GROSS OBSERVATIONS ON THE CERVICAL VERTEBRAE OF LEOPARD *(Panthera pardus)*

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Abstract

A study was conducted on the cervical vertebrae of two leopards. There were seven cervical vertebrae and among them the first two were atypical and differed greatly from all others. The third, fourth and fifth vertebrae had only minor differences. The sixth and seventh vertebrae presented distinct features to make their identification possible. There were some major structural variations observed from that of other small carnivores. In the atlas, transverse foramen was seen on its caudal border. The posterior extremity of spinous process of axis presented a distinct pointed tubercle. The ventral crest was indistinct in the axis to sixth cervical vertebrae. The cranial ventral tubercle of the transverse process of the third to sixth cervical vertebrae were very broad and plate like. These features might be interpreted as adaptations for the thick and strong extensor muscles on the nape of the neck for the predatory behavior seen in leopard.

Keywords: *Cervical vertebrae, leopard, osteology*

The cervical vertebrae give flexibility to the neck and are built to enhance the speed of running rather than to support the body weight. Several adaptations are seen in the skeleton and muscles of the neck region in *Felidae, Hyaenidae* and *Canidae* to provide necessary force for downward stabbing, tearing and swift walking by carrying large prey (Spoor and Badoux, 1986). Among the seven cervical vertebrae present, the first two are atypical and highly specialized for the movement of head on the neck (Anderson and Anderson, 1994). The remaining five are typical vertebrae. Review of literature revealed scanty information on the cervical vertebrae of leopard. Hence the present study was undertaken.

Materials and Methods

Cervical vertebrae were collected from two adult leopards that died of natural causes and were brought to the Department of Pathology for postmortem examination. Osteological studies were conducted on the bones processed by the method of Young (1980).

Results and Discussion

The atlas formed a bony ring comprising two large lateral masses which were joined by dorsal and a ventral arches. The former was wider than the latter as reported in dogs by Miller (1965). The dorsal arch presented a distinct bifid dorsal tubercle medially on its cranial border. The ventral arch presented a small ventral tubercle in the caudal border (Fig.1). Contrary to this, in canines both dorsal tubercle and conical ventral tubercle were present in the caudal border (Miller,1965). The shelf-like transverse processes or the wings extended laterally on both sides from the point where the two arches met each other. The fossae atlantis were depressions ventral to the wings for the passage of vertebral artery and vein. The root of each wing was pierced by a canal like transverse foramen on its caudal border that lead into the atlantal fossa. However, in dogs the transverse foramen perforated the dorsal surface of the base of

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Fig.1. Atlas of leopard- caudal view
1.Dorsal tubercle in dorsal arch, 2.Ventral tubercle in ventral arch 3.Fovea dentis, 4.Transverse process, 5.Transverse foramen 6.Caudal articular surface

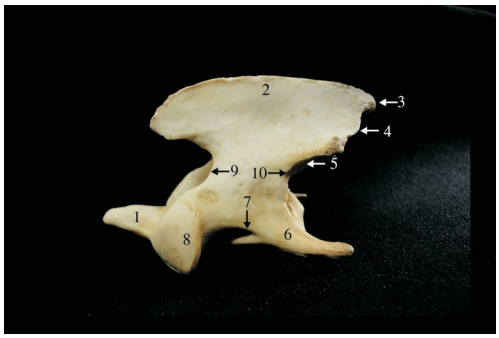

Fig. 2. Axis of leopard- left view
1.Odontoid process, 2.Dorsal spinous process
3.Tubercle on caudal extremity of spinous process
4. Lateral ridges 5. Caudal articular process
6. Transverse process 7.Transverse foramen
8. Cranial articular surface 9.Cranial vertebral notch
10. Caudal vertebral notch

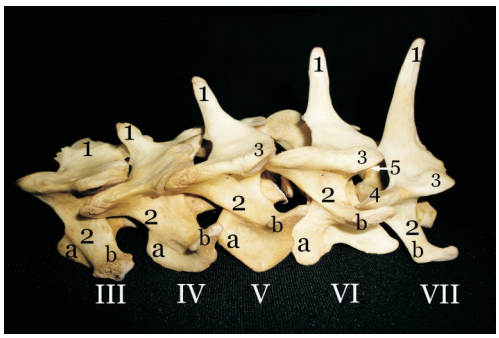

Fig.3. Third to seventh cervical vertebrae of leopard- left view
III, IV, V, VI VII – Third to seventh cervical vertebrae
1.Dorsal spinous process
2.Transverse process
a.cranial ventral tubercle
b.caudal dorsal tubercle
3.Tubercles on caudal articular surface
4.Cranial articular process
5.Caudal articular process

wing at the junction of the wing with the lateral masses (Smith, 1999). This might be due to the different relative positions of the traversing vertebral artery, vein and nerves between these two species. At the origin of transverse process on its cranial and caudal aspects cranial /alar and caudal notches were present. Medial to the alar notch there was a groove leading to the lateral vertebral foramen. The foramen was present on the craniodorsal part of the dorsal arch. The cranial articular surface consisted of two cotyloid cavities that articulated with the occipital condyles of skull to permit free extension and flexion of the head. The caudal articular surface consisted of two shallow glenoid cavities which formed a freely movable articulation with the second cervical vertebra. The caudal part of the dorsal surface of ventral arch presented the concave fovea dentis. Similar observations were made by Nickel *et al.* (1986) and Smith (1999) in carnivores.

The body of axis was dorsoventrally flattened, laterally compressed and extremely long characterized by the presence of odontoid process that reached almost to the occipital bone as reported in dogs (Nickel *et al.,* 1986; Dyce *et al.,* 1996) (Fig.2). The odontoid process was 'dens- like' as in tiger (Gaikwad *et al.,* 2010). The ventral crest on the body was indistinct cranially whereas, it was distinct caudally. Contrary to this, Nickel *et al.* (1986) reported that in dogs the ventral crest was prominent both cranially and caudally and divided the ventral surface of the body of axis into two fossae. The dorsal spinous process was ridge like and thin cranially and thick caudally. Its anterior and posterior extremities extended towards the atlas and third cervical vertebrae, respectively. The posterior extremity of spinous process presented a distinct pointed tubercle and had lateral ridges running downward to meet the caudal articular process. Below the caudal extremity of the spinous process a deep irregular fossa was noticed. Similar observations were made by Arora (2009) in tiger. However, in dogs the tubercle and deep fossa in the posterior extremity was indistinct (Miller,1965). The transverse processes were narrow and blade-like with only a caudal process and projected caudolaterally from the body. The root of the transverse process was perforated by a relatively large transverse foramen. Lateral to the dens, the body presented two distinct and triangular convex cranial articular surfaces. The caudal articular process was fused to the

ventral surface of the spinous process. The cranial and caudal vertebral notches concurred on either side with those of the atlas and third cervical vertebra respectively to form the large intervertebral foramina, as in canines (Miller,1965; Nickel *et al.,* 1986).

The length of the body of vertebrae decreased progressively from third to seventh (Fig.3.). Their cranial extremities were moderately convex and caudal were slightly concave. The seventh vertebra had costal facets on the caudal extremity. These observations were in accordance with that of Nickel *et al*. (1986) in carnivores. The ventral crest was indistinct in third, fourth, fifth and sixth cervical vertebrae unlike in dogs where in it was distinct and became more pronounced caudally (Smith, 1999). On the dorsal surface of the bodies of third to seventh cervical vertebrae spinous processes were flattened from side to side, inclined cranially and increased in length from before backwards. The dorsal spinous process of third vertebra was ridge like with a small cranial tubercle but in the seventh vertebra it was almost in vertical direction with a rough blunt tip. These observations tally with the findings of Arora (2009) in tiger. The transverse processes of the third, fourth and fifth cervical vertebrae were divided into a cranial ventral tubercle and caudal dorsal tubercle that was three sided. The cranial ventral tubercle was broad and plate like bending slightly backwards and downwards and became distinct caudally. The transverse process of the fifth cervical vertebrae was shortest, however its ventral tubercle was broader. The unique transverse process of the sixth vertebra allowed it to be distinguished from the others. Its ventral tubercle was the broadest and formed a sagittal plate that had cranial and caudal parts separated by a notch. However, Nickel *et al.* (1986) observed that the ventral tubercle was a slim branch in the third, fourth and fifth vertebrae while in the sixth, the ventral lamina was a broad sagittal plate and the notch was absent in dogs. These differences might be attributed to the well developed scalenus muscles that are inserted on to the transverse process to depress the neck with unusual force for the predatory behavior seen in leopards. In the seventh cervical vertebra, the transverse process was single and only caudal tubercle was present in the form of a distinct transversely directed rod. These observations concur with the reports of Arora (2009) in Indian tiger. The transverse foramina of the third to sixth vertebrae were distinct and were absent in the seventh, as reported in dogs (Nickel *et al.,* 1986). The cranial and caudal vertebral notches were deep and formed wide intervertebral foramina that were overlapped laterally by the cranial articular processes. Dorsally the caudal articular processes presented tubercles for the multifidus muscle. The size of the tubercles decreased from third to seventh cervical segment. The interarcuate spaces were very narrow.

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