



## Topographic, Morphological and Morphometric Investigation of Mandible in Norduz Sheep

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(Received: 08.04.2022, Accepted: 14.09.2022, Online Publication: 29.09.2022)

**Keywords**  
 Anatomy,  
 Mandible,  
 Osteometry,  
 Surgery,

**Abstract:** In order to contribute to animal welfare, veterinary maxillofacial surgery is a branch of science that requires a thorough understanding of a region's anatomy. Therefore, the purpose of this study was to define the mandible by using macroanatomical, morfometric and topographic methods to better understand the morphophysiology of the mandible in Norduz sheep. In this study ten male Norduz sheep mandibles were used. The mandibles were initially examined using classical morphometric and topographic methods. The mandible was observed to be composed of corpus, ramus and angulus parts. It was observed that the mental foramen was oval and round in shape and varied in number on the lateral edge of the mandible. The mandible foramen was found to be elliptical. According to the statistical analysis, mandible length was measured as 149.12±4.75 mm, on the right side and 148.12±4.50 mm, on the left side in Norduz sheep. Mandible height was determined as 160.81±4.72 mm, on the right and 160.74±5.11 mm, on the left side. The distance from the mandible foramen to the infradental space was 127.85±4.62 mm, on the right and 125.31±4.11 mm, on the left side. Diastema length was found to be 38.05±1.34 mm, on the right and 40.87±2.81 mm, on the left side. The length of the premolar and molar teeth on the margo alveolaris of the mandible was 56.69±2.38 mm, on the right side and 54.13±2.73 mm, on the left side. The distance from the foramen mentale to the gonion caudale was analyzed as 118.34±4.22 mm, on the right and 118.90±4.12 mm, on the left side. According to the statistical analysis, the length of mandible foramen (L17) was statistically significant (p<0.05) when measured over the right (8.74±0.47 mm) and left (6.61±0.69 mm) mandibles.

## Norduz Koyununda Mandibulanın Topografik, Morfolojik ve Morfometrik Olarak İncelenmesi

**Anahtar Kelimeler**  
 Anatomi,  
 Mandibula,  
 Osteometri,  
 Cerrahi,

**Öz:** Hayvan refahına katkıda bulunmak için veteriner çene cerrahisi uzmanlık alanları içerisinde bölge ile ilgili derin anatomik bilgi sahibi olmayı gerektiren bilim alanlarındandır. Bu nedenle, bu çalışmada Norduz koyununda mandibula'nın morfofizyolojisinin anlaşılması için makroanatomik, morfometrik ve topografik yöntemler kullanılarak mandibula'nın tanımlanması amaçlandı. Çalışmada on adet erkek hayvana ait Norduz koyun mandibula'sı kullanıldı. Mandibulalar önce klasik morfometrik ve topografik yöntemlerle incelendi. Mandibula'nın corpus, ramus ve angulus bölümlerinden oluştuğu görüldü. Foramen mentale'nin oval ve yuvarlak şekilde olduğu, değişik sayılarda mandibula'nın lateral kenarında bulunduğu saptandı. Foramen mandibula'nın eliptik bir şekilde olduğu gözlemlendi. Yapılan istatistiksel analize göre Norduz koyununda mandibula uzunluğu sağ tarafta 149.12±4.75 mm, sol tarafta 148.12±4.50 mm, olarak ölçüldü. Mandibula yüksekliği sağ tarafta 160.81±4.72 mm, sol tarafta 160.74±5.11 mm, olarak analiz edildi. Foramen mandibula'nın infradental aralığa uzaklığı sağ tarafta 127.85±4.62 mm, sol tarafta 125.31±4.11 mm, olarak belirlendi. Diastema uzunluğu sağ tarafta 38.05±1.34 mm, sol tarafta 40.87±2.81 mm, olarak analiz edildi. Mandibula'nın margo alveolaris'i üzerinde premolar ve molar dişlerin uzunluğu sağ tarafta 56.69±2.38 mm, sol tarafta 54.13±2.73 mm, olarak belirlendi. Foramen mentale'nin gonion caudale'ye olan uzaklığı sağ tarafta 118.34±4.22 mm, sol tarafta 118.90±4.12 mm, olarak analiz edildi. Yapılan istatistiksel analize göre sağ (8.74±0.47 mm) ve sol (6.61±0.69 mm) mandibulalar üzerinden ölçülen, foramen mandibula'nın uzunluğu (L17) istatistiksel olarak anlamlıydı (p<0.05).

## 1. INTRODUCTION

Behavioral biology, physiology, and morphology provide ecological information on how animals interact in their natural environment and captivity [1]. Because oral disease has an effect on systemic health [2,3], veterinary dentistry is one of the most promising fields for improving animal welfare [2,4]. Early diagnosis and treatment of oral diseases are critical to reducing individual morbidity and mortality [2,5,6]. Deep topographic and anatomical knowledge of the area to be treated is necessary in order to avoid any intervention that may adversely affect animal welfare during the correct treatment [2,7,8].

The formations found in the cranium and mandible as a whole are the distinguishing features of each animal, allowing for differentiation not only between races and species, but also within species. Sex-related differences are strongly evident in the head skeletons of ruminant animals within a species [9]. Numerous research on the bones that comprise the skull in an integral way has made significant contributions to both comparative anatomy and clinical applications [10-23]. It can be utilized to determine the characteristics of bones obtained in excavation studies as well as morphometric research used as a reference for comparative anatomy and practical applications. The data obtained during the zooarchaeological excavations carried out for this purpose can provide insight into the history and livestock conditions of that time. In such investigations, morphological determinations are made based on morphometric results [24]. In addition, the differences in the skull and mandible and the measured parameters are examined for intraspecies variations and sex analysis. [25,26]. Norduz sheep are a type of domestic sheep that is bred in rural areas in the region called Norduz, Gürpınar district of Van province [27].

Therefore, this study aims to contribute to a better understanding of local morphophysiology, the interpretation of imaging studies, and the improvement of anesthetic and clinical status during surgical techniques in live adult species; it also aims to define it morphologically, morphometrically, and topographically.

## 2. MATERIAL AND METHOD

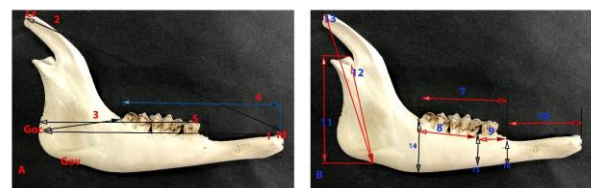
In this study, ten male Norduz sheep mandibles were utilized. The study was approved by the Animal Experiments Local Ethics Committee of Kafkas University (KAÜ-HADYEK/2022-066). Study materials were obtained from the Gürpınar district of Van province. Dissection procedures were performed on the supplied materials. After separating the skin and muscles from the mandibles, they were subjected to a controlled maceration process. In order to bleach the bones, the materials were kept in hydrogen peroxide, following which the drying process was undergone. Mandibles were morphologically examined bilaterally. For the morphometric evaluation, 21 parameters were measured on the materials with the help of a Digital Caliper (28) (Figure 1). Six parameters were measured to determine

the topographic location of the foramen mandible and foramen mentale for clinical applications (Figure 2). For statistical analysis, the data were subjected to Independent-Samples T Test, using the SPSS 22.0 software package (Table 1). After the materials were photographed, they were written down in accordance with *Nomina Veterinaria Anatomica* [29].

## 3. RESULTS

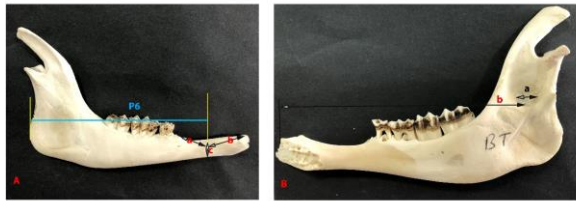
The mandible of Norduz sheep was seen to be composed of ramus, corpus and angulus parts. The processus coronoideus was seen to extend beyond the processus condylaris and to curve backwards with a distinct arc. The width of the processus condylaris varied between the materials. It was observed that certain materials were narrowly bent backwards, while others were curved by broadening. The materials of the foramen mentale were observed to be in the form of two holes in 30% and round or oval in shape.

Twenty one reference points were measured morphometrically over the mandibles. According to the statistical analysis, mandible length was measured as  $149.12 \pm 4.75$  mm, on the right and  $148.12 \pm 4.50$  mm, on the left side in Norduz sheep. Mandible height was analyzed as  $160.81 \pm 4.72$  mm, on the right and  $160.74 \pm 5.11$  mm, on the left side. The distance from the foramen mandible to the infradentale space was  $127.85 \pm 4.62$  mm on the right and  $125.31 \pm 4.11$  mm, on the left side. Diastema length was analyzed as  $38.05 \pm 1.34$  mm, on the right and  $40.87 \pm 2.81$  mm, on the left side. The length of the premolar and molar teeth on the margo alveolaris of the mandible was  $56.69 \pm 2.38$  mm, on the right and  $54.13 \pm 2.73$  mm, on the left side. The distance from the foramen mentale to the gonion caudale was analyzed as  $118.34 \pm 4.22$  mm, on the right and  $118.90 \pm 4.12$  mm, on the left side. According to the statistical analysis results, the length of the foramen mandible (L17) was significantly different in direction between the materials ( $p < 0.05$ ).



**Figure 1.** Condylion (cnd); the caudal endpoint of processus condylaris, Cr (coronion); the caudal endpoint of processus coronoideus, Gonionventrale (Gv); The inferior endpoint of the angular mandible, Gonioncaudale (Gc); The caudal endpoint of processus angularis, Infradentale (Id); The rostro-superior point of the alveoli between incisive teeth, A: Length 1(1): length between gonion caudale and infradentale, Length 2(2): length between infradentale and aboral edge of condylar process, Length 3(3): length between gonion caudale and aboral alveolar edge of 3rd molar tooth, Length 4(4): length between infradentale and aboral alveolar edge of 3rd molar tooth, Length 5(5): length between gonion caudale and rostral alveolar edge of 2nd premolar tooth, B: Length 7(7): length between first premolar tooth and last molar tooth, Length 8(8): length between first and last molar teeth, Length 9(9): length between first and last premolar teeth, Length 10(10): length of diastema, Length 11(11): length between gonion ventrale and condylion, Length 12(12): length between gonion ventrale and the deepest point of incisura mandibulae, Length 13(13): length between gonion ventrale and coronion, Length 14(14): height of

mandible level of alveolar edge of 3rd molar tooth, Length 15(15): height of mandible level of rostral alveolar edge of 1st molar tooth, Length 16(16): height of mandible level of rostral alveolar edge of 2nd premolar tooth.



**Figure 2.** Measured reference points for anesthesia administration of foramen mandible and foramen mentale, **A; Length 6 (P6):** length between gonion caudale and aboral edge of mental foramen, **Length 19(a):** Distance between first premolar tooth and mental foramen, **Length 20(b):** Distance between lateral incisor tooth and mental foramen, **Length 21(c):** Distance between the base of the mandible and mental foramen, **B; Length 17(a):** The length of mandible foramen, **Length 18(b):** Distance between foramen mandible and infradental

**Table 1.** Table containing the statistical analysis of the parameters taken and evaluated from the mandible

Parameters	Right(mean±st. error)	Left (mean±st. error)
Length 1	149.12±4.75	148.12±4.50
Length 2	160.81±4.72	160.74±5.11
Length 3	47.83±1.39	48.12±1.21
Length 4	99.71±3.00	100.07±3.76
Length 5	104.06±3.58	102.55±2.99
Length 6	118.34±4.22	118.90±4.32
Length 7	56.69±2.38	54.13±2.73
Length 8	26.61±1.91	25.73±3.17
Length 9	28.53±0.81	30.11±1.25
Length 10	38.05±1.34	40.87±2.81
Length 11	62.99±2.31	62.99±1.99
Length 12	55.25±3.60	63.45±3.42
Length 13	84.53±3.08	83.52±6.29
Length 14	31.50±0.82	31.26±1.16
Length 15	22.61±0.72	20.91±1.06
Length 16	14.42±0.50	14.50±0.42
Length 17	8.74±0.47	6.61±0.69
Length 18	127.85±4.62	125.31±4.11
Length 19	16.83±0.79	17.32±1.09
Length 20	20.46±0.64	21.70±0.47
Length 21	6.79±0.22	7.09±0.24

#### 4. DISCUSSION AND CONCLUSION

In this study, the mandible of male Norduz sheep was examined morphologically, topographically, and morphometrically.

According to the literature review, the length of the mandible was 167.8 mm, in Hemsin sheep [14], 152.4 mm, in Morkaraman sheep [30], 147.8 mm, in Tuj sheep [30], 157.6 mm, in Mehra-ban sheep [12], 181.6 mm, in Barbados sheep [13], 198.0±0.28 mm, in Yankasa sheep [32], and 186.30±9.30 mm, in Hasmer sheep [33]. Avdic et al. [2013] reported this value as 176.0 mm, in their study on sheep in Sarajevo, and 185.91±13.33 mm, for Sharri sheep [22]. Mandible length in Norduz sheep was discovered as 149.12±4.75 mm, on the right side and 148.12±4.50 mm, on the left side. According to this data, the Norduz sheep mandible was slightly longer than that of Tuj sheep, but significantly shorter than the other breeds.

The height of the mandible has also been reported to be 94.2 mm, for Hemsin sheep [14], 87.0 mm, for

Morkaraman sheep [30], 85.4 mm, for Tuj sheep [30], 95.7 mm, for Mehra-ban sheep [12], 107.9 mm, for Barbados sheep [13], 129.0±0.57 mm, for Yankasa sheep [32], and 108.68±2.36 mm, for Hasmer sheep [33]. It was 99.6 mm, according to Avdic et al. [2013][34], in their study on sheep in Sarajevo. Mandible height in Norduz sheep was determined to be 160.81±4.72 mm, on the right and 160.74±5.11 mm, on the left side. Mandible height was found to be higher in male Norduz sheep compared to other sheep breeds.

In Norduz sheep, the height of the mandible at the level of the last molar tooth [P14] was analyzed as 31.50±0.82 mm, on the right and 31.26±1.16 mm, on the left side. This parameter was reported to be 37.47±3.25 mm, in Hasmer sheep [33], 37.93 mm, in Hemsin sheep [14], and 38.88 mm, in Morkaraman sheep [30]. This parameter was reported as 36.75 mm, in females and 35.61 mm, in males in Abaza goats [19]. It was observed that the mandible height was lower in male Norduz sheep compared to other sheep breeds.

In Norduz sheep, the mean distance between gonion ventral and processus condylaris was 62.99±2.31 mm, on the right and 62.99±1.92 mm, on the left side. The same parameter was reported as 68.52 mm, in Hemsin sheep [14], 74.58±1.75 mm, in Hasmer sheep [33], and 77.50 mm, in Mehra-ban sheep [12]. The same parameter was reported as 63.57 mm, in female and 63.33 mm, in male Abaza goats [19]. This parameter was found to be lower in male Norduz sheep compared to other sheep breeds.

The length of the molar teeth [P8] on the margo alveolaris of the mandible in Norduz sheep was measured to be an average of 26.61±1.91 mm, on the right and 25.73±3.17 mm, on the left side. This parameter was reported as 57.2 mm, in Hemsin sheep [14], 49.26±3.11 mm, in Hasmer sheep [33], and 53.12 mm, in Morkaraman sheep [30]. It was observed that the molar tooth length in Norduz sheep was quite small compared to other sheep breeds analyzed in the literature. In a study conducted on Abaza goats [19], this parameter was measured as 58.28 mm, in females and 53.66 mm, in males. Margo interalveolaris (Diastema) length was reported as 43.54±3.48 mm, [33] and 43.74 mm, [14] in Hasmer sheep; 45.81±3.73 mm, in Sharri sheep [22] and 45.81±3.73 mm, in female and 45.98±3.87 mm, in male Bardhoka sheep [26]. In the mandibles of Awassi sheep [41], this parameter was reported as 46.27±3.29 mm, in females and 48.97±5.82 mm, in males. Diastema length (P10) in male Norduz sheep was analyzed as 38.05±1.34 mm, on the right and 40.87±2.81 mm on the left side.

The distance between foramen mentale and gonion caudale (6); was reported as 137.4 mm, in Mehraban sheep[12], 152.3 mm, in Barbados sheep[13], 165.0 mm, in Yankasa sheep[32], 112.9 mm, in Iranian domestic sheep [35], and 149.40±11.02 mm, in Hasmer sheep [33].

In studies on goats in the literature, the same parameter was found to be 128.87 mm, in female, 118.84 mm, in male Abaza goats [19], 125.30±8.49 mm, in female,

151.31±0.5 mm, in male Gurcu goats [42], 43±0,08 cm, in Blackbucks [36], 11.69±0.40 cm, [37], in Black Bengal goats, 9.26±0.49 cm, [38] in GVD goats, 15.23±1.46 cm, [31] in Barbados black belly sheep, and 11.8±0.89 cm, [39] in Black Bengal goats.

The blockage of the mandibular nerve is important in all surgical procedures affecting the mandible's incisive, premolar, and molar teeth. The blockage of the mental nervus, which is a continuation of the nervus mandibularis and passes through the foramen mentale, is also very important. Three reference points for the blockade of the relevant nerve passing through the foramen mentale in Norduz sheep were identified and measured.

The mean distance between the 1st premolar tooth and the foramen mentale (P19) was found to be 1.68±0.79 cm, on the right and 1.73±1.09 cm, on the left side. This parameter was reported as 2.25±0.38 cm, in Barbados black belly [31] sheep, 1.98±0.21 cm, in Hemşin sheep [18], and 1.46±0.09 cm, in Black bengal goats [39].

The distance between the foramen mentale and the lateral incisor teeth (P20) was measured as 2.04±0.64 cm, and 2.17±0.47 cm, on the left side in Norduz sheep. This parameter was found to be 2.11±0.17 cm, in Black bengal goats [37], 2.25±0.31 cm, in Barbados black belly sheep [31], 1.58±0.19 cm in Gwembe Valley dwarf goats [38], 2.01±0.05 cm, in Black bengal goats [39], 1.56±0.22 cm, in West African dwarf goats [40], and 2.40±0.37 cm in Hemsin sheep [18].

The distance between the foramen mentale and margo ventralis (P21) was measured as 0.67±0.22 cm on the right and 0.70±0.24 cm on the left side in Norduz sheep. This parameter was reported as 0.70±0.18 cm in Barbados black belly sheep [31], 0.69±0.13 cm in Hemşin sheep [18], 2.35±0.26 cm in Gwembe Valley dwarf goats [38], and 0.77±0.04 cm, in Black bengal goats [39].

The findings of this study are significant in many ways; morphologically, morphometrically, and most important clinically, during surgical interventions in the head area. Due to the lack of information in the current literature regarding the parameters investigated in this sheep breed, the available data provide a solid foundation for comparative anatomy with other ruminant animals and further research in other fields such as zooarchaeology and animal welfare.

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