The Bioscan 12(2): 811-814, 2017
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

GROSS MORPHOMETRICAL STUDIES ON CRANIAL BONES IN TIGER

YOGITA PANDEY[1]*, R. VAISH[1], A. PANDEY[2] AND DEVENDRA PODHADE[3]
[1]Department of Veterinary Anatomy and Histology,
College of Veterinary Science and Animal Husbandry, N.D.V.S.U., Jabalpur - 482 001 (M.P.)
[2]Department of AGB, College of Vety. Sci. and A. H., N.D.V.S.U., Jabalpur - 482 001 (M.P.)
[3]Wildlife Health and Management, School of Wildlife Forensic and Health, N.D.V.S.U., Jabalpur - 482 001 (M.P.)
e-mail: drdevendrapodhade@rediffmail.com

KEYWORDS
Cranial bones
Tiger
Gross morphology
Mophometrical study

Received on :
12.12.2016

Accepted on :
13.04.2017

***Corresponding author**

ABSTRACT
Tiger is protected species under Wildlife Protection Act 1972 and topmost species in food chain. But due to poaching such majestic animal, it comes under Schedule-I category. The literature regarding cranial bones of tiger is scanty which major is lacuna for identification of species. Therefore, gross anatomical study was conducted on skulls of 5 adult tigers of either sex, on following cranial bones as; Parietal, Frontal, Temporal, Interparietal, Occipital, Ethmoid, Sphenoid and various parameters were recorded with the help of vernier caliper/ thread/ scale in centimeter. The gross morphological and morphometrical parameters were established and information obtained by the study will be of academic importance. The nuchal crest was prominent and angular and was directed caudally. The interparietal bone was not distinguishable externally. The parietal bone was rhomboid in outline, and strongly curved. The external surface of the frontal bone was crossed by a curved temporal line which extended in a curve from the external sagittal crest to the zygomatic process separating the squama from the temporal surface. The external acoustic meatus was wide and very short. The sphenoid bone formed the rostral two third of the base of the neurocranial between the basioccipital caudally and the ethmoidrostrally.

INTRODUCTION

Tiger is the national animal and pride for our country. Tiger is poached for many products like fat, which is valued as an aphrodisiac and as a remedy for rheumatism. The clavicles or 'lucky bones' which are rudimentary collar bones found loose in the muscles of lower neck near the shoulder joint, and claws are prized as charm and ornaments. Bones of tiger are used for the preparation of Traditional Chinese Medicine which sold clandestinely in Western and European country (Menon and Kumar, 1999). Unfortunately, these species are at the verge of extinction (Podhade, 2014). Morphological and anatomical differences in hairs of some wild mammals have been recorded by Kait, *et al*. (2008). But, literature of identification of species on the basis of cranial bones of tiger skull is meager. Therefore, present study was carried with the objective to limelight comprehensive data on the cranial bones of tiger.

MATERIALS AND METHODS

Present study was conducted on skulls of 5 adult tigers of either sex procured two skeletons from Department of Veterinary Anatomy and Histology, two from Department of Wildlife Health and Management, College of Veterinary Science and Animal Husbandry. N.D.V.S.U., Jabalpur (M.P.) and one from museum of Van-Vihar National Park, Bhopal (Madhya Pradesh). The work was carried out in the Department of Veterinary Anatomy and Histology, College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Jabalpur (M.P.). Gross morphology and morphometric study was done on cranial bones of tiger skull and various parameters were recorded with the help of vernier caliper, thread, and scale in centimeter. These were adapted Brehm *et al*. (1985); Onar *et al*. (2001); Endo *et al*.(2002); Al Sagair and EI Mougy (2002); Olopade and Onwuka (2008, 2009) and Yahaya *et al*.(2012). The data collected were analyzed for mean and standard error as per the standard procedure of Panse and Sukhatme (1967) and Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Occipital

The nuchal crest was prominent and angular and was directed caudally. The average length and width of bone was 11.17 ± 0.23 cm and 4.97 ± 1.50 cm respectively (Table 1). Just ventral to the crest, there were two rough imprints for muscular attachment. The surface ventral to the muscular imprints was convex from side to side and concave dorsoventrally. On each side at the junction with the squamous part of the temporal bone was the small mastoid foramen, it opened into the cranial cavity. The condyles were convex and widely separated dorsally. At the medial side of each condyle was a short condyloid canal which opened into a temporal meatus. The jugular processes were small (Plate 2). The basilar part was wide and joined the tympanic bulla on either side, its ventral surface was flattened and the basilar

Table 1: Range, mean and S.E. of different foramina of skull

Name of foramen	Long diameter (cm) Range	Mean ± SE	Short diameter(cm) Range	Mean ± SE
Foramen magnum	2.80 - 2.90	2.83 ± 03	2.30 - 2.50	2.43 ± 0.07
Foramen ovale	0.80 – 0.90	0.83 ± 0.03	0.60 - 0.60	0.60 ± 0.00
Foramen alar	0.60 - 0.60	0.77 ± 0.03	0.60 - 0.61	0.60 ± 00
Foramen orbitorotendum	1.40 - 1.50	1.43 ± 0.03	0.90 - 0.90	0.93 ± 0.03
Optic foramen	0.70 – 0.80	0.77 ± 0.03	0.50 - 0.60	0.53 ± 0.03
Sphenopalatine foramen	1.00 -1.00	1.00 ± 00	0.60 - 0.70	0.60 ± 0.06
Jugular foramen	1.40 - 1.60	1.50 ± 0.06	0.70 - 0.80	0.77 ± 0.03
Infraorbital foramen	1.70 - 1.90	1.83 ± 0.07	1.00 - 1.20	1.07 ± 0.07
Foramen lacerum	0.90 - 0.90	0.93 ± 0.03	0.40 - 0.40	0.40 ± 00
Length and width of some bones of skull				
Zygomatic malar: length(cm)	5.60 - 6.60		6.13 ± 0.25	
Zygomatic malar: width(cm)	2.10 - 2.70		2.43 ± 0.08	
Temporal: length(cm)	6.20 - 7.10		7.03 ± 0.46	
Temporal: width(cm)	5.30 - 6.00		5.70 ± 0.21	
Tympanic bulla: length(cm)	4.10 - 4.50		4.27 ± 0.12	
Tympanic bulla: width(cm)	2.80 - 3.00		2.90 ± 0.06	
Zygomatic arch: length(cm)	9.50 - 11.00		10.23 ± 0.43	
Zygomatic arch: width(cm)	3.20 - 3.70		3.43 ± 0.15	
Frontal: length(cm)	10.20 - 12.50		11.27 ± 0.67	
Frontal: width(cm)	7.50 - 8.60		8.17 ± 0.23	
Mastoid process length (cm)	1.90 - 2.00		2.00 ± 0.07	
Mastoid process width (cm)	1.20 -1.30		1.23 ± 0.03	
Parietal: length(cm)	8.60 - 9.80		9.17 ± 0.35	
Parietal: width(cm)	5.10 - 5.90		5.43 ± 0.24	
Interparietal: length(cm)	5.80 - 6.10		5.93 ± 0.09	
Interparietal: width(cm)	2.40 - 3.10		2.77 ± 0.20	
Occipital: length(cm)	10.80 - 11.60		11.17 ± 0.23	
Occipital: width(cm)	6.10 - 6.80		4.97 ± 1.50	

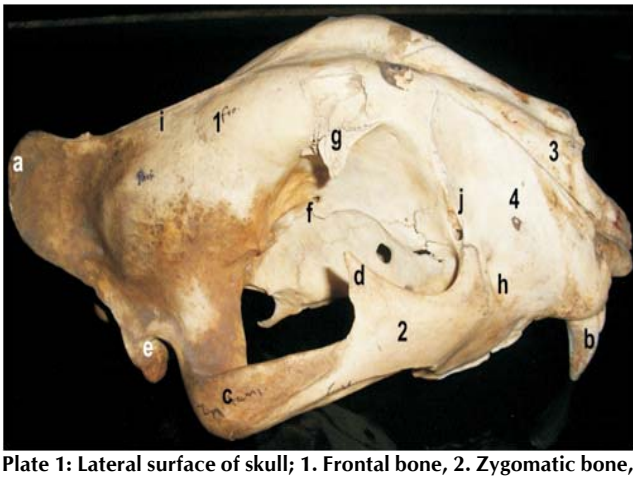

Plate 1: Lateral surface of skull; 1. Frontal bone, 2. Zygomatic bone, 3. Nasal bone, 4.Maxilla, a. Nuchal crest, b. Canine tooth, c. Zygomatic process of temporal bone, d. Frontal process of zygomatic bone, e. Mastoid process, f. Ethmoidal foramen, g. Zygomatic process of frontal bone, h. Infraorbital foramen, i. External sagittal crest, j. Opening of lacrimal canal.

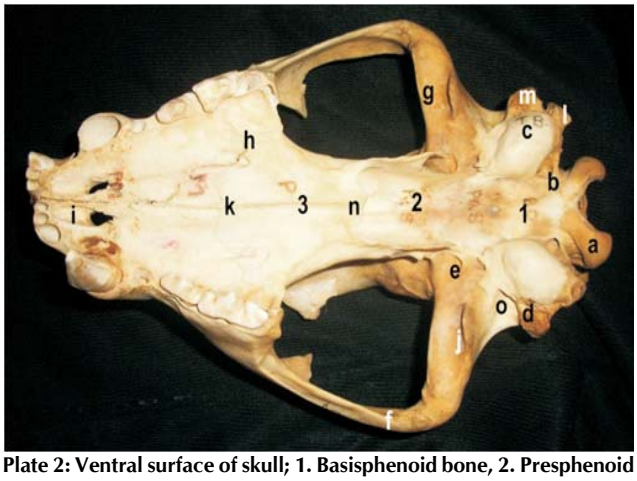

Plate 2: Ventral surface of skull; 1. Basisphenoid bone, 2. Presphenoid bone, 3. Palatine bone, a. Occipital condyle, b. Jugular foramen, c. Tympanic bulla, d. Stylomastoid foramen, e. Oval foramen, f. Zygomatic arch, g. Mandibular condyle, h. Major palatine foramen, i. Palatine fissure j. Retroglenoid process, k. Palatine sulcus, l. Jugular process, m. Mastoid process, n. Posterior nasal spine of palatine, o. External acoustic meatus

tubercles were not traceable. The hypoglossal foramen was small and placed close to the jugular foramen in the ventral condyloid fossa. The jugular foramen bounded rostrally with the tympanic bulla caudally and medially by the occipital bone (Plate 2). The squamous part fuses with the interparietal. The median occipital crest extending from nuchal crest was thick, more prominent in its proximal part, gradually becomes thin and fades out in distal part; a sharp tubercle was present on posterior surface of midline of the two squamous parts of occipital bones.

Interparietal

The interparietal bone was not distinguishable externally

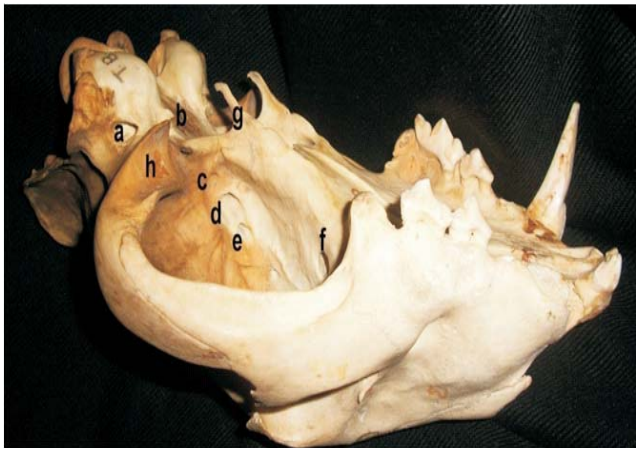

Plate 3: Lateral view of skull; a. External acoustic meatus, b. Oval foramen, c. Alar foramen, d. Foramen orbitorotundum, e. Optic foramen , f. Sphenopalatine foramen, g. Hamulus of pterigoid bone, h. Mandibular condyle

because it was completely fused with the supraoccipital and parietal bones, it formed the high caudal part of external sagittal crest and wedged between the two parietal bones.

Parietal

The parietal bone was rhomboid in outline, and strongly curved. It was extensive (9.17 ± 0.35 cm in length and 5.43 ± 0.24 cm in width) and formed the dorso-lateral part of the cranial cavity (Table 1). In between the right and left parietal bones, there was a prominent external sagittal crest which was continued upon the frontal bone (Plate 1). It formed coronal suture with frontal bone. The ventral border articulated with the wing of basisphenoid by its rostral part and with the squamous part of the temporal bone behind. The external surface formed the part of temporal fossa.

Frontal

The length and width of frontal bone was 11.27 ± 0.67 cm and 8.17 ± 0.23 cm respectively (Table 1). The external surface of the frontal bone was crossed by a curved temporal line which extended in a curve from the external sagittal crest to the zygomatic process separating the squama from the temporal surface. The frontal squama of both side together formed a central depression and slope ventrad and rostrad. Supraorbital process was very short so that the supraorbital margin was incomplete (Plate1). The supraorbital groove and supraorbital foramen were not seen. At the sphenofrontal junction, ethmoidal foramen was present (Plate1). The frontal sinuses were confined to the frontal bone. The frontal bone articulated with the maxilla, parietal, basisphenoid, lacrimal, palatine and ethmoid bones. Similar report has been made by Pandit (1994) in tiger and Kumar (2008) in leopard.

Temporal

The temporal bone measured 7.03 ± 0.46 cm in length and 5.70 ± 0.21 cm in widthZygomatic process curved widely laterad and rostrad. Its rostral part was beveled ventrally and articulated extensively with the temporal process of the zygomatic bone (Plate 1). The articular surface for the condyle of the mandible was consisted of transverse groove which was continued upon the rostral part of the large retroglenoid process (Plate 2). The mastoid process (2.00 ± 0.07cm in length and 1.23 ± 0.03 cm in width) was distinct (Table 1).The external acoustic meatus was wide and very short (Plate 2). The tympanic bulla was very large, smooth and oval in shape. Its medial side was concealed with the basilar part of the occipital bone. A retroglenoid process and tympanic bulla were wide apart. Externally retroglenoid foramen was not visible. Similar findings have been mentioned by Kumar (2008) in leopard and Pandit (1994) in tiger, whereas retroglenoid foramen was situated posterior to the retroglenoid process in dog (Evans and Christensen, 1964).

Dorsal to the junction and roofed by the union of the petrous part of the temporal and basal part of the occipital bone was the petrooccipital canal. Jugular foramen opens into a narrow depression, caudal to the tympanic bulla. The carotid canal branches off from the petrooccipital canal passes rostrad, lateral to it and through the rostral part of the tympanic bulla and opened rostrally at the carotid foramen. The auditory opening was lateral to the carotid foramen. The muscular process was extremely rudimentary while fused with basisphenoid bone and was present in the form of ridge present on the body of the sphenoid bone.

Sphenoid

The sphenoid bone formed the rostral two third of the base of the neurocranial between the basioccipital caudally and the ethmoid rostrally. There were two divisions of sphenoid bone, the rostral presphenoid and the caudal basisphenoid. A small ethmoidal foramen was observed in tiger at the junction of frontal and sphenoid bone. The present finding was in support with the finding of Kumar (2008) in leopard and Pandit (1994) in tiger. In case of dog, two ethmoidal foramina have been reported, one at frontosphenoidal junction and another in frontal bone (Evans and Christensen, 1964).

Basisphenoid

The basisphenoid bone was composed of a body, a pair of wings and pterygoid processes and articulated with temporal, parietal, frontal, occipital and presphenoid bone. The temporal wings were extensive and articulated dorsally with the parietal. Perforating the root of the temporal wings, the following foramina named from before backward (Plate 3).The optic foramen (large diameter: 1.27 ± 0.03 cm) passed through the orbital wing. Foramen orbitorotundum was a large foramen placed behind optic foramen. Foramen alar was present above and behind to the foramen orbitorotundum, it perforated the temporal wing in its anterior third. Oval foramen was present behind and medial to the temporomandibular articulation. Similar report has been made by Pandit (1994) in tiger and Kumar (2008) in leopard. In case of dog, foramen rotundum is a separate foramen situated inside the alar canal (Evans and Christensen, 1964).

Presphenoid

The presphenoid bone consisted of a body and a pair of orbital wings. It articulated with the basisphenoid, frontal, ethmoid and vomer bone. Caudally it completed the rostral part of the floor of the middle cranial cavity where it marked by a shallow chiasmaticsulcus. The orbital wings were smaller than the temporal wing of the basisphenoid. At the

frontosphenoidal suture, there was a small ethmoidal foramen which led into the ethmoidal fossa (Plate 1).

Ethmoid

The cribiform plate was extensive and the ethmoidal (olfactory) fossae were very deep. The ethmoidal foramen measured 0.40 ± 0.00 cm in large diameter (Table 1).

Plate No. 3: Lateral view of skull

a. External acoustic meatus, b. Oval foramen, c. Alar foramen, d. Foramen orbitorotundum, e. Optic foramen , f. Sphenopalatine foramen, g. Hamulus of pterigoid bone, h. Mandibular condyle

ACKNOWLEDGEMENT

Authors are thankful to Vice-Chancellor, Nanaji Deshmukh Veterinary Science University, Jabalpur and Dean, college of Veterinary Science and Animal Husbandry, N.D.V.S.U., Jabalpur for providing the necessary facilities to carry out the research work.

REFERENCES

Al-Sagair, O. and El Mougy, S. A. 2002. Post- natal development in the linear and tricmorphometrics of the camelidae skull. *Anatomia Histologia Embryologia* 09/2002; **31(4):** 232-6. DOI : 10.1046/j.1439-0264.2002.00401.x.Accessed on 24.09.2016.

Endo, H., Hayashi, Y., Yamazaki, K. Motokawa, M., Pei, J., Lin, L., Chou, C. and Oshida, T. 2002. Geographical variation of the mandible size and shape in the wild pig (Sus Scrofa). *Taiwan and Japan Zoological Studies*. **41:** 452-460.

Evans, H. E. and Christensen, G. C. 1964. Anatomy of the Dog. W.B. Saunders Co., Philadelphia. p. 941.

Jouve, S. F. and Courant, D. M. 2001. Disparity of skull morphology in dogs: Geometrical morphology approach. *J. Morphology*. **248:** 246.

Kait, R., Kumar, S. and Sahi, D. N. 2008. Morphological and anatomical differences in hairs of some wild mammals of district Jammu (J&K). *The Bioscan*. **3(1):** 83-87.

Kumar, R. 2008. Studies on characteristic features of axial skeleton of leopard as an aid in wildlife forensic. M.V.Sc. Thesis, JNKVV, Jabalpur. p. 59.

Malik, M. R., Shrivastava, A. M. and Panwar, B. S. 1988. Biometry of tiger's skull. *J. of the Remount and Veterinary Corps*. Sept. **22(3):**159-162.

Olapde, J. O. and Onwuka, S. K. 2009. Morphometric analysis of the skull of the Sahel goat breed: basic and clinical anatomy. *Italian J. Anatomy and Embryology*. **14:** 167-178.

Olapde, J. O. and Onwuka, S. K. 2008. Acraniofacial analysis of the skull Red Sokoto (Maradi) goat (Capra hirus) *European J. Anatomy*. **12:** 57-62.

Onar , V.1999. A morphometric study on the skull of the German shepherd dog (Alsatian). *Anatomia Histologia Embryologia*. **28:** 253-256.

Pandit, R. V. 1994. Osteology of Indian tiger (*Panthera tigris)*. Tech. Bull. No. VI, Conservator of Forest and Director, Project Tiger, Melghat, Amravati. pp. 1-27.

Panse, V. G. and Sukhatme, P. V. 1967. Statistical Methods for Agricultural Workers, 2nd edn. I. C. A. R., New Delhi, pp. 152-157.

Podhade, D. N., Shrivastav, A. B. and Vaish, R. 2014. Osteomorphological and morphometric studies on humerus of leopard. *Veterinary Practitioner* Vol. 15 No**. 2:** 282-283.

Sisson, R. 1975. Sisson and Grossman's the Anatomy of the Domestic Animals-II.5thedn. Publ., The Mac millan Co. of India Ltd. pp.1427-1503.

Snedecor, G. W. and Cochran, W. G. 1994. Statistical Methods. 6thedn. Oxford and IBH Publishing Co., Bombay. p. 593.

Yahaya, A., Olapade, J. O., Kwari, H. D. and Wiam, I. M. 2012. Osteometry of the skull of one humped camels, Part I: immature animals. *Italian J. Anatomy and Embryology*. **117(1):** 23-33.

Menon, K. and Kumar, A. 1999. Wildlife Crime. *An Enforcement Guide, Wildlife Protection Society of* India. p. 61.