Rapid Assessment of Adrenal Gland Volume in the Rat.

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Introduction.

Adrenal glands function to produce hormones typically associated with stress and with fluid/salt level homeostasis, and their dysfunction can result in serious illness. Clinical assessment of adrenal pathology by MRI has been well described[1]. Reports from animal studies are much more limited, one notable exception describing adrenal growth in a transgenic mouse model[1].

In this report we describe a fat-suppressed fast spin echo method suitable for rapid volume assessment of the adrenal glands in the freely breathing anaesthetised rat.

Methods.

All experiments were performed in accordance with the Animal (Scientific Procedures) Act 1986 (UK).

8 male Sprague Dawley rats (250-280 g at the start of the experiment) were dosed orally with vehicle suspension of carboxymethyl-cellulose (1% in water, 10ml/kg) daily throughout this experiment. For MRI, anaesthesia was induced and maintained using 2-3 % Isoflurane in air/O2 (70/30%). Rectal temperature was maintained using a homeothermic electrical blanket system. Respiration rate was maintained at 50-70 breaths per minute. A respiratory triggered 16-slice fat-suppressed fast spin echo protocol was used as this generated a bland, uniform intensity for the adrenal glands that was well contrasted from the surrounding tissues. Images were acquired at 4.7 T (Bruker Biospec) using a 69 mm quadrature birdcage coil (Rapid Biomed). FSE parameters were TEeff=21 ms, ETL=8, 128 (read) x 256 (phase) matrix, FOV=30x60 mm. 16x 0.5 mm slices. 4 (out of 16) slices were acquired following each respiratory trigger, giving a TR defined by the duration of 4 breaths (ca. 4 s) and a scan duration of ca. 8-9 minutes. CHESS fat suppression was used. Receiver bandwidth was ca. 100 kHz, and RF pulse width was 2 ms to minimise chemical shift artefact in the read and slice directions. TR was sufficiently long to prevent overt artefacts derived from respiration rate dependent degrees of T1 relaxation. 4 NEX was used for both SNR improvement and reduction of residual motion artefact. Non fat-suppressed images were also acquired and used to guide ROI positioning on the fat suppressed image. Rats were scanned 3 times over a two week period (day 1, 5 and 15). Following MRI on day 15 the rats were killed and the adrenal glands removed for *post mortem* (*PM*) analysis (including weighing). Adrenal gland volumes were assessed manually using the ImageJ software package, and took approximately 5-10 minutes per animal.

Results and discussion.

Typical fat-suppressed images of the adrenal glands are given in Fig 1, and adrenal gland volume and post mortem mass data are given in Fig 2.

Adrenal gland volume increase was detected between the start of the study and day 5 (LSD test, $p<0.0004$), but not between days 5 and 15 ($p>0.74$). There was a correlation ($r=0.79$) of adrenal volume for the 15 day scan, and *PM* mass, and a positive mass offset of ca. 4 mg/adrenal, possibly resulting from adherent fatty tissue that cannot easily be removed from the adrenal without inducing damage. The Group Cut-Off for the smallest detectable difference[3] in organ growth is 8.1 %, thus the growth that occurred between the days 0 and 5 can be correctly ascribed to genuine organ growth. We cannot, at present, exclude stress derived from dosing and/or MRI as being causal. These data also predict that a 35% organ growth could be reliably detected using n=3.

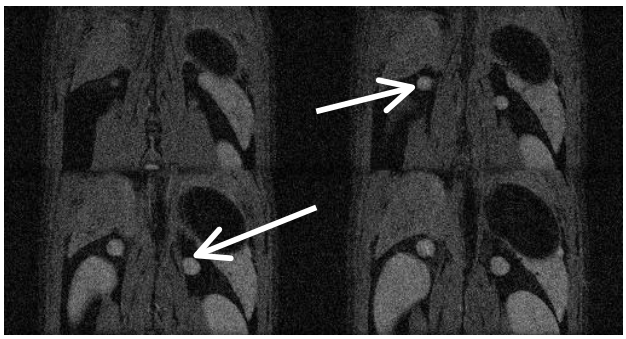

Fig. 1. 4 contiguous, 0.5 mm thick slices through the abdomen of a free breathing rat acquired in ca. 8 minutes. Fat suppression and respiratory triggering were used. Adrenals glands are well contrasted from the surrounding tissues and fat (see arrows).

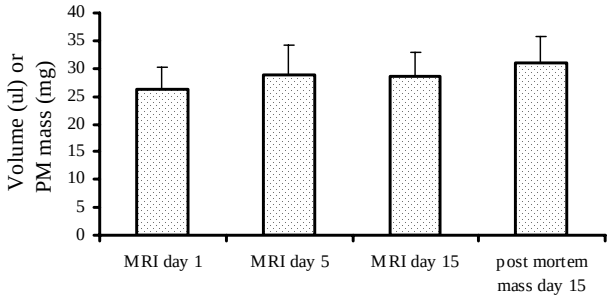

Fig. 2. Adrenal gland volume by MRI and *PM* mass (mean±SD). Growth (ca. 10 %) was detected between day 0 and 5 ($p<0.001$) but not between day 5 and 15. Volume at 15 days correlated with *PM* mass ($r>0.79$).

Conclusion

Adrenal gland volume in the rat can be assessed quite simply using fat suppressed FSE within an acceptable scan and analysis time. The use of repeated MRI scans in the same animals permits reduction in smallest detectable differences and/or in sample size, thus the method offers the capability for performing efficient screening examinations of adrenal gland volume change in the rat.

References.

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