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CARDIOTHORACIC RATIO IN SUNDA PORCUPINE (*Hystrix javanica*)

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ABSTRACT

The present study aimed to standardize cardiothoracic ratio (CTR) in clinically healthy Sunda porcupine. This study was an explorative study using four Sunda porcupines, male and female, with an estimated age of 6 months-2years. The sampled animals were radiographed in ventrodorsally projection using a digital X-ray machine with 50 kVp and 6 mAs. Each animal was injected with xylazine as sedation agent at 2 mg/kg BW, intramuscularly route in the dorsal part of animal's tail. The radiogram showed that Sunda porcupine heart tends to be round and more massive, characterized as the convex edge of the heart. The cardiothoracic ratio (CTR) showed that the ratio of the broadest expansion of the heart relative to the thoracic width in a ventrodorsally projection ranged from 0.48-0.55 with an average 0.52. Standard heart size was less than half of the largest thoracic diameter (normal CTR<0.5). Sunda porcupine heart tends to be round and larger characterized as the convex edge of the heart. The CTR values obtained were 0.48-0.55.

Key words: cardiothoracic ratio, heart, *Hystrix javanica*, radiography, Sunda porcupine

ABSTRAK

Penelitian ini bertujuan mengukur rasio kardiotoraks (CTR) pada landak jawa yang sehat. Penelitian ini merupakan penelitian eksploratif dengan menggunakan 4 ekor landak jawa, jantan dan betina, dengan perkiraan umur 6 bulan-2 tahun. Pemeriksaan radiografi pada sampel dengan proyeksi ventrodorsal menggunakan mesin x-ray digital dengan nilai 50 kVp dan 6 mAs. Setiap hewan diinjeksi dengan xylazine sebagai agen sedasi dengan dosis 2 mg/kg berat badan melalui rute intramuskular di bagian dorsal ekor hewan. Radiogram menunjukkan jantung landak jawa cenderung bulat yang ditandai dengan tepi jantung yang cenderung cembung. Hasil pemeriksaan CTR menunjukkan rasio lebar terluas jantung terhadap lebar toraks dalam proyeksi ventrodorsal berkisar antara 0,48-0,55 dengan rata-rata 0,52. Standar ukuran jantung umumnya kurang dari setengah diameter terlebar toraks (CTR normal<0,5). Jantung landak jawa cenderung berbentuk bulat dan lebih besar yang ditandai dengan tepi jantung berbentuk cembung. Nilai CTR yang diperoleh sebesar 0,48-0,55.

Kata kunci: rasio kardiotoraks, jantung, Hystrix javanica, radiografi, landak jawa

INTRODUCTION

Indonesia is known as the second-largest biodiversity country (mega biodiversity) with the highest endemic species (Mittermeier *et al*. 2002; Whitten *et al*. 2004). Sunda porcupine (*Hystrix javanica*) is one of the porcupine endemic species in Indonesia which can be found in Java, Bali, Sumbawa, Flores, Lombok, Madura, and Tanahjampea Island (Purwaningsih 2013; Van Weers 1983). The animal is protected by Environmental and Forestry Minister with Regulation No. P.20/MENLHK/SETJEN/ KUM.1/6/2018. It is necessary to protect the sustainability of this species to protect Indonesian biodiversity. There is the need to preserve these wild species and to understand the fundamental aspects of these species, such as anatomy, physiology, pathophysiology and clinical sciences. Besides, in an attempt to answer questions focused on conservation or management of the entire population or species, providing valuable data for zoological medicine is needed (Buchholtz *et al*. 2007; Fox *et al*. 2008; Alves *et al*. 2012; Paul *et al*. 2016).

Research and information in the veterinary medical aspect about Sunda porcupine is still lacking due to the difficulty in handling the species. Therefore, necessary studies are needed as reference efforts in handling and treating the endemic wildlife, especially Sunda porcupine (Wahid *et al*. 2018). As is true in all mammals, Sunda porcupine as rodents have four chambered hearts. Investigation of cardiac disease by diagnostic imaging tools is widely used in veterinary medicine (Reichle and Wisner 2000). In this context, a radiographic image can help to detect abnormalities occurred to be more apparent (Krupinski 2010; Hellbach *et al*. 2017). Radiographic screening should have a standard figure to be able to determine the presence of abnormalities (Thrall and Robertson 2015). Measurement techniques have been developed for objective estimation of cardiac disease. Two of the essential measurement systems that are simple and useful tools for assessment of cardiac size in screening for cardiovascular disease are the vertebral heart scale (VHS) and cardiothoracic ratio (CTR) (Ghadiri *et al*. 2010; Nabi *et al*. 2014; Rocha-Neto *et al*. 2015; Dickson *et al*. 2016; Garcia *et al*. 2016; Halilu *et al*. 2017; Noviana *et al*. 2018; Ukaha 2013; Ukaha 2015; Ukaha and Iloh 2018a; Ukaha and Iloh 2018b). CTR widely used in medicine as a prediction of the heart function and life span of cardiac patients. Unfortunately, radiologic reports in the Sunda porcupine are scarce.

The study aimed to standardize the average values of the CTR in Sunda porcupine. The data were collected to provide baseline information for the radiographic interpretation of cardiac disease in the Sunda porcupine, contributing to the diagnosis, treatment, and clinical preservation of the species.

MATERIALS AND METHODS

This study has been ethically approved by Animal Ethics Committee of Institute for Research and Public Service Program of IPB University with the number of 130-2018 IPB. Four healthy Sunda porcupines were used as the subject of the study (6 months male; 8 months male; 20 months female; and 24 months male; body weight, 7-10 kg). The use of the sample was limited because the Sunda porcupine was one of the protected animals in Indonesia. The samples were acclimatized for two weeks. During the acclimatization period, the samples were fed with vegetables, fruits, and drinking water in ad libitum. All porcupine presented for a general health check-up to the My Vets Animal Clinic, Bumi Serpong Damai (BSD) in South Tangerang and IPB Veterinary Teaching Hospital were subjected to thorough physical examination.

Sedation Protocol

Xylazine (Xyla® Interchemie werken "De Adelaar" B.V., Metaalweg 8, 5804 CG Venray, The Netherlands; 2 mg/kg i.m) was used as a sedative agent and injected in the muscle of the dorsal part of the animal's tail (Morin and Berteaux 2003). The blood pressure, heart, and respiratory rate were monitored throughout the procedure. A blood pressure cuff was placed on the animal hindlimb. Monitoring of heart rate and respiratory rate was performed using electro-cardiography and patient monitor.

Radiographic Examination

The radiographic examination included the right lateral (RL) and ventrodorsally (VD) projections. Radiography was performed with sedation using standard exposure techniques. All of the radiographs were taken at the time of full inspiration using digital x-ray machine (Indoray IKL-17E-100/24, PT. Poly Jaya Medikal, Cilodong, Depok, West Java 16413, Indonesia) and x-ray flat panel detector (CareView 1800L - 17x17" Tethered, CareRay Medical Systems Co., Suzhou (SIP) Jiangsu 215123, China). The apparatus was calibrated with 1 m focus to film distance and exposure techniques of 50 kVp and 6 mAs. Evaluation of the radiographs was performed by measuring CTR.

Measuring Cardiothoracic Ratio

CRT value was obtained by comparing the highest widths of the cardiac silhouette divided by the most considerable distance between the thoracic wall in VD or dorsoventral (DV) projection. The heart width was obtained by summing the values of the two most significant distances between the left and right border of the heart from the vertical midline (spinal processes of the thoracic vertebrae) (ML + MR) (Rocha-Neto *et al*. 2015). ML was the distance from the vertical midline to the left side, and MR was the distance from the vertical midline to the right side. The thoracic width was similarly measured at the point of its greatest diameter (Figure 1). Cardiac size measurement using CTR of Sunda porcupine can be seen in Figure 1. The heart and thoracic width were measured by MicroDicom software.

RESULTS AND DISCUSSION

The cardiac silhouette of the animals have homogeneous and elongated opacity and was located between the fourth and tenth ribs, in the middle mediastinum in VD projection, and between the second and sixth intercostal spaces, in the middle mediastinum in the right lateral projection. The value of the CTR can be seen in Table 1.

Table 1. Cardiothoracic ratio (CTR) in Sunda porcupines

Porcupine	CTR
I	0.55
II	0.48
III	0.51
IV	0.53
Average	0.52

The interpretation of Sunda porcupine thoracic radiogram showed that the heart of Sunda porcupine was more rounded characterized by more convex shape, causing the silhouette to be more rounded (Figure 1).

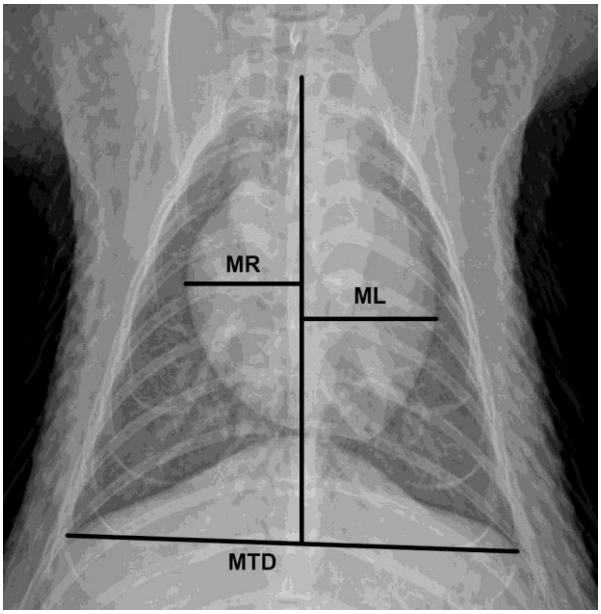

Figure 1. Radiographic image of the thoracic cavity of a Sunda porcupine at the time of full inspiration registered by digital radiography in ideal ventrodorsal projection with drawing for CTR calculation. (MR+ML: represent the two most considerable distances from the vertical line that divides the right and the left side of the heart; MTD: the widest diameter of the thorax)

The CTR, the ratio of the broadest expansion of the heart relative to the thoracic width in a ventrodorsal

projection, ranged from 0.48-0.55 with an average of 0.52 in radiographs studied. Standard heart size was less than half of the largest thoracic diameter (normal CTR < 0.5). The standardization of this index for the Sunda porcupine in the present study (0.48-0.55) showed normal values but higher than those observed in humans (Dimopoulos *et al*. 2011). Although cardiothoracic ratio was compatible with installed heart disease (Gustafsson *et al*. 2003; Solomon *et al*. 2005), the animals studied did not show clinical or radiographic signs that compatible with heart insufficiency to any degree. Allied to this, data previously reported in *Macaca tonkeana* (0.59), *M. fascicularis* (0.58) (Xie *et al*. 2014), black rumped agoutis (0.51-0.52) (De Moura *et al*. 2015), New Zealand white rabbit (0.54) (Ukaha and Iloh 2018a), were similar to our findings, suggesting that the Sunda porcupine present higher CTR values than those observed in humans.

In veterinary radiology, various cardiac and thoracic indices have been reported for pets, exotic animals, endemic animals, and a few other animals. However, none of these indices is ever found faultlessly suitable for general clinical and field use as a result of differences in thoracic conformation among animal species and breeds (Lamb and Boswood 2002; Litster and Buchanan 2000).

CONCLUSION

Sunda porcupine heart tends to be round and larger characterized as the convex edge of the heart. The CTR values obtained were 0.48-0.55.

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