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Brown adipose tissue identification in an adult human using IDEAL MRI

Narendra L Reddy[1], Terence A Jones[1], Sarah C Wayte[2], Oludolapo Adesanya[3], Yen Yeo[4], Gyanendra Tripathi[1], Philip G McTernan[1,] Harpal S Randeva[1], Sudhesh Kumar[1], Charles E Hutchinson[1,3], Thomas M Barber[1]

Warwick Medical School[1], University of Warwick, Clinical Sciences Research Laboratories, Coventry, UK

Departments of Medical Physics[2], Radiology[3] & Histopathology[4], University Hospitals of Coventry & Warwickshire, UK

Aim

Manipulation of human brown adipose tissue (BAT) represents a novel therapeutic option for diabesity. The aim of our study was to develop and test a novel Magnetic Resonance Imaging (MR) based method to identify human BAT and delineate it from white adipose tissue (WAT), and validate it by providing immuno-histochemical confirmation.

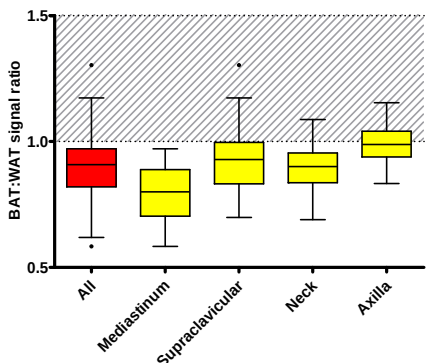

Figure 1: Variation in BAT_{retro}:WAT_{retro} signal ratio according to anatomical location, with significantly lower signal ratio within mediastinum and neck. The shaded area represents a ratio >1 (i.e.WAT_{retro} signal > BAT_{retro} signal)

Methodology

Initial scanning with ^{18}F-FDG PET-CT radiotracer uptake on a 25-year old Caucasian female with primary hyperparathyroidism, showed avid uptake within the mediastinum, neck, supraclavicular fossae and axillae, consistent with BAT. Subsequently, serial MR scans were performed using 3-echo IDEAL (iterative decomposition of water and fat with echo asymmetry and least-squares estimation) sequence. Retrospectively, regions of interest (ROIs) were identified on MR corresponding to PET-CT images. Prospectively, ROIs were identified on MR images based on signal intensity and appearance, and compared with PET-CT. Immunohistochemical staining using uncoupling protein-1 antibody was performed on fat samples corresponding to low MR-signal, obtained during parathyroidectomy.

Results

Of the 111 retrospectively identified ROIs from PET-CT scans, 88 (79%) showed corresponding low signal on the MR images: 100% in mediastinum, 29/31 (93.5%) in neck, 31/41 (75.6%) supraclavicular, and 8/14 (57%) in axillae. Prospectively, 47/54 (87%) of ROIs identified on MR scans corresponded to increased areas of uptake on PET-CT scans. Histology and immunohistochemistry confirmed BAT.

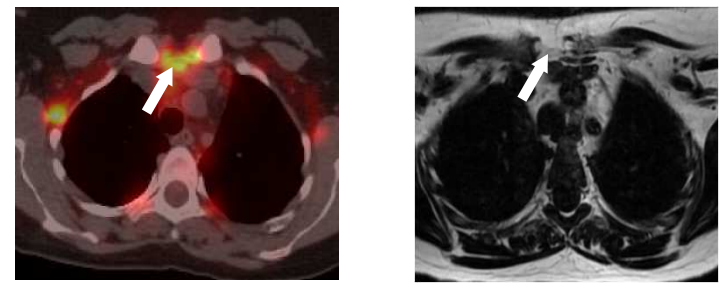

Figure 2*:* (a) ^{18}F-FDG uptake within the suprasternal notch on PET-CT (arrow); (b) fat:IDEAL MR at the same level showing corresponding low signal in the suprasternal notch; (c) Haematoxylin-Eosin staining (d) UCP1 immunostaining

Anatomical region	No of BAT_{retro} ROIs with lower MR signal than adjacent fat	No of BAT_{retro} ROIs with similar MR signal to adjacent fat	Total number of ROIs	Total area of ROIs (mm^2)
All regions	93	18	111	9030
Mediastinum	25	0	25	2348
Supraclavicular	31	10	41	3313
Neck	29	2	31	1451
Axillae	8	6	14	1918

Conclusion

We provide the first ever report that MR can be used reliably to identify BAT in a human adult, with histological and immunohistochemical confirmation. Our data demonstrate proof of concept to support the development of MR, a safe and reproducible imaging modality, as a biomarker for human BAT.

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