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PRENATAL AND POSTNATAL DEVELOPMENT AND COMPARATIVE ANATOMY OF THE MANDIBLE OF THREE BREEDS OF SHEEP: A GROSS STUDY

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ABSTRACT - This study aims to evaluate and compare the development of the mandible and gross anatomy in three breeds of sheep. A total of 180 and 720 prenatal and postnatal samples were used respectively, their skulls were macerated and mandibles detached. In prenatal life, the mental and mandibular foramina were rudimentary in the late 1st trimester and 2nd trimester and developed in the 3rd trimester. The alveolus and mandibular canal differentiated in the 3rd trimesters respectively. In the postnatal life, the ventral border was convexed in Uda but flat in Balami and Yankasa breeds. The angular part of the ramus was thin in Uda and thick in Balami and Yankasa. The mandibular tuberosity was absent in Balami and Yankasa but present in Uda. There was a small accessory foramen caudal to the mental foramen just below the first premolar teeth in the Uda and Yankasa. The labial surface was wide and rough in Balami and Uda but smooth in Yankasa. The medial surface was flat in the young postnatal and convexed in the adult postnatal. It was brought to a conclusion that the mandible in the Nigerian breeds undergoes various morphological changes from prenatal and postnatal ages with peculiar differentiating features.

Key words: Mandible, Foramina, Uda, Balami, Yankasa.

INTRODUCTION

The mandible is the strongest and largest bone of the head, it accommodates the teeth of the lower jaw. It consists of a horizontal portion, the body, and a vertical portion, the rami, which unite with the ends of the body at right angles. The mandible plays a vital role in the ingestion and mastication of food, when it is malformed or fractured will lead to deleterious nutritional problems as the animal will be unable to feed. Morphometric studies of the mandible have been reported in Ecotypes of Sahelian breeds goat (Shawulu et al., 2011), spotted deer (Kumawat et al., 2014), blackbuck (Choudhary et al., 2015), Indian blue bull (Kumar, 2017), Madras Red Indian sheep (Sundaram et al., 2019) and Kosovo breed of sheep (Gündemir et al., 2020). However, little is known about the prenatal and postnatal morphological development of the mandible. Therefore, this study aims to evaluate and compare the prenatal and postnatal development of the mandible in three breeds of sheep. The findings from this study will contribute to the knowledge of mandibular anatomy and aid in the diagnosis of congenital malformation involving the mandible.

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MATERIAL AND METHODS

Prenatal sample collection

This study was approved by the Institutional Animal Care and Use Committee of Usman Danfodiyo University Sokoto reference no. UDUS/FAREC/2019/AUP-RO-17. A total of 180 wasted prenatal samples (60 each of Balami, Uda and Yankasa breeds) obtained from the slaughtered animals in the abattoirs across Nigeria were used for this study, each breed was subdivided into 20 per trimester (1st, 2nd and 3rd trimesters) shown on table 1.

Prenatal sample preparation

Their heads were decapitated at the occipito-atlantal joint, weighed and brains flushed out using water and spatula (Hena and Sonfada, 2013). Scalpel blade, scissors and forceps were used to remove the skin and muscles of the head. The chemical maceration technique was adopted in the bone preparation using 20% potassium hydroxide (KOH) for 48 hours to remove attached muscle remnants.

Postnatal sample collection

A total of 720 postnatal head samples (240 each of Balami, Uda, and Yankasa) were collected from their naturally dominated geographical locations within four States abattoirs of Nigeria were used for this research. The age of the heads was determined using their incisors teeth (Umar et al., 2018) and sub-grouped into three based on their age; day-old age group, ≤1 year/young age group and >1 year/adult age group (Table 2). These heads were obtained from slaughtered Uda breeds in the Sokoto State metropolitan abattoir, Yankasa breed of sheep from Kaduna State abattoir, and Zamfara State abattoir and Balami breeds from Gombe State Township abattoir. All the heads were transported in nylon bags and sacks containing ice to the Gross Anatomy Laboratory of the Veterinary Faculty, Usmanu Danfodiyo University, Sokoto for preparation and analysis.

Postnatal sample preparation

The heads were macerated using the hot water technique to harvest the skull (Onar et al., 1997). The morphology of the viscerocranial bones was described and peculiar features and differences were noted among the three breeds.

Table 1. Age group distribution of the prenatal samples

Breed	1st trimester	2nd trimester	3rd trimester	Total
Balami	20	20	20	60
Uda	20	20	20	60
Yankasa	20	20	20	60
Total	60	60	60	180

Table 2. Age group distribution of the postnatal samples

Breed	Day-old		≤ 1year		>1 year		Total
	Male	Female	Male	Female	Male	Female	
Balami	20	20	50	50	50	50	240
Uda	20	20	50	50	50	50	240
Yankasa	20	20	50	50	50	50	240
Total	60	60	150	150	150	150	720

RESULTS AND DISCUSSION

Prenatal Mandible

In the second (2nd) trimester, the mental and mandibular foramina were present, tiny, and grossly invisible except with the aid of a magnifying lens. The mental foramina had a longitudinal groove on its anterior aspect, the Balami, Uda and Yankasa mandible had a developing inferior alveolar canal for the teeth on the dorsomedial aspect of the mandibular body, the alveolus was opened and the mandibular foramina canal were undifferentiated from the teeth alveolus. The mandibular body was convexed on the medial surface and the mandibular rami had a fossa on its lateral surface, the mandibular tuberosity was absent, and the condyloid and coronoid processes were present (Figure 1). In the third (3rd) trimester, the 3rd deciduous premolar, 1st, and 2nd deciduous molar began to erupt within the inferior alveolar canal, the erupting teeth were covered by a membranous sheath, and the alveolus was closed except at the dorsal border where the teeth erupt/protrude.

Figure 1: 2nd trimester medial and lateral surfaces of the mandible of Uda (A) and Yankasa (B) fetuses, showing; developing alveolus (1), mental foramina groove (2), condyloid process (3), coronoid process (4), and fossa (5)

The mandibular foramina canals were differentiated from the alveoli canal, it passes across the length of the mandibular body, below the alveoli canal, extending from the mental foramen to the mandibular foramen. The mandibular foramina canal and teeth alveoli canal both had about three external openings/perforations on the caudolateral surface of the mandibular body. The mental and mandibular foramina were more developed and grossly visible. The medial and lateral surfaces of the mandibular body were flat. The mandibular tuberosity was also absent (Figure 2).

Figure 2: 3rd trimester medial and lateral surfaces of the mandible of Balami (A) and Yankasa (B) fetuses showing; the mental foramen (1) and mandibular foramen (2), mandibular body (3), mandibular rami (4), and alveolus opening (5)

In the day old, the 2nd and 3rd deciduous premolar and 1st and 2nd molar had begun to erupt above the alveolus to the dorsal border of the mandible, a big and small-sized deciduous 1st and 2nd incisors teeth have also erupted above the alveolus. The mandibular foramina canal and alveolus still shared the same opening, but the erupting teeth were sealed by a membranous sheath. The openings on the caudolateral surface of the mandibular body were covered by a thin sheath of bone (Figure 3).

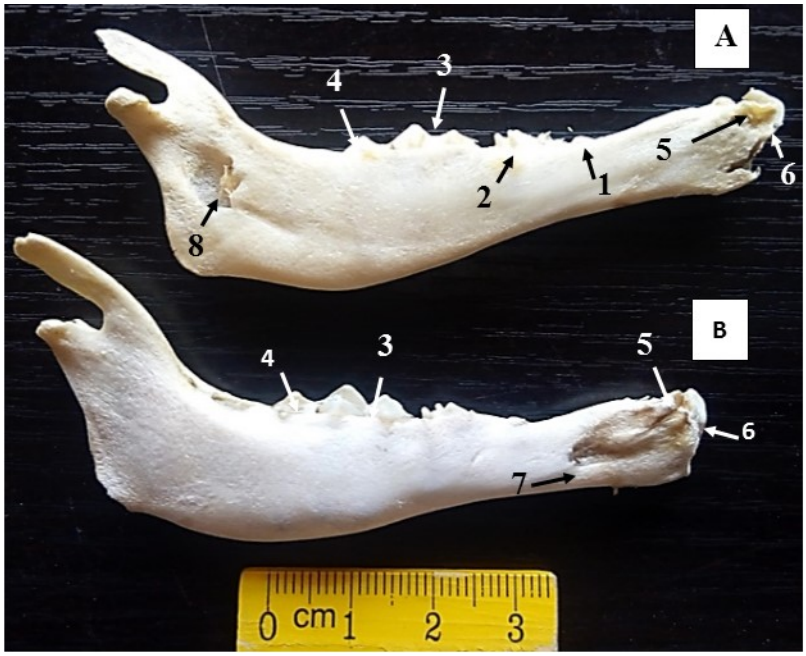

Figure 3: Day old postnatal medial and lateral surfaces of the mandible of Uda (A) and Yankasa (B) breeds showing; the 2nd deciduous premolar (1), 3rd deciduous premolar (2), 1st molar (3) 2nd molar (4), 1st incisor (5), 2nd incisor (6), mental foramen (7), and mandibular foramen (8)

This study has shown that the mental foramen develops earlier than the mandibular foramen in the three breeds of sheep, although the mental foramen developed earlier in Yankasa than in Balami and Uda probably due to breed differences, the ossification of the mandible which began at the mandibular body is responsible for the early development of the mental foramen. This agrees with the work in humans where it was reported that the initial site for mandibular osteogenesis is between the mental branches of the alveolar nerve at the rostral part of the Meckel's cartilage in humans (Ichim et al., 2006). The undifferentiated openings that formed the mandibular foramina canal and teeth alveoli indicate that they both had a single origin during ossification.

Postnatal Mandibular bone

The mandible was the largest bone of the skull, it was paired and articulated at the rostral end to form the mandibular symphysis. The symphysis does not ossify in both young and adult, and the symphysial surface was marked with rough and irregular projections and corresponding depressions. The mandible has two parts, the body

(horizontal part) and ramus (the vertical part). The body bore all the teeth of the lower jaw. On the lateral surfaces of the body are two mental foramina one each on the left and right halves of the three breeds of sheep at the junction of the incisive and molar parts, however, there was a small accessory foramen caudal to the mental foramen just below the first premolar teeth in 40% and 50% of the Uda and Yankasa breeds respectively. The incisive part of the body was concaved cranially on its lateral surface and the molar part was convexed caudally. The labial surface was wide and rough in Balami and Uda but smooth in Yankasa. The ventral border of the body was convexed caudally and when placed on a flat surface, both ends of the mandible were lifted from the ground surface in Uda, but the rostral end touches the ground in Balami and Yankasa. The angular part of the ramus was pronounced and laterally concaved in Uda than Balami and Yankasa, it is thin and compressed on both sides in Uda, and thick in Balami and Yankasa. The margin of the ramus was thin and concaved in Uda, thick and convexed in Yankasa and thick and rounded in Balami.

A big triangular and smooth fossa was seen on the lateral surface of the ramus in Uda. The mandibular tuberosity was absent in Balami and Yankasa but present in Uda. The articular extremity was composed of the condylar process and coronoid process with the intervening intercondylar notch. The medial surface was flat in the young and convexed in the adult. The three breeds all have one large mandibular foramen in the middle of the medial surface of the ramus. The coronoid process was curved caudolaterally and extend caudodorsally above the condyle to form the highest point of the mandible, this point was straight in Yankasa and Uda but curved laterally in Balami. The head of the condylar process project above the notch and extended lateromedially, the lateral and medial parts were thin and thick respectively (Figure 4 - 7).

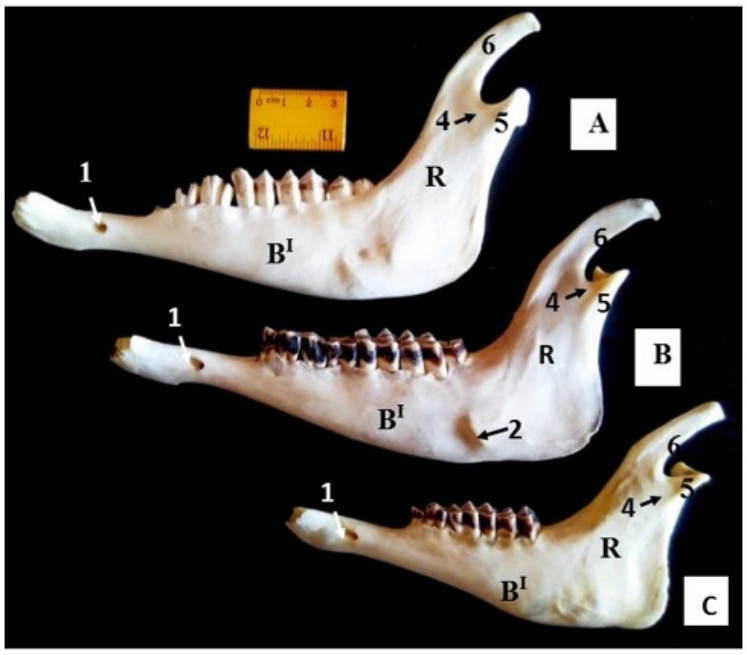

Figure 4: Adult postnatal lateral view of the mandible of Balami (A), Uda (B), and Yankasa (C) showing; body (B^I), ramus (R), mental foramen (1), mandibular tuberosity (2), mandibular angle (3), intercondylar notch (4), condylar process (5), and coronoid process (6)

Figure 5: Adult postnatal medial view of the mandible of the mandible of Balami (A), Uda (B), and Yankasa (C) showing body (B), ramus (R), symphysial surface (1), and mandibular foramen (2)

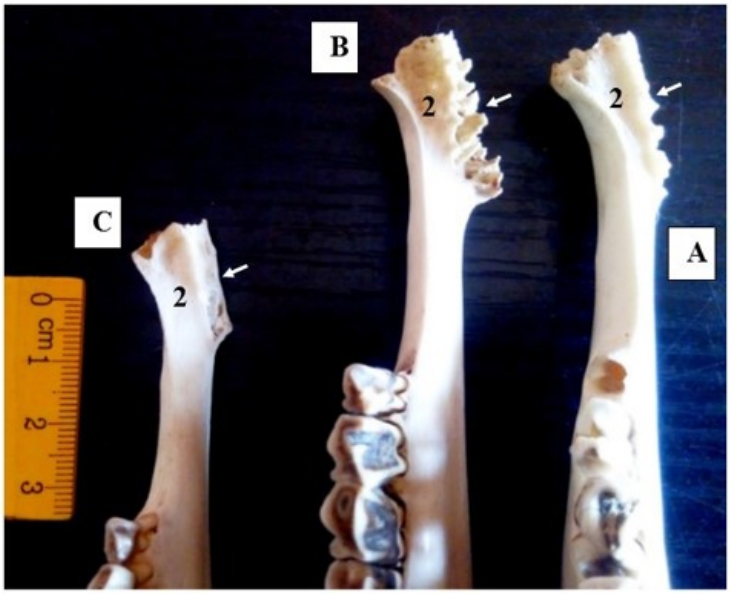

Figure 6: Adult postnatal dorsal view of the cranial halves of the mandible of the Balami (A), Uda (B), and Yankasa (C) showing the symphysial surface (1) and labial surface (2)

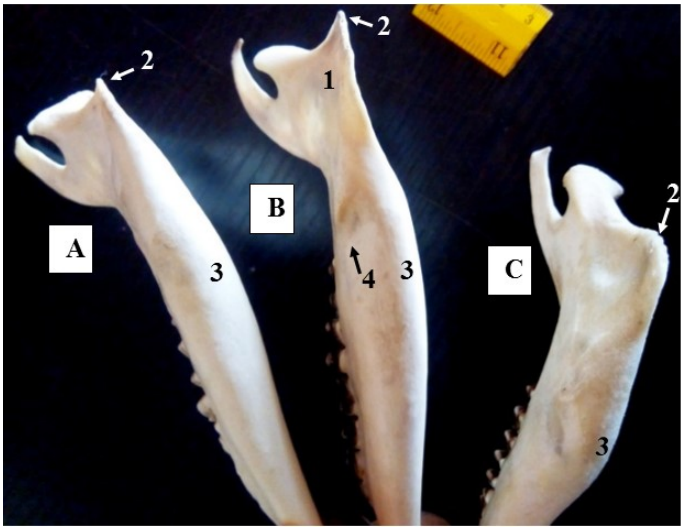

Figure 7: Adult postnatal latero-ventral view of the caudal halves of the mandible of the Balami (A), Uda (B), and Yankasa (C) showing; body (B) and rami (R), mandibular fossa (1), mandibular angle (2), ventral border (3), and mandibular tuberosity (4).

The two halves of the mandible which formed the lower jaw of the skull were the largest bone of the skull does not ossify in both young and adult postnatal stages, and

the symphysial surface was marked with rough and irregular projections and corresponding depressions. Which was similar to the findings in Kosovo breed of sheep (Gündemir et al., 2020), Madras Red Indian sheep (Sundaram et al., 2019), Indian blue bull (Kumar, 2017), blackbuck (Choudhary et al., 2015), spotted deer (Kumawat et al., 2014), chital (Ramswarup, 2011) and tiger (Tiwari et al., 2011) whereas in contrast, it was reported that the mandibular symphysis was completely ossified to in horse (Sisson and Grossman, 1975; Hillmann, 1975) and camel (Singh, 1984). Animals that have un-fused mandibles, like the goat, does not only have a ratio of working to balancing side adductor muscle force of 1:1 and that they have mandibles that rotate independently during occlusion and have a vertical tooth movement during the power stroke of mastication (Lieberman and Crompton, 2000). Such independent rotatory movement is expected to be pronounced in these three breeds of Nigerian sheep where the two halves of the mandibles do not fuse completely at the symphysis in both young and old animals.

The two mental foramina on the lateral surfaces of the body one each of the left and right halves of the three breeds of sheep, and the small accessory foramen caudal to the mental foramen in some of the Uda and Yankasa breeds in this study is in accordance with several authors who reported that only one mental foramen was present in Indian blue bull (Kumar, 2017), in Indian blackbuck (Indian antelope) (Choudhary et al., 2015), in chital (Tiwari et al., 2011), in the horse (Sisson and Grossman, 1975, Hillmann, 1975), in ox (Sisson and Grossman, 1975, Raghavan, 1964), in yak (Archana et al., 1997), in rhinoceros (Bordoloi et al., 1995) and spotted deer (Kumawat et al., 2014), but it has been reported that in addition to main mental foramen, several small accessory foramina opened behind it on the lateral ramus in the pig (Mcfadyean, 1953). However, two mental foramina were observed in leopard (Kalita et al., 2001; Ray et al., 1997) and Ecotypes of Sahelian breeds of goat (Shawulu et al., 2011). However, in the tiger (Joshi, 2004), camel (Singh, 1984), and dog (Miller et al., 1964) there were three mental foramina. The double opening of the mental foramen seen in some specimens of the Uda and Yankasa in the alveolar spaces may suggest the occurrence of the accessory mental nerve from the smaller foramen. These occurrences are of great importance since accessory foramina in the mandible has been known to transmit nerve branches supplying the roots of the teeth. Local nerve block techniques might fail if any of these nerves or their branches pass through these foramina and escape the nerve block. The sources of these foramina might also be an alternate route for tumor spread (Das and Suri, 2004).

CONCLUSIONS

It was concluded that the mandible in the Nigerian breeds undergoes various morphological changes from prenatal and postnatal ages with peculiar differentiating features.

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