Quantification of Brown Adipose Tissue in DIXON Water-Fat Separation and T2* Mapping

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Purpose: Scientific studies have demonstrated an inverse correlation on the amount of brown adipose tissue (BAT) with percentage of fat, body-mass index (BMI) and age in human [1]. Previous measurement on such energy expenditure tissue relied on PET/CT diagnosis. With technological advancement and deeper understanding in the tissue cell structures, it is now feasible to conduct MRI assessments to avoid unnecessary radiation exposures and contrast agent intake. The purpose of this study was to verify the accuracy of using DIXON water-fat separation method and T2* mapping to quantify BAT in adolescents.

Methods: A chemical-shift water-fat separation MRI sequence with DIXION and T2* MR imaging technique was applied on obese teenagers (mean BMI = 32.4 $kgm^{-2,}$ range: 26.8-37.5 kgm^{-2}; mean age = 15.6, range: 14.2-17.2) and control group (mean BMI = 23.3 $kgm^{-2,}$ range: 19.9-26.3 kgm^{-2}; mean age = 20.1, range: 19.9-20.3). Fat-fraction signal and T2* mapping were generated with the multiecho scanning and specially focused on interscapular-supraclavicular region. Water-fat fraction and T2* mappings were generated to quantify fat tissue distribution within the body. In reference with BAT imaging characteristics in previous studies [2], the two imaging methods were then jointly used with a probabilistic mapping technique to visualize distribution of various fat tissues.

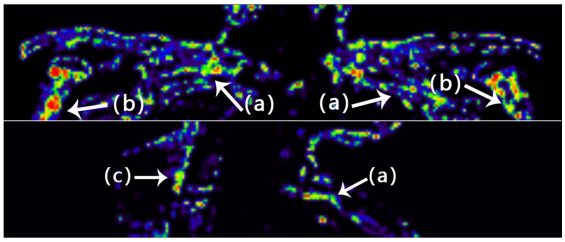

Fig. 1 BAT majority deposit in coronal view (upper) and sagittal view (lower). (a) interscapular-supraclavicular, (b) axillary and (c) spine.

Results: The interscapular-supraclavicular region appeared to have high concentration of BAT in our analysis, as expected in the hypothesis (Fig.1). Results indicated volume of BAT was significantly less in obese subjects than that in normal controls.

Discussion: Results obtained from our study demonstrated good coherence with results from other similar studies. Majority of BAT is located at interscapular-supraclavicular, axillary and spine as indicated in Fig. 1. In this cohort of obese adolescent, the total volume of BAT is more than that in normal controls. Nevertheless, when the ratio of BAT/WAT is compared, obsess subjects have significantly lower BAT ratio than the healthy one. The high accumulation of WAT indirectly reduced the BAT/WAT ratio, even the total volume of BAT in obese subject is higher. Based on Lichtenbelt et al. [3] that the activity of BAT is reduced in overweight subjects, we can postulate that only a portion of them is triggered to regulated energy expenditure. However, further researches should be carried out to understand relationship between obese and inactive BAT.

Conclusion: The proposed algorithm could accurately measure the volume of BAT in human and could be served as an alternative to detect BAT and WAT based on the differences of their physical properties under MR.

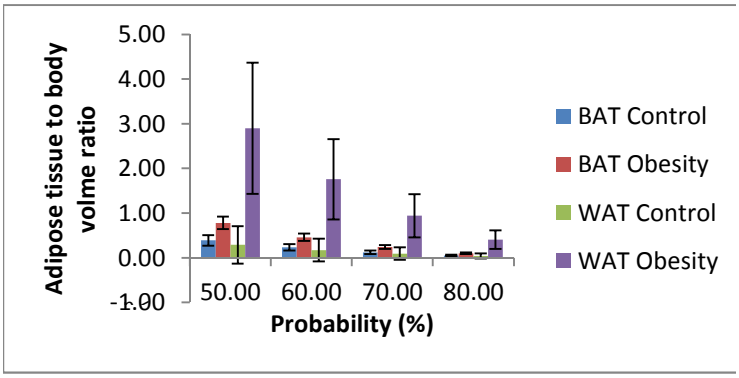

Fig. 2 BAT and WAT volume to body volume ratio

References:

[1] V. Gilsanz, et al., *J Pediatr,* vol. 158, pp. 722-6, May 2011; [2] Rasmussen, et al., *PLoS One,* vol. 9, Jan 9 2014; [3] Lichtenbelt et al., *N Engl J Med,* vol. 360, pp. 1500-8, Apr 9 2009.