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Computed Tomography Imaging, Macroanatomical and Morphometric Analysis of Os penis in Brown Bear (*Ursus arctos*)

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Abstract: The aim of this study is to reveal the macroscopic features of the brown bear (*Ursus arctos*) os penis (baculum), as well as its morphometric measurements with the help of computerized tomography and digital electronic caliper. The study material was obtained from an adult male brown bear weighing approximately 400 kg, which was brought to the Wildlife Protection and Rehabilitation Unit of Kafkas University and died as a result of a traffic accident in the Sarıkamış district of Kars. After the skin and soft tissues around the baculum were removed, they were kept in hydrogen peroxide for 2-3 hours. In the macroscopic examination, it was determined that the baculum was straight, close to the pen, except for a slight curve in the distal part, and ended with a small tubercle at the distal end. A small notch was found in the proximal part. In addition to the prominent sulcus urethralis in the ventral of the baculum, a short groove was also detected in its lateral. A cartilage tissue of 11.08 mm in length and 4.67 mm in thickness was determined in the distal of the bone. In the morphometric measurements made with a digital electronic caliper, the length of the baculum was 148.95 mm, while the diameters were measured as 4.58 mm in the distal and 13.72 mm in the proximal, respectively. In computed tomography, baculum length was 148.84 mm, distal diameter length was 5.63 mm, and proximal diameter length was 13.12 mm. In addition, computed tomography measured the length of the cortex as 0.76 mm, the length of the medulla as 5.74 mm in the distal, the cortex length of 0.77 mm and the medulla length of 5.32 mm in the proximal region. As a result, in this study, the macro anatomical and morphometric features of the brown bear baculum, which live in high altitude and cold climate conditions, were revealed.

Keywords: Brown bear, baculum, os penis, macroanatomy, morphometry, computed tomography

1. Introduction

The brown bear (*Ursus arctos*) is a large bear with the widest distribution of any living ursid (Serhveen et al. 1999). The brown bear's principal range includes parts of Russia, Central Asia, China, Canada, the United States, Scandinavia, the Carpathian region, Anatolia, and Caucasus (McLellan et al. 2008; Zedrosser et al. 2001) The normal range of physical dimensions for a brown bear is a head-and-body length of 1.4 to 2.8 m and a shoulder height of 70 to 153 cm. The tail is relatively short, as in all bears, ranging from 6 to 22 cm in length (Parker 1990; Nowak 1999).

The os penis is a bony structure located in the corpus cavernosus penis in the distal part of the penis. There is a groove called sulcus urethralis in the ventral of the bone. This groove loses its width and depth as it goes from proximal to distal. The proximal end of the os penis is thick, while the distal end is thin. The distal end ends with cartilage. (Dursun 2000; Nickel et al. 1981; Getty 1975; Gültekin et al. 2004). Several investigators have described the anatomy of the penis of both Carnivora and wild animals, the anatomy and bacula growth are well described for that, but no report on that of the brown bear. (Getty 1975; Gültekin et al. 2004; Miller 1979; Miller et al. 2000; Abella et al. 2013, Münzel et al. 2021). On the other hand, morphological of the penis bone in the brown bear has not been investigated so far. Therefore, the present study contributes to the knowledge of quantitative characteristics of the size of the penis bone in the brown bear. This first study of the brown bear baculum will contribute to the literature by providing very important information.

2. Materials and Method

The study material, os penis, was obtained from an adult male brown bear, weighing approximately 400 kg, who died as a result of a traffic accident in the Sarıkamış district of Kars. The procedures of classic maceration were applied to the example and the penis bone was brought out by cleaning. After the penis bone was macerated for 2-3 hours with hydrogen peroxide, measurements were by using digital caliper (0.001, BTS, UK) from the penis bone. Surfaces of the penis bone were examined for macroanatomical observations. Nomina Anatomica Veterinaria (NAV, 2017) was used in the spelling of anatomic terminology.

3. Results

In the brown bear, the length of the os penis was 148.95 mm, its proximal width was 13.72 mm, and its distal width was 4.58 mm. Its weight was determined as 5.73 g. In computed tomography, the length was measured as 148.84 mm, the distal diameter was 5.63 mm, and the proximal diameter was 13.12 mm. In addition, computed tomography measured the length of the cortex as 0.76 mm, the length of the medulla as 5.74 mm in the distal, the cortex length of 0.77 mm and the medulla length of 5.32 mm in the proximal region.

It was determined that the thickness of the os penis decreased from proximal to distal. Except for a slight curve in the distal part of the os penis, it was found to be almost straight and almost quadrangular in shape. It was determined that the distal end ended with a small tubercle. On the proximal part, there was a small notch. In addition to the prominent sulcus urethralis in the ventral aspect of the os penis, a short groove was also detected in its lateral aspect. A fibrous cartilage tissue with a length of 11.08 mm and a thickness of 4.67 mm was detected distal to the bone.

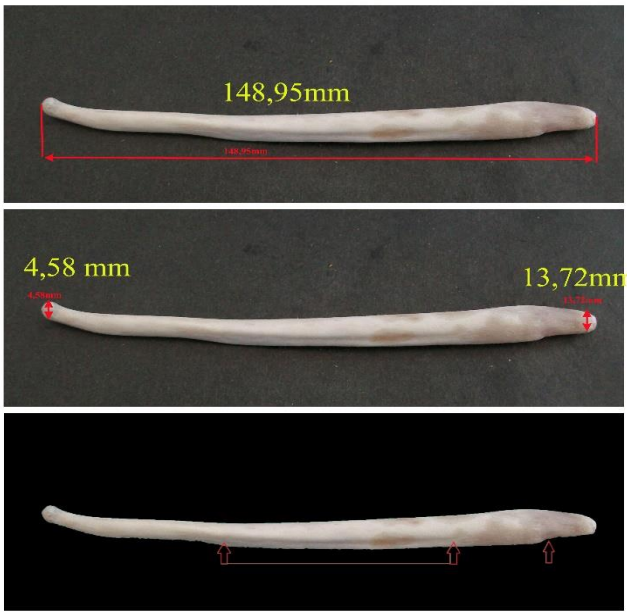

Figure 1. Points measured on the os penis with the help of digital caliper

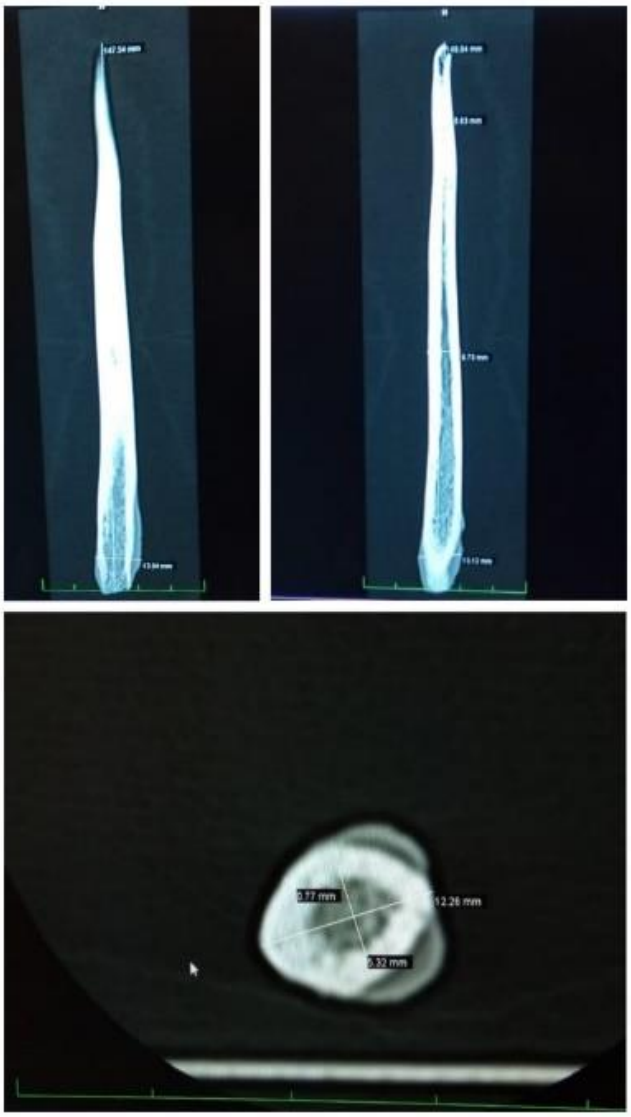

Figure 2. Measuring points measured by CT over the os penis

Table 1. Findings measured on the baculum by classical morphometry and computed tomography

Parameters	Morphometric measurement	CT Measurement
Length of the os penis	148.95 mm	148.84 mm
Distal diameter	4.85 mm	5.63 mm
Proximal diameter	13.72 mm	13.12 mm
Cortex length of Distal		0.76 mm
Medulla length of Distal		5.74 mm
Cortex length of Proximal		0.77 mm
Medulla length of Proximal		5.32 mm

4. Discussion

In this study, the length, proximal width distal width, and weights of the brown bear's os penis were determined as 148.95 mm, 13.72 mm, 4.85 mm, and 5.73 g, respectively. According to the analysis made with CT, the length of the os penis was 148.84 mm, the distal diameter length was 5.63 mm, and the proximal diameter length was 13.12 mm. Similarly, the proximal length of the cortex was 0.77 mm, the proximal length of the medulla was 5.32 mm, the distal length of the cortex was 0.76 mm, and the distal length of the medulla was 5.74 mm.

Dyck et al. (2004) reported the os penis dimensions of a 3-year-old polar bear *(Ursus maritimus)* living in the Canadian Arctic as 140 mm in length, 9.12 mm in width and 5.92 g in weight, respectively. According to Abella et al. (2013), lengths of fossil os penises are 151 mm in Sloth bear (Melursus ursinus), 104.7 mm in Andean bear (Tremarctos ornatus), 137 mm in American black bear (Ursus americanus), Asiatic Black Bear (Ursus thibetanus) length 118.25 mm, Grizzly bear (Ursus arctos) 133.8 mm, the bear indarctos (Indarctos arctoides) 238.6 mm and the polar bear (Ursus maritimus) They stated that the length was 186.5 mm.

Lønø (1970) stated that the os penis length of the adult polar bear *(Ursus maritimus phipps)* living in the Svalbard region was 155 mm, and its weight was 8.10 g. Didier (1950) stated the penis length as 135.4 mm in Grizzly bear (Ursus arctos) and 168 mm in the polar bear (Thalarctos maritimusos). Miller et al. (2000) stated that adult the Steller Sea Lion (Eumetopias Jubatus) os penis averaged 180.1 mm in length, its weight was 36.7 g. According to the literature information given, it was seen that the os penis length of an adult living in Sarıkamış, weighing 400 kg, had higher values than many ursus breeds.

According to Abella et al. (2013) os penis's shape is slightly more sigmoidal and its distal tip is relatively better developed; only the baculum of Malayan sun bear (Helarctos malayanus) has developed an ossified tip at its distal end. Evans and Delahunta (2010) stated that is cartilaginous and not completely ossified throughout its life cycle in canidae. In our study, apart from a slight inclination in the distal part of the os penis, it was almost straight to the pen, and a fibrous cartilage tissue of 11.08 mm in length and 4.67 mm in thickness was detected in the distal part of the os penis.

The brown bear's os penis has sulcus urethralis at its ventral edge, similar to that of red fox and dog, and is gradually tapering from proximal to distal. Gültekin et al., (2004) reported that the os penis is triangular and has a crista at its distal end in Red Fox, whereas in brown bears the os penis is quadrilateral and has a tubercle at the distal end. Miller (1979) and Gültekin et al. (2004) mentioned in dogs and Red Foxes respectively, it was determined that the dorsoventral diameter of the entire os penis was larger than the laterolateral diameter.

5. Conclusion

As a result, in this study, the morphological features of the Brown bear os penis, which live in high altitude and cold climate conditions, were revealed and compared with some wild species. It is thought that the data obtained in the study can be used in future morphometric, zoo-archaeological and taxonomic studies.

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Authors' contributions: SD, GKD, YA, analyzed morphometrically and macroanatomically. TÇ and VK examined by CT. All authors edited and wrote the article.

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