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Applied Anatomy of the Head Region of the Indian Wild Pig (*Sus scrofa*) and its Clinical Value during Regional Anesthesia

Om Prakash Choudhary, Pranab Chandra Kalita, Probal Jyoti Doley and Arup Kalita

Department of Veterinary Anatomy and Histology, College of Veterinary Sciences and Animal Husbandry, Central Agricultural University, Selesih, Aizawl, Mizoram, INDIA

**Corresponding author: OP Choudhary; Email:dr.om.choudhary@gmail.com*

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ABSTRACT

The present study involved some osteometric parameters of the upper jaws and mandibles of adult Indian wild pigs without any apparent skeletal disorders. The supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length of the Indian wild pig were 4.56±0.056 cm, 6.54±0.063 cm, 32.55±0.40 cm, 22.90±0.24 cm, 18.27±0.17 cm and 14.93±0.13cm, respectively. The skull of the Indian wild pig was dolichocephalic according to the skull index. The skull index was 70.56±0.22. In addition, the distances from process of alveolar socket of canine tooth to the infraorbital canal and from the latter to root of the fourth upper premolar tooth were 5.40±0.048 cm and 3.57±0.069 cm, respectively. The length and height of the mandible were 33.25±0.30 cm and 16.88±0.124 cm, respectively. Furthermore, the distances from the lateral alveolar root to mental foramen and from the mental foramen to caudal mandibular border were 3.00±0.028 cm and 29.33±0.374 cm, respectively. In the present study, 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 7.44±0.069 cm and 7.04±0.05 cm, respectively. Also, the distances from the base of mandible to condyloid fossa and from the latter to the maximum height of mandible were 15.96±0.14 cm and 0.98±0.017 cm, respectively. Finally, the distance from caudal border of mandible to mandibular foramen and from the latter to mandibular angle were 7.76±0.041 cm and 7.13±0.082 cm, respectively.

Keywords: Applied anatomy, maxillofacial, mandibular, wild pig, regional anesthesia

The Indian wild boar is also known to be a wild pig resembling the domestic pig in the country. Adult boars are covered with stiff, coarse black and brindle hair with a thick crest from the nape and reaching down the back. Adult males have well developed tushes (canines), both in the upper and lower jaws. These curve upward and protrude out from the long snout, giving them quite a formidable appearance.

The Indian wild pig is tall-skulled wild pig, the dorsal margin of its skull being flat rather than concave, and its teeth are proportionally small and its nasal bones are short (Groves, 1981). It lacks the facial bands present on some other Asian wild pig taxa. The Indian wild pig is protected by law under Wildlife Protection Act, 1972.

The head is a very important region for animals; therefore gross morphological and radiographic studies on the skull of Indian blackbuck has been studied in detail (Choudhary and Singh, 2016). The head is the location of vital organs as the brain, eyes, nose, tongue ear and mouth. Also, the health of an animal can be deduced from the functional state of any of these organs (Olopade and Onwuka, 2003). Additionally, a unique aspect of the anatomy of any animal is the skull typology of that animal with usefulness in providing a database on the bone features (Olopade and Onwuka, 2003). The regional anatomy of the head is therefore, very useful tool that will aid in the regional anesthesia (Olopade and Onwuka, 2003). The osteometry of skull of Indian wild pig is scarcely reported. The present study was therefore undertaken to study

osteometric parameters of maxillofacial and mandibular region of skull of Indian wild pig.

MATERIALS AND METHODS

This study involved some important morphometric parameters of the maxillofacial and mandibular region of six adult Indian wild pigs without any apparent skeletal disorders. A total of twenty three morphometric measurements were done in both side of the upper jaw and mandibles using scale, thread and digital calipers and the results were presented as means±SD in Table 1.

Table 1: Different measurements of head region of Indian wild pig (*Sus scrofa*) in cm

Sl. No.	Different Parameters	Mean+SD
A	Skull length	32.55±0.40
	Cranial length (A1)	18.27±0.17
	Nasal length (A2)	14.93±0.13
B	Skull width	22.90±0.24
C	Skull/Cephalic index	70.56±0.22
D	Supraorbital foramina distance	4.56±0.056
E	Distance between orbital rim to supraorbital foramina	3.51±0.056
F	Infraorbital foramina distance	6.54±0.063
G	Diameter of Infraorbital foramina	0.97±0.025
H	Circumference of Infraorbital foramina	6.10±0.16
I	Distance from process of alveolar socket of canine tooth to the infraorbital canal	5.40±0.048
J	Infra-orbital canal to the root of alveolar tooth	3.57±0.069
K	Infraorbital foramina to rim of orbit	6.65±0.058
L	Lateral alveolar root to mental foramen	3.00±0.028
M	Mental foramen to the caudal mandibular border	29.33±0.374
N	Mandibular length	33.25±0.30
O	Mandibular height	16.88±0.124
P	Mandibular foramen to base of mandible	7.44±0.069
Q	Caudal border of mandible to below mandibular foramen	7.04±0.05
R	Condyloid fossa to the height of the mandible	0.98±0.017
S	Condyloid fossa to the base of the mandible	15.96±0.14
T	Caudal border of mandible to the level of mandibular foramen	7.76±0.041
U	Mandibular foramen to mandibular angle	7.13±0.082

The various osteometric parameters are described below and shown in Figure 1-4.

A. Skull Length; from the dorsal lateral nasal cartilages to the external occipital protuberance; sub-divided into cranial length (A1) and nasal length (A2).

B. Skull width; maximum distance between two zygomatic arches.

C. Skull/cephalic index (SI/CI): Calculated using the ratio between the maximum width and length of the skull of Indian wild pig {Skull width/ Skull length X 100} (Miller *et al.*, 1964).

D. Supraorbital foramina distance; maximum distance between the supraorbital foramina.

E. Distance between orbital rim to supraorbital foramina.

F. Infraorbital foramina distance; maximum distance between two infraorbital foramina.

G. Diameter of Infraorbital foramina; maximum diameter in between the rim of infraorbital foramina.

H. Circumference of Infraorbital foramina; calculated by the formula $2\pi r$ where r is radius of the infraorbital foramina.

I. Distance between process of alveolar socket of canine tooth to the infraorbital canal; from the level of the most lateral bulging of the process of alveolar socket of canine tooth to the mid level of the infra-orbital canal.

J. Infra-orbital canal to the root of alveolar tooth; the measurement was taken vertically from the mid-level of the infra-orbital canal to the root of the alveolar tooth.

K. Distance between orbital rim to infraorbital foramina.

L. Lateral alveolar root to mental foramen; from the mental foramen to the lateral extent of the alveolar root of lower incisor.

M. Mental foramen to the caudal mandibular border; from the level of the mental foramen to the extreme caudal border of the mandible.

N. Maximum 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.

O. Maximum mandibular height; from the basal level of the mandible to the highest level of the coronoid process.

P. Mandibular foramen to base of mandible; vertical line from the ventral limit of the mandibular foramen to the base of the mandible.

Q. Caudal border of mandible to below mandibular foramen; length from the caudal most border of the mandible to the vertical line produced by a description of the measurement of the mandibular foramen to the base of the mandible.

R. Condyloid fossa to the height of the mandible; from the maximum height of mandible to the condyloid fossa.

S. Condyloid fossa to the base of the mandible.

T. Caudal border of mandible to the level of mandibular foramen.

U. Mandibular foramen to mandibular angle; distance from the mandibular foramen to the extreme caudal border of the angle of the mandible.

The above mentioned parameters of the mandible were measured and subjected to routine statistical analysis (Snedecor and Cochran, 1994). The photographs of the skull of the Indian wild pig were taken by *the Nikon D3200 digital SLR camera and labeled with Adobe Photoshop 7 and CS6 extended version 13.0.1.*

RESULTS AND DISCUSSION

In the present study, the supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length of the Indian wild pig (Fig. 1) were 4.56±0.056 cm, 6.54±0.063 cm, 32.55±0.40 cm, 22.90±0.24 cm, 18.27±0.17cm and 14.93±0.13 cm, respectively. However, these measured 18.3 cm, 6.43 cm, 46.2 cm, 32.5 cm and 13.3 cm, respectively in Iranian one humped camel (Monfared, 2013a) and 6.35±0.047 cm, 8.41±0.076 cm, 48.75±0.244 cm, 22.66±0.108 cm, 32.73±0.484 cm and 16.89±0.283 cm, respectively in dromedary camels (Choudhary *et al.,* 2016). In donkey the skull length, skull width and cranial length were 44.307±5.35 cm, 16.90±1.76 cm and 20.782±2.22 cm, respectively (Zhu *et al.,* 2014).

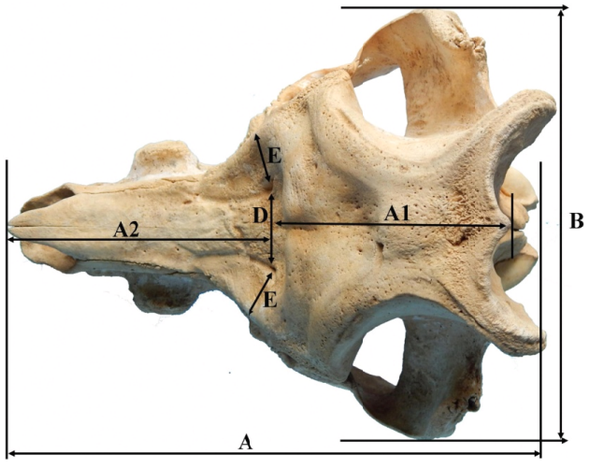

Fig. 1: Measurements of the skull of Indian wild pig showing skull length (A), cranial length (A1), nasal length (A2), skull width (B), distance between supraorbital foramina (D) and distance between orbital rim to supraorbital foramina (E)

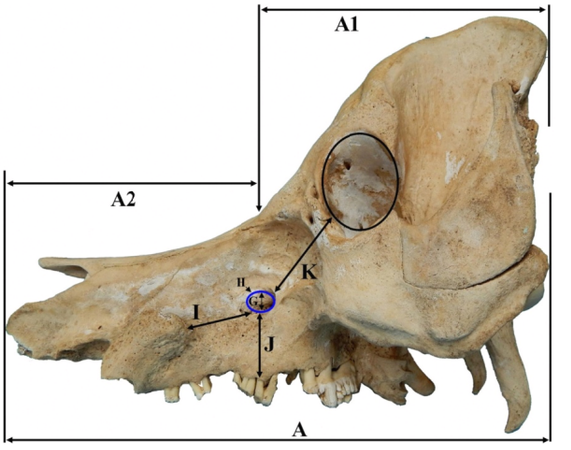

Fig. 2: Measurements of the skull of Indian wild pig showing skull length (A), cranial length (A1), nasal length (A2), skull width (B), diameter of the infraorbital foramina (G), circumference of the infraorbital foramina (H), distance from process of alveolar socket of canine tooth to the infraorbital canal (I), Infra-orbital foramina to the root of fourth premolar alveolar tooth (J), infraorbital foramina to the orbital rim (K)

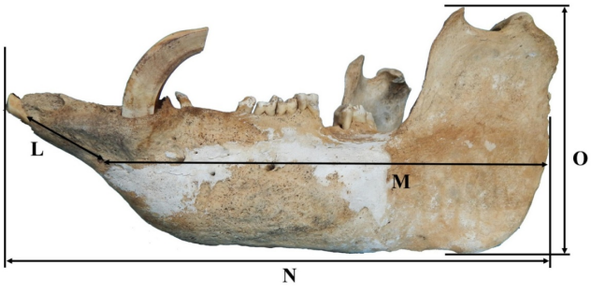

Fig. 3: Measurements of the mandible of Indian wild pig showing distance from lateral alveolar root to mental foramen (L), mental foramen to the caudal mandibular border (M), mandibular length (N) and mandibular height (O)

Fig. 4: Measurements of the mandible of Indian wild pig showing maximum mandibular height (S), distance from mandibular foramen to base of mandible (P), caudal border of mandible to below mandibular foramen (Q), condyloid fossa to height of mandible (R), condyloid fossa to the base of the mandible (S), caudal border of mandible to the level of mandibular foramen (T), mandibular foramen to mandibular angle (U)

The distance between orbital rim to the supraorbital foramina and infraorbital foramina (Fig. 1) was 3.51±0.056 cm and 6.65±0.058 cm, respectively in Indian wild pig, however it was 5.66±0.051 cm and 5.87±0.053 cm, respectively in the dromedary camel (Choudhary *et al.,* 2016).

The skull index or cephalic index in the present study was found to be 70.56±0.22 which indicate that the skull of Indian wild pig was dolichocephalic. The cephalic index was 38.23±0.85 in donkey (Zhu *et al*., 2014), 46.12±0.12 cm in blackbuck (Choudhary and Singh, 2015b) and 46.51±0.29 cm in dromedary camel (Choudhary *et al.,* 2016).

The distance from the process of alveolar socket of canine tooth to the infraorbital canal and from the latter to the root of the fourth upper premolar alveolar tooth directly ventral to it (Fig. 2) was 5.40±0.048 cm and 3.57±0.069 cm, respectively in Indian wild pig. However the distance from the facial tuberosity to the infra-orbital canal and from the latter to the root of the alveolar tooth directly ventral to it was 1.6-1.8 cm and 1.3-1.6 cm in west African dwarfs goats (Olopade and Onwuka, 2005); 2.06±0.14 cm and 1.13±0.11 cm in Gwembe Valley dwarf goat (Kataba *et al.*, 2014); 2.8 cm and 2.5 cm in Iranian native cattle (Monfared, 2013b); 2.37±0.009 cm and 0.72±0.008 cm in blackbuck (Choudhary and Singh, 2015a); 2.19±0.068 cm and 3.21±0.078 cm, respectively in dromedary camel (Choudhary *et al.,* 2016) and 1.85±0.14 cm and 1.75±0.19 cm in black Bengal goat (Uddin *et al*., 2009).

The data generated for above parameters may be utilized as a guide for tracking the infra-orbital nerve, and necessary for its desensitization during the manipulations in the skin of the upper lip, nostril and face at the level of the foramen. 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 premolar teeth (Choudhary *et al.,* 2015b).

The distance between the lateral end of the alveolus of the third incisor tooth to the mental foramen (Fig. 3) was 3.00±0.028 cm in Indian wild pig, however, it was 1.6±0.22 cm in west African dwarf goat (Olopade and Onwuka, 2005), 2.0±0.30 cm in Red Sokoto (Maradi) goat (Olopade and Onwuka, 2007), 4.74 cm in Iranian one-humped camels (Monfared, 2013a), 2.45±0.008 in blackbuck (Choudhary *et al.,* 2015b) and 9.22±0.059 cm in dromedary camel (Choudhary *et al.,* 2016). The location of mental foramen is an important landmark for locating the mental nerve for the regional nerve block in Indian wild pig. In the anterior aspect of the mandibular canal, injection can be made through the mental foramen to desensitize mental aspect of the mandibular nerve. This will ensure the loss of sensation of the lower incisors, premolar and lower lip on that side (Hall *et al.,* 2000). The distance from the mental foramen to the caudal mandibular border was 29.33±0.374 cm in Indian wild pig. However, it was 13.43±0.081 cm in Iranian one-humped camels (Monfared, 2013ba) and 32.12±0.165 cm in dromedary camel (Choudhary *et al.,* 2016).

The length and height of the mandible (Fig. 3) were 33.25±0.30 cm and 16.88±0.124 cm, respectively in Indian wild pig. These were 12.00±1.89 cm and 6.90±1.09 cm in west African dwarfs goats of Nigeria (Olopade and Onwuka, 2005); 27.4 cm and 15.88 cm in Iranian native cattle (Monfared, 2013b); 39.9 cm and 9.92 cm in Iranian one-humped camels (Monfared, 2013a); 16.53±0.128 cm and 10.69±0.024 cm in blackbuck (Choudhary *et al*., 2015a); 42.98±0.624 cm and 22.58±0.287 cm, respectively in dromedary camel (Choudhary *et al.,* 2016).

The distances between the condyloid fossa to the height of mandible and condyloid fossa to the base of the mandible (Fig. 4) were 0.98±0.017 cm and 15.96±0.14 cm, respectively in Indian wild pig; whereas, same distances were found to be 3.09±0.008 and 7.57±0.024 cm in blackbuck (Choudhary and Singh, 2015a) and 4.175±0.046 cm and 18.38±0.15 cm, respectively in dromedary camel (Choudhary *et al.,* 2016).

The distance between the vertical line drawn downward from the caudal border of mandible (S) and the vertical line drawn from the mandibular foramina downwards (P) shown in Fig. 4 was 7.04±0.05 cm (Q), while same distance was observed 1.85±0.011 cm in blackbuck (Choudhary and Singh, 2015a).

The most frequent technique failure in anesthesia of the inferior alveolar lies in the inappropriate setting of the needle, due to the inaccurate location of anatomic repairs (Hetson *et al.*, 1988), among which the mandibular foramen. The risk of undesirable mandibular fractures might decrease when the mandibular foramen is taken as anatomic repairs in osteotomies performed for orthognathic purposes (Quevedo, 2004).

The distances from the mandibular foramen to the base of the mandible, caudal border of mandible to the level of mandibular foramen and the mandibular foramen to the border of mandibular angle (Fig. 4) were 7.44±0.069 cm, 7.04±0.05 cm and 7.13±0.082 cm, respectively in Indian wild pig; however, these were 4.18±0.014 cm, 1.36±0.010 cm and 3.07±0.006 cm, respectively in blackbuck (Choudhary and Singh, 2015a) and 8.84±0.085 cm, 5.88±0.055 cm and 8.29±0.079 cm, respectively in dromedary camel (Choudhary *et al.,* 2016). Equivalent figures for west African dwarfs goats of Nigeria were 1.57±0.44 cm, 2.58±0.34 cm, respectively, for the caudal border of mandible to below mandibular foramen and the mandibular foramen to the base of the mandible (Olopade and Onwuka, 2005).

In horse and dogs the distance between the mandibular foramen and the base of the mandible was 3 cm and 1.5 to 2 cm, respectively (Hall *et al.*, 2000). The anesthetic agents must be injected on the medial side of the mandible, thereby; a successful nerve block produces anesthesia of the lower jaw with its teeth and the lower lip. These various distance measured may be utilized for proper anatomical location in achieving the regional anesthesia of the mandibular nerve and also have clinical importance for desensitization of all the teeth in lower jaw.

In conclusion, the morphometric measurements of the skull of the Indian wild pig provide an important baseline data for further research in the field of applied anatomy. Furthermore, these results may be exploited for accurate location of anatomical land marks that will improve the accuracy of regional anesthesia of the various nerves around the head region, especially during treating head injury, dental extraction and mandibular fractures in Indian wild pigs.

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