Determination of the relationship between ultrasonographic examination of hepatic lipidosis and obesity assessment parameters in cats of different body conditions

Research Article

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ABSTRACT

This study aimed to determine the relationship between ultrasonographic examination of hepatic lipidosis and obesity assessment parameters in cats of different body conditions. For this purpose, 27 cats in different body conditions which have not any systemic health problems were evaluated. Body condition score and body fat index were examined by inspection and palpation; subcutaneous adipose tissue thickness, hepatorenal index and hepatic lipidosis grade by ultrasonography. The relationship between parameters on the basis of all individuals was evaluated. Also, the cats were divided into three groups according to their body conditions, and whether there was any difference between these groups in terms of subcutaneous adipose tissue thickness, hepatorenal index and hepatic lipidosis grade were investigated. There was a significant positive correlation between body condition score and body fat index, subcutaneous adipose tissue thickness, hepatic lipidosis grade and hepatorenal index, respectively. Different degrees of hepatic lipidosis were observed in at least some individuals in all body condition groups. There was a significant difference between the different body condition groups in terms of subcutaneous adipose tissue thickness, hepatorenal index and hepatic lipidosis grade. This study showed that mild hepatic lipidosis can be seen even in cats with normal body condition; increased body condition and body fat cause an increased risk of hepatic lipidosis in cats; subcutaneous adipose tissue thickness measurement during clinical evaluation and hepatorenal index during ultrasonographic examination can be a use practical and reliable option for prediction and grading of hepatic lipidosis.

Keywords: Feline, Body condition score, Body fat index, Hepatorenal index, Hepatic lipidosis grade

INTRODUCTION

Obesity is defined as the accumulation of fat in the body that causes health problems. The ratio of body fat to body weight between 15% and 20% in cats and dogs is considered as normal and above these rates is important in terms of obesity risk. (Armstrong&Lusby, 2011). Obesity is often associated with insulin resistance, diabetes, cancer, cardiovascular, orthopedic, reproductive, dermatological and urological problems (Loftus & Wakshlag, 2015). In addition, an increase in the serum fatty acids (triglyceride) concentrations in obese individuals can cause damage to the liver, which is the metabolic center of the body (Fujiwara et al., 2015). Triglycerides accumulated in the liver in obese individuals causes hepatic lipidosis, which is characterized by stress, calorie restriction and long-term fasting, with vomiting, anorexia, jaundice, blindness and coma (Pazak et al., 1998).

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There are a number of methods that can be used to assess body composition in humans in terms of obesity risk. Body condition score, body fat index, measuring with tape measure, body mass index, bioelectrical impedance analysis, isotope dilution methods, dual energy x-ray absorptiometry, ultrasound, magnetic resonance and computed tomography are the most commonly used methods (Santarossa et al., 2017).

In the literature review, a very limited number of studies on hepatic steosis were found in pets, especially in cats which obesity is common because they generally lead a sedentary life. With this study, it is aimed to reveal the sensitivity of the evaluation by comparing the subcutaneous fat layer measurement and hepatorenal index, which is a practical and objective evaluation method that can be easily applied in routine examinations, with other methods.

MATERIAL and METHOD

Animal Studied

This study was carried out on 27 cats of different breeds, between 3.5-8.4 kg and 1-6 years old, who were brought to our clinics and did not have any systemic health problems. The cats were divided into three groups according to their body condition scores as ideal (BCS 4 and 5, n:9), above-ideal (BCS 6, n:9) and overweight/obese (BCS 7, 8 and 9, n:9).

The ethical approval of the study was provided by the University's Institutional Animal Care and Use Committee (approval number: 64583101/2021/021). In this study, a signed consent form was obtained from the owners for the study.

Methods

In the study, firstly, the relationship between body condition score and body fat index, subcutaneous adipose tissue thickness, hepatic steatosis and hepatorenal index were examined in all cats (n:27). Then, whether there was a significant difference between the groups in terms of subcutaneous adipose tissue thickness, liver fat level and hepatorenal index in ideal, above-ideal and overweight/obese cats was examined.

For body condition scoring, 9-point scoring system used by Laflamme et al. (1997), and for body fat index scoring, the system, giving score from 20 to 70 in 10-point increments described by Witzel et al. (2014), was preferred.

Subcutaneous adipose tissue thickness measurements were made by measuring the hypodermis thickness between the dermis and the muscle layer in the region behind the last rib from the right side in the left lateral lying position, as defined by Iwazaki et al. (2018). An 8 MHz frequency microconvex probe ultrasound device (Mylab 30-Esaote, Genova, Italy) was used for all ultrasonographic measurements.

In order to determine the degree of hepatic lipidosis Hamaguchi's hepatic steatosis scoring system was used and images were taken from the right hepatorenal window in the left lateral recumbency and from the diaphragmatic window in the dorsal recumbency for this purpose. To calculate the Hamaguchi score the scores for a, b, and c are added together (if A ≥1) and hepatic lipidosis diagnosed if the score is ≥ 1. A; Bright liver and hepato-renal contrast (0: both absent; 1= hepato-renal contrast or bright liver present; 2: mild bright liver, hepato-renal contrast present; 3: severe bright liver, hepato-renal contrast present), B; Deep attenuation (0: absent; 1: impaired visualization of diaphragm; 2: no visualization of the diaphragm), C; Vessel blurring (0: absent; 1: present).

Images taken from the right hepatorenal window were analyzed to calculate the hepatorenal index using the gray scale measurement feature on the ImageJ.v1.31 program (developed by National Institutes of Health and available as open source). Hepatorenal index was obtained by dividing the gray scale mean of 3 regions selected from the caudate lobe of the right liver by the gray scale mean of 3 regions selected from the cranial cortex of the right kidney, as defined by Yabuki et al. (2008) (Figure 1).

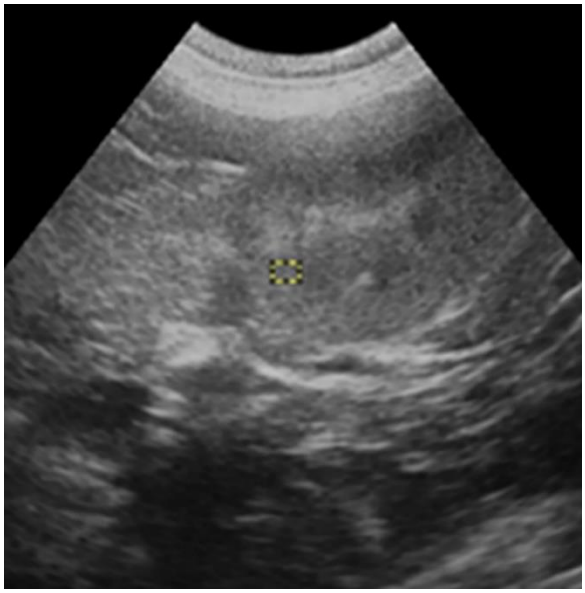

Figure 1. Selection area for kidney echogenicity

Statistical Analysis

Pearson and Spearman correlation analyzes were used to determine the relationship between parameters such as body condition score, body fat index, subcutaneous adipose tissue thickness, hepatorenal index and the degree of liver fattening measured by ultrasonography, in accordance with the type of data. Group averages were compared with one-way analysis of variance (One Way Anova) in subcutaneous adipose tissue and hepatorenal index measurements, and Tukey test as an advanced test. Due to the sequential data type of liver fattening, the Dwass-Steel-Critchlow-Fligner advanced stage test was used too, after examining with the Kruskal-Wallis test. The all tests were carried out with the IBM® SPSS Statistics V22.0 (New York, USA) package program, and $p<0.05$ was taken as the significance criterion in all tests.

RESULTS

A positive significant correlation was found between body condition score and body fat index, subcutaneous adipose tissue thickness, hepatic lipidosis grade and between hepatorenal index and hepatic lipidosis grade parameters obtained from all cats included in the study. (Table 1).

Table 1. Correlation between body condition score and body fat index, subcutaneous adipose tissue thickness, hepatic lipidosis grade and between hepatorenal index and hepatic lipidosis grade (n:27)

PARAMETERS	Body Condition Score	Hepatorenal Index	Body Fat Index	Subcutaneous Adipose Tissue Thickness (mm)	Hepatic Lipidosis Grade
Body Condition Score	-	0.915***	0.979***	0.828***	0.935***
Hepatorenal Index	-	-	-	0.749***	0.960***
***p<0.001					

Significant differences were found between ideal, above-ideal and overweight/obese groups in terms of subcutaneous fat thickness, hepatorenal index and hepatic lipidosis grade ($p<0.001$) (Table 2).

Table 2. The differences between the body condition groups in terms of subcutaneous fat thickness, hepatorenal index and hepatic lipidosis grade

Parameter Body Condition Score	Subcutaneous Adipose Tissue Thickness (mm) $\bar{X} \pm S_{\bar{x}}$	Hepatorenal Index $\bar{X} \pm S_{\bar{x}}$	Hepatic Lipidosis Grade $\bar{X} \pm S_{\bar{x}}$
İdeal	2.058±0,20[c]	1.065±0,13[c]	0.333±0,50[c]
Above-ideal	2.521±0,07[b]	1.325±0,11[b]	1.778±0,44[b]
Overweight/obese	3.184±0,85[a]	1.536±0,11[a]	2.667±0,50[a]
a, b, c: Differences between the mean indicated by different letters in the same column are significant ($p<0.001$).			

From a different angle, mild hepatic lipidosis was detected in 33.3% of the cats with ideal body condition. While 22.2% of the cats with above-ideal body condition had mild hepatic lipidosis, 77.7% of them had moderate hepatic lipidosis. In the overweight/obese group, 33.3% had moderate hepatic lipidosis and 66.6% had severe hepatic lipidosis (Figure 2).

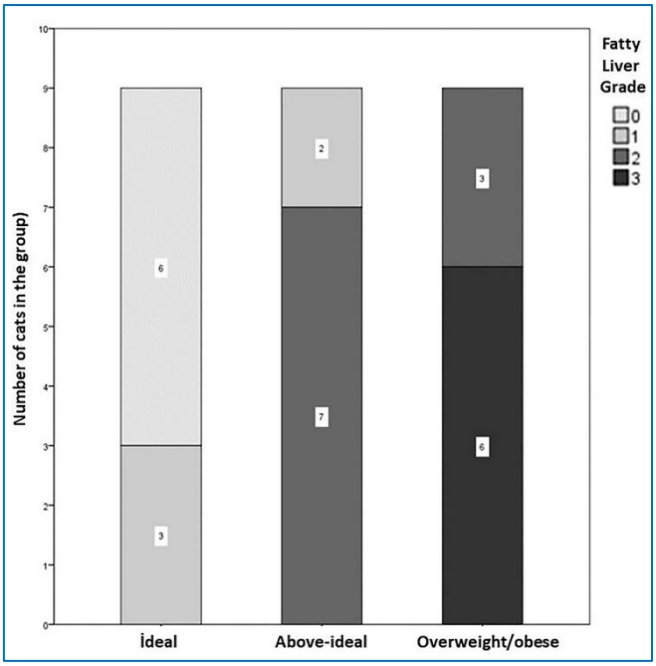

Figure 2. Distribution of hepatic lipidosis grades by group

In addition, hepatorenal index was measured as 0.981±0.018 in cats without hepatic lipidosis, 1.208±0.048 in mild hepatic lipidosis, 1.382±0.074 in moderate hepatic lipidosis, and 1.595±0.055 in severe hepatic lipidosis. (Figure 3).

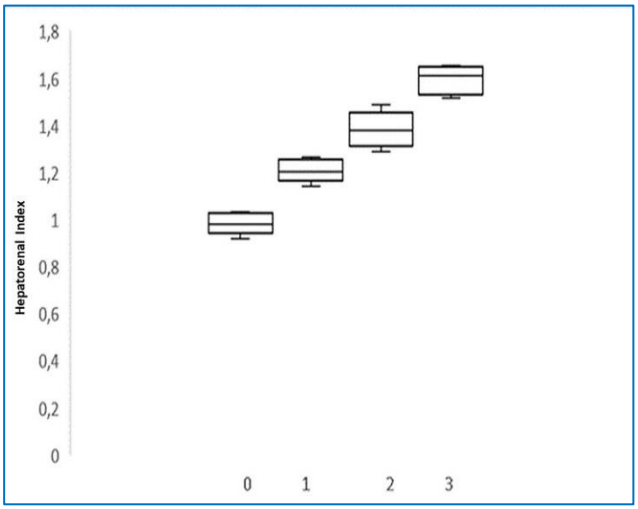

Figure 3. Hepatorenal index values of cats with different degrees of liver fattening

DISCUSSION

Various body composition analysis methods are used in the evaluation of obesity in cats and dogs. Body condition score and body fat index are frequently preferred in veterinary clinics. Both methods have their own advantages. In studies with different animal groups, it has been shown that body condition score can be determined more easily, and body fat index better represents body fat ratio (Mattiello et al., 2009; Witzel et al., 2014). In a study conducted with cats and dogs based on the evaluation of animal owners, a significant positive correlation was found between these two evaluation methods. Supporting this study, there are other studies showing that body condition score and body fat index decrease linearly in both cats and dogs in weight loss (Christmann et al., 2015; Christmann et al., 2016). In the present study, a positive significant correlation was found between body condition score and body fat index, which supports previous studies ($P<0,001$, $r = 0.979$). Since the relevant methods were applied by a single veterinarian in the study, it was thought that the correlation rate was higher than previous studies. From this point of view, it is revealed that the results obtained will be more consistent if the relevant evaluations are made by a single experienced person. In addition, it is thought that both methods can be used interchangeably due to the positive significant correlation between the two parameters.

Measurement of subcutaneous adipose tissue thickness is another method that can be used to evaluate body composition. A variable correlation between the subcutaneous fat layer in different body regions and the body condition score was shown in dogs, previously (Payan-Carreira et al., 2016). Similarly, in another study conducted in cats, a positive significant correlation was found between both parameters and also declared that the mean subcutaneous fat layer thickness to be 0.22 ± 0.01 cm in cats up to 10 years of age. (Iwazaki et al., 2018). In the present study, although a positive significant correlation was obtained between these two parameters ($P<0.001$); The average values of subcutaneous fat layer thicknesses in different body condition groups were also calculated. Although the number of animals in the group is low, these data can guide the body composition of cats to be evaluated more quickly and objectively based on the thickness of the subcutaneous fat layer, which can be easily measured from the abdomen during ultrasound examination in clinics.

In the later stages of obesity, in addition to subcutaneous fat, fat accumulation can occur in muscle and liver tissue (Fabbrini et al., 2010). From this point of view, obesity is important in

terms of the risk of hepatic lipidosis. However, the number of studies examining the relationship between body condition score and hepatic lipidosis in veterinary medicine is limited. In a study with cows, it was shown that increases in body condition score also cause an increase in the degree of liver fat detected by biopsy (Šamanc et al., 2010). In the human studies, a highly significant positive correlation was obtained between the hepatic lipidosis grade determined by biopsy and the grades obtained in the ultrasonographic hepatic lipidosis grading system used in the presented study (Hamaguchi et al., 2007). Based on this, the study examined the relationship between the degree of hepatic lipidosis detected by Hamaguchi's grading system and the hepatorenal index and significant positive correlation was found between both parameters ($p<0.001$).

In addition, the distribution of hepatic lipidosis grades in different body condition groups was also examined in the study. Unexpectedly, mild hepatic lipidosis was observed even in some cats in the ideal body condition group. For this reason, it is thought that performing ultrasonographic examinations in terms of liver fat at regular intervals in cats may be beneficial in preventing possible cases of hepatic lipidosis.

Today, hepatorenal index has also been used in human medicine, in addition to the liver fat grading method using ultrasonography (Ferraioli & Monteiro, 2019; Marshall et al., 2012). Hepatorenal index values corresponding to different degrees of hepatic steatosis have already been defined in human medicine (Avramovski et al., 2020; Chauhan et al., 2016). In veterinary medicine, there are limited studies in which mean hepatorenal index values are determined in cats (Drost et al., 2000; Yabuki et al., 2008). In the present study, a positive and significant correlation was found between the degrees of liver fattening determined by ultrasonography and the hepatorenal index values. In addition, mean hepatorenal index values corresponding to different degrees of hepatic lipidosis were also calculated. It is thought that these data will guide the faster and more objective evaluation of hepatic lipidosis in clinics.

CONCLUSION

The fact that mild hepatic steatosis was observed even in cats with normal body condition in this study suggests that it is necessary to monitor hepatic lipidosis in cats that are generally kept at home and lead a relatively sedentary life. Subcutaneous fat layer measurement and hepatorenal index, among the parameters evaluated in the study, are relatively easier and more objective than other methods. A high correlation of these parameters with the increase in body condition score and hepatic lipidosis grade, even in a small number of cats, shows that they can be considered as a practical option for the prediction and grading of hepatic lipidosis.

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Ethical approval:

The ethical approval of the study was provided by the Aydın Adnan Menderes University Animal Experiments Local Ethics Committee (approval number: 19.02.2021 / 64583101/2021/021). In this study, a signed Consent form was obtained from the owners for the study.

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Conflict of interest:

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