

Applied Anatomy of the Head Region of the Iranian Native Goats (*Capra hircus*)

¹Ali Louei Monfared, ¹Hamzeh Naji and ²Mohammad Taghi Sheibani

¹Department of Anatomy, Faculty of Para-veterinary Medicine, University of Ilam, Ilam, Iran

²Department of Basic Sciences, Faculty of Veterinary Medicine, University of Tehran, Tehran, Iran

Abstract: This study involved some morphometric parameters of the mandibles and upper jaws of thirty Iranian native goats without any apparent skeletal disorders. The distance from the base of horn to caudal border of orbit, to mid-level of dorsal arch of orbit and to rostral border of orbit were 2.5 cm, 3.3 cm and 6.5 cm, respectively. The distances from facial tuberosity to the infra-orbital canal and from the latter to the root of the alveolar tooth were 1.92 cm and 1.64 cm, respectively. The length and height of the mandibles were 14.10 cm and 8.69 cm, respectively. The distances from the lateral alveolar root to mental foramen and from the mental foramen to caudal mandibular border were 2.40 cm and 11.34 cm, respectively. The distances from mandibular foramen to the base of mandible as well as from caudal border of mandible to below of the mandibular foramen were 2.88 cm and 1.29 cm, respectively. The distances from the base of mandible to condyloid fossa and from the latter to the maximum height of mandible were 4.33 cm and 2.29 cm, respectively. The distance from caudal border of mandible to mandibular foramen and from the latter to mandibular angle were 0.9 cm and 2.5 cm, respectively. These data as important landmarks are discussed with regard to their application to clinical maneuvers around the head of the Iranian native goat such as regional anesthesia during dehorning, treating horn injury and dental extraction.

Key words: Applied Anatomy • Head • Goat • Iran

INTRODUCTION

The morphologic and morphometric studies of the head region are not only reflect contributions of genetic and environmental components to individual development and describe genetic and ecophenotypic variation, but also are foundations of the clinical and surgical practices [1,2]. Also, applied anatomy is one of the principles of the clinical and surgical practice; because it enables the clinician to visualize details of structures relevant to the case at hand [3,4]. Furthermore, the applied anatomy of the head region is very important because of such vital organs and structures as the brain, tongue, eyes as well as ears, teeth, nose, lips, horn and skull. Thus the head is needed for coordinating the body as well as for deglutition, olfaction and defense [4, 5]. Similarly, the directions of the cranial nerves and their passages from different foramina in the skull are of clinical importance in regional anesthesia around the head [4,6].

The goat was the first domesticated animal capable to produce food for the human being about ten thousand years ago. The goat production is an activity that has been developing a lot in the last years. About 90% of the goats of the world are found in areas in development evidencing the capacity of the goat in adapting to the adverse conditions, justifying its reputation of rustic animal [7].

As a result of the large population of the Iranian native goat breed-about 25 million heads and their important economic values especially for their meat, milk and fibers [8], there has been an increasing interest and necessity to have more information concerning the applied anatomy of the head region of this specie. Since, there is very little information on the applied anatomy of the head osteology of the Iranian native goats in the literatures; therefore the aim of this study was to evaluate some morphometric parameters of the head region of this specie.

Corresponding Author: Ali Louei Monfared, Department of Basic Sciences, Division of Anatomy and Histology, Faculty of Para-Veterinary Medicine, University of Ilam, Ilam, Iran.
Pajooohesh Street, Bangonjab, University of Ilam, Ilam, Iran.
Tel: +98-8412222015, +989183419098.

MATERIALS AND METHODS

To make the present work, a total of thirty Iranian native male goats aged between 3-4-year-old were used. The live animals were first selected during ante mortem examination at Ilam abattoir based on parameters of apparent good health and no skeletal disorders. After slaughter, the heads were severed at the occipito-atlantal joint, purchased and processed in the veterinary anatomy laboratory of Ilam University using the boiling maceration techniques for skeleton preparation that have been reported by Simoens *et al.* [9]. The main steps in skull skeleton preparing briefly are following:

- On the working day, frozen goat head were allowed to thaw.
- Skin and most of the muscles were separated and eyes were enucleated.
- Heads were heated to over 80 °C for at least 1 hour in solution of polycaboxylate and anionic surfactant (detergent) and soap chips
- Muscles of boiled heads were separated with the aid of forceps and scalpel in running water.
- Further separation of muscles and ligaments from the skulls was done after left in detergent water at least 20-30 minutes.
- Separation of remaining muscles and ligaments from the skull was done after left in 1% sodium hypochlorite solution for at least 24 hours.
- After that, the skulls were left in the above solution, for 48-72 hours with solution, being changed at least twice and clean in running tap water.
- The skulls were then left to dry.

A total of 15 morphometric measurements were done in the upper jaw and mandibles using scale, thread and digital calipers and the results were presented as means ± SD in Table 1. These morphometric parameters of the upper and lower jawbones of the Iranian native goat's skulls are defined below and shown in Figs.1-4.

- The base of horn to caudal border of orbit: The distance between the base of the horn to caudal most border of the orbit.
- The base of horn to mid-level of dorsal arch of orbit: The distance between the base of the horn to the mid-level of dorsal arch of the orbit.
- The base of horn to rostral border of orbit: The distance between the base of the horn to rostral most border of the orbit.

Table 1: Mean ± SD of the morphometric measurements of the mandibles and upper jaws of Iranian native goats (cm)

Morphometric parameter	Mean ± SD
A	2.5 ± 0.13
B	3.3 ± 0.27
C	6.5 ± 0.34
D	1.92 ± 0.17
E	1.64 ± 0.11
F	14.1 ± 1.03
G	2.40 ± 0.26
H	11.34 ± 0.96
I	2.88 ± 0.93
J	1.29 ± 0.12
K	2.29 ± 0.67
L	4.37 ± 0.59
M	8.69 ± 0.18
N	0.9 ± 0.48
O	2.50 ± 0.73



Fig. 1: Skull of the Iranian native goat; lateral view. A: The base of horn to caudal border of orbit, B: The base of horn to mid-level of dorsal arch of orbit, C: The base of horn to rostral border of orbit. D: Facial tuberosity to infra-orbital canal, E: Infra-orbital canal to root of alveolar tooth.

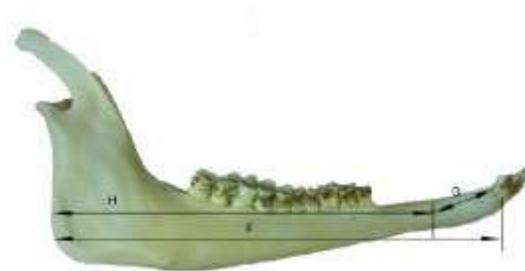


Fig. 2: Mandible of the Iranian native goat; lateral view. F: Mandibular length, G: Lateral alveolar root to mental foramen, H: Mental foramen to caudal mandibular border.

- Facial tuberosity to infra-orbital canal: From the level of the most lateral bulging of the facial tuberosity to the mid level of the infra-orbital canal.



Fig. 3: Mandible of the Iranian native goat; medial view. I: Mandibular foramen to base of mandible, J: Caudal border of mandible to below of the mandibular foramen, K: Condyloid fossa to height of mandible, L: Condyloid fossa to the base of the mandible, M: Maximum mandibular height.



Fig. 4: Mandible of the Iranian native goat; medial view. N: Caudal border of mandible to the level of mandibular foramen, O: Mandibular foramen to mandibular angle.

- Condyloid fossa to height of mandible: From the maximum height of mandible to the condyloid fossa.
- Condyloid fossa to the base of the mandible.
- Maximum mandibular height: From the basal level of the mandible to the highest level of the coronoid process.
- Caudal border of mandible to the level of mandibular foramen.
- Mandibular foramen to mandibular angle: Shortest distance from the mandibular foramen to the extreme caudal border of the angle of the mandible.

RESULTS

In the present study, the distance from the base of horn to caudal border of orbit, to mid-level of dorsal arch of orbit and to rostral border of orbit were 2.5 cm, 3.3 cm and 6.5 cm, respectively. The distance from facial tuberosity to the infra-orbital canal and from the latter to the root of the alveolar tooth was 1.92 cm and 1.64 cm in the Iranian native goat (Figure 1, Table 1). The distance between the root of the teeth and the foramen was 1.64 cm. The distance between lateral alveolar roots to mental foramen was 2.40 cm (Figure 2, Table 1). The mandibular length and height in the Iranian native goats are inserted in the Table 1. In the Iranian native goat, the mandibular length and also the maximum mandibular height were 14.1 cm and 8.69 cm, respectively. The caudal border of the mandible to bellow of the mandibular foramen (Figure 3) was 1.29 cm in the Iranian native goats. The distance from the caudal border of mandible to the level of mandibular foramen and from the latter to the border of mandibular angle were 0.90 cm and 2.50 cm, respectively.

DISCUSSION

Although there was not literature data on the horn morphometric indices with which comparison could be made but these data have clinical value in the nerve block purposes and also regional anesthesia during dehorning and treating of the horn injuries. Dehorning of goats is carried out to make handling of goats safer and reduce the incidence of damage to other animals. Alternatively, for goat's dehorning and similar surgeries the cornual nerve supply must be blocked. It has been demonstrated that the nerve supply to the horn region in the goat is originated from the cornual branches of the lachrymal (zygomatico-temporal) and infra-trochlear nerves and both of these must be blocked prior to dehorning [3]. As the cornual branch of the lachrymal nerve is course dorsal on

- Infra-orbital canal to root of alveolar tooth: Measurement is taken vertically from the mid-level of the in infra-orbital canal to the root of the alveolar tooth.
- Mandibular length: From the level of the cranial extremity of the alveolar root of the incisor to the level of the caudal border of the mandible.
- Lateral alveolar root to mental foramen: Shortest distance from the mental foramen to the lateral extent of the alveolar root of lower incisor.
- Mental foramen to caudal mandibular border: From the level of the mental foramen to the extreme caudal border of the mandible.
- Mandibular foramen to base of mandible: Vertical line from the ventral limit of the mandibular foramen to the base of the mandible.
- Caudal border of mandible to below of the mandibular foramen: Length from the caudal most border of the mandible to the vertical line produced by description of measurement of mandibular foramen to base of the mandible.

the dorsolateral aspect of the orbit and distributed in the root of the horn [10], so the value of distance from the base of horn to caudal border of orbit is most beneficial for determining the appropriate side for injection of local anesthetic agents. Similarly, as the cornual branch of the infra-trochlear nerve runs dorsad along the wall of the orbit and perforates in the rostro-lateral surface of the base of the horn [10], so the value of the distance from the base of horn to mid-level of dorsal arch of orbit as well as to rostral border of orbit are of clinical importance for the achieving the appropriate side for injection of local anesthetic drugs.

The distance from facial tuberosity to the infra-orbital canal and from the latter to the root of the alveolar tooth were 1.92 cm and 1.64 cm in the Iranian native goat (Figure 1, Table 1) while in the West African Dwarfs goats were 1.6-1.8 cm and in the Black Bengal goat were 1.85-1.75 cm [11,12]. Since the facial tuberosity is very prominent as a guide for tracking the infra-orbital nerve and necessary for the desensitization of the skin of the upper lip, nostril and face on that side of the level of the foramen, so these data are of clinical importance. The injection of local anesthetic agents within the canal via the infra-orbital foramen will also lead to analgesia of the incisor, canine and first two premolars. Furthermore, the infra-orbital foramen is located directly dorsal to the first upper premolar tooth in Iranian native goats where as in Black Bengal and Red Sokoto goats [11,12]. This information together with the observed distance of 1.64 cm between the root of the teeth and the foramen would provide a major landmark to regional anesthesia involving the infra-orbital nerve in the Iranian native goat.

The distance between lateral alveolar root to mental foramen was 2.40 cm (Figure 2, Table 1) which is an vital guide that will detect the location of the mental nerve for this regional nerve block in the Iranian native goat, while it was 2.11, 1.6 and 2.0 cm in the Black Bengal goat, West African Dwarf goat and Nigerian Red Sokoto (*Maradi*) goat, respectively [5,11, 12]. The injection of the local anesthetic drugs can be made in the rostral aspect of the mandibular canal through the mental foramen to mandibular nerve block in the mental zone. This will ensure the loss of sensation of the lower incisors, premolar and lower lip on the same side [6] during dental extraction and treatment of tooth injuries.

The mandibular length and height in the Iranian native goats (Table 1) were higher than the data obtained for Western African Dwarf goat which were 12.00 cm and 6.9 cm, respectively [5]. By contrast the mandibular

length of 14.1 cm and maximum mandibular height of 8.69 cm in Iranian native goat were lower than the value obtained for Black goat of Bangladesh which were 14.21 cm and 8.83 cm, respectively [11], similar results had been reported in the values of the distances between the mandibular foramen to base of mandible, the condyloid fossa to height of mandible and condyloid fossa to the base of the mandible by Olopade and Onwuka [5,12]

The caudal border of the mandible to bellow of the mandibular foramen (Figure 3) was 1.29 cm in the Iranian native goats, while in the Black Bengal goat it was 1.47 cm. Also, in the Iranian native goats, the distance from the caudal border of mandible to the level of mandibular foramen and from the latter to the border of mandibular angle were 0.90 cm and 2.50 cm, respectively (Figures 3 and 4, Table 1) while in the Black Bengal goat it was 0.90 cm and 2.65 cm, respectively. These data are necessary for achieving the regional anesthesia of the mandibular nerve and also have clinical importance for desensitization of all the teeth in lower jaw [6]. To best knowledge of the authors, there is no literature data on the morphometric parameters of the head region especially about horn's applied anatomy in the Iranian native goats with which comparisons could be made. In conclusion, the morphometric values of the skull and applied anatomy of the head region of the Iranian native goats are comparable to other ruminants and present results provide an important baseline for further studies on the skull of goat. Furthermore, these results are of clinical importance that will aid the regional anesthesia of the different nerves around the head especially during dehorning, horn injuries and dental extraction.

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