



Original Contribution

A COMPARATIVE STUDY OF CROSS SECTIONAL ANATOMY AND COMPUTED TOMOGRAPHY OF PERIRENAL FAT DEPOTS IN NEW ZEALAND WHITE RABBITS

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ABSTRACT

(CT) is a contemporary non-invasive imaging technique that gains an increasing importance for *in vivo* investigations of subcutaneous and visceral fat. The purpose of this investigation was to describe the topography and anatomy imaging features of perirenal fat depots at the level of both kidneys in clinically healthy New Zealand White rabbits that attained slaughter weight. The CT consecutive transverse scans from the last thoracic to the fifth lumbar vertebrae showed that in rabbits, perirenal fat appeared as a homogeneous hypodense structure at the background of denser shadows of lumbar and abdominal muscles, kidneys and abdominal organs. Perirenal fat depot exhibited a soft tissue density with average attenuation of -120.97 ± 4.73 HU. On CT scans, the largest dimensions of the perirenal fat depot were 1.3 ± 0.01 cm at the level of the right kidney's cranial pole; 1.96 cm in the plane where the right renal hilus was visualized; 1.66 ± 0.08 cm at the level of the right kidney's caudal pole; 1.10 ± 0.18 cm in the plane where the left renal hilus was visualized and 1.06 ± 0.15 cm at the level of the left kidney's caudal pole. No subcutaneous fat deposits in the abdominal area were seen.

Results obtained in the present study could be used as basic information for various anatomy investigations of rabbits as well as experimental designs for study of obesity in animals and humans.

Key words: Computed tomography, cross sectional anatomy, perirenal fat, rabbits.

INTRODUCTION

Computed tomography (CT) is a contemporary non-invasive imaging technique that gains an increasing importance for *in vivo* investigations of fat tissue in both animals and men. CAT allows a differentiated measurement of subcutaneous and visceral fat, which differ both with regard to their topography and metabolic activity (1). In men, CAT is used for determination of intraabdominal fat to evaluate the risk of cardiovascular disease (2). In veterinary medicine, the method is successfully used to assess the body status, productivity and feed utilization in animals (3). In the clinical

practice, CAT is applied to investigate obesity in dogs (4) as well as preparations for body weight, respectively fat tissue reduction (5).

(6) Have used computed tomography to determine the changes in all tissues of growing rabbits and demonstrated a sharp increase in fat tissue volume in rabbits weighing 2.5 and 3.5 kg. (7) performed a similar study in rabbits of different genotypes. By means of magnetic resonance imaging, the authors observed a strong positive correlation between the perirenal fat depot volume and slaughter weight of rabbits. (8) Described the computed tomography and topographic features of the neck, thorax and abdomen in rabbits but without specifying fat depots' topography.

Rabbits are prone to deposition of large visceral fat amounts, i.e. exhibits a central obesity type. In this species, the perirenal fat depot is the largest (9). Diet-induced obesity

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and castration of rabbits result not only in statistically significant increase in perirenal fat volume, but also in increased blood plasma glucose, triglycerides, total lipids and cholesterol concentrations, correlating positively with higher body weight (9, 10, 11, 12). The large amount of visceral perirenal fat tissue in rabbits causes higher interstitial pressure in kidneys and hypertension. These signs are also observed in heavily obese people as well (13).

According to (3) each tissue with computed tomography attenuation values lower than zero and higher than -300 HU (Hounsfield Units) is defined as adipose. According to (14) these values range between -150 and -50 HU (15) reported that in rabbits, CT attenuation of fat tissue was from -140 to -50 HU. The average attenuation values decrease parallelly to body weight increase due to the higher lipid content of tissues (4, 16).

The purpose of this investigation was to describe the topography and anatomy imaging features of perirenal fat depots in clinically healthy New Zealand White rabbits that attained slaughter weight.

MATERIAL AND METHODS

In this study, 10 clinically healthy 3-month-old New Zealand White rabbits from both genders, weighing 3.0 to 3.5 kg were used.

Rabbits were fed twice daily with compound pelleted feed containing 18.3% crude protein, 12.5% crude fibre, 1.2% fat and 2224.92 J energy.

Experiments were conducted under strict observance of requirements of the Animal Ethics Committee at the Faculty of Veterinary Medicine, Trakia University.

Blood was sampled from all rabbits in order to assay plasma concentrations (in mmol/L) of total cholesterol (TC), triglycerides (TG), low-density lipoproteins (LDL) and high-density (HDL).

CT was performed on a tomograph Siemens ART(X) with anode tension 110 kV, anode current 70 mA, 512 X 512 matrix image, scans at 5 mm; without interval between them, scan time 3 s.

For more precise performance of tomography, rabbits were anaesthetized with 5 mg/kg Zoletil^(R) 50 (Virbac) intramuscularly and were fixed in dorsal recumbency on CT table. The

abdominal cavity was scanned between the last thoracic and the fifth lumbar vertebrae. The perirenal fat width was determined at the greatest thickness site at the level of cranial poles, hili and caudal poles of both kidneys. Also, the soft tissue density of perirenal fat depot was determined.

After euthanasia, rabbits were fixed in dorsal recumbency and deep-frozen at -10 °C. Bodies were removed from the camera after at least 24 hours. Transverse cross sections of the abdominal cavity were performed by means of an electric saw from the last thoracic to the fifth lumbar vertebra at 8–10 mm intervals.

The topography and the thickness of right and left perirenal fat depots were observed and measured on transverse topographic abdominal cross sections between the last thoracic and the third lumbar vertebrae. Perirenal fat thickness was measured at cranial poles, hili and caudal poles of both kidneys.

Blood parameters, morphometric and CT data were statistically processed (STATISTICA v 6.1, StatSoft Inc. 2002). Data are presented as mean $\pm$ standard error of the mean (SEM).

RESULTS

The blood biochemistry data in rabbits showed plasma total cholesterol concentrations of 1.45 ± 0.15 mmol/L, triglycerides 0.63 ± 0.01 mmol/L, low-density lipoproteins (LDL) 0.67 ± 0.11 mmol/L, high-density lipoproteins (HDL) 0.66 ± 0.03 mmol/L and blood glucose 5.15 ± 0.64 mmol/L. All parameters were within the reference range for the species.

The CT consecutive transverse scans from the last thoracic to the fifth lumbar vertebrae showed that in rabbits, perirenal fat appeared as a homogeneous hypodense structure at the background of denser shadows of lumbar and abdominal muscles, kidneys and abdominal organs. Perirenal fat depot exhibited a soft tissue density with average attenuation of -120.97 ± 4.73 HU. On CT scans, the largest dimensions of the perirenal fat depot were dorsolaterally vs the lateral renal border. Their average values were 1.3 ± 0.01 cm at the level of the right kidney's cranial pole; 1.96 cm in the plane where the right renal hilus was visualized; 1.66 ± 0.08 cm at the level of the right kidney's caudal pole; 1.10 ± 0.18 cm in the plane where the left renal hilus was visualized and 1.06 ± 0.15 cm at the level of the left kidney's caudal pole (**Fig. 1 and Fig. 2**).

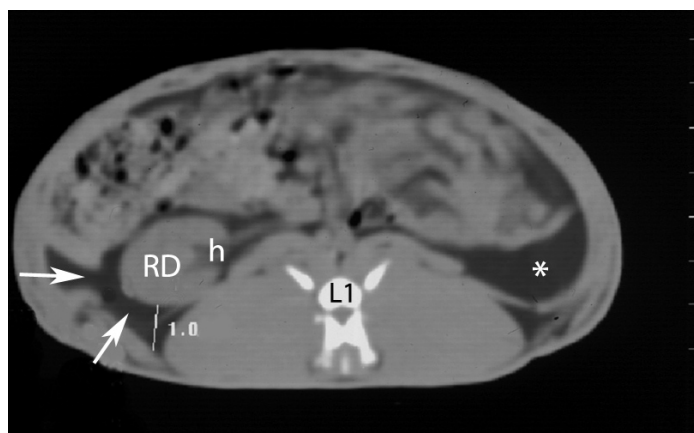


Fig. 1. Computed tomography image of rabbit abdominal cavity - transverse scan at the level of the first lumbar vertebra; L1 – first lumbar vertebra, RD – right kidney, h – hilus, → – right perirenal fat depot, * - left perirenal fat depot.

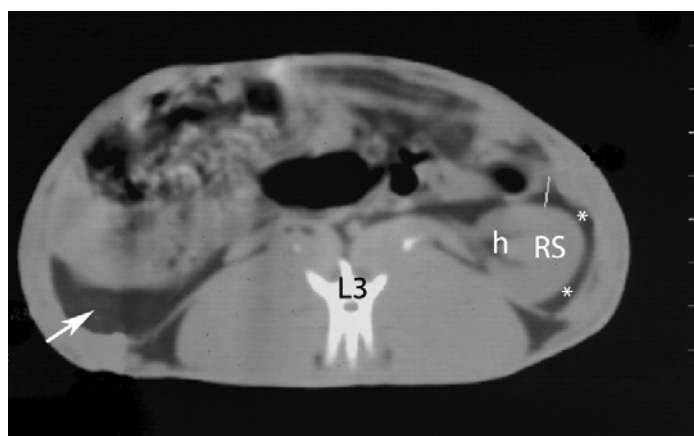


Fig. 2. Computed tomography image of rabbit abdominal cavity - transverse scan at the level of the third lumbar vertebra; L3 – third lumbar vertebra, RS – left kidney, h – hilus, → – right perirenal fat depot, * - left perirenal fat depot.

On transverse native cross sections from the last thoracic to the first lumbar vertebrae, right perirenal fat tissue touched the liver and the right diaphragmatic crus, whereas the left perirenal fat depot touched the stomach. Dorsally, both fat depots were adjacent to longissimus lumborum and psoas major muscles, laterally – to the transverse fascia and through it, to abdominal muscles; medially they embraced the caudal vena cava, the aorta, the left and right adrenal glands, the left and right renal arteries and veins, and both ureters. Fat tissue was not present only around the ventral surface of both kidneys as well as at the site when the right kidney contacted the liver.

Ventrally, the kidneys bordered the ascending colon and the jejunal ansa. On transverse cross sections, no subcutaneous fat deposits in the abdominal area were seen.

The thickness of the fat depot against the lateral kidney borders was as followed: 1.2 ± 0.01 cm at the level of the right kidney's cranial pole; 1.8 cm in the plane where the right renal hilus was visualized, 1.5 ± 0.08 cm at the level of the right kidney's caudal pole; 1.3 ± 0.18 cm in the plane where the left renal hilus was visualized, and 1.1 ± 0.15 cm at the level of the left kidney's caudal pole (**Fig. 3 and Fig. 4**).

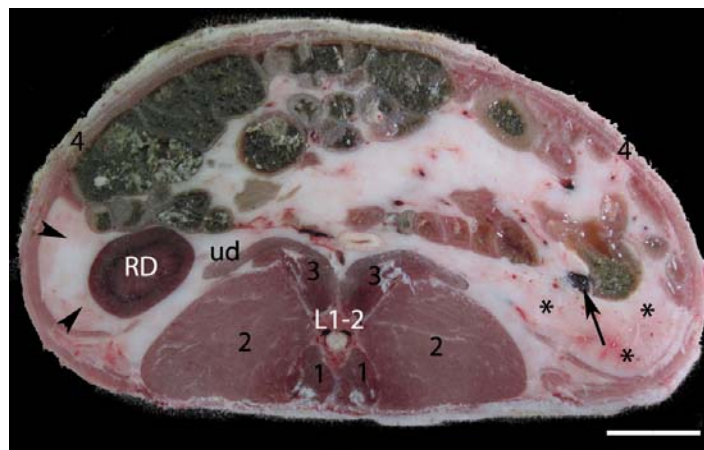


Fig. 3. Cross sectional anatomy of the abdominal cavity in a rabbit - transverse cut at the level of the first-second lumbar vertebra. Cranial view. Bar=2 cm

L1-2 –level of the first-second lumbar vertebra; RD – right kidney; RS – left kidney; →- left kidney's cranial pole; ud –right ureter; 1 - mm multifidi; 2 - m. longissimus lumborum; 3 - m. psoas major; 4 - m. obliquus

externus abdominis + m. obliquus internus abdominis + m. transversus abdominis; ► - right perirenal fat depot; * - left perirenal fat depot.

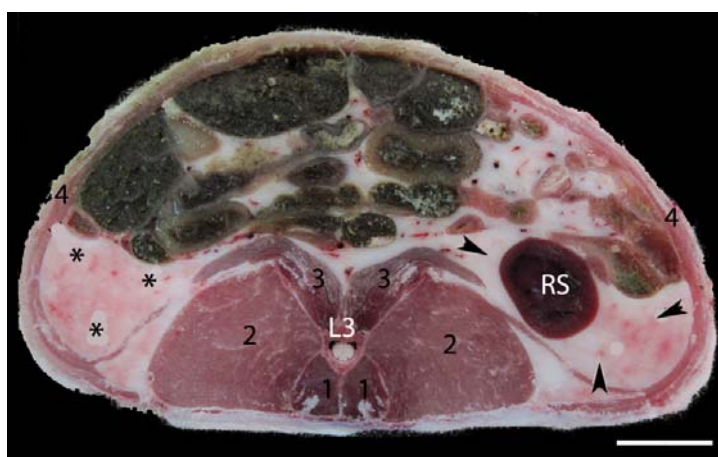


Fig. 4. Cross sectional anatomy of the abdominal cavity in a rabbit - transverse cut at the level of the third lumbar vertebra. Cranial view. Bar=2 cm

L3- level of the third lumbar vertebra; RS – left kidney; 1 - mm multifidi; 2 - m. longissimus lumborum; 3 - m. psoas major; 4 - m. obliquus externus abdominis + m. obliquus internus abdominis + m. transversus abdominis; ► - right perirenal fat depot; * - left perirenal fat depot.

DISCUSSION

The present investigations demonstrated that clinically healthy New Zealand White rabbits fed a standard ration and having attained slaughter weight, had normal blood lipid and glucose profile. Nevertheless, CT scans and cross sectional anatomy views showed a profuse amount of perirenal fat that encircled both

kidneys dorsolaterally and medially, but found only at a small amount or absent on the side of the ventral renal surface. Subcutaneous fat deposition was not observed in transverse and CT scans made. It was reported (9, 10 11, 12) that high-energy diets and castration also contributed to large perirenal fat deposits formation but accompanied with increased blood lipid profile indices and high blood glucose concentrations. On the other side it was shown (13) that the profuse perirenal adipose tissue exerted a mechanical compression upon renal parenchyma and renal blood vessels. The in vivo evaluation of perirenal fat depot by means of computer tomography allowed its measurement with a high

precision for a short time. The average soft tissue attenuation values of rabbit perirenal fat -120.97 ± 4.73 HU were very similar to those obtained in humans: -126.5 to -23.7 HU (17). Transverse native anatomical cross sections of rabbit abdominal cavity were of considerable assistance for interpretation of CT scans. Contrary to some authors (8) we believe that fat tissue should also be a subject for description along with the topography of organs on cross sectional anatomy views. Also, these investigators have used a ventral recumbency of rabbits, whereas in this study as well as (18), were performed the examinations in dorsal recumbency because in this position, the compression of abdominal organs was avoided and therefore, was more appropriate.

In conclusion, the results obtained in the present study could be used as basic information for various anatomy investigations of rabbits as well as experimental designs for study of obesity in animals and humans.

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