Automatic Segmentation of Intra-abdominal and Subcutaneous Adipose Tissue in 3D Whole Mouse MRI

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Introduction

The distribution of adipose compartments is important when evaluating anti-obesity compounds. The aim here was to create a fully automatic segmentation routine for intra-abdominal (IAT), subcutaneous (SAT) and total adipose tissue (TAT=IAT+SAT) in mice, to replace tedious and subjective manual segmentation.

Materials and Methods

In vivo whole mouse 3D MRI were acquired on a Bruker BioSpec 9.4T/20 USR using a 50 mm i.d., 90 mm long quad resonator (m2m Imaging). Two whole body 3D FISP scans (TE/TR 1.7/3.3 ms, FOV 100x45x45 mm, matrix 428x192x192, NA 1) were acquired with flip angles 20º and 45º. The novel fully automatic image segmentation algorithm, a) outlines body, b) extracts fat, and c) segments IAT and SAT using the Narrowest Passage Transform (NPT) which codes each pixel with the radius of the narrowest passage on the widest possible 3D path to the body outline, and competitive region growing on the fat mask transform such that competing classes meet at narrow passages. Finally, manual and automatic segmentations of IAT and SAT were conducted on images from 32 fat fed mice independent to those used for algorithm development (Fig. 1).

Results

Automatic processing took an average 28 seconds on a 3.6 GHz Pentium computer with 2 GB RAM. Manual segmentation typically took one hour per image volume. The correlation coefficients between manual and automated segmentation of TAT and IAT were 0.97 and 0.94, respectively.

Discussion

Previous attempts to use region growing to segment IAT and SAT in rodents have suffered from leakage through the peritoneum because, to date, it is not possible to fully resolve these small structures with MRI. We have solved this by developing an algorithm to select IAT seed points based on the size of the narrowest passage through the peritoneum wall and performing competitive region growing such that competing classes meet at narrow passages. The NPT implementation is very efficient since there is no need to explicitly compute any of the huge number of possible paths. The proposed fully automatic method shows good correlation to manual segmentation and dramatically speeds up body composition measurements, allowing body composition MRI to be used in the anti-obesity drug discovery pipeline.

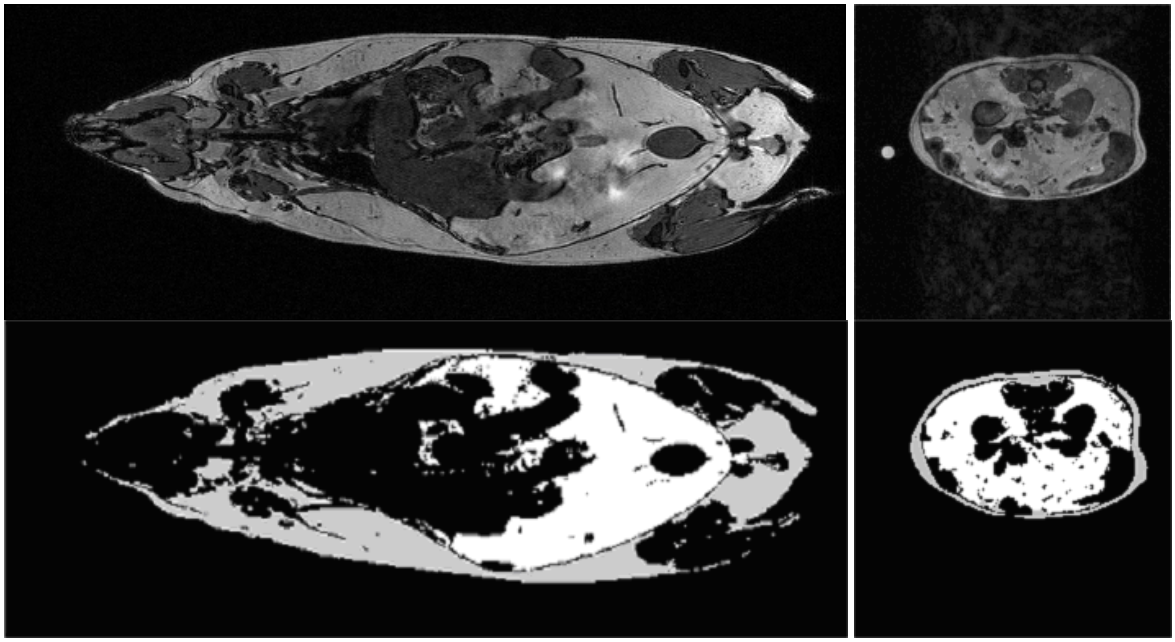

Fig. 1a Example FISP FA20 coronal and axial slices through one mouse

Fig 1b IAT and SAT fully automatic 3D segmentation