

## Development of fontanelle and paranasal sinuses in the skull of prenatal buffalo (*Bubalus bubalis*)

M. Santhi Lakshmi<sup>1,\*</sup>, T.S. Chandrasekhara Rao<sup>2</sup>, K. Rajalakshmi<sup>3</sup>

<sup>1</sup>Department of Veterinary Anatomy, College of Veterinary Science, Sri Venkateswara Veterinary University, Hyderabad 500030, India

<sup>2</sup>Faculty of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati 517502, India

<sup>3</sup>Animal Husbandry & Animal Welfare Department, Puducherry 605001, India

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**Abstract :** The maxillary sinus appeared first among the sinuses of the skull at 92 days of prenatal stage. The early formation of frontal sinus was observed at 157 days in the cranial most part of the frontal bone while the early formation of palatine sinus was observed at 170 days. A total of five fontanelles were observed in prenatal skulls of buffalo. The largest and unpaired fontanelle was anterior fontanelle. The mastoid and sphenoidal fontanelle were paired. The ossification of anterior fontanelle was first observed at 164 days. All the fontanelles were ossified completely prenatally.

**Keywords :** development, fontanelle, paranasal sinuses, prenatal buffalo, skull

### Introduction

Very little information is available on the development of paranasal sinuses in ox [2] and domestic animals [5]. Various fontanelles were described in human [1] and mouse [3]. However the information pertaining to fontanelle is not available in any domestic animal species while information on development of sinuses is not available in Buffalo. Hence the present study was undertaken.

### Materials and Methods

The study was made on 509 embryos and fetuses belonging to 112 age groups starting from 26 days to 310 days. Four to eight specimens of each age group were studied. The prenatal embryos and fetuses of unknown age irrespective of the sex were collected irrespective of age, nutritional status and breed of the mother. The curved crown rump length (CVRL) was measured in cm by using thread and scale. The CVRL of the specimens studied was ranged from 2.1 cm (38 days) to 105 cm (310 days). The age of the specimens was calculated by adopting Soliman's formula [10] coined for buffalo i.e  $Y = 28.66 + 4.496x$  if CVRL is  $< 20$  cm and  $Y = 73.544 + 2.256x$  if CVRL is  $\geq 20$  cm where Y is the age in days and X is the curved crown rump length in cm.

All the embryonic specimens and heads of fetuses from 50 days to 101 days of age were fixed in 10% buffered neutral formalin and Bouin's fluids and processed for serial paraffin

sections of 6-8  $\mu$  thickness. The foetal heads of 70 days (CVRL: 9.2 cm) and above were subjected to decalcification by formic acid - Sodium citrate method after fixation [8]. The sections were subjected to Mayer's Haematoxylin and Eosin [8]. The skulls from 90 days (CVRL: 13.7 cm) to 310 days (CVRL: 105 cm) were used for the gross study by making different cross, longitudinal and frontal sectional profiles of skulls after dissection.

### Results

#### Fontanelle

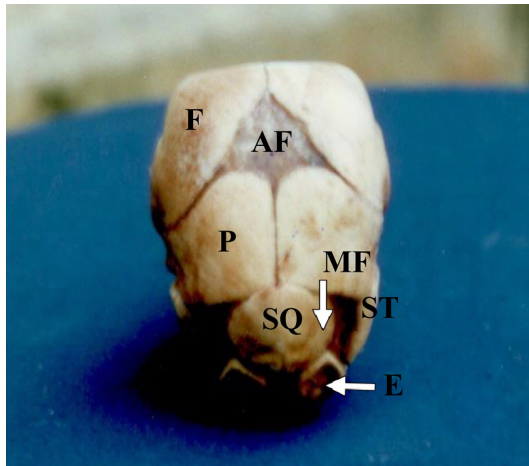
At the angles between two or more cranial bones union was delayed at some places and these spaces were covered by membrane constituting fontanelles. Five fontanelles i.e unpaired anterior fontanelle and paired mastoid and sphenoidal fontanelles were observed. The anterior fontanelle was triangular in shape and located at the junction between two frontal and two parietal bones (Fig. 1). The mastoid fontanelle was observed between squamous temporal, squamous occipital, exoccipital and parietal bones (Fig. 1). The sphenoidal fontanelle (Fig. 2) was located between orbital plate of frontal and orbitosphenoid.

The ossification of fontanelles was observed by growth and extension of bones surrounding them and no separate ossification centers for fontanelles were observed in the membranes covering them. The ossification of anterior fontanelle began at 164 days of gestation and completed at 225

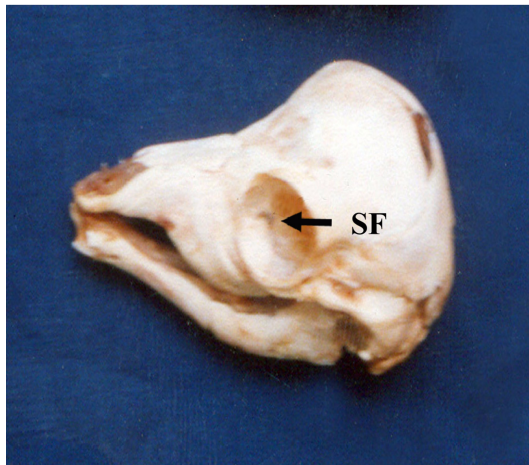
\*Corresponding author

Tel: +91-9849948015, Fax: +91-040-24015143

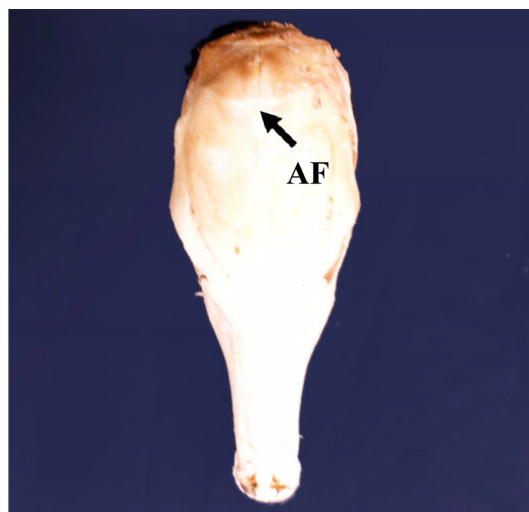
E-mail: santhi.mukku@gmail.com



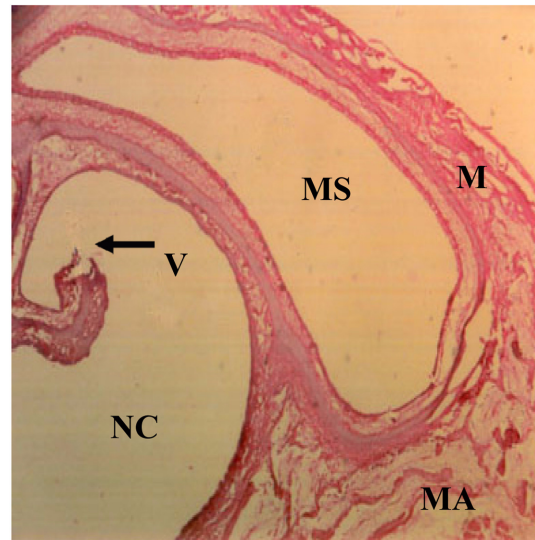
**Fig. 1.** Photograph of posterior view of 126 day foetal skull showing anterior fontanelle (AF) and mastoid fontanelle (MF). SQ: upper part of squamous occipital, E: exoccipital, ST: squamous temporal, P: parietal, F: frontal.



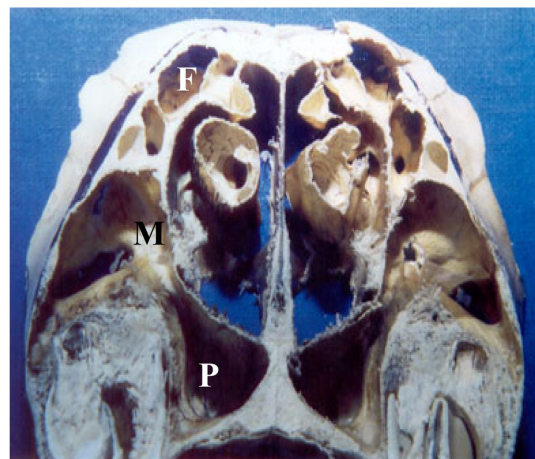
**Fig. 2.** Photograph of lateral view of 137 day foetal skull showing Sphenoidal fontanelle.



**Fig. 3.** Photograph of dorsal view of 225 day foetal skull showing complete ossification of Anterior fontanelle.



**Fig. 4.** Photomicrograph of cross section of 92 day foetal skull showing early formation of maxillary sinus (MS). M: ossification of maxilla, MA: ossification of malar, N: nasal cavity, V: ventral turbinate. H&E Stain,  $\times 40$ .



**Fig. 5.** Photograph of cross sectional profile of 283 day foetal skull showing well formed frontal (F), maxillary (M) and palatine sinuses (P).

days (Fig. 3). The sphenoidal and mastoid fontanelles showed complete ossification at 161 days and 173 days of gestation respectively.

#### Paranasal Sinuses

The maxillary sinus appeared first among paranasal sinuses of skull at 92 days of gestation (Fig. 4) and it was well developed and extended into lacrimal and malar bones at 283 days (Fig. 5).

The early formation of frontal sinus was observed at 157 days in the cranial most part of the frontal bone. At 310 days the frontal sinus was confined to the cranial most part of the frontal bone extending caudally only a little behind the cranial margin of the orbit. The early formation of palatine sinus



**Fig. 6.** Photograph of saggittal (medial) view of buffalo skull showing early formation of palatine sinus (P) at 170 days.

was observed at 170 days (Fig. 6) and it was well marked at 180 days. At 283 days it was prominent in horizontal part of the palatine and palatine process of maxilla and extended caudally from the level a little in front of infraorbital foramen (Fig. 5). However the sphenoidal sinus was not noticed in the skulls used for the study during the prenatal period.

### Discussion

The posterior fontanelle was not encountered in the present study. But Soana *et al.* [9] reported the presence of only anterior and mastoid fontanelles in bovines while Indian Council of Agricultural Research (ICAR) [2] described fontanelle only between frontals and parietals (*i.e.* Anterior fontanelle). The most prominent and largest fontanelle was the anterior fontanelle as reported in human [7] and mouse [3].

According to Williams *et al.* [12] the anterior fontanelle of human persisted until about 18 months after birth, while sphenoidal fontanelles were observed to fill in within 2 or 3 months after birth whereas mastoidal fontanelle was reported to fill near the end of first year. The fontanelles were reported to get ossified soon after birth in domestic animals [6] and in mouse [3]. But in the present study all the fontanelles were ossified prenatally and the anterior fontanelle was the last one that showed complete ossification among all the fontanelles.

The maxillary sinus was reported to appear first at 56 days [11] or during 3rd month [4] in human. According to Arey [1] the paranasal sinuses were first indicated in human skull during 4th month of prenatal life.

Latshaw [5] reported the poor development of sinuses at birth in domestic animals. According to ICAR [2] the paranasal sinuses were mostly postnatal in their development and excavation of the maxillary and palatine sinuses was much earlier than the frontal. In the present study also maxillary and palatine sinuses were found to be in more advanced state of development than frontal sinus throughout the prenatal period. There was no trace of cornual diverticulum in the embryonic skull of Buffalo as reported by ICAR [2] in ox as frontal sinus was confined to the cranial most part of frontal bone.

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