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Evaluation of radiographic liver length to 11th thoracic vertebral length ratio in deep chested dog

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ABSTRACT

Aim: Main purpose of the study was to evaluate radiographic liver length to 11th thoracic vertebral length ratio for setting up a quantitative index in clinically healthy deep chested dogs.
Method and materials: A total number of 89 deep chested dogs were examined through computed radiography. One year and above aged dogs of 6 deep chested breed of different body weights were included in the study. A complete computed radiography was done for right lateral (RL) and ventro-dorsal (VD) views in all dogs. The ratio was evaluated according to age, sex, body weight, breed and neutering status.
Results: The ratio of radiographic liver length to T11 vertebrae length was recorded as 6.01±0.12, 6.31±0.24, 6.44±0.22 and 5.96±0.18 in 1-3 year, 3-6 year, 6-9 year and 9-12 year of age group, respectively. Sex wise ratio 6.05±0.14 in male and 6.13±0.13 female group was measured. Body weight wise ratio was 5.38±0.21, 6.13±0.12, 6.47±0.17, 6.39±0.65 in 10-20 Kg, 20-30 Kg, 30-40 Kg and 40-50 Kg of body weight group, respectively. Breed wise ratio was 6.09±0.13, 6.24±0.21, 5.82±0.29, 6.34±0.2, 6.28±0.44 and 5.6±0.38 in German shepherd, Belgium Shepherd, Dobermann, Golden Retriever, Great Dane and Siberian Husky dog breed, respectively. Neuter status wise ratio was 5.8±0.26 and 6.15±0.1 in castrated or spayed and intact group, respectively.
Conclusion: It was concluded that the ratio of radiographic liver length to T 11 vertebrae length has set as a quantitative index of radiographic liver size in deep chested dogs. The normal radiographic liver length was concluded 6.09 times of T11 vertebrae length in deep chested dogs.

Keywords: Radiographic liver length, 11th thoracic vertebrae length, deep chested dogs.

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Introduction

Health of pet is having major importance while liver plays key role to maintain dog's health. The liver is an important organ within the body that has a central role in metabolic homeostasis, as it is responsible for the metabolism, synthesis, storage and redistribution of nutrients, carbohydrates, fats and vitamins. Being first tissue to be exposed to toxins entering the body, the liver is often main site of cell damage (Taub, 2004 and Michalopoulos, 2007). Liver size is a significant prognostic indicator of survival in humans with compensated cirrhosis and hepatic failure (Sekiyama *et al*., 1994). The liver is inspected for potential anomalies using radiographic changes in hepatic size, shape, location and opacity.

The existence of liver disease is not excluded by a normal liver size. However, liver size is helpful in screening for and making a differential diagnosis of liver illnesses. Hepatomegaly may be a sign of primary and metastatic cancer, steroid-induced hepatopathy, inflammatory and infiltrative illness, or hepatic congestion. Hepatic cirrhosis and other chronic inflammations such as portosystemic shunts may be represented by microhepatica (Larson, 2013; Dennis *et al*., 2010 and Wrigley, 1985).

Changes in hepatic size are frequently used as indicators of liver disease (Wrigley, 1985; Choi *et al*., 2013; Cockett, 1986; Lee and Leowijuk, 1982; Penninck and Berry, 1997). Radiographic evaluation of liver size involves both morphological and quantitative assessment. In dogs with generalized liver enlargement, the caudoventral liver margin appears round or blunt and extends beyond the costal arch and caudal deviation of the gastric axis is seen (Wrigley, 1985;

Suter, 1982; Partington, and Biller, 1995 and Larson, 2018). In cats, it can be difficult to determine whether change in radiographic liver size is caused by liver disease, in contrast to the relationship between liver size and liver disease observed in dogs (Tivers and Lipscomb, 2011).

The clarity with hepatic margin is demarcated and depended upon the amount of fat within the falciform ligament (Wrigley, 1985; Suter, 1982; Partington, and Biller, 1995; Larson, 2018). The exact position of caudo-ventral tip of the liver is appreciated in the lateral projection (Lee and Leowijuk, 1982; Root, 1974; Hardy, 1975). It appears as a wedge-shaped shadow with its apex extending caudally and consists of the partially superimposed right medial and left lateral lobes (Suter, 1982; Gibbs, 1981 and Obrien, 1978). Its relationship to the costal arch is a parameter often used to evaluate liver size (Wrigley, 1985; Suter, 1982; Gibbs, 1981; Obrien, 1978; Douglas and Williamson, 1970; Ackerman and Silverman, 1977; Chandna and Nigam, 1980), but this protrusion can merge and be difficult to distinguish from the outline of the spleen (Douglas and Williamson, 1970 and Kealy, 1979). A substantially enlarged or reduced liver size is a reliable sign of disease (Suter, 1982).

Liver diseases are frequently encountered in the veterinary clinical practices. Dogs primarily present with parenchymal pathologies such as hepatitis (Watson, 2004 and Center, 2009). The estimated frequency of canine hepatitis depends on the investigated population and accounts for 1%–2% of clinic referral population (Poldervaart *et al*., 2009) and up to 12% in a general population (Watson *et al*., 2010). Potential causes of canine hepatitis include micro-organisms, toxins and drugs and immune-mediated reactions. Disorders of copper metabolism account for roughly 30% of chronic canine hepatitis cases (Favier, 2009) Liver affections i.e. hepatomegaly, microhepatica, liver cyst and abscess, neoplasia and mineralization of liver etc. are commonly observed (Negasee, 2021).
The radiographic liver length to T11 vertebrae length ratio could also be used as an objective method for quantifying liver size in deep chested dogs. The aim of the current study was to evaluate the normal range of radiographic liver length to T11 vertebrae length ratio values in clinically healthy deep chested dogs.

Materials and Methods

The study was performed in 6 deep chested dog breeds with total 89 dogs that underwent thoraco-abdominal computed radiography. Dogs having good general body conditions, no history of chronic illnesses and any systemic diseases and brought to the hospital for general check up included in the study. Dogs of one year and above aged of different body weight were included in the study. Radiographs were obtained using a 500 mA X-Ray machine (EP-CORSA 40kw/Epsilon Health care solutions Pvt. Ltd.) with a focal film distance of 90cm. Right lateral and ventro-dorsal radiographs were imaged and reviewed in all dogs. Radiographs in which caudo-ventral liver margin could not be clearly identified were excluded from the study. On right lateral radiographs, radiographic liver length, radiographic T11 vertebra length and thoracic depth were obtained. Radiographic liver length (cm) was measured as the length of the axis from ventral border of caudal vena cava to the apex of hepatic caudal border. The length of T11 vertebra was measured at the level of the midpoint parallel to the long axis of the vertebral body. The data obtained were subjected to analysed by independent sample t test and one-way analysis of variance (ANOVA) technique (Snedecor and Cochran, 1989) using the statistical package SPSS software version 21.

Results and Discussion

The ratio of radiographic liver length to T11 vertebrae length was recorded 6.09±0.09 as a mean ± S.E. in all dogs which includes German Shepherd (n=50), Belgium Shepherd (n=6), Doberman (n=8), Golden Retriever (n=13), Great Dane (n=6) and Siberian Huskey (n=6) dog breeds. Radiographic liver length to T11 vertebrae length ratio was recorded according to age, sex, body weight, breed and neutering status. Age wise values of RLL: T11 L ratio was recorded non-significantly lower in 9-12 year of age group with5.96±0.18 followed by6.01±0.12 in 1-3 year of age group, 6.31±0.24 in 3-6 year of age group and6.44±0.22 in 6-9 year of age group (Table 1). Sex wise values of RLL: T11 L ratio was recorded non-significantly ($p>0.05$) lower in male group as 6.05±0.14 than the female group with 6.13±0.13 (Table 2). Body weight wise recorded values of RLL: T11 L ratio in 10-20 Kg body weight group was significantly lower ($p<0.05$) from remaining body weight groups that was 5.38±0.21and non-significantly differ ($p>0.05$) in 20-30 Kg with 6.13±0.12, 30-40 Kg with 6.47±0.17 and 40-50 Kg body weight group with 6.39±0.65 (Table 3). Breed wisevalues of RLL: T11 L ratio was recorded non significantly different(p>0.05) in each breed group with higher in Golden Retriever as 6.34±0.2 followed by 6.28±0.44 in Great Dane, 6.24±0.21 in Belgium Shepherd, 6.09±0.13 in German Shepherd, 5.82±0.29 in Doberman and lowest in Siberian Husky breed as 5.6±0.38 (Table 4). Neutering of status wise values of RLL: T11 L ratio was recorded non significantly (p>0.05) higher in intact group as 6.15±0.1 than the lower in castrated/spayed group as 5.8±0.26 (Table 5).

Table 1: Age wise Mean ± S.E. values of RLL: T11 L ratio

Ratio	Age			
	1-3 year	3-6 year	6-9 year	9-12 year
RLL: T11 L	6.01±0.12	6.31±0.24	6.44±0.22	5.96±0.18

Means having different superscripts in a row differ significantly (p<.05)

Table 2: Sex wise Mean ± S.E. values of RLL: T11 L ratio

Ratio	Sex	
	Male	Female
RLL: T11 L	6.05±0.14	6.13±0.13

Mean superscripted in a row differ significantly (p<.05)

Table 3: Body weight wise Mean±S.E. values of RLL: T11 L ratio

Radiographic measurements	Body weight			
	10-20 Kilograms	20-30 Kilograms	30-40 Kilograms	40-50 Kilograms
RLL: T11 L	5.38^{a}±0.21	6.13^{b}±0.12	6.47^{b}±0.17	6.39^{b}±0.65

Mean superscripted in a row differ significantly (p<.05)

Table 4: Breed wise Mean ± S.E. values of RLL: T11 L ratio

Radiographic measurements	Breed					
	GSD	BSD	Doberman	GR	GD	SH
RLL: T11 L	6.09 ±0.13	6.24 ±0.21	5.82 ±0.29	6.34 ±0.2	6.28 ±0.44	5.6±0.3 8

Mean superscripted in a row differ significantly (p<.05)

Table 5: Status of neutering wise Mean±S.E. values of RLL: T11 L ratio

Radiographic measurements	Status of neutering	
	Castrated/ Spayed	Intact
RLL: T11 L	5.8±0.26	6.15±0.1

Mean having different superscript in a row differ significantly (p<.05)

The caudal border of the liver was not clearly delineated in some radiographs and in few radiographs hepatic silhouette merged with splenic silhouette. Therefore, data for that radiographs were excluded from present study. The liver length was measured on right lateral view and compared with T11 vertebrae length in this study because the ratio of the length of the liver to the length of T11 has been reported to have a significant correlation with the ratio of the radiographic liver volume to body weight in dogs. In present study, the ratio of radiographic liver length to T11 vertebrae length was recorded 6.09±0.09 as a mean±S.E. in all dogs. Similarly, it was more consist with previous studies reported ratio of radiographic liver length to T11 vertebrae length which was varied between 4.8 and 7.8 with a mean and standard deviation of 6.1±0.8 in deep chested dog breeds (Bree and Sackx, 1987), 5.83±0.23 as mean ±S.E. in normal liver size group of dogs (Kim *et al.*, 2018), 5.4±0.74 in non-brachycephalic dogs & 4.64 ± 0.65 in Pekingese dogs & 5.16±0.74 with a mean and standard deviation in non-Pekingese brachycephalic dogs, respectively (Choi *et al.*, 2013). 5.9±1.0 with a mean and standard deviation in normal small dog breeds (Lee *et al.*, 2019). Contrary to it, recorded ratio of radiographic liver length to T11 vertebrae length was 4.22±0.54 in clinically normal cats as mean with standard deviation (An *et al.*, 2019).

It was evaluated the radiographic liver length to T11 vertebrae length ratio with age, sex, body weight, breed and neuter status in normal deep chested dogs. In this portion of the study, there was no significant difference in the radiographic liver length to T11 vertebrae length ratio according to age, sex breed and status of neutering among individuals above one years of age except according to body weight. Therefore, when the caudal margin of the liver is extended over the costal arch in older dogs (misinterpreted as hepatomegaly) the radiographic liver length to T11 vertebrae length ratio may be helpful in assessing the actual liver size. Young dogs under one year of age have not yet attained full vertebral growth and because of the short vertebral length, the ratio of radiographic liver length to T11 vertebrae length could be overestimated. Therefore, liver size evaluation using the radiographic liver length to T11 vertebrae length ratio is not advisable for dogs under one year of age and these deep chested dogs were excluded from the study (Thrall and Robertson, 2016).

Conclusion

It was concluded that ratio of radiographic liver length to T11 vertebrae length has been set as a quantitative index of radiographic liver size in deep chested dogs. It was found that the ratio of radiographic liver length to T11 vertebrae length may be varied according to signalment characteristics of dogs. The normal radiographic liver length was concluded 6.09 times of T11 vertebrae length in deep chested dogs.

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