



Two-dimensional cardiothoracic ratio for evaluation of cardiac size in German shepherd dogs

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Received 14 November 2013; received in revised form 8 August 2014; accepted 18 August 2014

KEYWORDS

Radiography;
Heart;
Cardiomegaly;
Microcardia;
Canine

Abstract Objectives: To evaluate cardiac size in normal German shepherd dogs (GSD) using the two-dimensional cardiothoracic ratio (CTR) and to use this measure for diagnosing GSD with altered cardiac size.

Animals: One hundred clinically normal GSD as well as 46 GSD with altered cardiac size (microcardia or cardiomegaly).

Methods: The CTR was computed as the percentage area of the cardiac silhouette relative to the area of the dog's thorax. Measurements were performed using a digital software program on lateral and ventro-dorsal radiographs at the points of peak inspiration and expiration. Receiver operating characteristic (ROC) curve analysis was used to determine the diagnostic accuracy of the CTR for diagnosing cardiomegaly or microcardia.

Results: The mean (\pm SD) CTR on lateral radiographs of normal dogs was $27.60\% \pm 1.10\%$ and $30.13\% \pm 1.42\%$ at the points of peak inspiration and expiration, respectively. For ventro-dorsal radiographs, mean CTR was $30.45\% \pm 1.39\%$ at peak inspiration and $33.34\% \pm 1.46\%$ at peak expiration. The cutoff value of the CTR for diagnosing microcardia on lateral radiographs was 22.98% (inspiration) and 25.06% (expiration), compared to 25.03% (inspiration) and 23.97% (expiration) on ventro-dorsal radiographs. Cutoff values for diagnosing cardiomegaly were 30.28% (inspiration) and 33.44% (expiration) on lateral radiographs and 36.80% (inspiration) and 37.99% (expiration) on ventro-dorsal radiographs.

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Conclusions: CTR may provide a clinically useful tool for evaluating cardiac size in dogs.

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Abbreviations

AoD	aortic root dimension
AUC	area under the curve
CI	confidence of interval
CTR	two-dimensional cardiothoracic ratio
FS	fractional shortening
GSD	German shepherd dogs
LADs	left atrial dimension at end-systole
LVIDd	left ventricular internal dimension at end-diastole
LVIDs	left ventricular internal dimension at end-systole
ROC	receiver operating characteristic
RVIDd	right ventricular internal dimension at end-diastole
VHS	vertebral heart scale

Introduction

Evaluation of cardiac size is an important clinical variable in dogs¹ and changes in cardiac size may be used to monitor and grade disease severity.² However, a normal cardiac size does not rule out the presence of disease.¹ Various diagnostic tools have been used to evaluate cardiac size including thoracic radiography, echocardiography and electrocardiography.³ Thoracic radiography remains the most commonly used method.^{4,5}

Subjective radiographic evaluation of cardiac size with a guide of 2.5–3.5 intercostal spaces on the lateral projection is commonly used in canine practice.^{6–8} The limitations of this subjective evaluation may include superimposition of the ribs as well as the effects of breed, thoracic conformation, and phase of respiration.^{1,8,9} An objective evaluation of cardiac size using the vertebral heart scale (VHS) is a widely accepted method first described by Buchanan and Bucheler in 1995.¹ The VHS measurement is based on measuring the cardiac height (long axis) and width (short axis) compared to the animal's vertebral body length. A possible limitation of the VHS is that it relies only on two linear measurements for evaluation of cardiac size and not to the entire cardiac circumference. Therefore, subtle changes in cardiac size may not

be detected by VHS. Considerable changes in the cardiac contour can exist without subsequent dilatation, as in diseases which cause concentric hypertrophy.^{1,10,11} The development of an objective method for evaluation of cardiac size based on the entire cardiac silhouette may provide a useful tool for diagnosing subtle changes in cardiac size as well as generalized cardiac enlargement.

We hypothesize that cardiac size can be evaluated through evaluation of the cardiac area in comparison to the thoracic area in dogs by use of a two-dimensional cardiothoracic ratio (CTR). The purpose of the present study was to evaluate the cardiac size in normal German shepherd dogs (GSD) using CTR, and to use this measure for evaluating dogs with cardiomegaly or microcardia.

Materials and methods

Dogs and radiography

The present study was done in 146 GSD. All study procedures were approved by the animal care and use ethical committee of the Faculty of Veterinary Medicine, Cairo University. One hundred healthy client-owned GSD (67 males and 33 females) aged 2.8 ± 0.6 years old and weighing 31.2 ± 5.4 kg were admitted to the clinic of the Department of Surgery, Anesthesiology and Radiology, Faculty of Veterinary Medicine, Cairo University for routine examination. Dogs included in the study were free of clinical signs of cardiovascular or respiratory disease. All dogs were evaluated by physical examination, electrocardiography (standard 12-lead ECG) and echocardiography before enrollment in the study. In addition, 46 GSD (30 males and 16 females) aged 3.1 ± 0.5 years and weighing 30.8 ± 5.2 kg were also included in the study. These dogs were diagnosed with altered cardiac size (cardiomegaly or microcardia) based on subjective radiographic evaluation (hearts less than 2.5 or more than 3.5 intercostal spaces based on lateral radiographs),^{6–8} echocardiography (according to values obtained from previous studies on normal GSD)^{12,13} and electrocardiography.¹⁴ The 46 GSDs with altered cardiac size included 35 dogs with cardiomegaly [dilated cardiomyopathy ($n = 16$), persistent arterial duct (6), mitral insufficiency (5), aortic insufficiency (3),

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