

PRENATAL DEVELOPMENT OF OCCIPITAL BONE IN THE BUFFALO (*Bubalus bubalis*)M. Santhi Lakshmi<sup>1</sup> and T.S. Chandrasekhara Rao<sup>2</sup>

## ABSTRACT

The basioccipital, exoccipital and the lower part of the squamous occipital were formed from the basal plate. The endochondral part of the occipital bone was developed from four ossification centers. The squamous occipital was formed in both membrane and cartilage. The early ossification of the exoccipital and basioccipital was evident at 62 days. The consolidation of the different components of the occipital bone was observed at 126 days. Complete ossification of the squamous occipital, basioccipital and exoccipital was noticed at 132 days.

**Keywords:** occipital, prenatal development, buffalo

## INTRODUCTION

The prenatal development of the occipital has been studied in detail only in human and has received very little attention among farm animals. The literature pertaining to developmental features of the occipital particularly in buffalo is not available. Hence the present study was undertaken with aim to contribute to the existing anatomical knowledge and provide a basis for further investigations.

## MATERIALS AND METHODS

The study was made on 155 specimens of different embryonic and foetal stages starting from 26 days to 310 days. The prenatal specimens of unknown age and irrespective of the sex were collected from local slaughter houses. The CVRL (Curved Crown Rump Length) of specimens studied ranged from 2.1 cm (38 days) to 105 cm (310 days). The age of the specimens was calculated by adopting Soliman's (1975) formula for buffalo.

The embryos for serial microtomy were collected starting from the earliest possible age (26 days). The embryonic specimens were fixed in 10% buffered neutral formaline and Bouin's fluids and processed for serial paraffin sections of 6-8  $\mu$  thickness. The foetal heads of 70 days (9.2 cm CVRL) and above were subjected to decalcification by the formic acid - sodium citrate method after fixation and the sections were subjected to Mayer's Haematoxylin and Eosin staining method for routine developmental study (Singh and Sulochana, 1997), the Von Kossa staining method for calcium deposits (Humason, 1967), the Alcian blue staining method to differentiate cartilaginous tissue from bony tissue (Humason, 1967) and the Bismarck brown - methyl green method to differentiate cartilaginous tissue from bony tissue (Gurr, 1956).

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The foetal heads beyond the age of 70 days were subjected to the Alizarin Red S method for studying the extent of bone formation (Humason, 1967) and the Alizarin Red S and Toluidine Blue method for differentiating cartilage and bone (Burdi, 1965) in embryos. The slides were viewed under a microscope to study the number of ossification centers and the type, time and extent of ossification pertaining to the occipital bone at different embryonic and foetal stages. The heads of the specimens beyond the age of 90 days (13.7 cm CVRL) were utilized to study gross morphological changes by taking various cross and longitudinal sectional profiles of skulls after dissection.

## RESULTS AND DISCUSSION

The basioccipital, exoccipital and the lower part of the squamous occipital were formed from the basal plate cartilage (Figure 1), while the basal plate was reported to form only the lateral and basilar parts of the occipital bone in domestic animals (Latshaw, 1987). The lower part of the squamous occipital and exoccipital were developed in occipital arches.

The endochondral part of the occipital showed four centers of ossification, a median center ventral to the foramen magnum that formed the basioccipital, a median center dorsal to the foramen magnum which formed the lower part of the squamous occipital and a pair of centers on either side of the foramen magnum formed the exoccipital (Figure 2) as described in man (Arey, 1965) and in domestic animals (Getty, 1975). The consolidation of the three components was observed at 126 days to form a single occipital bone. However, the fusion of the different components of the occipital did not take place even at 310 days. The demarcation

between the lower part of the squamous occipital and the exoccipital was persistent even at 310 days while the demarcation between the condyles of the exoccipital and basioccipital disappeared at 295 days.

The occipital bone was developed by endochondral ossification except for the upper part of the squamous occipital, which developed by intramembranous ossification. Early ossification of the basioccipital was evident at 62 days (Figure 3). The basioccipital showed an advanced state of ossification at 92 days (Figure 4). The basilar tubercles were evident at 254 days. According to Matthews (1972), the first ossification center in the bovine occipital was observed in the basioccipital by 53 days followed by the exoccipital cartilage at 56 days, whereas Soana *et al.* (1996) observed the ossification of the occipital bone at 97 days in bovines.

The exoccipital was cartilaginous at 46 days. The occipital condyles and paramastoid processes showed early ossification at 62 days (Figure 5) and 92 days, respectively. The two occipital condyles were closely placed in the early stages. From 98 days to 310 days, the occipital condyles diverged ventrally as age advanced. In all prenatal skulls, the foramen magnum was diamond shaped. The occipital condyles and paramastoid processes showed early ossification at 62 days and 92 days, respectively, while Mall (1906) and Williams *et al.* (1989) reported the ossification of the exoccipital at 56 days and during the eighth prenatal week, respectively, in human. There was very little flexion in the skull base during the development of the buffalo skull unlike in primates, where flexion was great and the foramen magnum was forced downward as reported by Latshaw (1987) in domestic animals.

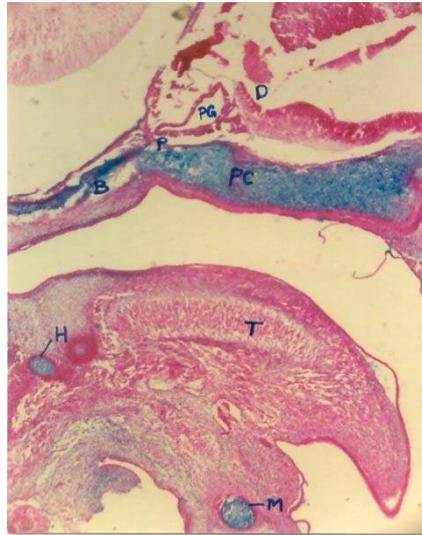


Figure 1. Photomicrograph of a sagittal section of the head of a 47 day embryo showing cartilaginous form of the cranial end of the basal plate (B) marked by caudal edge of pituitary fossa (P) Alcian Blue and Kernechtrot method x 40 H. Hyoid M. Meckel's cartilage PC. Prechordal part D. Diencephalon T. Tongue PG. Pituitary gland.

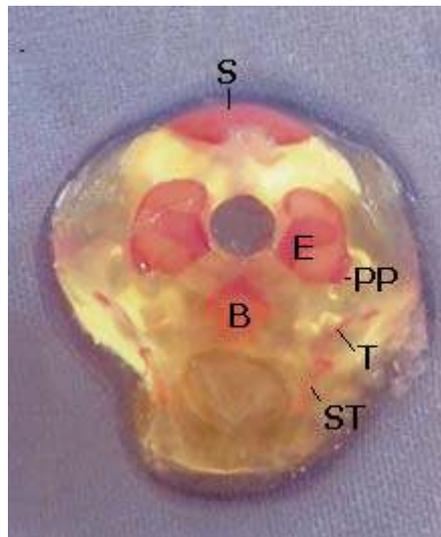


Figure 2. Photograph of an Alizarin Red S stained cross sectional profile of a 92 day foetal head showing ossification centers of the basioccipital (B), occipital condyle (E), lower part of squamous occipital (S) and paramastoid process (PP). ST. Stylohyoid T. Tympanic ring.



Figure 3. Photomicrograph of cross section of head of 62 day foetus showing early ossification of basal plate i.e Basioccipital (B) Von Kossa method x 40  
P. Petrous temporal M. Membranous labyrinth  
BR. Rhombencephalon

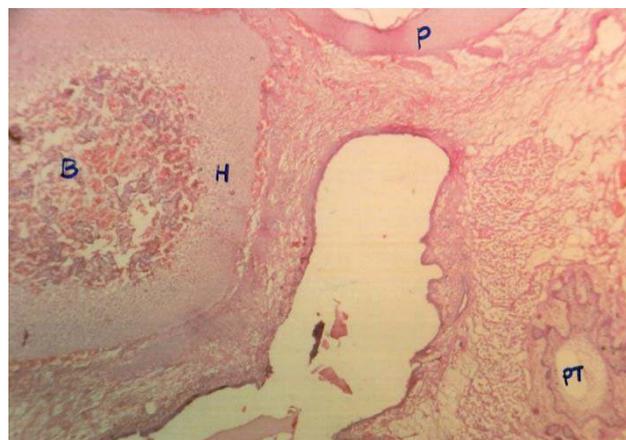


Figure 4. Photomicrograph of cross section of the head of a 92 day foetus showing the advanced state of endochondral ossification in the Basioccipital (B) H & E x 40 H. Hyaline cartilage P. Petrous temporal PT. Palatine tonsil.

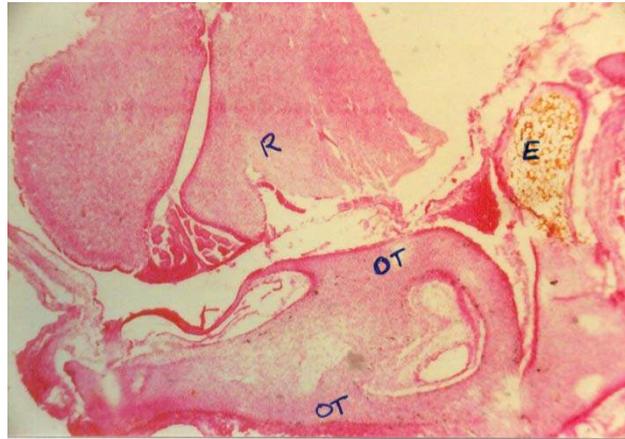


Figure 5. Photomicrograph of cross section of the head of a 62 day foetus showing early endochondral ossification of the occipital condyle (E) Von Kossa method x 40 OT. Otic capsule R. Rhombencephalon.

The squamous occipital was formed in both membrane and cartilage i.e. the upper part by intramembranous ossification and the lower part by endochondral ossification as described by Iyengar and Alur (1964) in ox. However the squamous part of the occipital bone was reported to be developed completely by intramembranous ossification in bovines (Soana *et al.*, 1996), while Matthews (1972) observed only endochondral ossification of the squamous occipital in bovines.

The lower part of squamous occipital and exoccipital were formed in the occipital arches as extensions of the basal plate at 43 days. It was in cartilaginous form at 47 days. The early endochondral ossification of the lower part of squamous occipital was evident at 64 days. However, Mall (1906) reported the ossification of the lower portion of the squamous occipital of human during the 7<sup>th</sup> week. Matthews (1972) reported ossification of the squamous occipital at 56 days without specifying membranous or cartilaginous portion. The upper part of the squamous occipital was developed from a single intramembranous ossification center. The ossification in the upper part of the squamous occipital was observed at 65 days, while in human

ossification was reported to take place at 56 days (O' Rahilly and Gardner, 1972) and 60 days (Williams *et al.*, 1989). Complete ossification of the squamous occipital, basioccipital and exoccipital was noticed at 132 days.

## SUMMARY

The study was conducted on 500 specimens of embryonic and foetal stages belonging to several age groups from 26 days to 310 days. The basal plate was cartilaginous at 45 days. The basal plate cartilage formed the basioccipital, exoccipital and the lower part of the squamous occipital. The endochondral part of the occipital showed four centers of ossification. The early ossification of the exoccipital and basioccipital was evident at 62 days, while in lower part of squamous occipital was observed at 64 days. The bone wise sequence of appearance of ossification in the occipital was the exoccipital, the basioccipital, (62 days), the lower part of the squamous occipital (64 days) and the upper part of the squamous occipital (65 days).

## ACKNOWLEDGEMENT

The authors are thankful to the Indian Council of Agricultural Research for providing financial support in the form of a senior research fellowship in ICAR ad-hoc research project to conduct this study.

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