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Original Research Article

Morphological Investigations on Epistropheus in Ox and the Comparison of it with Resembling Bone in Horse, Dog, Sheep and Goat

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ABSTRACT

Background: The documentation of anatomical features of epistropheus, which is also called as axis (C2) in different animals is not abundantly available on record. The observance of this C2 bone in ox made and compared it with the similar bone in different species of animals as to Horse, Dog, Sheep and Goat. The axis of ox was positioning cranially with spout like odontoid process which called as the dens. It was projected from the body. Due to its tooth like process, it was also known as vertebra dentata. The blade like supraspinous cranial process had increasing height and thickness towards its caudal progression, however, its infraspinous process was observed as the median ridge. While knowing such differential anatomical characters of axis (C2) in different species of animals as to Horse, Dog, Sheep and Goat this study is undertaken for comparison with the axis of Ox.

Aims: Present endeavour aiming to have the comparative anatomical studies of the epistropheus i.e. axis (C2) bone of Ox and its comparison with the similar bone of Horse, Dog, Sheep and Goat.

Materials and Methods: Six dried samples of second cervical of Ox (*Bos indicus*) were collected and explored its anatomical features. The comparative anatomical studies of the similar bone were performed in different species including horse (*Equus ferus*), dog (*Canidae canis*), sheep (*Ovis aries*) and goat (*Capra hircus*).

Results: In horses, epistropheus i.e. axis the axis had longer body than the ox. The dens was conical and narrow. The axis of dog had cylindrical longer dens. Large and heightened spine as the pendant was observed, which was terminating caudally by the tuberosity of two crests. The axis of sheep had small, blunt and convex dorsal spinous process without remarkable ventral spine. The axis of goat had thin and heighted dorsal spinous process that overlaps the adjacent cranial and caudal cervical vertebrae.

Conclusion: The findings of present studies are not only bringing the expositions of axis, the important bone of cervical region in different animals but also this is sufficiently bringing the fullest use for radiographic anatomy.

KEY WORDS: Anatomy, Axis, Epistropheus, Ox, Horse, Dog, Sheep, Goat.

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INTRODUCTION

Epistropheus or Axis (C2) or epistropheus is the second cervical vertebra which identifies as the longest and heaviest among all cervical vertebrae [1]. On the anterior aspect of this vertebra, a tooth-like process is observed, reasoning this vertebra is also known as the vertebra dentata [2]. Moreover, this vertebra is also named as epistropheus, owing the formation of uniaxial pivot kind of joint with atlas (C1). This atlanto-axial joint facilitates rotary movement of head that hold by the atlas [3] and [4]. The atlanto-axial (aa) are the paired articulations between the inferior articulating processes of the atlas and the superior articulating processes of the axis. These joints are primarily

responsible for the 0 to 45 degrees of lateral rotation in each direction of the cervical spine [5] and [6]. The exceptional structural module of atlas and axis vertebrae makes the head rotate in maximum. Both these vertebrae are neurologically important as the brain stem extends down to the axis.

The axis is atypical vertebra comparable to that of first cervical vertebra as it lacks a typical body or a large flat portion, that bony structure which observed equally in other vertebrae. The cranio-ventral aspect of an axis has a bony peg like projection which named as the dens. It rests in a fovea located in the ventral portion of the vertebral foramen of the atlas, where it bound together by the apical ligament, alar ligaments and the transverse ligament of the atlas [7]. Present attempt is the exploration of thorough studies of six each axis bone in ox (*Bos indicus*) and its comparison with the same bone from other four different species as to horse (*Equus ferus*), dog (*Canidae canis*), sheep (*Ovis aries*) and goat (*Capra hircus*).

MATERIALS AND METHODS

The cadavers of different animal species were processed after proper maceration, cleaning, drying and disinfection with the help of hot air oven. Six each dried samples of second cervical vertebrae viz. axis from every mentioned species were chosen for present anatomical studies. These different species of animals were including ox (*Bos indicus*), horse (*Equus ferus*), dog (*Canidae canis*), sheep (*Ovis aries*) and goat (*Capra hircus*). The anatomical studies of axis in ox were explored in comparison with the similar bone of other species. This study was the part of revolving fund project for articulation of bones to have the skeletons of different animals and thereby supplies the same to other educational institutions as the study material.

RESULTS

The differential studies on axis is undertaken in different species of animals, hence species wise characterization is mentioned separately.

Axis of Ox: Axis (C2) of ox was identified as the longest and heaviest among all of the cervical vertebrae.It had spout like appearance named after odontoid process that was cranially projected from the body of axis (Fig. 1). It was identical to the fovea dentis of atlas. Its cylindrical body (corpus vertebrae) carries a well developed ventral crest (crista ventralis). The cranial extremity of the body was characterised by a centrally located dens, which might be regarded as the displaced body of the atlas based on its development (Fig. 2). The axis of Ox is also called vertebra dentata due to its tooth like process which named after dens. The dorsal surface of dens was deeply concave due to their either side elevation of lateral mass, which had rough surface for the attachment of ligaments that hold it in place. The ventral articular surface of the dens (facies articularis ventralis dentis) was confluented with the cranial articular surface (facies articularis cranialis) (Fig. 3). The cranial extremity of the body and the ventral surface of the dens were harmonized in forming the single, wide articular surface for the atlas (Fig. 4). The caudal articular surface was smooth, concave and facing towards the intervertebral disc (Fig. 5).

The lateral vertebral foramen was circular and discovered very much closer to the cranial border of the arch. The circular intervertebral foramen was positioned at the base of the transverse process. The transverse processes which were less pointed and smaller had a perforation toward their root by a transverse foramen in accommodating the vertebral artery, vein and nerve (Fig. 1).

The blade resembling dorsal supraspinous process showed its increase in height and thickness towards caudal progression and terminated abruptly at the level of caudal articular surface that was looking as the tubercle (Fig. 5 and 6). The infraspinous process was observed in the form of a median ridge (Fig. 4).

Axis of Horse: The body was longer in comparison with that of ox. The conical shaped dens was long, narrower and pointed. The cranial extremity had an undulated saddle shaped articular area. The archial border of dens had an either side foramen at its base that was known as the lateral foramen. The groove that extended ventrally and caudally

from the lateral foramen was sufficiently showed the position of ventral branch of second cervical spinal nerve. The revealed illustrations on caudal border has the usual notches [2]. The spine was more massive and dividing posteriorly into two ridges, which terminate on the posterior articular processes. The ventral articular surface of the dens (facies articularis ventralis dentis) was confluented with the cranial articular surfaces (facies articularis cranialis) as in the ox. The caudal extremity has also observed with usual shallow depression cavity. The ventral crest had a resemblance with that of typical vertebra as described by *Getty et al* [2]. The ventral articular surface of the dens (facies articularis ventralis dentis) was also confluented with the cranial articular surface (facies articularis cranialis) similar to that of ox. The spine was continuous with caudal articulating surface (Fig. 7). The oval shaped intervertebral foramen was observed with thinner transverse process.

Axis of Dog: The cranial extremity of the axis was identified in the name of dens that was cylindrically rounded rod shaped longer structure. It had inclined little above in a way to be positioned almost upto the occipital bone. The margin of dens had a condyloid oblique area for cranial articulation. A largely heighted and notable sized spine was evident which was analogous to the dorsal arch of atlas which was identical to the pendant. It was projected cranially above the dens. The spine was terminated caudally by the tuberosity, which had a connection of two crests with the posterior articular processes. The anterior notches were large. The caudal articulating surface was smooth and concave that was facing intervertebral disc. The transverse processes were pointed, directing backward & outward and had perforation by relatively large transverse foramen (Fig. 8). The present revelations were very much similar as mentioned by Konig and Liebich [4].

Axis of Sheep: The small spinous process of the axis was blunt and convex. The ventral spine was insignificant. The free end of transverse process was pointed to some extent. The dorsal spine was also comparative with the similar structure in ox but it was not finishing as the tubercle. The thickness of cranial and middle part of dorsal spine was almost same like ox, where the middle part of dorsal spine was thinner than cranial one. At ventral aspect, the posterior boarder of axis was roughly triangular in ox but no such structure was present in sheep and goat. In sheep, the caudal part of dorsal spine and the caudal articular process was very close to each other while in goat and ox they were far apart. Tubercle at posterio- ventral surface was rough and wider. The ventral surface of cranial articular ring had a deep notch. Transverse processes were smaller (Fig. 9).

Axis of Goat: The dorsal spinous process was thin and heightened rather than the sheep. It was observed over lapping the adjacent cranial and caudal cervical vertebrae. The large inter vertebral foramen was there but the transverse foramen was not observed. Tubercle at posterio-ventral surface was smooth and narrower. The ventral surface of cranial articular ring had a shallow notch. Transverse processes were long and reaching next cervical bone (Fig. 10).

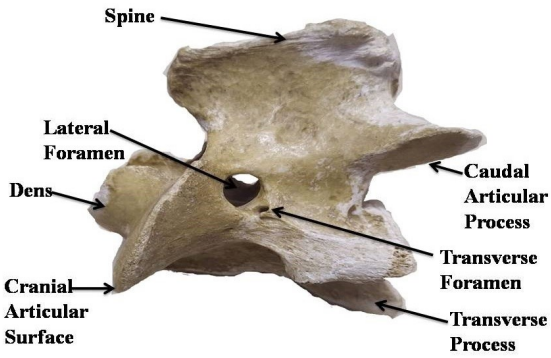

Fig. 1: Lateral view of axis bone of Ox.

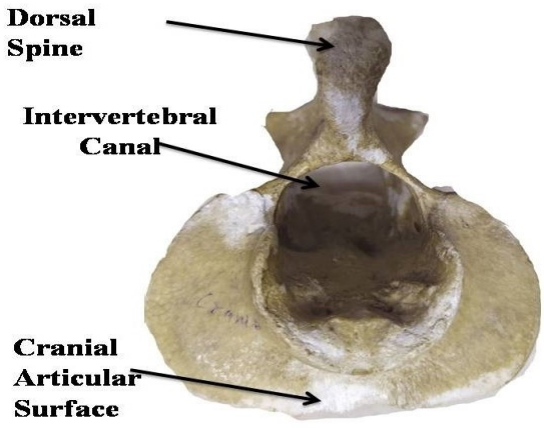

Fig. 2: Cranial view of axis bone of Ox.

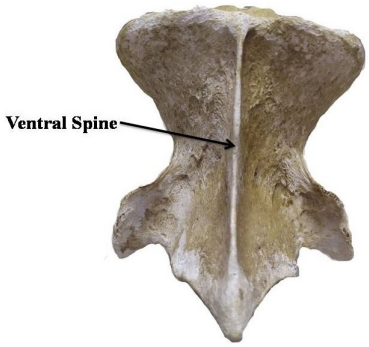

Fig. 3: Ventral view of axis bone of Ox.

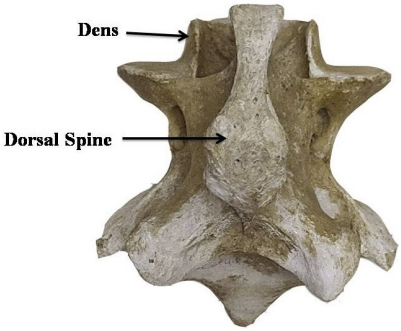

Fig. 4: Dorsal view of axis bone of Ox.

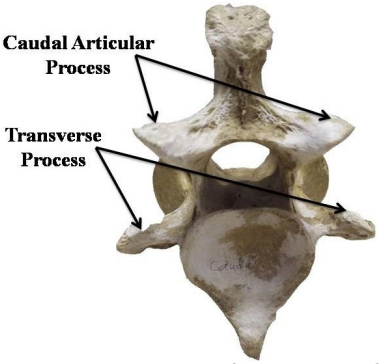

Fig. 5: Caudal view of axis bone of Ox.

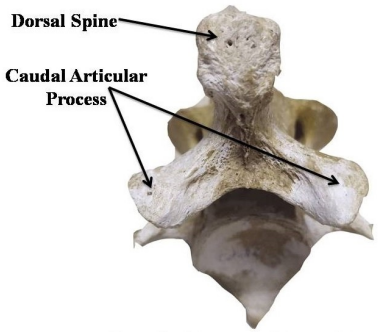

Fig. 6: Caudo-Dorsal view of axis bone of Ox.

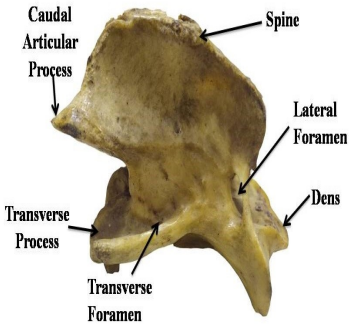

Fig. 7: Lateral view of axis bone of Horse.

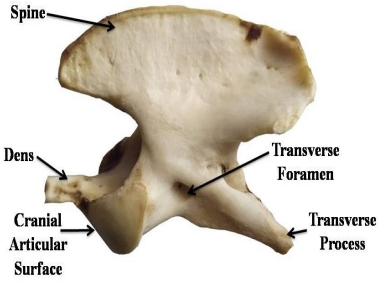

Fig. 8: Lateral view of axis bone of Dog.

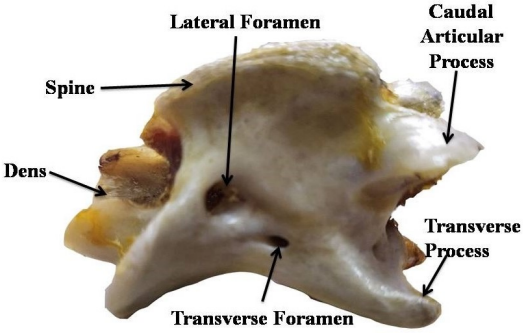

Fig. 9: Lateral view of axis bone of Sheep.

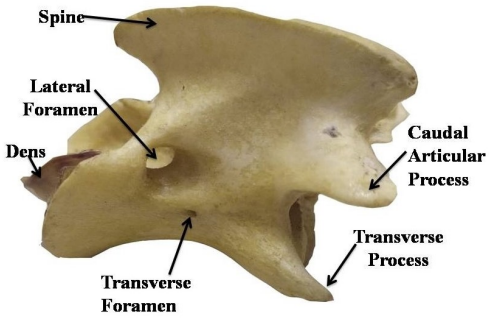

Fig. 10: Lateral view of axis bone of Goat.

DISCUSSION

The observations which were recorded for the axis of Ox were very much corroborating as per the mentioning cited by Ghosh [8]. Pertaining to the axis of horse, its ventral crest had a resemblance with that of typical vertebra [2] and also the oval shaped intervertebral foramen was observed with thinner transverse process [4]. The axis of a dog has shown smooth and concave caudal articulating surface which was facing intervertebral disc. The transverse processes were pointed, directing backward & outward and had perforation by relatively large transverse foramen [4]. A largely heighted and notable sized spine was evident which was analogous to the dorsal arch of atlas which was identical to the pendant. It was projected cranially above the dens. These findings were similar to the mentioning of Battacharya et al. [9]. In the axis of sheep, transverse processes were smaller and at its ventral surface of cranial articular ring had a deep notch. But, the axis of Goat had long transverse processes which were reaching next cervical bone. The present observations were very much comparable with the revelations of the similar bone in larger ruminants [8].

Conflicts of Interests: **None**

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