audience: Scientists and clinicians who are interested in water-fat imaging and body compositions in developmental embryos of animals.

Purpose: Approaches for quantitative evaluation of triglyceride (fat) distribution throughout bodies of animals are critically needed as they provide valuable tools to study obesity, metabolic abnormality, nutrition, or disease conditions involving excess fat accumulation. In developmental biology, accurate evaluation of adipose tissue, particularly brown adipose tissue's distribution within organs and specific sites in the body, are of particular interest because of the ability of these cells to burn fat**.** MRI has been emerging as a comprehensive tool for fat quantification. Relaxometry-based and chemical shift-based water-fat imaging (WFI) has been developed and extensively applied [1-3]. In this study, WFI was executed on chick embryos *in ovo* on a 7T MR scanner to examine body composition, especially fat, in the embryos.

Methods: MR experiments were conducted on an Agilent (Varian) 7.0T/210/ASR small animal scanner. The gradient coils provide a maximum gradient (at 300 A) of 600 mT/m, with duty cycle of 14%. A phantom consisting of 3 vials, i.e., one vegetable oil and two water vials, was first scanned with a 3D gradient echo sequence, with the following parameters: TR=20ms , FA=20º, six different TEs of 1.9, 2.06, 2.22, 2.38, 2.54, 2.70, and 2.85 ms, acquisition matrix=128 x 128, FOV=40 mm x 40 mm. Following the phantom scan, a chick embryo (day15) was scanned in compliance with local ethics committee. The scan protocols are

1. The embryo anatomy was acquired with a fast spin echo with multiple slices (FSEMS) sequence: TR=3000 ms, ESP=10 ms, segment/ETL=16/8, acquisition matrix=128 x 128, effective TE=40 ms, FOV=60 mm x 50 mm, 15 slices, slice thickness=1.5mm, gap=0.0 mm, average=1
2. Gradient echo sequence with multiple slices (GEMS): TR=200 ms, FA=20º, acquisition matrix=128 x 128, FOV=60 mm x 50 mm, 15 slices, slice thickness=1.5mm, gap=0.0 mm, average=1. Six TEs were acquired at 2.85, 3.01, 3.17, 3.33, 3.49, and 3.65 ms, respectively. Note that these TEs were determined to generate phase differences (3.5ppm or 1050 Hz at 7.0T) between water and fat to be 0 (in phase), $\pi/3$, $2\pi/3$, π (out of phase), $4\pi/3$, $5\pi/3$.

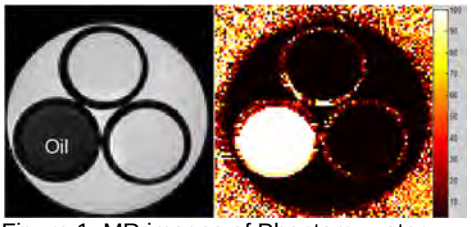

Figure 1: MR images of Phantom: water image (left); fat fraction map (right)

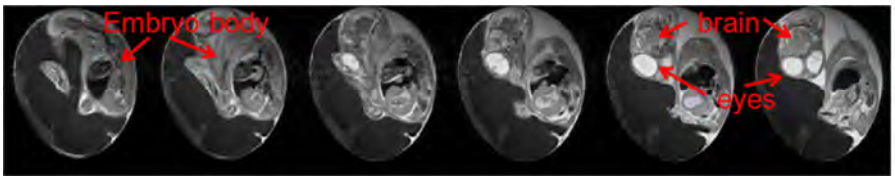

Figure 2: MR images of chick embryo (selected slices).

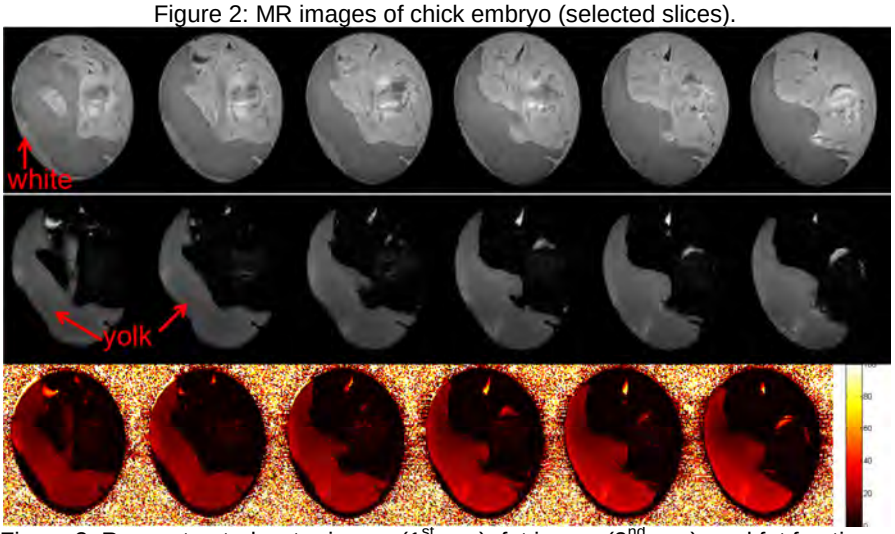

Figure 3: Reconstructed water image (1st row); fat image (2nd row); and fat fraction map (3rd row) after post-processing with WFI algorithms.

Data Processing and Results: MR raw (k-space) data acquired were processed with Matlab software (Mathworks, Natick, MA.). A WFI toolbox containing different WFI algorithms [4] was employed to reconstruct the water- and fat-images. Fat fraction map was calculated as a ratio of fat/(water+fat). Figure 1 presents the reconstructed water image and fat fraction map, acquired from the oil/water phantom. Figure 2 illustrates MR images of the chick embryo, which clearly illustrate anatomy of the embryo at day 15 of incubation. Figure 3 shows the reconstructed water/fat images, and fat fraction maps, of six selected slices (out of 15), after post-processing with WFI algorithms. Large area of egg yolk and distributed fat in organs of the embryo are clearly illustrated in the fat images.

Discussion and Conclusion: Through this preliminary study we investigated the feasibility of examining the body (or fat) composition of chick embryos using the chemical shift-encoded water-fat imaging (WFI) approach. The results indicate that the WFI provides a consistent estimate of fat distribution in the embryo body. Further longitudinal study of the body composition during embryo development will be conducted, as well as confirmation with fat histology.

Acknowledgements: This study is supported by EPA grant (83555101) and NIH grant S10RR023706 from the National Center for Research Resources.

References: [1] Dixon WT. Radiology 1984:153 [2] Glover GH et al Magn Reson Med 1991:18 [3] Reeder SB et al Magn Reson Med 2004:51 [4] Hu, HH et al NMR Biomed 2013.