Haryana Vet. (March, 2022) **61(SI)**, 56-59 **Research Article**

COMPUTED RADIOGRAPHIC MEASUREMENT OF DIFFERENT THORACIC PARAMETERS IN HEALTHY GERMAN SHEPHERD DOGS

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ABSTRACT

The present study was designed to draw the reference values of radiographic measurement of thoracic cavity in apparently healthy German shepherd dogs. The dogs were divided into two groups based on age; Group 1 (n=15 dogs with age ≤ 6 months), Group 2 (n=15, dogs with age > 6 months). Radiographic images were obtained in ventro-dorsal, right lateral and left lateral projections of the thoracic cavity. Different parameters *viz.*, thoracic depth width, thoracic length, caudal vena cava and aorta diameter vertebrae length at dorsal of carina and 4th rib width, cardiac inclination angle, tracheal inclination angle, tracheal depth, thoracic inlet diameter, costophrenic angles, distance between the thoracic wall and the cardiac silhouette and cardiosternal contact were measured and correlated with the age and body weight of the dogs. Significant difference were recorded in the values of TrD, ThID, , TD, TW, TL, vertebral length, R4 diameter, thoracic wall to cardiac distance, CVC and Aorta in both the age groups. All these parameters showed significant positive correlation with age and body weight. Generated data of this study may act as a reference range for the thoracic radiography in healthy German shepherd dogs and these parameters do not differ with the right or left lateral radiographic position.

Keywords: Different parameters, German shepherd dogs, Radiographic measurement, Reference values

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Radiography is a fast and non-invasive diagnostic technique for evaluation of thorax in dogs (Root and Bahr, 2002). Despite availability of advanced diagnostic modalities like ultrasonography, CT scan; digital radiography is important and essential due to its easy access and cost effectiveness (Pal *et al.*, 2015; Singh *et al.*, 2019). In normal canine thorax, there are more anatomical variations than in any other organ due to its different conformation and it is inherently variable in size because of its contractions and expansions during the cardiac cycle which necessitates the knowledge of normal values of thoracic parameters in all breeds of the dogs (Root and Bahr, 2002). The present study was designed with an aim to obtain normal thoracic parameters and their standard ratios in apparently healthy German shepherd dogs (GSD).

MATERIALS AND METHODS

Selection of Animals: The present study was conducted on client owned 30 healthy GSD dogs free from cardiothoracic diseases presented for general clinical examination. The dogs were divided into two groups (I and II), each containing 15 animals. In group-I dogs; age ≤ 6 months and in Group II dogs; age > 6 months were included in the study.

Radiographic Examination: Radiographic images of complete thoracic region from thoracic inlet to diaphragm by including all the thoracic vertebrae, entire lung field and the sternum were obtained using 500 mA X-Ray machine (EP-CORSA 40 kw/Epsilon Health care solutions Pvt. Ltd). The images were acquired by computerized radiographic (CR) system (FCR-CAPSULA XLII). Radiographs of inspiratory phase were selected for the study. Different parameters were measured using different standard procedures described as follows:

Right and left lateral radiographic views were used to measure the thoracic inlet diameter (ThID), tracheal diameter (TrD) (Lee *et al.*, 2017) (Fig. 2B), diameter of fourth rib (R-4), length of thoracic vertebra dorsal to carina (VL), CVC diameter, Aorta diameter (Fig. 2C) (Lehmkuhl *et al.*, 1997), thoracic depth (TD) (Fig. 2A) (Jepsen-Grant *et al.*, 2013), sternal contact (Mattoon *et al.*, 2001) (Fig. 3A), cardiac (Alves *et al.*, 2012) (Fig. 3C) and tracheal inclination angle (Mattoon *et al.*, 2001) (Fig. 3B).

Ventro-dorsal (V/D) radiographs were used to measure the thoracic width (TW) (Jepsen-Grant *et. al.*, 2013) (Fig. 1A), length of thoracic cavity (TL) (Fig. 1B), costophrenic angle (Fig. 1D) and distance between thoracic wall to cardiac silhouette (Alves *et al.*, 2012) (Fig. 1C).

Statistical analysis

The results of different parameters were analyzed by SPSS Statistics version 22. Independent sample t-test was used to test the level of significance at 1 and 5%. The Bivariate Pearson's correlation coefficient (r) was used to determine the correlation between radiographic parameters and age and body weight.

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RESULTS AND DISCUSSION

In the present study, a significant difference ($P \leq 0.01$) was observed for the measurement of caudal vena cava (CVC) and Aorta diameters in both the groups and these values were significantly ($P \leq 0.01$) correlated with body weight.

The CVC diameter 1.47±0.40 (SD) cm and Ao diameter (1.46 ± 0.39 SD) have been reported previously in left lateral radiographs of inspiratory phase in healthy dogs (Lehmkuhl *et al.*, 1997) which are in accordance to present study. The vertebral length, R-4 diameter, CVC and Aorta diameter were significantly ($P \leq 0.01$) and positively correlated with the age and the body weight of the dogs. Therefore, they changed with the age of the dogs, and hence were significantly different in both the groups. CVC to VL ratio showed the non-significant differences in right and left recumbency which is in agreement with the Buchanan and Bucheler (1995). Different ratio of CVC to Ao, VL and R4 have been reported previously in mixed breed of healthy dogs and are in agreement of present study and these ratios are useful to diagnose the right heart failure in dogs (Hayward *et al.*, 2008).

In right lateral view, the shape and position of the apex of cardiac silhouette was consistent and had an increased sternal contact than on the left lateral view but values were non-significantly differed. In left lateral view, the cardiac silhouette was round and the apex was displaced slight dorsal to the sternum (Johnson *et al.*, 2008). Right lateral view is often used to assess the right ventricular enlargement when compared to normal values (Mattoon *et al.*, 2001). Hypertrophy or dilatation of right ventricle causes an increased sterna contact in the lateral view and increase in the right ventricular size decreases the cardiac inclination angle to the sternum (Kealy *et al.*, 2011).The mean values of cardio -sternal contact; cardiac inclination angle and tracheal angle in 6-healthy German shepherd dogs of this study were different from those described earlier (Mishra *et al.*, 2020). The variation might be due to high sample size and the measurements taken in inspiration phase as suggested by Mattoon *et al.* (2001).

Increased distance from thoracic wall to heart have been found increased in right side showing the closeness of heart to left side in previous study (Diniz *et al.*, 2013). Alves *et al.* (2012) measured the distances of the cardiac silhouette, in relation to the right and left walls of the thoracic cavity in capuchin monkey and found the increased distance on right side of thorax; 1.52 ± 0.26 SD cm in right and 0.84 ± 0.14 SD cm in left side.

Ratio of TW/TL was also non-significantly different in both the groups but this ratio was negatively correlated with the age and body weight showing that thoracic length increases in high proportion as compared to thoracic width. This ratio can be used to calculate the shape and size of the dogs as thoracic depth to width (TD/TW) ratio has been used by many researchers for dogs; to determine the shape of the thorax (Jepsen-Grant *et al.*, 2013).

Ratio of TrD/ThID was not significantly different but positively correlated with age and body weight; this finding indicates that tracheal diameter increases in more proportional as compared to thoracic inlet diameter. This ratio (TrD/ThID) has been used in different studies to objective assessment of lumen size; this ratio is variable in different breeds of dogs in the long range of 0.11±0.03 to 0.21±0.03 and respiratory phase does not change this ratio significantly but extension of head and neck can reduce the tracheal lumen (Hayward *et al.*, 2008). Brachycephalic breeds, with and without respiratory signs, have a smaller average tracheal-diameter-to-thoracic-inlet ratio than non-brachycephalic dogs and bulldogs have even more smaller ratio as compare to other brachycephalic breeds (Harvey and Fink, 1982).

Measurement of tracheal diameter, thoracic inlet diameters and their ration has been used in many studies to know the tracheal collapse, coughing status and relation of respiratory pathology in relation to tracheal diameter change (Lee *et al.*, 2017). In our study TrD/ThID ratio in both groups, ranged from 0.25 to 0.27 which agrees with the findings of Dennis *et al.* (2010) who obtained values 0.20 or more in normal non-brachycephalic and 0.16 or higher in brachycephalic dogs and suggested that these values can alter in pathological conditions.

CONCLUSION

The data generated, may act as a reference range for the thorax radiography in healthy German shepherd dogs. The thoracic radiographic parameters do not differ with the right or left lateral radiographic position.

REFERENCES

Alves, F.R., Costa, F.B., Machado, P.P. Diniz, A.N. Araujo, A.V.C., Ambrosio, C.E. and Guerra P.C. (2012). Anatomical and radiographic appearance of the capuchin monkey thoracic cavity (*Cebus apella*). *Pesq. Vet. Bras.* **32(12)**: 1345-1350.

Buchanan, J.W. and Bucheler, J. (1995). Vertebral scale system to measure canine heart size in radiographs. *J. Anim. Vet. Med. Assoc.* **206(2)**: 194-199.

Dennis, R., Kirberger, R.M., Barr, F. and Wrigley, R.H. (2010). Lower respiratory tract. In: Handbook of small animal radiology and ultrasound techniques and differential diagnosis. Dennis, R., Kirbergar, R.M., Barr, F. and Wrigley, R.H. (Edts.), (2nd Edn.), Churchill Livingstone Elsevier Publication. Edinburgh. pp. 145-173.

Diniz, A.N., Silva-Junior, J.R., Ambrosio, C.E., Sousa, J.M., Sousa, V.R., Carvalho, M.A.M., Nascimento, D.M. and Alves, F.R.

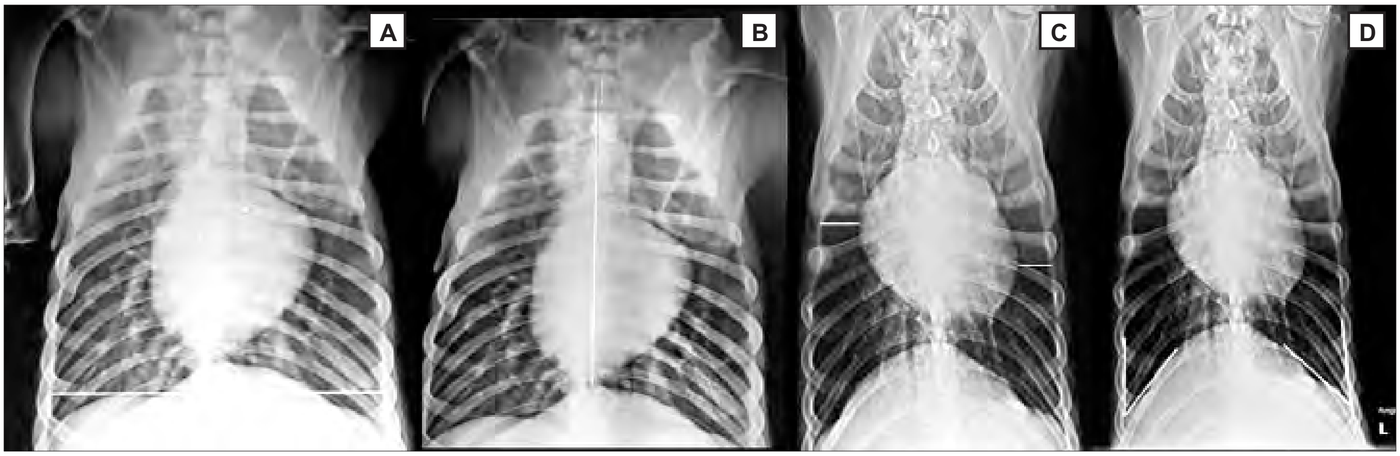

Fig. 1. Ventro-dorsal (VD) radiographic views - **(A)** Measurement of thoracic width (TW) from the distance between the medial borders of the eight ribs at their most lateral curvature. **(B)** Measurement of Thoracic cavity length (TL) from the distance between the thoracic inlet and the most cranial portion of the cupula of the diaphragm. **(C)** measurement of the distance between the right and left thoracic wall in relation to the cardiac silhouette. **(D)** Measurement of costophrenic angles from the right and left sides.

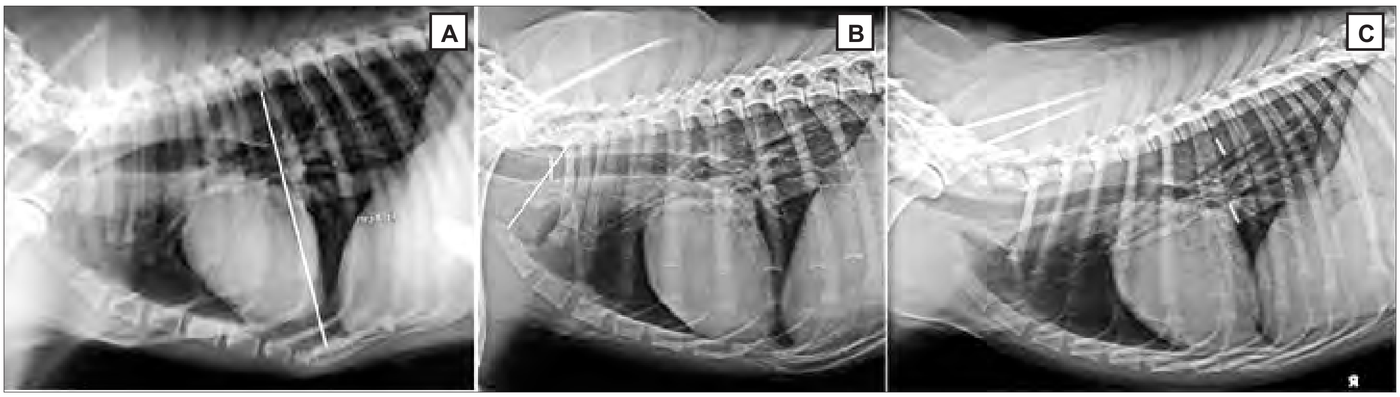

Fig. 2. Lateral thoracic radiographic views - **(A).** Thoracic dept (TD) from dorsal margin of the xiphoid process to the ventral margin of the vertebral body, with the digital caliper, aligned perpendicular to the vertebral column. **(B).** Tracheal diameter (TrD) was determined by drawing line at the level of the thoracic inlet (black line) and the diameter of thoracic inlet (ThID) (white line) from the dorso-cranial aspect of the manubrium (at minimal thickness) to the caudoventral aspect of the body (at seventh cervical vertebrae). **(C).** Measurement landmark of CVC and Aorta insame intercostal space.

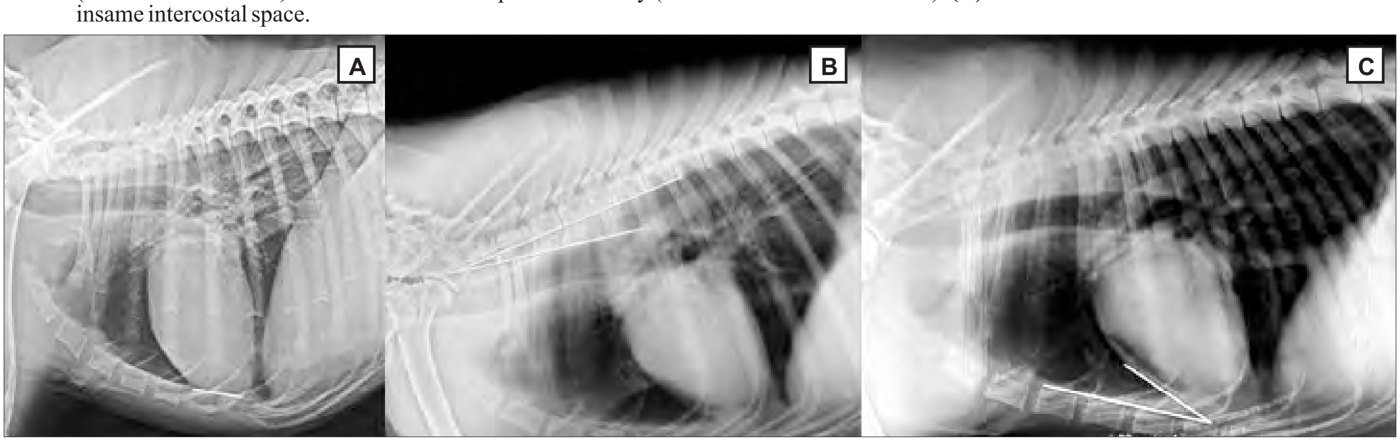

Fig. 3. Lateral thoracic views- **(A).** Measurement of how many sternebraeare in contact with the cardiac silhouette, **(B).** Tracheal Inclination Angle determined by drawing lines along the dorsal border of the trachea and the ventral margin of the cranial thoracic vertebrae. **(C).** Cardiac inclination angle by using as reference the angle formed between the cranial cardiac border and the sternum.

(2013). Thoracic and heart biometrics of non-anesthetized agouti measured on radiographic images. *Pesq. Vet. Bras.* **33(3)**: 411-416.

Harvey, C. and Fink, E. (1982). Tracheal diameter: Analysis of radiographic measurements in brachycephalic and non-brachycephalic dogs. *J. Am. Anim. Hosp. Assoc.* **18**: 570-576.

Hayward, N., Tobias Schwarz, T. and Weisse, C. (2008). The trachea In:BSAVA Manual of Canine and Feline Thoracic Imaging. Schwarz, T. and Johnson, V. (Edts). Gloucester: BSAVA, pp. 213- 227.

Jepsen-Grant, K., Pollard, R.E. and Johnson, L.R. (2013). Vertebral heart scores in eight dog breeds. *Vet. Radiol. Ultrasound.* **54(1)**: 3–8.

Johnson, V., Hansson, K., Mai, W., Dukes-McEwan, J., Lester, N., Schwarz, T., Chapman, P. and Morandi, F. (2008). The heart and major vessels. In: BSAVA Manual of canine and feline thoracic imaging. Schwarz, T. and Johnson, V. (Edts.). Gloucester:

Table 1

Mean (±SE) values of different parameters and their correlation with age and body weight in group-I and II

Parameters	Group-I	Group- II	Correlation with Age	Correlation with B.W.
Right CVC** (cm)	1.25±0.07	1.59±0.5	0.453*	0.637**
Right Aorta** (cm)	1.34±0.08	1.63±0.05	0.301	0.539**
Right CVC/Aorta	0.94±0.03	0.99±0.04	0.175	0.92
Left CVC** (cm)	1.27±0.06	1.58±0.05	0.337	0.527**
Left Aorta** (cm)	1.33±0.07	1.63±0.05	0.365*	0.575**
Left CVC/Aorta	0.97±0.04	0.98±0.04	0.028	0.061
Right cardiac inclination angle (degree)	23.60±1.88	24.40±1.42	0.050	0.073
Left cardiac inclination angle (degree)	24.93±1.64	27.00±1.16	0.125	0.192
Right tracheal inclination angle (degree)	9.13±0.66	9.993±0.40	0.006	0.070
Left tracheal inclination angle (degree)	9.40±0.62	10.47±0.61	0.064	0.096
Right cos to phrenic angle (degree)	28.47±1.38	31.20±1.29	0.160	0.355
Left cos to phrenic angle (degree)	30.33±1.08	32.13±1.06	0.182	0.392
Right sternal contact (s)	1.97±0.06	1.95±0.06	-0.181	-0.223
Left sternal contact (s)	1.83±0.07	1.88±0.061	0.176	0.226
Right TD** (cm)	14.63±0.73	18.50±0.40	0.492**	0.697**
Left TD** (cm)	14.70±0.74	17.33±1.16	0.159*	0.499**
TW** (cm)	15.09±0.56	17.97±0.47	0.508**	0.841**
TL** (cm)	17.97±0.84	23.56±1.08	0.569**	0.721**
TW/TL	0.85±0.03	0.78±0.04	-0.289	-0.209
Right thoracic wall to cardiac silhouette distance (cm)	2.91±0.18	3.57±0.15	0.414*	0.599**
Left thoracic wall to cardiac silhouette distance (cm)	2.87±0.19	3.63±0.19	0.517**	0.679**
Right VL** (cm)	1.67±0.07	2.03±0.04	0.525**	0.726**
Left VL** (cm)	1.65±0.07	2.01±0.04	0.500**	0.697**
Right CVC/VL	0.75±0.02	0.79±0.03	0.052	0.073
Left CVC/VL	0.77±0.03	0.78±0.02	-0.122	-0.156
Right R4** (cm)	0.63±0.04	0.81±0.04	0.462*	0.639**
Left R4** (cm)	0.59±0.04	0.84±0.04	0.459*	0.631**
Right CVC/R4	2.04±0.09	2.09±0.12	-0.103	-0.181
Left CVC/R4	2.22±0.13	1.92±0.10	-0.311	-0.418*
Right TrD** (cm)	1.49±0.12	2.01±0.05	0.445*	0.613**
Right ThID** (cm)	5.87±0.30	7.47±0.15	0.535**	0.718**
Right TrD/ThID	0.25±0.01	0.27±0.01	0.208	0.357
Left TrD** (cm)	1.49±0.12	1.99±0.05	0.468**	0.654**
Left ThID** (cm)	5.88±0.30	7.50±0.17	0.555**	0.740**
Left TrD/ThID	0.25±0.01	0.26±0.00	0.252	0.326

**Significant correlation at the $P \leq 0.01$, *Significant correlation at the $P \leq 0.05$

BSAVA, pp. 87-176.

Kealy, J.K., McAllister, H. and Graham, J. (2011). The thorax. In: Diagnostic radiology and ultrasonography of the dog and cat. Elsevier, St. Louis. pp. 199-349.

Lee, J., Yun, S., Lee, I., Choi, M. and Yoon, J. (2017). Fluoroscopic characteristics of tracheal collapse and cervical lung herniation in dogs: 222 cases (2012–2015). *J. Vet. Sci.*, **18(4)**: 499-505.

Lehmkuhl, L.B., Bonagura, J.D., Biller, D.S. and Hartman, W.M. (1997). Radiographic evaluation of caudal vena cava size in dogs. *Vet. Radiol. Ultrasound.* **38(2)**: 94-100.

Mattoon, J.S., Gerros, T.C. and Brimacombe, M. (2001). Thoracic radiographic appearance in the normal llama. *Vet. Radiol. Ultrasound.* **42(1)**: 28-37.

Mishra, M., Purohit, S., Pandey, R.P., Sharma, A. and Srivastava, M. (2020). Radiographic cardiac indices, cardiothoracic ratio and their correlation with age and body weight of apparently healthy German shepherd dogs. *Indian J. Vet. Surg.* **41(2)**: 113-117.

Pal, M., Singh, P., Tayal, R., Behl, S.M., Dinesh, Saharan, S. and Chandolia, R.K. (2015). Comparative 2d and 3d ultrasonographic study of splenic development with advancement of age in dogs. *Haryana Vet.* **54(1)**: 61-63.

Root, C.R. and Bahr, R.J. (2002). The heart and great vessels In: Thrall, D.E. (Edt.), Textbook of Diagnostic Veterinary Radiology. (4th Edn.), W.B. Saunders Company, Philadelphia. pp. 402-419.

Singh,S., Palecha, S. and Bishnoi, P. (2019). Computed radiographic and computed tomographic diagnosis of pectoral limb fracture in dogs. *Indian J. Vet. Surg.* **40(1)**: 16-19.