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Morphological and Applied Anatomical Studies on the Head Region of Local Mizo Pig (Zovawk) of Mizoram

Estudios Morfológicos y Anatómicos Aplicados en la Cabeza de Cerdo Local Mizo (Zovawk) de Mizoram

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SUMMARY: Zovawk is newly identified breed of pig of Mizoram approved by breed registration committee of Indian Council of Agricultural Research (ICAR), New Delhi. This study was designed to provide maximum number of morphometrical parameters of skull and some valuable information on clinically important parameters of Zovawk. The skull of the Zovawk was dolichocephalic according to the cephalic index (53.56±0.11). The supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length of the Zovawk were 3.49±0.01 cm, 6.55±0.01 cm, 28.26±0.03 cm, 15.11±0.26 cm, 13.17±0.04 cm and 13.79±0.02 cm, respectively. The orbital margins were found to be incomplete with bilateral variation among the orbits of both the sides. 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 was 4.77±0.04 cm and 1.20±0.01 cm, respectively in Zovawk. The data are of clinical importance 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 distance between the lateral end of the alveolus of the third incisor tooth to the mental foramen was 3.57±0.04 cm in Zovawk, which is an important landmark for achieving the location of the mental nerve for the regional nerve block Zovawk. The length and height of the mandible were 25.02±0.09 cm and 10.54±0.07 cm, respectively in Zovawk. The morphometric measurements of the skull and applied anatomy of the head region of the Zovawk provide an important baseline data for further research in the field of applied anatomy.

KEY WORDS: Zovawk; Head; Applied; Nerve block; Indian Council of Agricultural Research.

INTRODUCTION

Piggery plays an important role in the rural economy of North East (NE) India. Among all the livestock, pig is one of the most valued and popular as almost 100 % tribal population in the region are pork eaters (Mayengbam *et al*., 2012).

North eastern region has the highest population and concentration of pig per household than any other state or region of the country. The total pig population of Mizoram is around 1,17,675 (Livestock Census, 2007) whereas the Zovawk population of Mizoram is about 43,000 (Livestock Census). Zovawk is newly identified breed of pig of Mizoram approved by breed registration committee of Indian Council of Agricultural Research (ICAR), New Delhi.

The head is a very important region for animals. It is the location of vital organs viz., 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.. Additionally, a unique head aspect of the anatomy of any animal is the skull typology of that animal with usefulness in providing a database on the bone features. The regional anatomy of the head is therefore, very useful tool that will aid the regional anesthesia (Olopade & Onwuka, 2003).

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For instance, Choudhary & Singh (2015a & b) determined the applied landmarks on the head region of the Indian blackbuck and their application to clinical maneuvers around the head. The results obtained after morphometry of the skull will be of clinical importance and used in regional nerve blocks of the supra-orbital, infra-orbital, mental nerves and mandibular nerves which are useful during surgical operations in head region and dental extraction. The application of local anesthetic agent is easier for the maxillary and mandibular nerve blocks through the injection of local anesthetic agent via the infra-orbital foramen and mental foramen respectively.

Regional nerve block is used for all painful procedures including dental removals via buccotomy, rasping of maxillary and mandibular molar teeth in case of sharp teeth, treatment of upper eyelid entropion, alar fold resection and in some cases of sinus surgery. It is useful in minimizing the dose of sedative and general anesthetics. The present work was carried out because there is no comprehensive data on the head region of Zovawk and its clinical implications during regional anesthesia.

MATERIAL AND METHOD

The present study was conducted on the head region of ten Zovawk pigs of either sex. The samples for the study were collected from local slaughter houses near to the college campus. The collected head samples of the Zovawk pig were macerated using the maceration technique given by Choudhary *et al*. (2015).

This study was designed to provide maximum number of biometrical parameters of skull and some valuable information on clinically important parameters of Zovawk. The following measurements were taken for different bones of the skull and were summarized in Tables I and II.

Skull parameters (Figs. 1 and 2).

a) Length (Lsk): Distance between the highest points of the parietal bone to the middle of the rostral margin of the incisive bone.
b) Width (Wsk): Distance between two zygomatic arches.
c) Skull/cephalic index (SI): Skull width/ Skull length X 100 (Miller *et al*., 1964).
d) Skull base length (LBsk): Distance between the midpoints of the dorsal margin of the foramen magnum to the level of the middle point of the rostral margin of the incisive bone.
e) Height of the skull with mandible (Hskm): Distance between the lines drawn between caudal margins of mandible to the middle point of the nuchal crest.

Cranial parameters (Fig. 1).

a) Cranial length (Lcr): Distance from the central point of the fronto-nasal suture to the middle point of the nuchal crest.
b) Cranial width (Wcr): Maximum distance between the highest points of the parietal bone.
c) Cranial index (Icr): Cranial width/ Cranial length X 100 (Miller *et al*., 1964).
d) Cranial height (Hcr): Distance between the central points of the ventral rim of the foramen magnum to the middle point of the nuchal crest.
e) Capacity of the cranial cavity: All the foramina of the cranial cavity were plugged with cotton. The cavity was then filled with mustard grains through the foramen magnum up to its brim. The mustard was then emptied into a measuring cylinder to get the capacity. This technique was already described by the Choudhary and Singh (2015a & b).

Orbital parameters (Fig. 4).

a) Orbital length (Ho): Maximum height of the orbit.
b) Orbital height (Lo): The perpendicular distance between the supraorbital and infraorbital margins of the orbit.
c) Orbital depth (Do): Distance between optic foramen and center of the orbital rim.
d) Inter-orbital width (Wio): Minimum distance between the upper edges of the orbits measured across the tip of the skull.
e) Orbital circumference length (Co): Maximum circumference of the orbit, along the rim. One imaginary line was drawn to join the two edges of the incomplete margins of the orbit.

Maxilla parameters (Fig. 3).

a) Length of maxilla (Lma): Maximum length of the maxilla.
b) Height of maxilla (Hma): Maximum width of the maxilla
c) Distance between infraorbital foramen (Diof): Maximum distance between two intraorbital foramen.
d) Diameter of infraorbital foramina (Diof): Maximum distance between the two edges of infraorbital foramina.

Premaxilla parameters (Fig. 3).

a) Length of premaxilla (Lpm): Maximum length of premaxilla.
b) Height of premaxilla (Hpm): Maximum height of premaxilla.

Lacrimal parameters (Fig. 3).

a) Length of lacrimal (Lla): Distance from the fronto-lacrimal suture to the junction between the lacrimal and maxilla bones.
b) Height of lacrimal (Hla): Distance from the fronto-lacrimal suture to the junction between the lacrimal and malar bones

Zygomatic parameters (Fig. 7).

a) Length of zygomatic (Lzy): Maximum length of zygomatic.
b) Height of zygomatic (Hzy): Maximum height of zygomatic.

Nasal parameters (Fig. 1).

a) Length of nasal bone (Lna): Distance from the central point of the fronto-nasal suture to the rostral end of the internasal suture.
b) Width across nasal bone (Wna): Maximum distance across the nasal bones or maximum distance between the naso-maxillary sutures.
c) Nasal Index (Ina)=Nasal width/ Nasal length X 100.

Palatine parameters (Fig. 2).

a) Length of palate (Lpa): Distance measured from the rostral mid sutured line of incisive bone to the caudal nasal spine of the palatine bone.
b) Width of palate (Wpa): Maximum distance at the horizontal plate of palatine bone behind the last molar tooth.

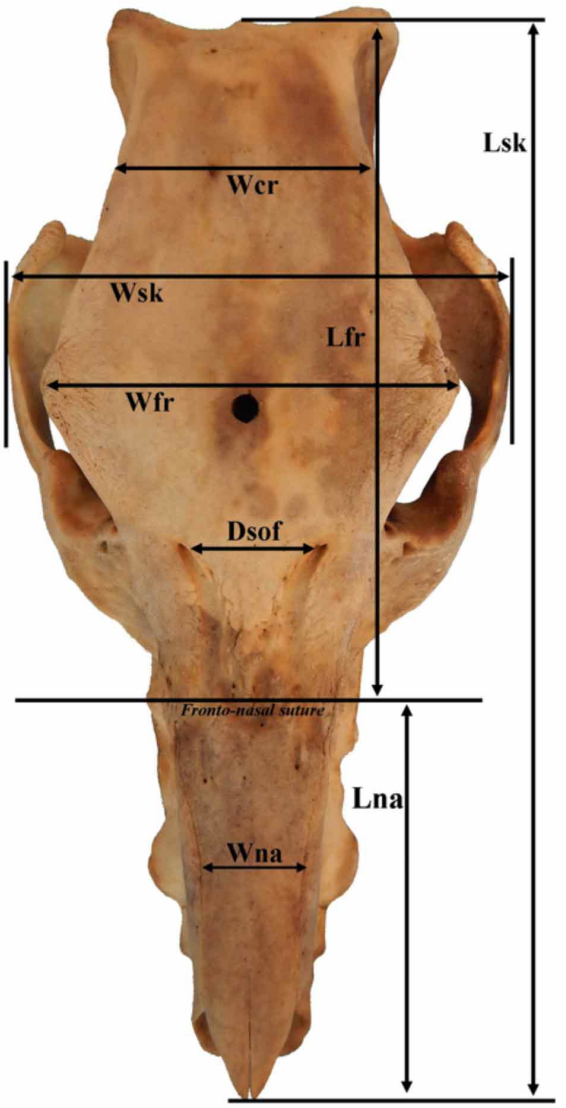

Fig. 1. Measurement of the skull of local Mizo pig (dorsal view) showing skull length (Lsk), skull width (Wsk), length of frontal (Lfr), width of frontal (Wfr), distance between two supraorbital foramina (Dsof), distance between supraorbital foramina to rim of orbit (Sof-rio) length of nasal (Lna) and width of nasal (Wna) and cranial width (Wcr).

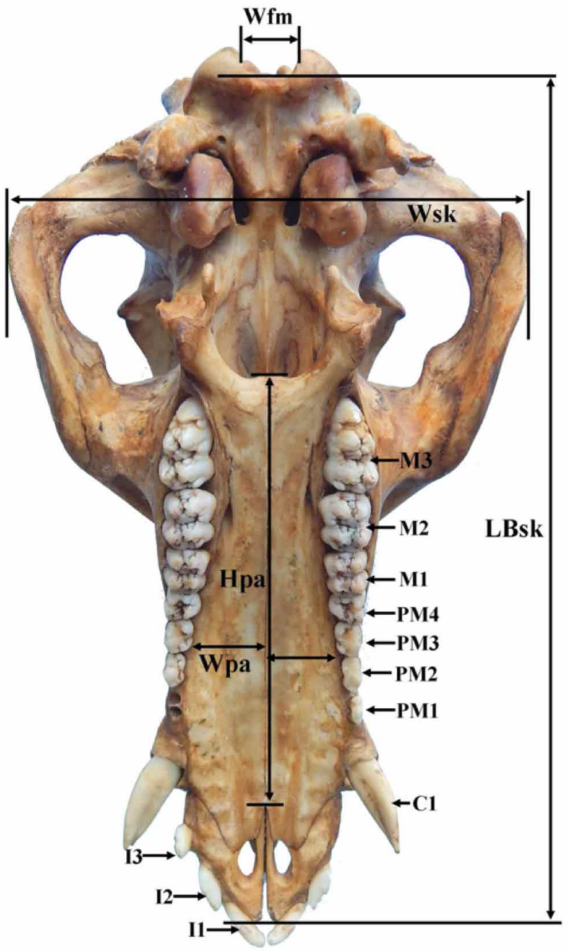

Fig. 2. Measurements of the skull of local Mizo pig (ventral view) showing width of foramen magnum (Wfm), base length of skull (LBsk), width of skull (Wsk), length of palatine (Lpa), width of palatine (Wpa) and incisor, canine, premolar, molar teeth (I1-3,C1,PM1-4,M3).

Occipital parameters (Fig. 5).

a) Width of occipital (Woc): Maximum distance between external margins of two paracondylar processes
b) Height of occipital (Hoc): Distance from base of the occipital condyle to the starting point of sagittal crest
c) Intercondylar width (Wic): Width between the lateral ends of the occipital condyles.
d) Interparacondylar width (Wipc): Width between the lateral ends of the paracondylar process.
e) Height of foramen magnum (Hfm): The distance between the midpoints of the dorsal ventral rims of the foramen magnum.
f) Width of foramen magnum (Wfm): The maximum distance between the two occipital condyles.
g) Foramen magnum index (Ifm): Foramen magnum height/Foramen magnum width X 100.
h) Area of foramen magnum (Afm): Calculated by using the formula- ≈* 22/7* WH, where W= width and H = height of the foramen magnum.
i) Circumference of foramen magnum (Cfm): Length of the entire rim of the foramen magnum.

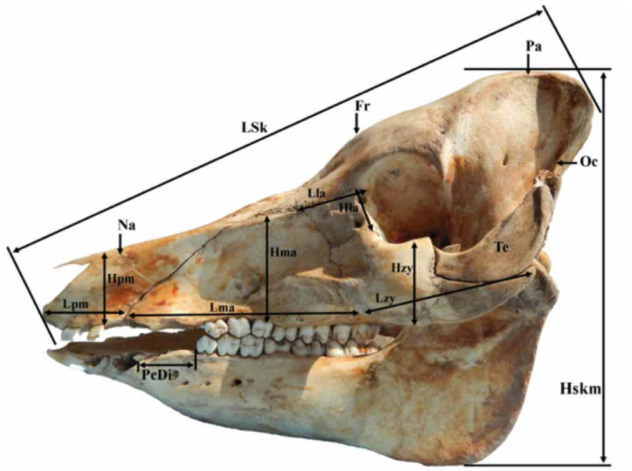

Fig. 3. Measurements of the skull of local Mizo pig (lateral view) showing length of premaxilla (Lpm), height of premaxilla (Hpm), length of maxilla (Lma), height of maxilla (Hma), length of zygomatic (Lzy), height of zygomatic (Hzy), length of lacrimal (Lla), height of lacrimal (Hla), height of the skull with mandible (Hskm), length of skull (Lsk), nasal bone (Na), frontal bone (Fr), palatine (Pa), occipital bone (Oc) and temporal bone (Te).

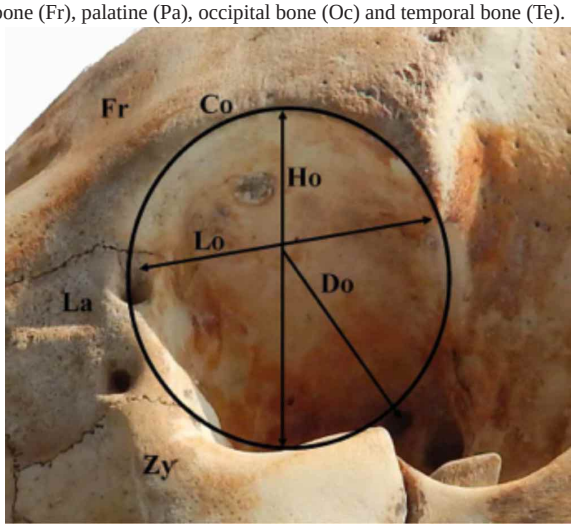

Fig. 4. Measurements of the orbit of local Mizo pig showing Height of orbit (Ho), length of orbit (Lo), depth of orbit (Do), circumference of orbit (Co), frontal (Fr), lacrimal (La) and zygomatic bone (Zy).

Parietal parameters:

a) Height of parietal (Hpa): Maximum height of parietal bone.
b) Width of parietal (Wpa): Maximum width of parietal bone.

Frontal parameters (Fig. 1).

a) Length of frontal (Lfr): Maximum length between parito-frontal suture and fronto-nasal suture.
b) Width of frontal (Wfr): Maximum length between two lateral edges of frontal bone.
c) Distance between supraorbital foramen (Dsof): Distance between two supraorbital foramen of frontal bone.
d) Distance between supraorbital foramen to rim of the orbit (Soffrio): Maximum straight distance between the supraorbital foramen and the edge of the orbital margin.

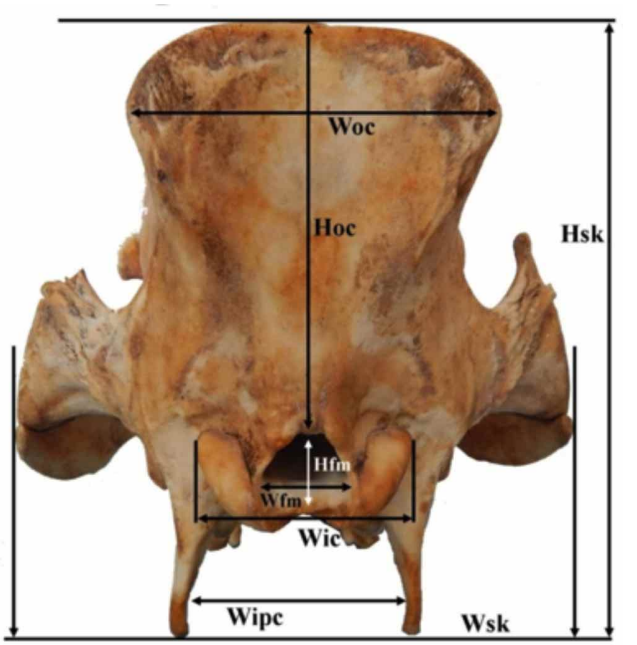

Fig. 5. Measurements of the skull of local Mizo pig (nuchal view) showing height of occipital (Hoc), width of occipital (Woc), intercondylar width (Wic) and interparacondylar width (Wipc), skull height (Hsk), skull width (Wsk), height and width of foramen magnum (Hfm & Wfm).

Mandible parameters (Figs. 7 and 8).

a) Lateral alveolar root to mental foramen (A): From the mental foramen to the lateral extent of the alveolar root of lower incisor.
b) Mental foramen to the caudal mandibular margin (B): From the level of the mental foramen to the extreme caudal margin of the mandible.
c) Mandibular length (C): From the level of the cranial extremity of the alveolar root of the incisor to the level of the caudal margin of the mandible.
d) Maximum mandibular height (D): From the basal level of the mandible to the highest level of the coronoid process.
e) Mandibular foramen to base of mandible (E): Vertical line from the ventral limit of the mandibular foramen to the base of the mandible.
f) Caudal margin of mandible to below mandibular foramen (F): length from the caudal most margin of the mandible to the vertical line produced by a description of the measurement of the mandibular foramen to the base of the mandible.
g) Condyloid fossa to the base of the mandible (G).
h) Caudal margin of mandible to the level of mandibular foramen (H).
i) Mandibular foramen to mandibular angle (I): Shortest distance from the mandibular foramen to the extreme caudal margin of the angle of the mandible.

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

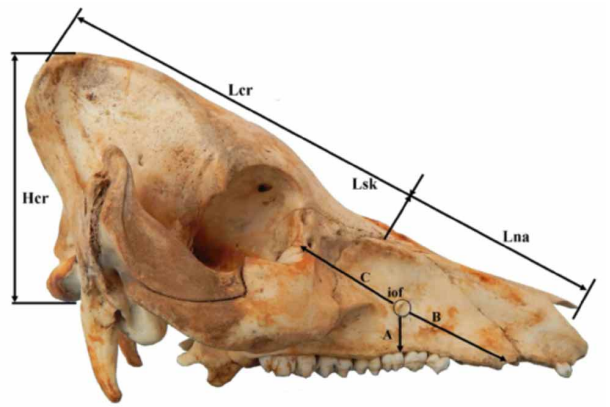

Fig. 6. Measurements of the skull of local Mizo pig (lateral view) skull length (Lsk), cranial length (Lcr), nasal length (Lna), height of cranium (Hcr), infraorbital foramen (iof), distance from infraorbital canal to root of 4th premolar tooth (A), distance from infraorbital canal to root of canine tooth (B), distance from infraorbital canal to orbital rim (C).

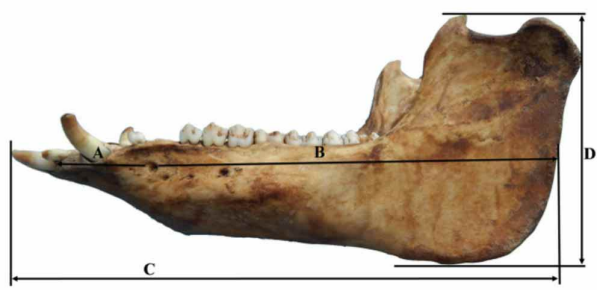

Fig. 7. Measurements of the mandible (lateral view) of local Mizo pig showing distance from lateral alveolar root to mental foramen (A), mental foramen to the caudal mandibular margin (B), mandibular length (C) and mandibular height (D).

Fig. 8. Measurements of the mandible (medial view) of local Mizo pig showing mandibular height (D), distance from mandibular foramen to base of mandible (E), caudal margin of mandible to below mandibular foramen (F), condyloid fossa to the base of the mandible (G), caudal margin of mandible to the level of mandibular foramen (H), mandibular foramen (mf).

RESULTS AND DISCUSSION

The skull of Zovawk was divided into frontal, lateral, nuchal and basal surfaces for the convenience of description as reported in Pygmy hog (Kalita *et al*., 2015). The frontal surface of the skull was formed by the frontal, parietal, nasal, parts of the maxilla and premaxilla (incisive) bone as reported in Kagani goats (Sarma, 2006), chital (Kumawat *et al*., 2014), Pygmy hog (Kalita *et al*.) and blackbuck (Choudhary & Singh, 2016b). The basal surface of the skull which formed the osseous hard palate was almost completely enclosed by the alveolar processes of the maxilla and incisive bones. The horizontal plate of the palatine bone also contributes quite considerably to the formation of the palate as reported in Pygmy hog (Kalita *et al*.). The nuchal surface of the skull of Zovawk was formed in the middle by the squamous and the lateral parts of the occipital bone as reported in Pygmy hog (Kalita *et al*.) and blackbuck (Choudhary & Singh, 2016b). The lateral surface of the skull was formed by the temporal, zygomatic, maxilla, premaxilla and some part of frontal as reported in blackbuck (Choudhary & Singh, 2016b).

The measurements demonstrated that the skull was elongated in shape as also reported in Kagani goat (Sarma, 2006), chital (Kumawat *et al*.) and blackbuck (Choudhary & Singh, 2016a).

The skull of the Zovawk was dolichocephalic according to the cephalic index as reported in chital (Kumawat *et al*.), blackbuck (Choudhary & Singh, 2016a) and Indian wild pig (Choudhary *et al*., 2017); however, it was brachycephalic in tiger (Joshi, 2004) and mesaticephalic in dog (Miller *et al*., 1964).

The skull index or cephalic index of Zovawk was 53.56±0.11, whereas it was 38.23±0.85 in donkey (Zhu *et al*., 2014), 46.12±0.12 cm in blackbuck (Choudhary and Singh, 2015b), 46.51±0.29 cm in dromedary camel (Choudhary *et al*., 2016) and 70.56±0.22 in Indian wild pig (Choudhary *et al*., 2017).

In the present study, the supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length of the Zovawk were 3.49±0.01 cm, 6.55±0.01 cm, 28.26±0.03 cm, 15.11±0.26 cm, 13.17±0.04 cm and 13.79±0.02 cm, respectively. Choudhary *et al*. (2015) reported that the supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length for 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±0.17cm and 14.93±0.13 cm, respectively. However, the supraorbital foramina distance, infraorbital foramina distance, skull length, cranial length and nasal length were 18.3 cm, 6.43 cm, 46.2 cm, 32.5 cm and 13.3 cm, respectively in the Iranian one-humped camels (Monfared, 2013a). Zhu *et al*. also reported skull length, skull width and

cranial length in donkey were 44.307±5.35 cm, 16.90±1.76 cm and 20.782±2.22 cm, respectively. Choudhary *et al*. (2016) mentioned that the supraorbital foramina distance, infraorbital foramina distance, skull length, skull width, cranial length and nasal length for the dromedary camels were 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. While according to Sarma (2006) in kagani goats; the mean lengths of the skulls were 24.72±0.93 cm, with the width and cephalic index of 10.40±0.61 cm and 41.95±0.97 cm, respectively; whereas the skull length was 20.06±1.71 cm in Mehraban sheep (Karimi *et al*., 2011) and 46.2 cm in Iranian native camels (Monfared, 2013b). Zhu *et al*. noted skull length and width 443.07±53.57 mm and 169.09±17.64 mm in donkey. The mean skull length of the lion, dog and cat was 39.75±1.04, 20.02±1.36 and 8.4±1.5 cm, while the skull width was 28±2.16, 10.04±0.56 and 6.8±1.4 cm respectively (Saber & Gummow, 2015). The mean cranial length of the lion's, dog's and cat's skulls were 18.86±4.77, 5.96±0.63 and 3.4±0.4 cm, respectively (Saber & Gummow).

The height of the skull with mandible (Hskm) in the present study was 24.55±0.13. The cranial width of the Zovawk was 8.45±0.04; however, it was 11.85±1.98, 5.13±0.34 and 4.1±0.2 cm respectively in lion's, dog's and cat's skulls (Saber & Gummow). The cranial index was 64.16±0.07 in Zovawk; however, cranial index was 52.76±1.13 in Mehraban sheep (Karimi *et al*.).

The orbital margins were found to be incomplete in Zovawk as also reported in tiger (Taluja *et al*., 2000), Pygmy hog (Kalita *et al*.) and Indian Wild pig (Choudhary *et al*., 2016). Whereas, the orbits were circular in blackbuck (Choudhary & Singh, 2015a) and elliptical in Mehraban sheep (Karimi *et al*.). The orbital margins were formed by frontal, lacrimal and zygomatic bone. The maximum contribution in the formation of the orbit was from frontal bone followed by the zygomatic and lacrimal bone. The interorbital distance in the present study was 7.81±0.07 cm.

Various orbital parameters showed bilateral variation among the orbits of both the sides. The orbital height (4.16±0.01 cm) was more in left than right orbit (4.08±0.01 cm), however the height of right orbit was more than left one in Kagani goats (Sarma, 2006).

The orbital depth and orbital circumference was 2.32±0.01 and 12.85±0.04 cm in the present study. Similarly, orbital depth and circumference have been recorded more in the left orbit (4.66±0.004 and 13.49±0.009 cm, respectively) than the right one (4.61±0.003 and 13.09±0.01 cm, respectively) in blackbuck (Choudhary & Singh, 2015c).

The cranial cavity of Zovawk was oval in outline as reported in blackbuck (Choudhary and Singh, 2016a). The capacity of cranial cavity was 101.16±0.51 cm^3 in the Zovawk, while it was 113±0.84 cm^3 in Kagani goat (Sarma, 2006), 130.86±11.55 cm^3 in Mehraban sheep (Karimi *et al*.) and 107.83±0.86 cm^3 in blackbuck (Choudhary & Singh, 2016a). The mean cranial capacity of the lion, dog and cat was 207.4±24.49, 86.4±11.87 and 20.8±1.95 cm^3 respectively (Saber & Gummow).

The height and width of the occipital bone was found to be 10.89±0.01 cm and 7.97±0.01 cm, respectively; whereas same occipital parameter was 5.21±0.01 cm and 5.76±0.008 cm, respectively in blackbuck (Choudhary & Singh, 2015b).

The intercondylar and interparacondylar width was 5.07±0.02 cm and 5.75±0.01 cm, respectively in Zovawk; whereas it was 4.62±0.01 cm and 5.29±0.01 cm, respectively in blackbuck (Choudhary & Singh, 2015b).

The foramen magnum was large and roughly oval in shape as also reported by Kumawat *et al*. in chital and Choudhary & Singh (2016b) in blackbuck.

The height, width, circumference and area of the foramen magnum in the Zovawk was 1.56±0.01 cm, 1.87±0.01 cm, 5.78±0.06 cm and 2.29±0.04 cm^2, respectively; whereas the same parameters were 1.74±0.008 cm, 2.03±0.006 cm, 8.22±0.01 cm and 2.77±0.006 cm^2, respectively in blackbuck (Choudhary & Singh, 2015b). Sarma (2006) also reported that the height, width, circumference and area of the foramen magnum in Kagani goat was 3.08±0.35 cm, 3.12±0.36 cm, 12.30±0.28 cm and 2.53±0.58 cm^2, respectively. Yahaya *et al*. (2012), noted a mean foramen magnum height and width of 4.04±0.15 and 3.70±0.16 cm, and 3.65±0.27 and 3.45 ± 0.21 cm in males and females of one humped camel.

The foramen magnum index was 83.42±0.03 in the present study, which was 98.71±0.03 in blackbuck (Choudhary & Singh, 2015b), 109.30±4.44 and 107.37±6.33 in males and females of one humped camel (Yahaya *et al*., 2012).

The length and width of the frontal bone in the Zovawk was 14.76±0.02 cm and 10.47±0.02 cm, respectively, whereas length and width of the frontal bone was 7.75±0.01 cm and 4.81±0.008 cm, respectively in blackbuck (Choudhary & Singh, 2015b).

The supraorbital foramina were small in Zovawk; whereas the supraorbital foramina was very large opening

with larger in right side (1.02±0.00 cm) than the left one (0.84±0.00 cm) in blackbuck (Choudhary & Singh, 2015b). The distance between supraorbital foramina to rim of orbit was 2.09±0.002 cm in present study.

The length and width of the maxilla bone was 10.16±0.04 cm and 5.42±0.01 cm, respectively in Zovawk, however it was 9.29±0.005 cm and 4.83±0.008 cm in blackbuck (Choudhary & Singh, 2015b). The diameter of the infraorbital foramen in the present study was 0.895±0.00 cm.

The length and width of the premaxilla was 10.68±0.01 cm and 3.70±0.05 cm, respectively, however it was 7.23±0.007 cm and 1.00±0.001 cm in blackbuck (Choudhary & Singh, 2015b).

The length and width of palatine bone was 15.47±0.04 cm and 5.07±0.01 cm, respectively, whereas length and width of palatine bone was 6.04±0.046 cm and 3.23±0.022 cm, respectively in blackbuck (Choudhary & Singh, 2015b). The length of the palatine suture in the present study was 14.04±0.02 cm.

The length and width of the nasal bone was 13.79±0.02 cm and 4.95±0.02 cm, respectively, however it was 5.69±0.01 cm and 1.29±0.01 cm, respectively in blackbuck (Choudhary & Singh, 2015b). The length of the nasal suture was 13.19±0.03 cm in present study. The nasal index for the Zovawk was 35.91±0.03.

The length and width of the lacrimal bone was 4.83±0.01 cm and 2.31±0.01 cm, respectively, whereas the length and width of the lacrimal bone was 4.36±0.01 cm and 1.71±0.01 cm. The lacrimal bone was situated on the lateral aspect of the skull and involved in the formation of the anterior margin of the orbit. There were three lacrimal foramina in the present study, two were situated at anterior margin and one was situated posteriorly in the orbital cavity.

The length and width of the zygomatic bone was 8.26±0.02 cm and 4.26±0.01 cm, respectively in Zovawk.

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 was 4.77±0.04 cm and 1.20±0.01 cm, respectively in Zovawk, while it was 5.40±0.048 cm and 3.57±0.069 cm, respectively in Indian wild pig (Choudhary *et al*., 2017). However, the distance from the facial tuberosity to the infraorbital 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 & Onwuka, 2005); 2.06±0.14 cm and 1.13±0.11 cm in Gwembe Valley dwarf goat (Parés-Casanova *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 & Singh, 2015b); 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 are of clinical importance 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*., 2015).

The distance between the lateral end of the alveolus of the third incisor tooth to the mental foramen was 3.57±0.04 cm in Zovawk, which is an important landmark for achieving the location of the mental nerve for the regional nerve block in Indian wild pig, while the same measurement was 1.6±0.22 cm in west African dwarf goat (Olopade & Onwuka, 2005), 2.0±0.30 cm in red sokoto (Maradi) goat (Olopade & Onwuka, 2007), 4.74 cm in Iranian one-humped camels (Monfared, 2013a), 2.45±0.008 in blackbuck (Choudhary *et al*., 2015), 9.22±0.059 cm in dromedary camel (Choudhary *et al*., 2016) and 3.00±0.028 cm in Indian wild pig (Choudhary *et al*., 2017).

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 margin was 18.47±0.01 cm in Zovawk. However, the distance from the mental foramen to the caudal mandibular margin was 13.43±0.081 cm in Iranian one-humped camels (Monfared, 2013a,b) and 32.12±0.165 cm in dromedary camel (Choudhary *et al*., 2016) and 29.33±0.374 cm in Indian wild pig (Choudhary *et al*., 2017).

The length and height of the mandible were 25.02±0.09 cm and 10.54±0.07 cm, respectively in Zovawk, however the length and height of the mandible were 12.00±1.89 cm and 6.90±1.09 cm in west African dwarfs goats of Nigeria (Olopade & 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*., 2015); 42.98±0.624 cm and 22.58±0.287 cm, respectively in dromedary camel (Choudhary *et al*., 2016) and 33.25±0.30 cm and 16.88±0.124 cm in Indian wild pig (Choudhary *et al*., 2017).

The distances between condyloid fossa to the base of the mandible was 10.51±0.02 cm in Zovawk; whereas, it was 7.57±0.024 cm in blackbuck (Choudhary & Singh, 2015a), 18.38±0.15 cm in dromedary camel (Choudhary *et al*., 2016) and 15.96±0.14 cm in Indian wild pig (Choudhary *et al*., 2017).

The distance between the vertical line drawn downward from the caudal margin of mandible (E) and the vertical line drawn from the mandibular foramina downwards (G) was (F) 4.45±0.03 cm, while same distance was observed to be 1.85±0.011 cm in blackbuck (Choudhary and Singh, 2015a) and 7.04±0.05 cm in Indian wild pig (Choudhary *et al*., 2017).

The distances from the mandibular foramen to the base of the mandible, caudal margin of mandible to the level of mandibular foramen and the mandibular foramen to the margin of mandibular angle were 4.56±0.01 cm, 3.81±0.00 cm and 4.84±0.002 cm, respectively in Zovawk; however, the distances from the mandibular foramen to the base of the mandible, caudal margin of mandible to the level of mandibular foramen and the mandibular foramen to the margin of mandibular angle were 4.18±0.014 cm, 1.36±0.010 cm and 3.07±0.006 cm, respectively in blackbuck (Choudhary & Singh, 2015a), 8.84±0.085 cm, 5.88±0.055 cm and 8.29±0.079 cm, respectively in dromedary camel (Choudhary *et al*., 2016) and 7.44±0.069 cm, 7.04±0.05 cm and 7.13±0.082 cm, respectively in Indian wild pig (Choudhary *et al*., 2017). Equivalent figures for West African dwarfs goats of Nigeria were 1.57±0.44 cm, 2.58±0.34 cm, respectively, for the caudal margin of mandible to below mandibular foramen and the mandibular foramen to the base of the mandible (Olopade & 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*.). 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 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.

CONCLUSIONS

The morphometric measurements of the skull and applied anatomy of the head region of the Zovawk provide an important baseline data for further research in the field of applied anatomy. Furthermore, these results are of clinical importance that will aid the regional anesthesia of the various nerves around the head, especially during the treatment of head injury, dental extraction and mandibular fractures in Zovawk pigs.

CHOUDHARY, O. P.; KALITA, P. C.; KONWAR, B.; DOLEY, P. J.; KALITA, G. & KALITA, A. Estudios morfológicos y anatómicos aplicados en la cabeza de cerdo local Mizo (Zovawk) de Mizoram. *Int. J. Morphol., 37(1)*:196-204, 2019.

RESUMEN: Zovawk es una raza de cerdo de Mizoram recientemente identificada, aprobada por el comité de registro de razas del Consejo Indio de Investigación Agrícola (ICAR), Nueva Delhi. Este estudio fue diseñado para proporcionar el número máximo de parámetros morfométricos del cráneo y cierta información valiosa sobre parámetros clínicamente importantes de Zovawk. El cráneo de Zovawk es dolicocefálico según el índice cefálico (53,56 ± 0,11). La distancia de foramina supraorbital, la distancia de foramina infraorbital, la longitud del cráneo, el ancho del cráneo, la longitud craneal y la longitud nasal del Zovawk fueron 3.49 ± 0.01 cm, 6.55 ± 0.01 cm, 28.26 ± 0.03 cm, 15.11 ± 0.26 cm, 13.17 ± 0.04 cm y 13.79 ± 0,02 cm, respectivamente. Se encontró que los márgenes orbitales estaban incompletos con una variación bilateral entre las órbitas de ambos lados. La distancia desde el proceso de la cavidad alveolar del diente canino al canal infraorbitario y desde este último a la raíz del cuarto diente alveolar premolar superior directamente ventral fue de 4.77 ± 0.04 cm y 1.20 ± 0.01 cm, respectivamente, en Zovawk. Los datos son de importancia clínica como guía para el seguimiento del nervio infra-orbital y necesarios para su desensibilización durante las manipulaciones en la piel del labio superior, fosa nasal y cara a nivel del foramen. La distancia entre el extremo lateral del alvéolo del tercer diente incisivo y el foramen mental fue de 3.57 ± 0.04 cm en Zovawk, que es un hito importante para lograr la ubicación del nervio mental para el bloqueo nervioso regional Zovawk. La longitud y la altura de la mandíbula fueron 25.02 ± 0.09 cm y 10.54 ± 0.07 cm, respectivamente, en Zovawk. Las mediciones morfométricas del cráneo y la anatomía aplicada de la región de la cabeza de Zovawk proporcionan datos de referencia importantes para futuras investigaciones en el campo de la anatomía aplicada.

PALABRAS CLAVE: Zovawk; Cabeza; Aplicado; Bloqueo nervioso; Consejo Indio de Investigación Agrícola.

REFERENCES

Choudhary, O. P. & Singh, I. Applied anatomy of the maxillofacial and mandibular regions of the Indian blackbuck (*Antilope cervicapra*). *J. Anim. Res., 5(3)*:497-500, 2015a.

Choudhary, O. P. & Singh, I. Morphological and radiographic studies on the skull of Indian blackbuck (*Antilope cervicapra*). *Int. J. Morphol., 34(2)*:775-83, 2016b.

Choudhary, O. P. & Singh, I. Morphological studies on cranial cavity, nasal cavity and dentition of Indian blackbuck (*Antilope cervicapra*). *J. Wildl. Res., 4(2)*:35-7, 2016a.

Choudhary, O. P. & Singh, I. Morphometrical studies on the skull of Indian blackbuck (*Antilope cervicapra*). *Int. J. Morphol., 33(3)*:868-76, 2015b.

Choudhary, O. P. & Singh, I. Orbitometry of Indian blackbuck (*Antilope cervicapra*). *Rumin. Sci., 4(2)*:149-51, 2015c.

Choudhary, O. P.; Kalita, P. C.; Kalita, A. & Doley, P. J. Applied anatomy of the maxillofacial and mandibular regions of the dromedary camel (*Camelus dromedarius*). *J. Camel Pract. Res., 23(1)*:127-31, 2016.

Choudhary, O. P.; Kalita, P. C.; Kalita, A. & Doley, P. J. Applied anatomy of the head region of the Indian wild pig (*Sus scrofa*) and its clinical value during regional anesthesia. *J. Anim. Res., 7(2)*:339-44, 2017.

Choudhary, O. P.; Singh, I.; Bharti, S. K.; Mohd, K. I.; Sathapathy, S. & Mrigesh, M. Gross and morphometrical studies on mandible of blackbuck (*Antilope cervicapra*). *Int. J. Morphol., 33(2)*:428-32, 2015.

Hall, L. W.; Clarke, K. W. & Trim, C. M. *Wright's Veterinary Anaesthesia and Analgesia.* 10th ed. London, ELBS and Baillierre Tindall, 2000.

Kalita, P. C.; Deka, A.; Kalita, A.; Doley, P. J. & Das, B. J. Morphology of the skull of pygmy hog (*Porcula salvanias). A Forensic Approach. IOSR J. Agric. Vet. Sci., 8(1)*:23-6, 2015.

Karimi, I.; Onar, V.; Pazvant, G.; Hadipour, M. & Mazaheri, Y. The cranial morphometric and morphologic characteristics of Mehraban sheep in Western Iran. *Glob. Vet., 6(2)*:111-7, 2011.

Kumawat, R.; Mathur, R.; Joshi, S. & Choudhary, O. P. Gross studies on cranial bones of chital (*Axis axis*). *Indian J. Vet. Anat., 26(1)*:54-5, 2014.

Livestock Census. *New Delhi, Directorate of Economics and Statistics, and Animal Husbandry Statistics Division*, Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture, 2007.

Mayengbam, P.; Tolenkhomba, T. C.; Ali, M. A.; Saikia, P.; Singh, N. S. & Hmar, L. Electrolyte (Na, K, Cl, Ca, Pi and Mg) profile of Zovawk pigs of Mizoram, India in different age groups. *Int. Multidiscip. Res. J., 2(2)*:49-51, 2012.

Monfared, A. L. Applied anatomy of the head regions of the one-humped camel (*Camelus dromedarius*) and its clinical implications during regional anesthesia. *Glob. Vet., 10(3)*:322-6, 2013b.

Monfared, A. L. Gross anatomical measurements of the head region of the Iranian native cattle (*Bos taurus*) and their clinical value for regional anesthesia. *Glob. Vet., 10(2)*:219-22, 2013a.

Olopade, J. O. & Onwuka, S. K. A preliminary investigation into some aspects of the craniofacial indices of the red Sokoto (Maradi) goat in Nigeria. *Folia Vet., 47(2)*:57-9, 2003.

Olopade, J. O. & Onwuka, S. K. Osteometric studies of the skull of red sokoto (Maradi) goats (*Capra hircus*): implications for regional anaesthesia of the head. *Int. J. Morphol., 25(2)*:407-10, 2007.

Olopade, J. O. & Onwuka, S. K. Some aspects of the clinical anatomy of the mandibular and maxillofacial regions of the West African dwarf goat in Nigeria. *Int. J. Morphol., 23(1)*:33-6, 2005.

Parés-Casanova, P. M.; Kataba, A.; Simukoko, H. & Mwaanga, E. Clinical anatomy of the head region of Gwembe valley dwarf goat in Zambia. *Int. J. Vet. Sci., 3(3)*:142-6, 2014.

Saber, A. S. & Gummow, B. Skull morphometry of the lion (*Panthera leo*), dog (*Canis lupus familiaris*) and cat (*Felis catus*). *J. Vet. Anat., 8(1)*:13-30, 2015.

Snedecor, G. W. & Cochran, W. G. *Statistical Methods.* 8th ed. Ames, Iowa State University Press, 1994.

Uddin, M. M.; Ahmed, S. S. U.; Islam, K. N. & Islam, M. M. Clinical anatomy of the head region of the black bengal goat in Bangladesh. *Int. J. Morphol., 27(4)*:1269-73, 2009.

Zhu, L.; Shi, X. D.; Wang, J. J. & Chen, J. G. A Morphometric Study on the Skull of Donkey (*Equus asinus*). *Int. J. Morphol., 32(4)*:1306-10, 2014.

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