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RESEARCH ARTICLE

Clinical Anatomy of the Head Region of Gwembe Valley Dwarf Goat in Zambia

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ABSTRACT

In this study, a total of 30 skulls of the Gwembe Valley Dwarf (GVD) goat were used. Clinical anatomical measurements for 12 parts of the skull were made. Additionally, the data obtained have been compared with those carried out on West African Dwarf (WAD) and Markhoz goats. The distance from the facial tuberosity to the infraorbital canal and from the latter to the lateral alveolar root were 2.06±0.14 cm and 1.13±0.11 cm, respectively. The distance from the lateral alveolar root to the mental foramen was 1.58±0.19 cm and from the mental foramen to the caudal mandibular border was 9.26±0.49 cm. In addition, the length and the maximum height of mandibles were 11.24±0.52 cm and 6.64±0.44 cm, respectively. The distance from the caudal border of mandible to below the mandibular foramen was 1.21±0.08 cm, while distance from the mandibular foramen to the base of the mandible, the caudal border of the mandible to the level of the mandibular foramen and mandibular foramen to the mandibular angle were 2.35±0.26 cm, 1.10±0.07 cm and 2.18±0.19 cm, respectively. According to our findings, the clinical anatomy values of the head region in this breed were more comparable to WAD and Markhoz goat. These results are of clinical importance and will aid in regional nerve blocks of the infraorbital, mental and mandibular nerves useful during head injuries, surgical operations involving the lips and dental extraction in this breed.

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INTRODUCTION

The Gwembe Valley Dwarf (GVD) goat (*Capra hircus*) is an indigenous goat breed mainly found in the Gwembe valley and Siavonga district in the Southern province of Zambia. This goat breed has adapted to hot and dry climatic conditions with low rainfall patterns (MACO, 2003). The goat population is estimated to be about 45,272 in Siavonga alone (DVLD, 2008). And due to its prolificacy and adaptation to conditions that do not support the flourishing of other livestock, this goat breed is of great socio-economic importance to local inhabitants where it is found (Lovelace *et al*., 1993). Because of the importance of this goat breed, regional anatomical study is of interest to clinicians as well as veterinary surgeons to visualize details of structures relevant to the case at hand (Dyce *et al*., 2002).

The regional anatomy of the head 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. The head is thus needed for coordinating the body as well as for deglutition, olfaction and defence (Dyce *et al*., 2002; Olopade, 2003). The foramina in the skull are of clinical importance in regional anaesthesia around the head (Hall *et al*., 2000).

Studies have been done on the heads of domestic animals including the horse, ox, dog and the goat (Dyce *et al*., 2002; Getty., 1975; Onar *et al*., 2001 and Olopade and Onwuka., 2005). Studies around the head region have been widely conducted in goats such as the brain morphometry (Olopade *et al*., 2003), dental eruption and oral pathologies (Kene and Agbo., 1998), clinical applications of the mandibular and maxillofacial osteometry (Olopade and Onwuka., 2005), clinical anatomy of the head region (Uddin *et al*., 2009) and the morphometric characteristics of the maxillofacial and mandibular regions of goat breed and its clinical value for regional anaesthesia (Goodarzi and Hosseini., 2013). Apart from the recent study on the gynomimicry of the GVD goat breed conducted by Parés *et al* (2014), there remains a dearth of information on the regional clinical anatomy of the head of GVD goat. Therefore this study was designed to provide information on clinically important landmarks of the head which could be useful in regional anaesthesia of the upper (maxilla) and the lower (mandible) jawbones of the GVD goat. In addition, the baseline data generated from the study will be useful in comparative studies of the skull anatomy of other goats. In addition, this information study will be compared to those carried out on WAD goat and Markhoz goat.

MATERIALS AND METHODS

Study area and animals of study

The study was carried out on indigenous goats from Siavonga district, located at 16.53° South latitude, 28.72° East longitude and 481 meters elevation above sea level in the Southern province of Zambia (Siavonga Maps, 2011). The climate is characterized by high temperatures of above 29°C and annual rainfall of less than 800 mm (Lundu, 2012). The district is largely rural with subsistence farming and animal husbandry with goat rearing being the major activities (DVLD, 2008).

Skeletal preparation

A total of thirty heads without any skeletal abnormalities of the GVD goat aged 18 months and above as determined by dentition (Vatta *et al*., 2006) from Siavonga district were obtained from a local goat abattoir and processed in the dissection room of the Samora Machel School of Veterinary Medicine at the University of Zambia using the boiling maceration techniques for skeletal preparation that have been reported by Simoens *et al* (1994). Briefly, the skin and most of the muscles were separated and eyes were enucleated. The heads were then put in polycaboxylate solution, anionic surfactant and soap chips and heated over 80°C for 30 minutes. The boiled heads were placed in running tap water and remaining muscles separated with the aid of sharp scalpel blade. Further separation of muscles and ligaments was done about 30 minutes after soaking in detergent water. Subsequently, the heads were kept in 1% sodium hypochlorite solution for 24 hours with further separation of remaining muscles and ligaments leaving only the bony skulls and mandibles. The skulls were left in the same solution for 48 hours and during this period, the solution was changed twice. The final stage of processing involved cleaning the skulls in running tap water and afterwards leaving skulls to dry completely.

The important clinical landmarks of the skull were taken on all the thirty samples. A total of 12 measurements were done in the upper jaw and mandibles using measuring tape, ovinometer and a pair of Vernier callipers of 0.02 mm. The measurements were taken following the established standard method (Olopade and Onwuka., 2005 ; Uddin *et al*., 2006) .The landmarks were measured for the upper and lower jawbones of the GVD goat as shown in Figures 1, 2, 3 and 4.

Measured landmarks

A. 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.
B. 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.
C. 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.
D. Lateral alveolar root to mental foramen: Shortest distance from the mental foramen to the lateral extent of the alveolar root of lower incisor.
E. Mental foramen to the caudal mandibular border: From the level of the mental foramen to the extreme caudal border of the mandible.
F. Mandibular foramen to base of mandible*:* Vertical line from the ventral limit of the mandibular foramen to the base of the mandible.
G. Mandibular angle to below 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.
H. Condyloid fossa to height of mandible: From the maximum height of mandible to the condyloid fossa.
I. Condyloid fossa to the base of the mandible: Vertical line from the condyloid fossa to the base of the mandible.
J. Maximum mandibular height: From the basal level of the mandible to the highest level of the coronoid process.
K. Caudal border of mandible to the level of mandibular foramen: Shortest distance from the mandibular foramen to the extreme caudal border of the angle of the mandible.
L. Mandibular foramen to mandibular angle: Length from the mandibular foramen to the angle of the mandible.

Statistical analysis

Data was analysed using Paleontological Statistics Software Package for Education and Data Analysis (PAST) (Hammer *et al*., 2001). All the measurements were expressed as mean measurements with the standard deviation (Mean±SD).

RESULTS

The distances from the facial tuberosity to the infraorbital foramen and from the latter to the root of the alveolar tooth were 2.06±0.14 cm and 1.13±0.11cm, respectively. The distance between the lateral alveolar root to the mental foramen and from the later to the caudal border of the mandible were 1.58±0.19 cm and 9.26±0.49 cm, respectively. The maximum mandibular height and the length were 6.64±0.44 cm and 11.24±0.52 cm, respectively The caudal border of the mandible to below the mandibular foramen to the base of the mandible were 1.21±0.08 cm and 2.35±0.26 cm, respectively The distance from the caudal border of the mandible to the level of the mandibular foramen to the mandibular angle were 1.10±0.07 cm and 2.18±0.19 cm, respectively. A summary of the results obtained in this study and information from other studies conducted in the West African Dwarf and the Markhoz goat is presented in table 1.

Table 1: Applied Clinical Anatomy measurements of the Gwembe Valley Dwarf goat compared to WAD goat and Markhoz goat (Olopade and Onwuka, 2005, Goodarzi and Hosseini, 2013)

Parameter (Mean ± SD cm)	Gwembe valley	WAD	Markhoz
A. Facial tuberosity to infra-orbital canal	2.06±0.14	--	1.81±0.06
B. Infra-orbital canal to root of alveolar tooth	1.13±0.11	1.3-1.6	1.7±0.08
C. Mandibular length:	11.24±0.52	12.0±1.89	13.37±0.67
D. Lateral alveolar root to mental foramen	1.58±0.19	1.56±0.22	1.58±0.11
E. Mental foramen to the caudal mandibular border	9.26±0.49	9.96±1.67	11.42±0.42
F. Mandibular foramen to base of mandible:	2.35±0.26	2.58±0.34	3.43±0.25
G. Mandibular angle to below mandibular foramen:	1.21±0.08	1.57±0.44	1.04±0.14
H. Condyloid fossa to height of mandible	1.43±0.22	2.21±0.37	2.45±0.15
I. Condyloid fossa to the base of the mandible.	4.07±0.37	2.68±0.45	5.87±0.44
J. Maximum mandibular height:	6.64±0.44	6.9±1.09	8.94±0.43
K. Caudal border of mandible to mandibular foramen.	1.10±0.07	--	1.19±0.17
L. Mandibular foramen to mandibular angle:	2.18±0.19	--	2.74±0.17

Fig. 1: Skull. Lateral view (Anatomical landmark); **A:** Facial tuberosity to infraorbital canal. **B**: Infraorbital canal to root of alveolar tooth.

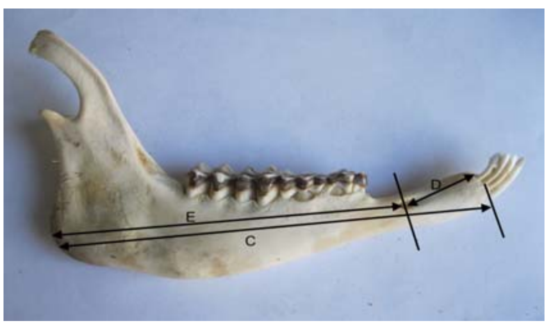

Fig. 2 : Mandible .Lateral view (Anatomical landmark); **C:** Mandibular length, **D:** Lateral alveolar root to mental foramen. E: Mental foramen to mandibular border.

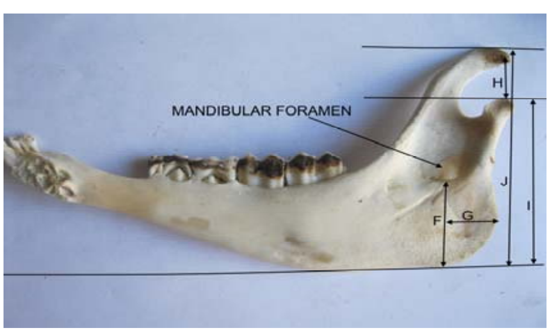

Fig. 3 : Mandible. Medial view (Anatomical landmark); **F:** Mandibular foramen to base of mandible, **G**: Mandibular angle to below mandibular foramen, **H**: Condyloid fossa to height of mandible, **I**: Condyloid fossa to the base of the mandible, **J:** Maximum mandibular height.

Fig. 4: Mandible .Medial view (Anatomical landmark); **K:** Caudal border of mandible to the level of mandibular foramen. **L:** Mandibular foramen to border of mandibular angle.

DISCUSSION

The distance from the facial tuberosity to the infra-orbital canal in the GVD goat was higher than the value reported in Markhoz goat (Goodarzi and Hosseini, 2013), (table 1) and the distance was similar to the goats found in middle regions of Nigeria (Samuel *et al*., 2013). In the GVD goat, the distance from the infra-orbital canal to the root of the alveolar tooth was lower than the range reported in the WAD goat (Olopade and Onwuka, 2005). The facial tuberosity is a vital and prominent feature as a guide in tracking the infra-orbital nerve, and is targeted during local anaesthesia to desensitize the skin of the upper lip, nostril and face on that side of the level of the infra-orbital foramen. These findings in the present study are of clinical significance in relation to the infra-orbital nerve block (Hall *et al*., 2000). The injection of a local anaesthetic agent within the canal through the infra-orbital foramen leads to the analgesia of the incisor, canine and the first two premolar teeth which can allow tooth extraction of any of these teeth. In this study, the infra-orbital foramen was located directly dorsal to the second or junction of the first and second upper premolar similar to what was observed in the black Bengal goat (Uddin *et al*., 2009). This information will prove a vital guide to regional anaesthesia involving the areas innervated by the infra-orbital nerve in the GVD goat.

The distance between the lateral alveolar root to the mental foramen in GVD goats was almost similar to those of WAD goat and Markhoz goats (Olopade and Onwuka., 2005; Goodarzi and Hosseini., 2013), whereas the distance was lower than those of observed in the Iranian

Native goat (Monfared *et al*., 2013). These finding are of greater clinical significance. The injection of local anaesthetic drugs can be made in the rostral aspect of the mandibular canal through the mental foramen to the mandibular nerve block in the mental zone. This ensures the loss of sensation of the lower incisors, premolars and lower lip on the same side (Hall *et al*., 2000) during dental extraction and treatment of tooth injuries.

The Mandibular length in the present study was lower than the values obtained in the WAD and Markhoz goats (Olopade and Onwuka, 2005; Goodarzi and Hosseini., 2013) . On the other hand, mandibular height of the GVD goat was slightly comparable to the WAD (Olopade and Onwuka, 2005) whereas the difference was marked in Markhoz goat (Goodarzi and Hosseini, 2013) and distance of the caudal border of the mandible to the level of the mandibular foramen and the distance from the latter to the border of the mandibular angle in GVD goat slightly lower than those of observed in Markhoz goat (Goodarzi and Hosseini, 2013). These parameters are of clinical importance and they aid in the regional anaesthesia of the mandibular nerve block, necessary for the desensitization of all the teeth on the lower jaw side of the block (Hall *et al*., 2000). The distance of the mandibular foramen to the base of the mandible and the distance from the caudal border of the mandible to below the mandibular foramen in the GVD goat was lower than in other dwarf goats (WAD and Markhoz) (Olopade and Onwuka, 2005; Goodarzi and Hosseini, 2013).

Interestingly, the distance of the condyloid fossa to the base of the mandible in the GVD goats was higher than observed in the WAD goat (Olopade and Onwuka, 2005). On the other hand, the distance was found to be lower than was observed in the Markhoz goat (Goodarzi and Hosseini, 2013). **.**In this study, the distance of the condyloid fossa to height of the mandible was lower than that observed in WAD and Markhoz goats (Olopade and Onwuka, 2005; Goodarzi and Hosseini, 2013) and even in Mehraban sheep (Karimi *et al*., 2012). These parameters are vital landmarks in carrying out a mandibular nerve block which is performed by injecting an anaesthetic agent on the medial aspect of the mandible which when done successfully produces desensitisation of the lower jaw with its teeth and the lower lip (Hall *et al*., 2000).

Conclusion

These results are of clinical importance and will aid in regional nerve blocks of the infraorbital, mental and mandibular nerves useful during head injuries, surgical operations involving the lips and dental extraction in this breed. Since there is no information on these parameters in the study animals nor any other domestic goat breed in Zambia. The authors can conclude that the study has generated baseline data for the clinical anatomy of the GVD goat.

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