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Research Article

DEVELOPMENT OF CERTAIN FACIAL BONES IN PRENATAL GOAT

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ABSTRACT

The study was conducted on heads of 10 goats (*Capra hircus*) foetii of non-descript breed, irrespective of sex. The age of selected goat foetii ranged from 50 days to 150 days of gestation. The material was collected from the foetii of known weight and gestational age available at the department of Veterinary Anatomy, DUVASU, Mathura. Fresh material was collected from aborted foetus/clinical cases and was fixed in 10% Neutral buffered formalin. The heads of foetii were collected and stained with Alizarin red-S technique. The purpose of the present study to describe the onset and pattern of the ossification of the malar, lacrimal, maxilla, premaxilla, mandible and nasal bone according to age of foetus. The malar bone was ossified in the form of ridge at 50 days of gestation. Almost half the length of nasal bone was ossified, periphery was intense and centre poorly ossified at 60 days of gestation. The ossification percentage in facial bones increased as age of foetii advanced. The body of mandible had alveolus and unossified incisor teeth at 130 days of gestation. In maxilla alveolar cheek teeth appeared but ossification in teeth were less marked at 130 days of gestation. The complete zygomatic arch was observed at 150 days of gestation. In body of mandible incisor teeth appeared, in horizontal part of ramus the ossification was more in extremities than in middle part. In maxilla the upper cheek teeth were appeared with intense ossification, caudal teeth were less ossified than cranial ones at 150 days of gestation.

Keywords: Bone, Development, Facial, Goat, Prenatal

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The domestic goat is a sociable, inquisitive and intelligent species, which has been used for meat, milk, skin, and fur since it was first domesticated 10,000 years ago (Miranda-de la Lama and Mattiello, 2010; Zeder and Hesse, 2000). Goats are capable of adapting to various agro-climatic conditions ranging from arid dry to cold arid to hot humid. Skull is the most important, complex and specialized part of the axial skeleton, for it lodges the brain and sense organs. Accurate knowledge of the anatomical structure of the skull can be an effective aid in ontogenic studies as well as the determination of sexual polymorphisms (Olopade and Onwuka, 2008). The facial skeleton serves to protect the organ of smell, sight and taste and provide a frame on which the soft tissues of the face can act to facilitate eating, facial expression, breathing and making sounds. The facial bones were developed from intramembranous ossification (Getty, 2012). Many investigators mentioned the study of ossification in different species of domestic animals (Lakshmi *et al.*, 2014; Soana *et al.*, 1996; Chaudhary *et al.*, 2019; Chaudhary *et al.*, 2020). The literature pertaining to developmental features of the facial bones particularly in goat at different stages is sporadic and sparse. The purpose of the present study is to describe the onset and the normal pattern of the ossification of the malar, lacrimal, maxilla, premaxilla, mandible and nasal bone according to age of foeti.

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MATERIALS AND METHODS

The study was conducted on heads of 10 goat foetii of non-descript breed, irrespective of sex from 50 days to 150 days of gestation. The material was collected from the foetii of known weight and gestational age available at the Department of Veterinary Anatomy, College of Veterinary Science and Animal Husbandry, U.P. Pt. Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura, Uttar Pradesh, India. Fresh material was also collected from aborted foetus/clinical cases and was fixed in 10% Neutral buffered formalin. Weight of the foetii was recorded on KERN digital balance. The approximate age of embryos/foetii has been estimated by using formula derived by Singh *et al.* (1979) in goat after interpolation of formula given by Hugget and Widdas (1951) in mammals; $W1/3 = 0.096 (t-30)$, where W = body weight of foetus in gram and t = age of foetus in days. The heads of foeti were collected and macerated with 3% KOH solution and then stained with 0.003 % Alizarin red in 1% KOH solution for two days. After staining cleaning was done with the help of solution contained glycerine, alcohol and benzene in ratio of 2:2:1 parts, respectively for two days (Chaudhary, 2014). The cleared samples were preserved in 100% glycerine. The results were analysed as calcified tissues were appeared red while uncalcified areas were remain unstained. This technique was used to study the appearance of centre of ossification and extent of

calcification. The detailed morphology of certain facial bones was recorded under stereo zoom microscope.

RESULTS AND DISCUSSION

At 50 days of gestation: The malar bone was ossified in the form of a ridge (Fig. 1). The lacrimal bone was ossified in the form of a narrow rod from the upper border (Fig. 1). The maxilla was ossified and seen triangular in shape with a portion towards malar was intensely ossified. The ossification in premaxilla was observed only in nasal process close to maxilla in goat foetii (Fig. 1) whereas Soana *et al.* (1996) observed ossification at 52 days of gestation in buffalo foetii. The horizontal ramus of mandible showed two centres of ossification start from extremities then to centre of ramus (Fig. 1). The vertical ramus was in the form of thin rode like structure. Coronoid process and condyle were not ossified. The nasal bone was not ossified at this stage (Fig. 1). In present study the ossification in malar, lacrimal, maxilla, premaxilla and mandible was first seen at 50 days of gestation, however, in buffalo foeti it was encountered at 45 days of gestation (Rao *et al.*, 2014; Lakshmi *et al.*, 2014).

At 60 days of gestation: In malar bone the ossification was observed in zygomatic process. The zygomatic process divided into two parts *viz*. frontal and temporal branch (Fig. 2). The lacrimal bone became thin plate like. The maxilla was ossified and seen triangular in shape. The ossification in the nasal process of premaxilla was increased than previous stage. In mandible, the ossification starts at junction of vertical and horizontal ramus. In vertical ramus, the ossification in condyle and in coronoid process was observed but terminal part of coronoid process remains unossified at this stage. The result of the present study was in agreement with Lakshmi *et al.* (2012) and Rao *et al.* (2014) buffalo foetii.

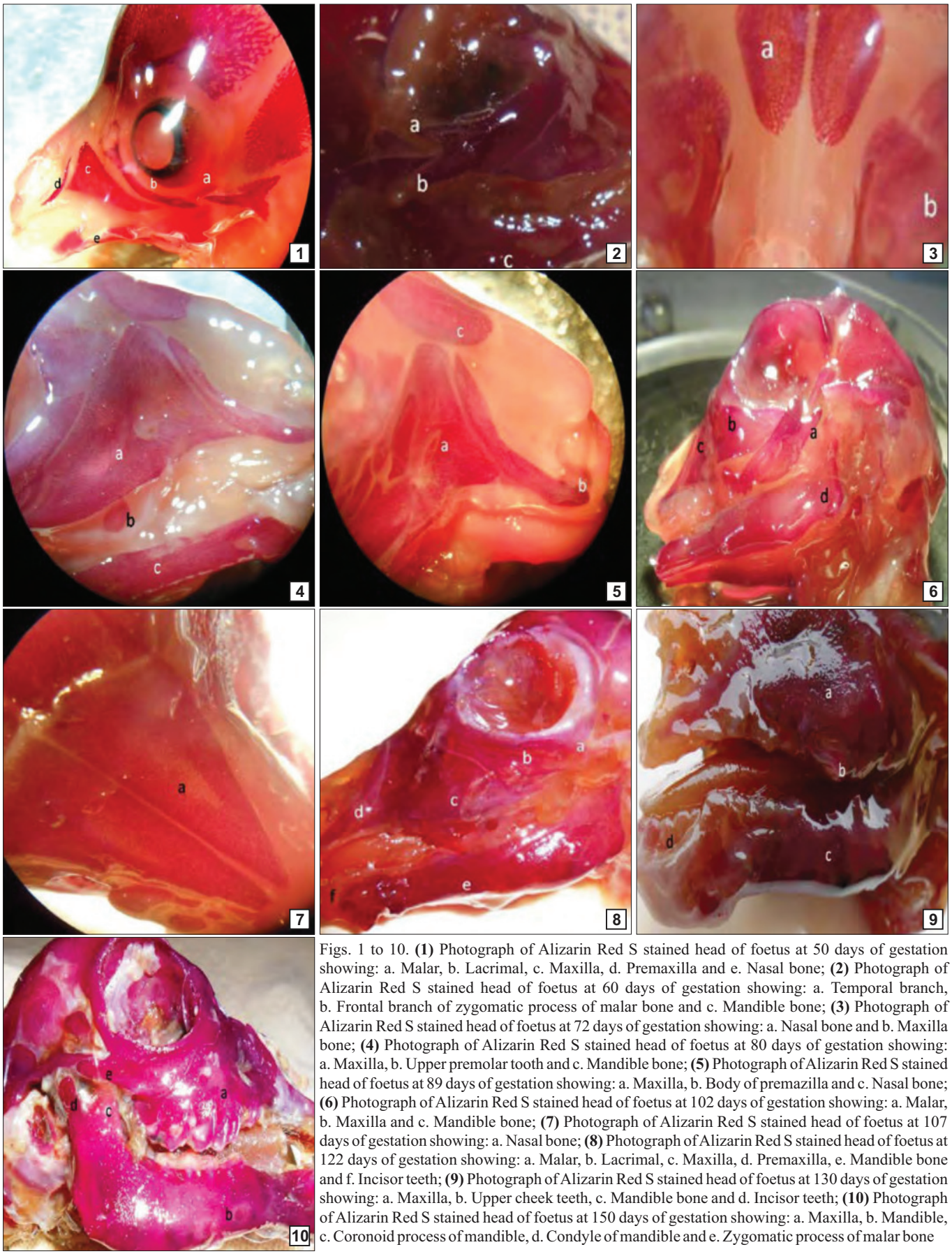
At 72 days of gestation: The malar bone was intensely ossified at this stage. In present study, the temporal part of zygomatic process joins the zygomatic process of temporal bone at 72 days of gestation while in buffalo foeti at 117 days of gestation (Soana *et al.*, 1996). The lacrimal bone was ossified and became triangular in shape. The ossification in maxilla was increased and bone became triangular in shape with portion towards malar was intensely ossified. The ventral border was largest one followed by dorsal border and anterior border. The nasal process of premaxilla showed intense ossification. The mandible was ossified, horizontal and vertical ramus were darkly stained. The condyle of mandible was developed by endochondral ossification at 75 days of gestation. The ossification in condyle was seen at 75 days in buffalo foeti (Lakshmi *et al.*, 2012). The ossification was intense in condyle than coronoid process. The terminal part of coronoid process above the zygomatic process was intensely ossified but at the point of origin from vertical ramus of mandible was poorly ossified. The body of mandible was not ossified at this stage. Half of the length of nasal bone was ossified. They appeared elongated oval shaped with periphery darker than centre (Fig. 3).

At 80 days of gestation: The malar bone was intensely ossified. The lacrimal bone showed intense ossification. The maxilla was triangular in shape and ossified upper premolar tooth was observed at alveolar border (Fig. 4). The Infraorbital foramen was also observed at this stage. The maxilla showed intense calcification at 80 days of gestation in goat foetii while in buffalo foeti it remains poorly mineralised up to 97 days of gestation (Soana *et al.*, 1996). The alveolar border of maxilla showed ossification centre of deciduous premolar tooth at 80 days of gestation and molar tooth at 130 days of gestation, respectively in goat foeti while in buffalo foeti the same was observed at 97 days of gestation and 212 days of gestation, respectively (Soana *et al.*, 1996). The body of premaxilla was observed but poorly ossified. The coronoid process of mandible was straight and darkly stained. Incisor teeth over body of mandible also visible but unossified. Nasal bone was ossified evenly at this stage.

At 89 days of gestation: The malar bone was intensely ossified forming boundary of orbital cavity. The lacrimal bone was very large, irregular and took its quadrilateral shape. The coronoid process of mandible increased in size, its terminal part directed backward. The condyle was intensely ossified. The maxilla was ossified and size increased as compare to previous age. The nasal process of premaxilla became wider and sword shape and some part of body also get ossified (Fig. 5). According to Soana *et al.* (1996) the body and palatine process of premaxilla also observed at 117 days of gestation in buffalo foetii. The nasal bone ossified and elongated oval in shape (Fig. 5).

At 102 days of gestation: The malar bone was irregular triangular in shape. Division of zygomatic process seen but incomplete zygomatic arch was observed. The lacrimal bone was seen triangular plate like with intense ossification. The coronoid process and condyle of mandible ossified but intense ossification observed in condyle than coronoid process (Fig. 6). The Maxilla was not completely fused with nasal process of premaxilla. The premaxilla was observed in the form of curved plate. In nasal bone, intense ossification observed at periphery than centre with rounded extremities.

At 107 days of gestation: The ossification in facial bones get intense than previous age. (Fig.7). The nasal bone get



Figs. 1 to 10. **(1)** Photograph of Alizarin Red S stained head of foetus at 50 days of gestation showing: a. Malar, b. Lacrimal, c. Maxilla, d. Premaxilla and e. Nasal bone; **(2)** Photograph of Alizarin Red S stained head of foetus at 60 days of gestation showing: a. Temporal branch, b. Frontal branch of zygomatic process of malar bone and c. Mandible bone; **(3)** Photograph of Alizarin Red S stained head of foetus at 72 days of gestation showing: a. Nasal bone and b. Maxilla bone; **(4)** Photograph of Alizarin Red S stained head of foetus at 80 days of gestation showing: a. Maxilla, b. Upper premolar tooth and c. Mandible bone; **(5)** Photograph of Alizarin Red S stained head of foetus at 89 days of gestation showing: a. Maxilla, b. Body of premazilla and c. Nasal bone; **(6)** Photograph of Alizarin Red S stained head of foetus at 102 days of gestation showing: a. Malar, b. Maxilla and c. Mandible bone; **(7)** Photograph of Alizarin Red S stained head of foetus at 107 days of gestation showing: a. Nasal bone; **(8)** Photograph of Alizarin Red S stained head of foetus at 122 days of gestation showing: a. Malar, b. Lacrimal, c. Maxilla, d. Premaxilla, e. Mandible bone and f. Incisor teeth; **(9)** Photograph of Alizarin Red S stained head of foetus at 130 days of gestation showing: a. Maxilla, b. Upper cheek teeth, c. Mandible bone and d. Incisor teeth; **(10)** Photograph of Alizarin Red S stained head of foetus at 150 days of gestation showing: a. Maxilla, b. Mandible, c. Coronoid process of mandible, d. Condyle of mandible and e. Zygomatic process of malar bone

mineralised up to its rostral process at 107 days of gestation in goat foetii whereas Soana *et al.* (1996) observed at 61 days of gestation and Lakshmi *et al.* (2014) at 97 days of gestation in buffalo foetii.

At 122 days of gestation: The ossification percentage in lacrimal, malar, maxilla increased as compare to previous ages (Fig. 8). The alveolar surface of maxilla was not smooth but slight elevation observed and in mandible surface almost smooth no ossified teeth observed in body but elevation of connective tissue was observed (Fig. 8).

At 130 days of gestation: The ossification percentage in lacrimal, malar, maxilla increased as compared to previous ages. The body of mandible had ossified alveoli and unossified incisor teeth (Fig. 9). In maxilla the alveoli and cheek teeth appeared but ossification in teeth less marked (Fig. 9). Palatine process of maxilla was also get ossified but sporadically. The nasal process of premaxilla gets intensely ossified but body was poorly ossified. The nasal bone got intensely ossified with pointed extremities were observed.

At 150 days of gestation: The malar bone was irregular triangular plate like. The frontal part of zygomatic process joined supraorbital process of frontal bone and the temporal part joined the zygomatic process of temporal bone to complete zygomatic arch. Ossification was intense in processes as compared to body of malar bone. The lacrimal bone was in the form of quadrilateral plate. The body of mandible had ossified incisor teeth while in buffalo foetii it was poorly mineralised up to 97 days of gestation and intensely ossified with two premolar teeth at 117 days of gestation. The ossification in horizontal part of ramus was more intense in extremities than middle part. The vertical ramus had curved coronoid process that reach across zygomatic process (Fig. 10). The condyle also intensely ossified. The angle of mandible was distinct. In maxilla upper cheek teeth were appeared with intense ossification, molar teeth were less ossified than premolar ones. Zygomatic process of maxilla joined corresponding part of malar and temporal bone. Palatine process gets ossified and form bases of hard palate. Facial crest was less prominent at this stage. Infraorbital foramen was seen. The body and nasal process of premaxilla were ossified but palatine process was not ossified up to this age. Two nasal bones became fused no gap observed in-between them. The majority of facial bones were developed by intramembranous ossification in goat foetii as observed by Soana *et al.* (1996) in buffalo foetii. According to Lakshmi *et al.* (2014) most of the bones of skull were ossified between 45th and 89th days of gestation in buffalo foetii. In human embryo the ossification in mandible and maxilla began at 19 mm CRL stage and malar at 23 mm CRL stage (Rahilly and Gardner, 1972). Most of the facial bones were ossified from single centre of ossification in goat foetii as observed by Rao *et al.* (2014) and Lakshmi *et al.* (2014) in buffalo foetii.

CONCLUSION

All facial bones were flat type and ossified through intra-membranous ossification and ossification was noticed in most of them at 50 days of gestation except nasal bone whose ossification begins at 60 days of gestation. All the facial bones were ossified by one centre of ossification except mandible which was ossified by two centres of ossifications.

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