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Dental morphometric investigation on the chinchilla (*Chinchilla lanigera*) using a three-dimensional reconstruction model

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Abstract: The aim of this study was to reveal the morphometric characteristics of the teeth of the chinchilla (*Chinchilla lanigera*), which are both kept as pet animals and raised for the economic value of their fur, using three-dimensional (3D) reconstructions created from two-dimensional (2D) multidetector computed tomography (MDCT) images and to investigate whether there was a difference between the sexes. A total of 12 chinchillas of both sexes (six males and six females) were used. The teeth reconstructions of the animals were performed with Mimics. 14.1 3D modeling software on the 2D images was taken in the prone position. According to the statistical results of the linear measurement, surface area, and volume values of the teeth obtained from the created model, sexual dimorphism was detected in all the teeth of the chinchilla. It was observed that the mandibular incisors were larger than the maxillary incisors, and the largest maxillary molar was M1 and the largest mandibular was M2. It is considered that the results of the study can contribute to anatomical and clinical research, as well as studies and applications in the field of veterinary dentistry.

Key words: Rodent, chinchilla, 3D imaging, morphology

1. Introduction

Teeth measurements are used in forensic medicine, anthropology, genetics, and odontology [1]. Teeth are the materials of choice for paleontologists because they are typically better preserved compared to bones or other tissues [2]. Both dental morphometric and morphological analyses are complementary forensic tools. The results of these analyses can help identify a suspected animal species more effectively and reliably [3]. Models created with the three-dimensional (3D) reconstruction of the teeth can help plan orthodontic treatment, design individual devices, and evaluate treatment results [4].

3D reconstruction from high-resolution data is a popular and valuable tool [5]. Among image acquisition modalities, computed tomography (CT) is the most effective way to create 3D objects [6]. In particular, CT has proven to be a useful tool for imaging mineralized hard tissues, such as enamel and cortical bone. Unlike conventional radiography, CT has the advantages of not overlapping images and higher contrast resolution [7, 8].

Morphometric studies have been carried out on the teeth of many species of Carnivora, including the European badger (*Meles meles*) [9], Iberian wolf (*Canis lupus signatus*) [3], red fox (*Vulpes vulpes*) [10, 11], and domestic dog and wolf [12]. In addition, the anatomical structure and morphometric measurement values of the teeth of the New Zealand rabbit (*Oryctolagus cuniculus*) from the order Lagomorpha have been previously revealed using a 3D model [13].

The order Rodentia represents the largest and most diverse group of mammals, accounting for approximately 40% of all mammal species [8]. There is a wide variety in the dental anatomy of the Rodentia, which are very large and spread across different habitats [14]. Depending on the species, premolars and molars have more or less different sizes and shapes [8]. Studies have been conducted on the tooth morphology of the fossil Rodentia, including Murinae and non-Arvicolinae cricetids [15] and the giant extinct rodent [2].

The chinchilla, an exotic animal from the order Rodentia, is now growingly adopted as a pet animal [16], and as a result, it is also grown on farms [17]. Dental diseases are very common in the chinchilla [16]. Most animals with dental diseases present with weight loss, decreased food intake or loss of appetite, drooling, or poor fur quality [18]. Considering that veterinarians encounter dental diseases in the chinchilla and make necessary interventions, it is important that they are familiar with the

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causes of such diseases, appropriate preventive measures, diagnostic techniques, and treatment options [16].

The anatomical structure of the skull of the chinchilla has been previously revealed using radiological and CT images [16]. In addition, the linear measurements of the chinchilla skull and tooth lengths have been measured with calipers [19]. The pathologically overgrown incisor and molar teeth of the chinchilla and the bone structures of the maxilla and mandible have been radiologically analyzed [17]. Furthermore, studies have been conducted on the anatomy and disorders of the oral cavity of the chinchilla and degus [18].

In the literature, there are various studies on the teeth of the chinchilla, but we found no study presenting detailed morphometric measurement values or constructing models with different software packages using imaging techniques for this investigation. Therefore, the aim of this study was to reveal the morphometric characteristics of the chinchilla teeth on a 3D model obtained using 2D multidetector computed tomography (MDCT) images and to investigate whether there was a difference between the sexes.

2. Materials and methods

This study was accepted by the ethics committee of Ceyhan Veterinary Faculty of Çukurova University on May 31, 2021 (decision number: 06/01, 02).

2.1. Number of the animals and weight

In the study, a total of 12 healthy adult (one-year-old) chinchillas *(Chinchilla lanigera)* of both sexes (six females, six males) weighing 500 to 600 g were used.

2.2. Anesthesia

The animals from which the images were to be taken were anesthetized with a mixture of 60 mg/kg ketamine (Ketalar, Pfizer®) and 6 mg/kg xylazine (Rompun, Bayer®) intravenously.

2.3. MDCT images

Under anesthesia, MDCT images were taken with the animals in the prone position. The parameters of the MDCT instrument (Somatom Sensation 64; Siemens Medical Solutions, Germany) were adjusted as follows: physical detector collimation, 32 × 0.6 mm; final section collimation, 64 × 0.6 mm; section thickness, 0.50 mm; gantry rotation time; 330 ms; kVp; 120; mA, 300; resolution, 512 × 512 pixel; and resolution range, 0.92 × 0.92. The dosage parameters and scans were performed by utilizing standard protocols in light of the literature [20,21]. Radiometric resolution (MONOCHROME2; 16 bits) was obtained at the lowest radiation level and with optimum image quality. The images were stored in the DICOM format and transferred to a personal computer containing the 3D modeling software of Mimics 14.1.

2.4. Three-dimensional reconstruction

The bordered and different colored images (as shown in Figure 1) were overlapped, and reconstruction was performed using the 3D transformer component of Mimics 14.1.

2.5. Measurements

The length, width, surface area, and volume of each tooth in the maxillary and mandibular were automatically measured from the 3D model obtained from the CT images. In addition, the length of the cheek tooth row (M3–P4), length of the molar row (M3–M1), partial length of the molar row (M3–M2 and M1–M2), partial length of the cheek tooth row (P4–M1 and P4–M2), diastema length, the distance between the first incisors, the distance between the fourth premolars, the distance between the third molars, the distance between the cusp tips of the first incisors both in the maxilla and mandible were measured from the 3D-reconstructed images as described in the literature [3,11,13,22] (as shown in Figure 2).

2.6. Statistical analysis

Statistical analysis was performed using SPSS software package 16.0. The independent-samples *t*-test was performed, and differences in the measurements according to the sex and side were revealed for the maxillary and mandibular teeth. Statistical significance was taken as $p < 0.05$.

3. Results

The chinchilla has the maxillary and mandibular arches on which incisive (I1), premolar (P4), and molar (M1-3) teeth are located (Figure 3). It was determined that the animals had a total of 20 different teeth, four incisive, four premolars and 12 molars, and the tooth formula 2 (I1/1, C0/0, P1/1, M3/3). There were two maxillary and two mandibular incisors (one on the right and one on the left) and no canine teeth. A total of four premolar teeth, one on the right and one on the left, were found in both the maxillary and mandibular bones. The incisive teeth on the mandible were larger than those on the maxilla. A total of 12 molar teeth were identified, of which six were in the maxillary arch and six in the mandibular arch, and the largest molar tooth in the maxillary arch was M1 and the largest tooth in the mandibular arch was M2 (as shown in Table 1).

There was a statistically significant difference in the surface area and volume of both the maxillary and mandibular teeth on the right and left sides between the male and female chinchillas. Statistical differences between the sexes were also detected in the tooth length on both sides in both maxillary and mandibular I1, M1, and M3, and in the tooth width in maxillary M1, mandibular I1, and M1. In addition, the teeth of the female chinchillas were found to be larger in size compared to the males.

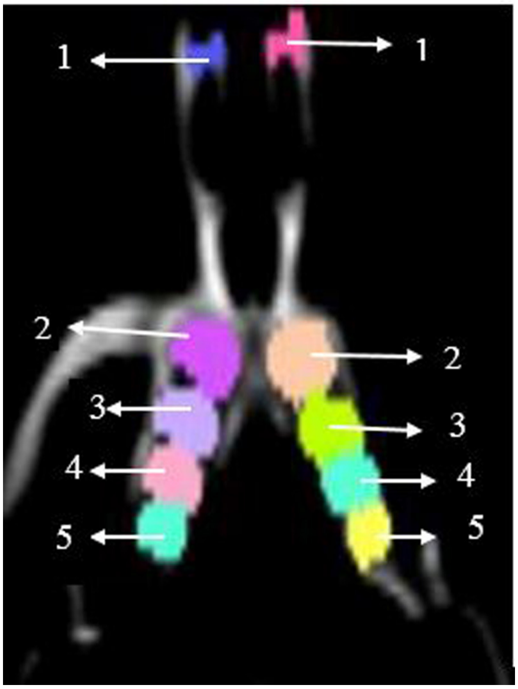

Figure 1. Limitation of the teeth on the coronal image using different colors on the maxilla. 1: Maxillary incisor 1, 2: Maxillary premolar 4, 3: Maxillary molar 1, 4: Maxillary molar 2, 5: Maxillary molar 3.

However, there was no significant difference between the right and left sides of both the males and females in any of the maxillary and mandibular teeth. The teeth on both sides were morphometrically similar to each other (as shown in Table 1).

Among the measurements performed between the right and left sides of the maxillary and mandibular arches, there were significant differences between the sexes in terms of the distance between the first incisors, the distance between the third molar, and the distance between the cusp tips of the first incisors in both the maxillary and mandibular teeth, while only the distance between the fourth premolar in the mandibular arch was significantly larger in the females compared to the males (as shown in Table 2).

Considering the comparison of the measurement values between the teeth of the male and female chinchillas on the right and left sides (as shown in Figures 4, 5), there was a statistical difference between the sexes in relation to the length of maxillary M3–P4, M3–M1, M3–M2, P4–M1, P4–M2, and M1–M2 and the diastema length on both the right and left sides. It was determined that the length between mandibular M3–P4, M3–M1, and M1–M2, and the diastema length were statistically significantly larger in the female chinchillas than in the males on both sides.

4. Discussion

Sulik et al. [17] stated that there were two incisor (I1), two premolar (P4) and six molar (M1, M2, M3) teeth in each arch of the chinchilla [16] and no canine teeth. The first three premolars have disappeared and only P4 is present [23]. The fairly large diastema gap in the Rodentia [24] has varying lengths on the maxilla and mandible [25]. In the chinchilla, we found the diastema gap to be larger in the maxilla than in the mandible in both males and females.

According to the morphometric measurements performed on the chinchilla teeth, there was a statistical difference between the male and females in I1, P4, M1, M2, and M3 on both the right and left sides of the lower and upper jaws. It has been reported that there is a statistical difference between the sexes in badger teeth I2, I3, C, P2, P3, and P4, with the values being greater in the males than in the females [9]. In contrast, in our study, the teeth of the female chinchilla were larger than those of the males. Our results are in agreement with those reported by Lammers et al. [26], indicating that female chinchillas have larger measurements than male chinchillas. The sexual dimorphism in Viscerocranium has been noted as a difference in diets or other uses of the jaw between males and females [26]. It has been suggested that sexual dimorphism in the badger tends to be more prominent in the incisors compared to the molars, especially in the upper jaw [9]. In the chinchilla, sexual dimorphism has been revealed in both the maxillary and mandibular teeth. In addition, it has been reported that the morphometric dental features of the Iberian wolf, another species belonging to the order Carnivora, show significant sexual dimorphism. It has also been stated that M1 is the largest of the series in both the maxillary and mandibular bones [3]. Similar to the Iberian wolf, we determined that the largest molar tooth was M1 in the maxillary bone and M2 in the mandibular bone.

In the current study, the maxillary tooth lengths of the chinchillas were measured as P4 8.27 ± 0.28 mm, M1 9.60 ± 0.39 mm, M2 6.95 ± 0.60 mm, and M3 5.26 ± 0.22 mm on the right side and P4 8.13 ± 0.58 mm, M1 9.62 ± 0.36 mm, M2 7.17 ± 0.40 mm, M3 5.51 ± 0.28 mm on the left side for the males, and P4 8.79 ± 0.58 mm, M1 10.30 ± 0.50 mm, M2 7.22 ± 0.55 mm, and M3 7.34 ± 0.52 mm on the right side and P4 8.49 ± 0.31 mm, M1 10.71 ± 0.22 mm, M2 7.49 ± 0.39 mm, and M3 7.09 ± 0.49 mm on the left side for the females. The mandibular tooth lengths were P4 6.63 ± 0.37 mm, M1 7.14 ± 0.52 mm, M2 8.68 ± 0.60 mm, and M3 6.50 ± 0.29 mm on the right side and P4 6.37 ± 0.32 mm, M1 7.48 ± 0.25 mm, M2 8.60 ± 0.64 mm, and M3 6.24 ± 0.16 mm on the left side for the males, and P4 6.56 ± 0.29 mm, M1 8.54 ± 0.62 mm, M2 8.90 ± 0.52 mm, and M3 7.32 ± 0.26 mm on the right side and P4 6.53 ± 0.36 mm, M1 8.13 ± 0.35 mm, M2 8.43 ± 0.37 mm, and M3 7.32

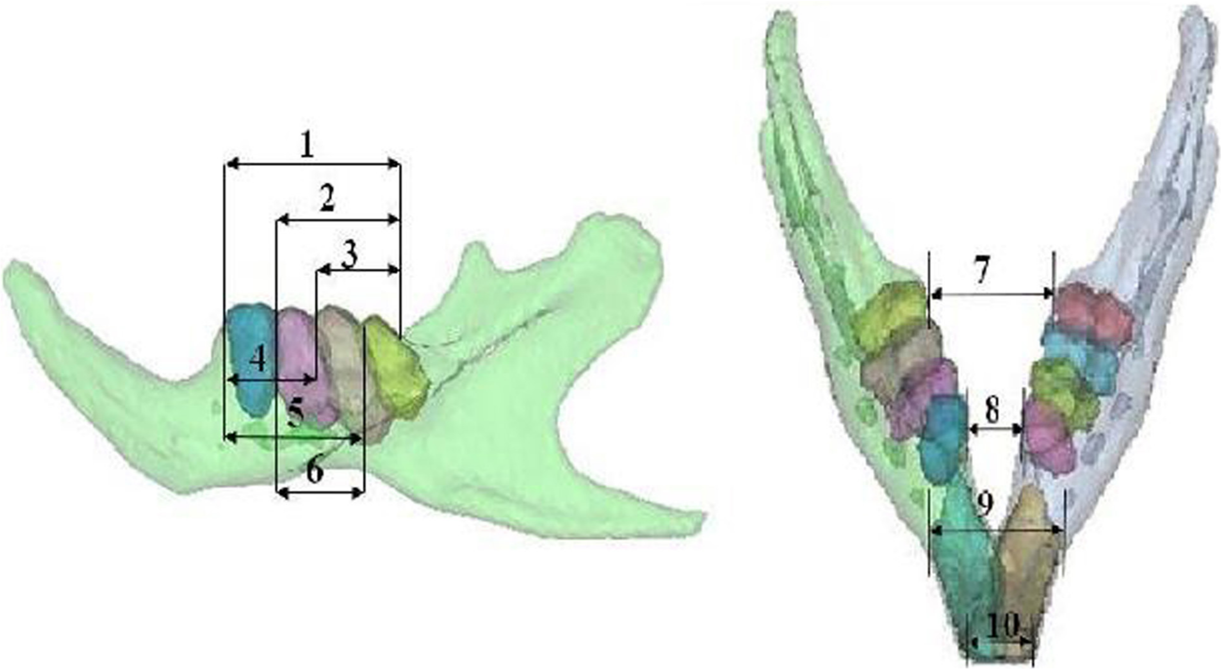

Figure 2. Measurements of the teeth of the chinchilla. 1: Length of the cheek tooth row (M3–P4), 2: Length of the molar row (M3–M1), 3: Partial length of the molar row (M3–M2), 4: Partial length of the cheek tooth row (P4–M1), 5: Partial length of the cheek tooth row (P4–M2), 6: Partial length of the molar row (M1–M2). 7: Distance between the third molars, 8: Distance between the fourth premolars, 9: Distance between the first incisors, 10: Distance between the cusp tips of the first incisors.

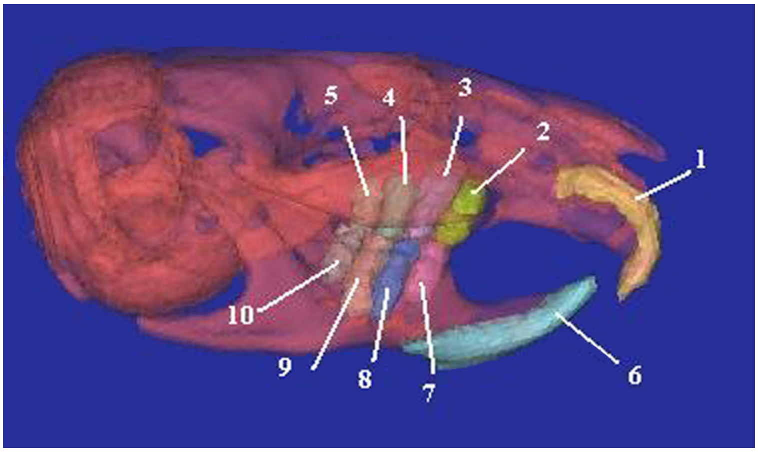

Figure 3. Lateral view of the dentition of the chinchilla obtained from 3D-reconstructed images. 1: Maxillary incisor 1, 2: Maxillary premolar 4, 3: Maxillary molar 1, 4: Maxillary molar 2, 5: Maxillary molar 3, 6: Mandibular incisor 1, 7: Mandibular premolar 4, 8: Mandibular molar 1, 9: Mandibular molar 2, 10: Mandibular molar 3.

± 0.36 mm on the left side for the females. Crossley and Miguelez [19] reported that the lengths of the maxillary teeth of the chinchilla were P4 7.5 mm, M1 7.8 mm, M2 7.7 mm, and M3 7.0 mm on the right side and P4 7.4 mm, M1 7.7 mm, M2 7.7 mm, and M3 7.0 mm on the left side, while those of the mandibular teeth were P4 8.0 mm, M1 7.8 mm, M2 7.9 mm, and M3 6.2 mm on the right side and P4 7.9 mm, M1 7.9 mm, M2 7.8 mm, and M3 6.6 mm for the left side.

Clinical intraoral findings in the chinchilla show that the maxillary molars are significantly shorter than the mandibular molars [27]. In the current study, we

Table 1. Statistical results of the linear measurement, surface area, and volumetric parameters of the maxillary and mandibular teeth of the chinchillas obtained from 3D-reconstructed computed tomography (CT) images (mean ± SD).

Tooth		Right (n = 6)		Left (n = 6)	
		Male	Female	Male	Female
Maxillary					
I1	Length (mm)	12.97 ± 0.68[a]	14.09 ± 0.66[b]	13.37 ± 0.25[a]	13.99 ± 0.28[b]
	Width (mm)	2.33 ± 0.41[a]	2.67 ± 0.30[a]	2.40 ± 0.41[a]	2.53 ± 0.22[a]
	Surface area (mm^2)	138.97 ± 4.05 [a]	193.85 ± 4.67[b]	136.77 ± 5.66[a]	196.38 ± 5.67[b]
	Volume (mm^3)	65.76 ± 2.80 [a]	117.84 ± 6.53[b]	66.15 ± 3.41[a]	123.78 ± 3.88[b]
P4	Length (mm)	8.27 ± 0.28 [a]	8.79 ± 0.58[a]	8.13 ± 0.58[a]	8.49 ± 0.31[a]
	Width (mm)	2.50 ± 0.24 [a]	2.83 ± 0.33[a]	2.41 ± 0.37[a]	2.58 ± 0.24[a]
	Surface area (mm^2)	92.46 ± 4.29 [a]	115.01 ± 4.37[b]	89.77 ± 4.45[a]	117.27 ± 3.04[b]
	Volume (mm^3)	58.66 ± 2.08 [a]	76.41 ± 2.53[b]	54.56 ± 4.39[a]	78.28 ± 6.27[b]
M1	Length (mm)	9.60 ± 0.39 [a]	10.30 ± 0.50[b]	9.62 ± 0.36[a]	10.71 ± 0.22[b]
	Width (mm)	2.54 ± 0.30 [a]	3.13 ± 0.34[b]	2.48 ± 0.12[a]	3.04 ± 0.29[b]
	Surface area (mm^2)	101.12 ± 3.21 [a]	127.78 ± 4.95[b]	103.29 ± 5.02[a]	126.45 ± 6.19[b]
	Volume (mm^3)	73.32 ± 3.78 [a]	90.52 ± 3.12[b]	73.42 ± 2.33[a]	86.96 ± 3.98[b]
M2	Length (mm)	6.95 ± 0.60 [a]	7.22 ± 0.55[a]	7.17 ± 0.40[a]	7.49 ± 0.39[a]
	Width (mm)	2.35 ± 0.29 [a]	2.36 ± 0.23[a]	2.37 ± 0.22[a]	2.44 ± 0.19[a]
	Surface area (mm^2)	80.42 ± 2.49 [a]	104.36 ± 3.91[b]	82.66 ± 2.77[a]	110.72 ± 6.36[b]
	Volume (mm^3)	50.93 ± 2.05 [a]	75.02 ± 1.89[b]	53.30 ± 3.33[a]	76.76 ± 4.37[b]
M3	Length (mm)	5.26 ± 0.22 [a]	7.34 ± 0.52[b]	5.51 ± 0.28[a]	7.09 ± 0.49[b]
	Width (mm)	2.38 ± 0.31 [a]	2.58 ± 0.24[a]	2.35 ± 0.14[a]	2.55 ± 0.16[a]
	Surface area (mm^2)	62.14 ± 3.97 [a]	89.50 ± 2.54[b]	63.48 ± 2.90[a]	90.79 ± 3.70[b]
	Volume (mm^3)	34.51 ± 3.00 [a]	56.56 ± 2.36[b]	35.20 ± 3.33[a]	54.43 ± 3.22[b]
Mandibular					
I1	Length (mm)	18.45 ± 0.61[a]	20.41 ± 1.61[b]	19.11 ± 0.54[a]	20.62 ± 1.19[b]
	Width (mm)	1.49 ± 0.11[a]	1.96 ± 0.42[b]	1.56 ± 0.13[a]	1.96 ± 0.29[b]
	Surface area (mm^2)	215.75 ± 4.25[a]	246.45 ± 6.44[b]	213.89 ± 4.51[a]	253.10 ± 9.37[b]
	Volume (mm^3)	123.04 ± 5.74[a]	167.46 ± 4.38[b]	117.38 ± 4.92[a]	171.85 ± 4.95[b]
P4	Length (mm)	6.63 ± 0.37[a]	6.56 ± 0.29[a]	6.37 ± 0.32[a]	6.53 ± 0.36[a]
	Width (mm)	2.61 ± 0.26[a]	3.02 ± 0.28[a]	2.56 ± 0.32[a]	2.96 ± 0.29[a]
	Surface area (mm^2)	68.23 ± 3.82[a]	77.71 ± 3.68[b]	64.75 ± 2.66[a]	74.40 ± 6.00[b]
	Volume (mm^3)	40.61 ± 1.35[a]	50.18 ± 2.61[b]	38.38 ± 2.90[a]	46.76 ± 4.66[b]
M1	Length (mm)	7.14 ± 0.52[a]	8.54 ± 0.62[b]	7.48 ± 0.25[a]	8.13 ± 0.35[b]
	Width (mm)	2.77 ± 0.28[a]	3.18 ± 0.30[b]	2.62 ± 0.29[a]	3.11 ± 0.30[b]
	Surface area (mm^2)	95.81 ± 3.56[a]	110.97 ± 3.14[b]	93.79 ± 2.54[a]	112.90 ± 3.38[b]
	Volume (mm^3)	65.50 ± 3.73[a]	81.30 ± 4.44[b]	65.51 ± 1.93[a]	82.93 ± 2.82[b]
M2	Length (mm)	8.68 ± 0.60[a]	8.90 ± 0.52[a]	8.60 ± 0.64[a]	8.43 ± 0.37[a]
	Width (mm)	2.54 ± 0.33[a]	2.54 ± 0.33[a]	2.47 ± 0.44[a]	2.22 ± 0.16[a]
	Surface area (mm^2)	96.80 ± 5.49[a]	105.44 ± 4.24[b]	95.28 ± 2.39[a]	103.73 ± 3.65[b]
	Volume (mm^3)	67.45 ± 3.84[a]	72.69 ± 1.68[b]	65.14 ± 2.30[a]	71.71 ± 3.11[b]
M3	Length (mm)	6.50 ± 0.29[a]	7.32 ± 0.26[b]	6.24 ± 0.16[a]	7.32 ± 0.36[b]
	Width (mm)	2.64 ± 0.25[a]	2.49 ± 0.32[a]	2.52 ± 0.18[a]	2.38 ± 0.10[a]
	Surface area (mm^2)	60.74 ± 4.46[a]	77.30 ± 3.73[b]	59.85 ± 2.00[a]	77.07 ± 2.00[b]
	Volume (mm^3)	34.41 ± 3.99[a]	50.05 ± 1.83[b]	31.44 ± 1.47[a]	47.70 ± 3.19[b]

[ab] Different letters in the same line indicate statistically significant differences ($p < 0.05$).

Table 2. Morphometric parameters of the teeth of the male and female chinchillas obtained from 3D-reconstructed computed tomography (CT) images (mean ± SD).

Parameters (mm)	Male (n = 6)	Female (n = 6)
Maxillary		
Distance between the first incisors	5.80 ± 0.54[aa]	6.61 ± 0.35[ab]
Distance between the fourth premolars	1.96 ± 0.34	1.95 ± 0.28
Distance between the third molars	4.86 ± 0.35[a]	5.43 ± 0.49[b]
Distance between cusp tips of the first incisors	4.76 ± 0.37[a]	4.01 ± 0.30[b]
Mandibular		
Distance between the first incisors	8.74 ± 0.64[a]	11.82 ± 0.46[b]
Distance between the fourth premolars	3.50 ± 0.40[a]	4.48 ± 0.45[b]
Distance between the third molars	9.58 ± 0.48[a]	11.87 ± 0.39[b]
Distance between the cusp tips of the first incisors	3.88 ± 0.48[a]	4.91 ± 0.56[b]

[ab] Different letters in the same line indicate statistically significant differences ($p < 0.05$).

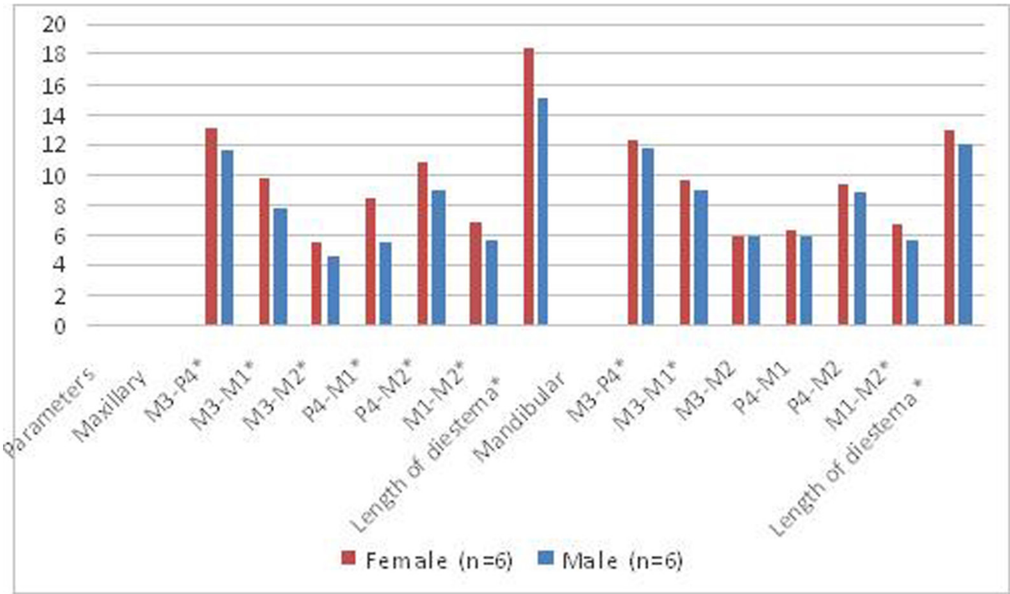

Figure 4. Mean values of the right teeth of the male and female chinchillas. M3–P4: Length of the cheek tooth row; M3–M1: Length of the molar row; M3–M2, M1–M2: Partial length of the molar row; P4–M1, P4–M2: Partial length of the cheek tooth row. *Statistically significant ($p < 0.05$).

determined that the lengths of M2 and M3 on the mandible were greater than those on the maxilla.

Although some features of the rodent and lagomorph teeth are similar, there are structural and functional differences between these two orders that are of particular interest and importance to veterinarians. Unlike the Rodentia, which have a single incisor on both their upper and lower jaws, the Lagomorphs also have a second, smaller pair of upper incisors [28]. It has been reported that the maxillary incisor (24.88 ± 2.31 mm) is longer than the mandibular incisor (23.24 ± 2.60 mm) in the New Zealand rabbit [13]. In this study, it was observed that the mandibular incisor was larger than the maxillary incisor in the chinchilla, unlike the New Zealand rabbit. In the current study, the lengths of the maxillary and mandibular incisors of the males were measured as 12.97 ± 0.68 mm and 18.45 ± 0.61 mm, respectively on the right side and 13.37 ± 0.25 mm and 19.11 ± 0.54 mm, respectively on the left side. In the female chinchillas, the lengths of the maxillary and mandibular incisors were 14.09 ± 0.66 mm

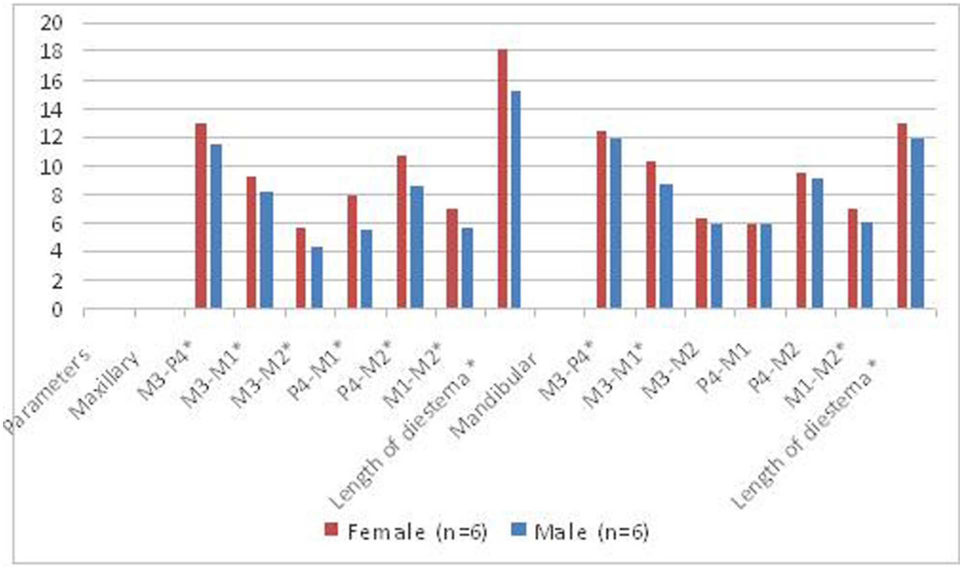

Figure 5. Mean values of the left teeth of the male and female chinchillas. M3–P4: Length of the cheek tooth row; M3–M1: Length of the molar row; M3–M2, M1–M2: Partial length of the molar row; P4–M1, P4–M2: Partial length of the cheek tooth row. *Statistically significant ($p < 0.05$).

and 20.41 ± 1.61 mm, respectively on the right side and 13.99 ± 0.28 mm and 20.62 ± 1.19 mm, respectively on the left side.

The shortest teeth of the chinchilla were determined to be the maxillary and mandibular third molar teeth, which is similar to the New Zealand rabbit [13]. In the New Zealand rabbit, the lengths of maxillary and mandibular M3 were reported as 7.31 ± 0.78 mm and 7.45 ± 0.95 mm, respectively. In the current study, the length of maxillary M3 was 5.26 ± 0.22 mm on the right and 5.51 ± 0.28 mm on the left side, while that of mandibular M3 was 6.5 ± 0.29 mm on the right and 6.24 ±0.16 mm on the left side for the male chinchillas. In the female chinchillas, the lengths of maxillary and mandibular M3 were measured as 7.34 ± 0.52 mm and 7.32 ± 0.26 mm, respectively on the right side and 7.09 ± 4.93 mm and 7.32 ± 0.36 mm, respectively on the left side.

The largest tooth of the chinchilla was found to be M1 in both the maxillary and mandibular arches. It is reported that M1 teeth are the largest among Rodentia spp., including *Eumyarion leemani*, *Megacricetodon minor*, and *Democricetodon larteti* and Cricetodon spp. In addition, the widest tooth has been shown to be M3 for *Spermophilinus bredai* from the other Rodentia and P4 in Chalicomys spp. [24]. Rodentia lives in a wide variety of habitats. Many anatomical variations of cheek teeth have emerged over time, depending on different diets and the food source of their environment [27].

We observed that the premolar and molar teeth of the chinchilla had a wider structure than the incisors, which is consistent with the herbivorous chinchilla having a larger chewing surface due to the consumption of more abrasive foods [14]. In addition, the width of the chewing teeth (premolar and molar) on the mandible was greater than on the maxilla, which can be attributed to the mandible being wider than the maxilla in the occlusion of the teeth, as reported by Brenner et al. [16].

The significant sex differences in the distance between the first incisors, the distance between the fourth premolars, the distance between the third molars and distance between the cusp tips of the first incisors in the mandibular arch and the distance between the first incisors, the distance between the third molars, and distance between the cusp tips of the first incisors in the maxillary arch in the chinchilla are in line with the greater distances between the right and left sides of the lower and upper jaws of the male Iberian wolf compared to the females [3]. In addition, according to the measurement values obtained in our study, the distances between the right and left sides of the maxillary arch in both the male and female chinchillas were smaller than those in the mandibular arch, which is consistent with the upper jaw being narrower than the lower jaw in Rodentia spp. [27,29].

In conclusion, our results indicate that there is sexual dimorphism in the morphometric tooth characteristics of the chinchilla and the measurement values of the females are larger than those of the males. The results of this study are expected to form the basis for future studies, and thus contribute to the diagnosis and treatment of dental diseases. It is also considered that developments in imaging techniques and computer software will be useful in analyzing pathology results and planning procedures.

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