

Time and order of appearance of ossification in the skull of prenatal buffalo

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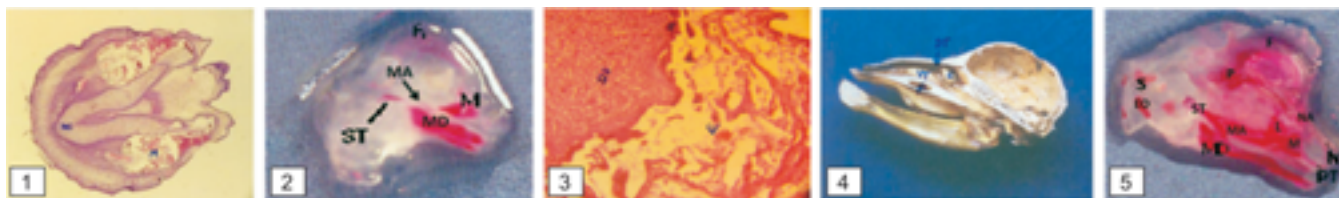
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The skull is the most important, complex and specialized part of the axial skeleton, which lodges the brain and sense organs. The present work was undertaken to study sequences in development of the skull which helps in understanding the basis of developmental anomalies.

The study was conducted at Department of Veterinary Anatomy, College of Veterinary Science, Tirupati. The prenatal embryos and foetii irrespective of the sex were procured from different slaughterhouses. Total 509 embryos and foetii were collected starting from 26 days. The CCRL (Curved Crown Rump Length) of the specimens studied was ranged from 2.1 cm (38 days) to 105 cm (310 days). All the embryonic specimens and heads of foetii from 50 to 101 days were fixed in 10% buffered neutral formaline and Bouin's fluids and processed for serial paraffin sections of 6–8m thickness. The foetal heads of 50 days (5.0 cm CCRL)

above were stained by Alizarin Red S method (Humason 1967). The foetal heads of 70 days and above were subjected to decalcification by formic acid-sodium citrate method after fixation. The sections were subjected to Mayer's haematoxylin and eosin staining method (Singh and Sulochana 1997) and Von Kossa staining method (Humason 1967).

The ossification of skull first appeared in mandible (Fig. 1), maxilla and malar (membranous viscerocranium) at 45 days. Exoccipital, tympanic bulla and basioccipital showed ossification first at 62 days. The ossification of desmocranium first appeared in frontal at 49 days while the ossification of cartilaginous viscerocranium first appeared at 62 days in stylohyoid. According to Soana *et al.* (1996) frontal bone showed early ossification 52 days in bovines. Ossification was clearly evident in mandible, maxilla, malar, squamous



Figs 1–5. **1.** Photomicrograph of frontal section of lower jaw of 45 day buffalo embryo showing early ossification in mandible (M) – MC, Meckel's cartilage. H & E×40; **2.** Photograph of Alizarin Red S stained head of 55 day buffalo foetus showing ossification in mandible (MD), maxilla(M), malar (MA), squamous temporal (ST) and frontal (F1). **3.** Photograph of Alizarin Red S stained head of 64 day buffalo foetus showing ossification in mandible (MD), maxilla(M), lacrimal (L), malar (MA), nasal (NA), nasal (N) and palatine (PT) processes of premaxilla, lower part of squamous occipital (S), exoccipital (EO), squamous temporal (ST), frontal (F) and parietal (P). **4.** Photomicrograph of cross section of head of 85 day buffalo foetus showing early ossification in perpendicular plate of ethmoid (E).H & E×100. dorsal portion of septal cartilage (DS). **5.** Photograph of sagittal section of skull of 193 day foetus showing early ossification of dorsal turbinate (DT), palatine sinus (P), ventral turbinate (VT), ethmoturbinate (E).

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temporal and frontal at 55 days (Fig. 2). The ossification of maxilla and malar were reported to be observed in human at 56 days of gestation (O' Rahilly and Gardner 1972). Most of the bones of the skull attained the fundamental shape of adult counterparts by 83 days. The malleus and stapes were the first and last bones to ossify at 141 and 173 days, respectively among the middle ear ossicles. The first sign of ossification

in perpendicular plate of ethmoid was evident at 85 days (Fig.3). The ossification of ethmoturbinates was first observed in great ethmoturbinate at 150 days. The cribriform plate was the last part of the ethmoid to become ossified. The last bone of the skull to ossify was the dorsal turbinate at 193 days (Fig.4). However Matthews (1972) reported that ethmoid was the last bone to ossify in bovine skull. The sequence of appearance of ossification of skull bones in prenatal buffalo was indicated in the Table 1.

The sequence of appearance of ossification in the buffalo skull in general was facial, calvarial, basicranial, hyoid, otic capsule and nasal capsule. Most of the skull bones showed beginning of ossification during 45–64 days (Fig. 5) of gestation while Lindsay (1972) reported appearance of most

of the ossification centers in bovine skeleton between 40–50 days of gestation. The bones of the membranous viscerocranium and membranous neurocranium were developed in a shorter period of time compared to cartilaginous neurocranium and cartilaginous viscerocranium. The ossification of most of the bones in buffalo skull appeared later than those found in similar bones of cow, which may be attributed to longer gestation period of buffalo.

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SUMMARY

The first bone to show ossification in the buffalo skull is mandible, maxilla and malar at 45 days. The sequence of appearance of ossification in the buffalo skull in general was facial, calvarial, basicranial, hyoid, otic capsule and nasal capsule. The last bone of the skull to ossify was the dorsal turbinate at 193 days. Most of the skull bones showed beginning of ossification during 45–64 days of gestation.

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Table 1. Sequence of appearance of ossification in the skull of prenatal buffalo

Name of the bone	Appearance of ossification (days)
Mandible, maxilla, malar	45
Frontal, Squamous temporal, Lacrimal, Tympanic ring	49
Palatine	53
Premaxilla, Vomer	56
Parietal	60
Nasal	61
Basioccipital, Exoccipital, Orbitosphenoid, Body of Basisphenoid, Alisphenoid, Tympanic bulla, Stylohyoid	62
Lower part of Squamous occipital, Interparietal	64
Upper part of Squamous occipital	65
Pterygoid	83
Perpendicular plate of ethmoid	85
Body of presphenoid	89
Petrous temporal	111
Malleus	141
Ventral turbinate	148
Ethmoturbinate	150
Body and other cornua of hyoid	159
Cribriform plate, Incus	170
Stapes	173
Dorsal turbinate	193