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Three-dimensional pelvimetric evaluation of the pelvic cavity in different dog breeds

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ABSTRACT

Objective: The mean of pelvis diameters and development of pelvis: It is known that it varies depending on many factors such as race, body size, gender, nutrition, movement rate and hormones. In this context, the study was carried out to examine the cavum pelvis of different breeds of dogs using multidetector computed tomography (MDCT).

Materials and Methods: A total of 43 dogs, 19 different breeds, were used in the study. The pelvis region was scanned with a 64-detector MDCT device with a section thickness of 0.625 mm. The obtained images were transferred to the RadiAnt DICOM Viewer program to create a three-dimensional model of the cavum pelvis, and then pelvic measurements were taken.

Results: In the pelvimetric examination, it was determined that conjugated diameter was highest in Kangal Shepherd dogs and vertical diameter was highest in Kangal Shepherd dogs. The lowest average of both diameters was found in Pomeranian dogs. Pelvis slope formed between these two axes was observed to be highest in Alabai breed dogs with 38° and lowest in Pekingese, Pomeranian and Setter breed dogs with 18°.

Conclusion: It is thought that it will be beneficial for many disciplines, especially gynecology, to reveal the differences between the breeds by comparing the results of the dog breeds whose metric characteristics of the cavum pelvis were examined.

Keywords: 3D, Computed tomography, Dog, Pelvis

INTRODUCTION

The pelvis is the part that provides the transition between the body and the lower limbs, it is the cavity formed by the ossa coxae from the sides and lower part, the os sacrum from the back and the first caudal vertebrae. It contains important structures such as urinary, digestive and reproductive organs as well as the birth canal (Moore, 2006; Liebich et al., 2007; Demiraslan et al. Hang on, 2022).. The size and shape of the bony framework of the pelvis are

important factors in the duration of labor (Sporri, 1994).

Gender determination using the skeletal system can be determined using the morphological or the morphometric features of the bone (Steyn, 2009; Gundemir et al., 2020a; Duro et al., 2021; Jashari et al., 2022; Pazvant et al., 2022; Şenol et al., 2022; Szara et al., 2022; Dayan et al., 2023; Güzel et al., 2023; İşbilir et al., 2023). The pelvic bone is an important structure used in gender determination (Gundemir

et al., 2020b; Manuta et al., 2023). While there is a 95% accuracy rate in gender prediction using the pelvic skeleton and 90% in gender prediction using the cranium, this rate can reach a very strong prediction level of 98% when both the pelvis and the cranium are used together (Şahiner, 2007; Garvin, 2012). In terms of archeology and forensic sciences, the pelvis is a very important part of the skeletal system in determining gender. The reason why the pelvis provides such a large amount of estimation in gender prediction is the effect of sex hormones on the pelvis (Komar and Buikstra, 2008; Dawson and Ross, 2011; Charles, 2013).

Pelvis diameters were first determined by manual pelvimetry, and with the developing technology, it was replaced by imaging systems (Radiography, Computed Tomography, Magnetic Resonance Imaging, Ultrasonography) that provide clearer results (Stark, 1985; Ohlerth and Scharf, 2007). Among these methods, the most reliable and accurate method is the measurements taken using computed tomography (Lenhard, 2009).

The presence of pelvic diameters and the development of the pelvis are assumed to depend on breed, body size, sex, nutrition, movement speed, hormones, environment and climatic conditions (Karakaş, 1988). In this context, in our study, it was aimed to determine the relations between the breeds and the genders of the same breed by performing the pelvic evaluation of different breed dogs. It is purposed that the obtained data will provide basic data for different disciplines, especially gynecology, and contribute to studies in the fields of zooarchaeology, evolutionary biology and taxonomy by determining the gender dimorphism data of the breeds.

MATERIALS and METHODS

Ethical approval

Istanbul University-Veterinary Faculty Unit Ethics Committee 15.11.2022/22-38 Local Ethics Committee Approval was obtained for this study.

Samples

19 different dog breeds (Alabai, German Shepherd, American Staffordshire, Beagle, Chihuahua, Cocker Spaniel, Golden Retriever, Siberian Husky, Jack Russell terrier, Kangal Shepherd, Cavalier King, Pekingese, Pompeian, Poodle, Rottweiler, Russian Tsvetnaya) were used in our study. A total of 43 dogs were used: Bolonka, Samoyed, Setter, Terrier. There were no health problems in the research. The

samples were made at Istanbul University, Faculty of Veterinary Medicine, Department of Radiology.

Retrieval of three-dimensional pelvimetry data

MDCT images were obtained by scanning the pelvis of the dogs used in the study with a 64-slice multidetector computed tomography (MDCT) (General Electronic Revolution) device at 80 kV, 200 mA, 639 mGY and 0.625 mm section thickness, and saved in DICOM (Digital Imaging and Communications in Medicine) format. Images were transferred to the RadiAnt DICOM Viewer program to take the pelvis measurements of the dogs whose MDCT images were taken, and pelvic measurements were taken from the points mentioned below. The study terminology was based on Nomina Anatomica Veterinaria (2017).

Pelvimetric measurements and reference points (Özkadif et al., 2014; Yılmaz et al., 2019; Demircioğlu et al., 2020; Özkadif et al., 2022):

- A. **Diameter conjugata:** Diameter between the cranial tip of the symphysis pelvina and the promontorium (Figure 1).
- B. **Diameter verticalis:** Diameter between the cranial tip of the symphysis pelvina and the facies pelvina of the sacrum (Figure 1).
- C. **Inclinatio pelvina:** Angle between diameter verticalis and diameter conjugata (Figure 1).
- D. **Diameter transversa**

D.1. Apertura pelvis cranialis in transvers diameters (Figure 2)

D.1.1. Dorsal transversal diameter: Diameter between the ends of two ala osis sacri.

D.1.2. Intermedial transversal diameter: Diameter between two tuberculum muscle psoas minoris.

D.1.3. Ventral transversal diameter: Diameter between two eminentia ilio-pubica.

D.2. Transverse diameters of the pelvic cavity (Figure 3)

D.2.1. Cranial transversal diameter: two inc. Diameter between anterior ends of ischiadica majores.

D.2.2. Medial (bispinous) transversal diameter: Diameter between two ischial spine (spina ischiadica).

D.2.3. Caudal (bituberous) transversal diameter: The distance between the inner faces of two ischial tuberosity (tuber ischiadicum).

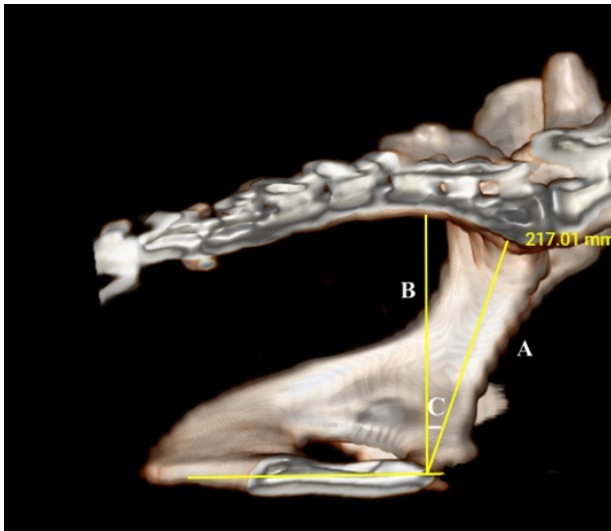


Figure 1. Measurement on lateral view of pelvis. A: Conjugate diameter, B: Vertical diameter, C: Pelvic inclination

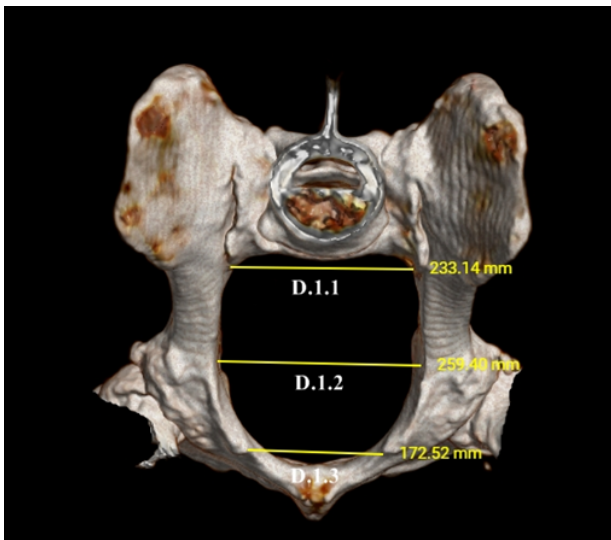


Figure 2. Transverse diameters of apertura pelvis cranialis (cranial view); D.1.1. Dorsal transverse diameter, D.1.2. Intermediate transverse diameter, D.1.3. Ventral transverse diameter

Statistical analysis

In the study, the minimum and maximum values of the pelvimetric measurements were taken separately for each group of dogs. Inclination pelvis values between females and males were obtained. These values were compared with ANOVA and the statistical difference between males and females was tried to be revealed. SPSS 22 package program was used for statistical analysis.

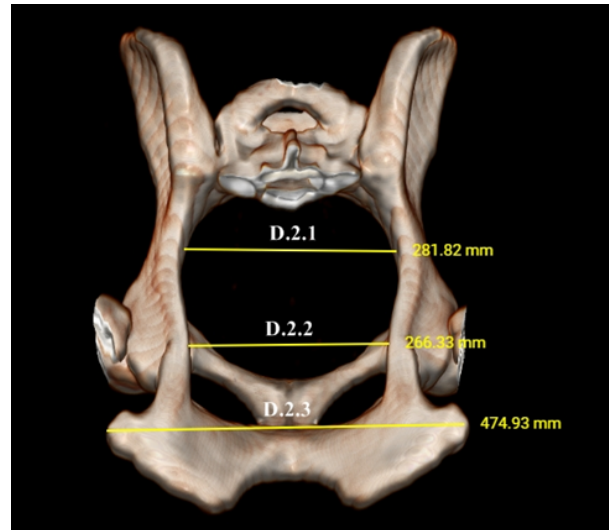


Figure 3. Transverse diameters of the pelvic cavity (caudal view); D.2.1. Cranial transverse diameter, D.2.2. Medial (bispinous) transverse diameter, D.2.3. Caudal (bituberous) transverse diameter

RESULTS

Radiographic pelvimetry data of the dog breeds that reveal the study material are given in Table 1. Diameter conjugata (A) was determined to be highest in Kangal Shepherd dogs with an average of 75.62 mm, and the lowest average in Pomeranian breed dogs. Diameter verticalis (B) was found to be 73.32 mm average in Kangal Shepherd dogs, and the lowest average was 29.50 mm in Pomeranian breed dogs. Inclination pelvis (C) was found to be highest in Alabai breed dogs with 38° and lowest in Pekingese, Pomeranian and Setter breed dogs with 18°. When the transversal diameters of the aperture pelvis cranialis were examined, it was determined that D.1.1 diameter was the largest in Alabai breed dogs, and D.1.2 and D.1.3 diameters were found in Rottweiler dogs. It was determined that D.2.1 and D.2.3 diameters in the width diameters of the pelvic cavity were higher in Alabai breeds and D.2.2 diameter in German Shepherd breeds. When the statistical comparison of the inclination pelvis in all dog breeds was made between the genders, no significant difference was observed between them (Table 2). In the dog breeds, we examined in this study, it was determined that the diameter verticalis fell to the more caudal of the sacrum in breeds with large body structures (Kangal Shepherd, German Shepherd, Alabai, Rottweiler).

Table 1. Pelvimetric data of dog breeds

Dogs		A (mm)	B (mm)	C (°)	D1.1 (mm)	D1.2 (mm)	D1.3 (mm)	D2.1 (mm)	D2.2 (mm)	D2.3 (mm)
Alabai (n:1)	Min.	79.30	71.20	38.00	56.00	62.70	41.40	63.80	63.80	139.60
	Max.	79.30	71.20	38.00	56.00	62.70	41.40	63.80	63.80	139.60
	Mean	79.30	71.20	38.00	56.00	62.70	41.40	63.80	63.80	139.60
German Shepherd (n:3)	Min.	72.90	70.10	22.00	49.90	57.20	40.80	56.60	55.70	128.10
	Max.	81.50	77.10	33.00	57.70	62.50	47.90	61.70	72.80	135.80
	Mean	77.93	72.77	28.33	54.40	60.07	44.03	58.77	65.67	132.03
American Staffordshire (n:1)	Min.	54.30	59.50	25.00	41.10	49.00	42.30	48.20	43.20	93.90
	Max.	54.30	59.50	25.00	41.10	49.00	42.30	48.20	43.20	93.90
	Mean	54.30	59.50	25.00	41.10	49.00	42.30	48.20	43.20	93.90
Beagle (n:2)	Min.	42.50	43.90	24.00	34.60	43.60	40.70	39.40	40.80	78.70
	Max.	46.60	50.50	38.00	38.70	50.30	41.40	44.00	41.40	79.80
	Mean	44.55	47.20	31.00	36.65	46.95	41.05	41.70	41.10	79.25
Chihuahua (n:2)	Min.	30.90	32.60	23.00	17.70	24.40	21.60	24.60	24.70	45.40
	Max.	31.30	33.50	35.00	26.90	36.50	23.00	31.90	31.60	55.80
	Mean	31.10	33.05	29.00	22.30	30.45	22.30	28.25	28.15	50.60
Cocker Spaniel (n:1)	Min.	48.90	53.60	29.00	41.6	48.40	36.10	43.10	42.60	89.10
	Max.	48.90	53.60	29.00	41.6	48.40	36.10	43.10	42.60	89.10
	Mean	48.90	53.60	29.00	41.6	48.40	36.10	43.10	42.60	89.10
Golden Retriever (n:10)	Min.	50.60	57.50	17.00	45.5	51.50	34.40	45.60	48.00	102.20
	Max.	71.80	75.30	31.00	51.80	58.80	44.10	54.10	60.80	130.40
	Mean	64.85	67.39	24.20	44.04	54.34	38.03	51.21	53.67	114.52
Siberian Husky (n:3)	Min.	48.10	64.80	25.00	47.50	53.30	32.00	53.40	43.90	110.40
	Max.	69.30	68.70	29.00	58.30	55.30	45.30	54.60	56.10	114.90
	Mean	60.13	67.23	27.33	54.27	54.10	38.33	53.83	51.47	111.93
Jack Russell terrier (n:1)	Min.	34.50	38.90	29.00	33.60	39.30	30.20	37.50	35.10	68.50
	Max.	34.50	38.90	29.00	33.60	39.30	30.20	37.50	35.10	68.50
	Mean	34.50	38.90	29.00	33.60	39.30	30.20	37.50	35.10	68.50
Kangal Shepherd (n:5)	Min.	69.70	66.80	21.00	50.60	53.70	35.90	54.20	52.50	121.50
	Max.	82.80	77.10	38.00	59.50	61.90	44.90	59.70	60.60	141.60
	Mean	75.62	73.32	32.00	54.32	58.04	40.62	56.42	57.66	128.86
Cavalier King Charles (n:1)	Min.	44.30	45.90	19.00	38.00	46.10	38.00	42.90	38.00	71.10
	Max.	44.30	45.90	19.00	38.00	46.10	38.00	42.90	38.00	71.10
	Mean	44.30	45.90	19.00	38.00	46.10	38.00	42.90	38.00	71.10
Pekingese (n:1)	Min.	36.40	38.40	18.00	27.20	39.50	30.10	38.00	33.20	62.00
	Max.	36.40	38.40	18.00	27.20	39.50	30.10	38.00	33.20	62.00
	Mean	36.40	38.40	18.00	27.20	39.50	30.10	38.00	33.20	62.00
Pompeian (n:1)	Min.	27.00	29.50	18.00	22.20	26.90	18.80	27.70	24.10	48.10
	Max.	27.00	29.50	18.00	22.20	26.90	18.80	27.70	24.10	48.10
	Mean	27.00	29.50	18.00	22.20	26.90	18.80	27.70	24.10	48.10
Poodle (n:2)	Min.	45.50	42.70	35.00	30.50	35.10	16.00	35.00	34.00	67.10
	Max.	52.40	45.30	37.00	35.80	42.90	31.70	38.90	40.90	77.10
	Mean	48.95	44.00	36.00	33.15	39.00	23.85	36.95	37.45	72.10
Rottweiler (n:1)	Min.	76.60	73.00	24.00	58.6	64.00	46.40	58.30	60.30	125.60
	Max.	76.60	73.00	24.00	58.6	64.00	46.40	58.30	60.30	125.60
	Mean	76.60	73.00	24.00	58.6	64.00	46.40	58.30	60.30	125.60
Russian Tsvetnaya Bolonka (n:1)	Min.	55.60	52.00	32.00	39.80	50.00	36.00	41.60	43.30	88.20
	Max.	55.60	52.00	32.00	39.80	50.00	36.00	41.60	43.30	88.20
	Mean	55.60	52.00	32.00	39.80	50.00	36.00	41.60	43.30	88.20
Samoyed (n:1)	Min.	58.80	55.70	32.00	43.70	49.70	33.80	46.90	46.30	99.00
	Max.	58.80	55.70	32.00	43.70	49.70	33.80	46.90	46.30	99.00
	Mean	58.80	55.70	32.00	43.70	49.70	33.80	46.90	46.30	99.00
Setter (n:1)	Min.	62.30	67.80	18.00	50.50	53.60	35.10	56.20	62.50	115.40
	Max.	62.30	67.80	18.00	50.50	53.60	35.10	56.20	62.50	115.40
	Mean	62.30	67.80	18.00	50.50	53.60	35.10	56.20	62.50	115.40
Terrier (n:5)	Min.	32.90	33.60	18.00	22.50	30.10	21.40	27.70	25.10	48.00
	Max.	47.70	46.20	32.00	37.70	40.80	31.70	41.30	36.90	76.80
	Mean	39.02	39.62	25.60	30.30	37.96	27.16	34.38	32.84	62.50

Table 2. Statistical analysis of inclinatio pelvis (C) between genders

Sex	N	Mean	SD	Min	Max	F	P Value
Female	14	25.79	6.42	17.00	37.00	1.057	0.310
Male	29	27.93	6.41	18.00	38.00		

DISCUSSION

In carnivores, the pelvis is the most suitable for birth among domestic animals. This is because the base of the pelvis canal is flat and backward. Moreover, due to the backward extension of the canal, the diameter verticalis falls back, causing the diameter to be longer and therefore easier delivery (Bahadır and Yıldız, 2016).

In studies on different carnivorous species and breeds, Özkadif et al. (2022) reported the diameter verticalis in males 49.75 ± 0.90 mm, in females 37.46 ± 5.18 mm, the diameter conjugata in males 52.54 ± 1.22 mm, in females 48.54 ± 3.71 mm, Inclinatio pelvis in males 49.60° , in females $49.50 \pm 0.46^\circ$ degrees in red foxes. Yilmaz et al. (2020) determined the same diameters and angles in female Van cats, respectively, as 38.9 mm, 32.2 mm, and 37.3° . Atalar et al. (2017), in the pelvimetric evaluation of kangal dogs reveal that the diameter verticalis in males is 92.21 ± 0.98 mm, in females, 83.55 ± 0.68 mm, the diameter conjugata in males is 93.12 ± 1.53 mm, in females 82.61 ± 2.32 mm, inclinatio pelvis in males 39.01° , in females, they reported it 44.67° degrees. Dobak et al. (2018) reported diameter conjugata as 59 ± 5 mm in English bulldogs, and Nganvongpanit et al. (2017) reported diameter conjugata as 64.19 mm in males and 60.31 mm in females in Retriever dogs. In our study, diameter conjugata belonging to 19 different dog breeds was the highest in Kangal Shepherd dogs and the lowest average was in Pomeranian breed dogs, diameter verticalis was highest in Kangal Shepherd dogs and lowest also in Pomeranian breed dogs, and for inclinatio pelvis, it was determined highest in Alabai breed dogs and lowest in Pekingese, Pomeranian and Setter breed dogs.

In this study, when the transverse diameters of the aperture pelvis cranialis were examined, it was observed that the intermediary transversal diameter had the highest value in all dog breeds, while the ordering of the dorsal transversal diameter and ventral transversal diameter values between breeds was determined. König and Liebich (2015) reported that the intermediary transversal diameter has the highest value among the transverse diameters of the aperture pelvis cranialis in dogs. Among the transverse diameters of the

aperture pelvis cranialis in red foxes (Özkadif et al., 2022), the intermediary transversal diameter is the highest and the ventral transversal diameter is the narrowest, while in Kangal dogs (Atalar et al. 2017), it was reported that the dorsal transversal diameter is the highest and the ventral transversal diameter was the narrowest.

CONCLUSION

In conclusion, three-dimensional pelvimetry results of 19 different dog breeds were obtained and pelvimetric measurements were revealed for different species. Although pelvis morphology and morphometry can be affected by many reasons, it is thought that the data revealed will be beneficial for many disciplines, especially for gynecology. Also, it is thought that determining the probability of difficult or easy birth by revealing the pelvimetric characteristics of these breeds is very important for the enterprises engaged in animal production and breeding, and it is thought that it will contribute in an industrial way.

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