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Full Length Research

Gross and microscopic assessment of pre-paturent heart and lungs of the red Sokoto goat

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ABSTRACT: The aim of this study is to determine the state of fetal preparedness to terrestrial life by studying the heart and lung of the red Sokoto goat fetus and to establish approximate fetal survival age. In this study, the cardiopulmonary status of fifty (50) red Sokoto goat fetuses recovered post slaughter were assessed. Grossly, the heart in 6 to 7 weeks old fetuses showed external divisions of the paraconal and subsinosal interventricular grooves, great vessels at the base and pointed apex. The full lobations of the lungs were identifiable. Microscopically, the cardiac fibers are arranged in a branching fashion with centrally located nuclei and large perimysial spaces. The alveolar cells were emerging with establishment of the apparatus. By 14 to 15 weeks of age, the alveoli cells were well established with well developed respiratory bronchioles. Similarly, cardiac fibers were developed with recognizable cross striation and greatly reduce perimysial spaces. Both the macroscopic and microscopic findings on the fetal heart and lungs of a day-old kid were similar to the findings observed on 14 to 15 weeks old fetuses. This therefore suggests that, in the event of a premature kidding at 14 to 15 weeks of gestation, the red Sokoto goat fetus could cope with extra uterine life, with adequate veterinary care.

Keywords: Cardiopulmonary, fetus, pre-partutrient, red Sokoto goat.

INTRODUCTION

Small ruminants are important domestic animals in tropical livestock production system (Al-Khaza'leh et al., 2015). Sheep and goats are members of the family Bovidae and sub-family caprine (Bolton, 2017) with a few morphological differences between them (Agrawal et al., 2014). Sheep and goats play an important role in the economy of many countries including Nigeria. The economic importance of these animals depends on the value of their production or services which include among others meat, fiber and skin. Meat and milk obtained from these animals constitute the major source of animal protein for a greater part of the world population (Al-Khaza'leh et al., 2015).

Although, goats were probably the first group of farm animals to be domesticated, there has been a general neglect of their study compared to cattle and sheep (Belanger and Bredesen, 2010). There is however, an increase awareness of the contribution of the goat to the world food system, especially in the less industrialized countries which, among them possess nearly 95% of the world's goat (Al-Khaza'leh et al., 2015).

In response to the increased demand for goat production, research has been intensified in all related aspects in order to gain information on this valuable species (Kwari et al., 2003). Antenatal and postnatal growth of certain organs and systems has been studied by several researchers (Dyce et al., 2004). According to Moore et al. (2015), the heart is formed as a result of migration of the splanchinic component of the mesoderm toward the ventral midline during embryonic development, splanchnic mesoderm also forms the cartilage, fascia, smooth muscles and vessels of the lung. The heart, according to Moore et al. (2015), is the first organ to start it definitive function, the growth and development depending on the blood that flows through it. Continuous

branching of the bronchial tree produced additional bronchioles and terminal sacs from which alveoli developed and breathing movements also take place in utero to prepare for postnatal respiration (Thomas and Avin, 2013). At birth, lungs contain amniotic fluid that drains off or it absorbed as air is breathed in. Alveolar cells produce a phospholipid surfactant that reduces surface tension and thus facilitate alveolar expansion as opposed to alveolar collapse (Thomas and Alvin, 2013).

Thus, this work is aimed at determining the state of fetal preparedness to terrestrial life by studying the heart and lung of the red Sokoto goat fetus and to establish approximate fetal survival age in case of premature birth based on the gross and histological assessments of fetal cardiopulmonary elements.

Plate 1. A cross section of red Sokoto goat fetuses at first trimester.

MATERIALS AND METHODS

A total of fifty (n=50) fetuses (18 female and 32 males) and two (n=2) day-old kids were sampled for this study. They were obtained from slaughtered red Sokoto does at Batta Abattoir, Dange Shuni Local Government Area and the State Central Abattoir, Sokoto State, Nigeria and transported immediately to the Veterinary Anatomy Laboratory Usmanu Danfodiyo University, Sokoto, Nigeria. A cross-sectional design was adopted for this study. The fetuses were aged using their crown-rump length and categorized into 1st, 2nd and 3rd trimesters and day-old (Plate 1) based on fetal age estimation criteria (Sivachelva et al., 1996).

The fetuses and day-old kids, were dissected based on the method described by Benzuidenhout and Homsveld (2000). The abdomen was slit open, and then an incision was made from the opening, cranially towards the neck region along the ventral midline through the linear alba. This exposed the organs of the thoracic cavity, especially the heart, lungs and associated structure. The heart and lung were then removed and observed.

Sections of the lungs and apex of heart were taken and fixed immediately in 10% buffered formaldehyde for the histological study. Fixed specimens were dehydrated in a graded ethanol (50, 70, 95 and 100%) series, cleared with xylene, infiltrated and embedded in paraffin blocks. The blocks were sectioned at 5 to 7 µm thickness using a Rotary microtome. These sections were mounted on an albumen smeared glass slide. The Harris hamatoxylin and eosin (H & E) staining method was used to stain each section as described by Suvarna et al. (2019). They were examined at low and high power magnifications using light microscope. Photomicrographs were taken using Olympus microscope (model: CX2) and transferred into a personal computer to observe and record findings.

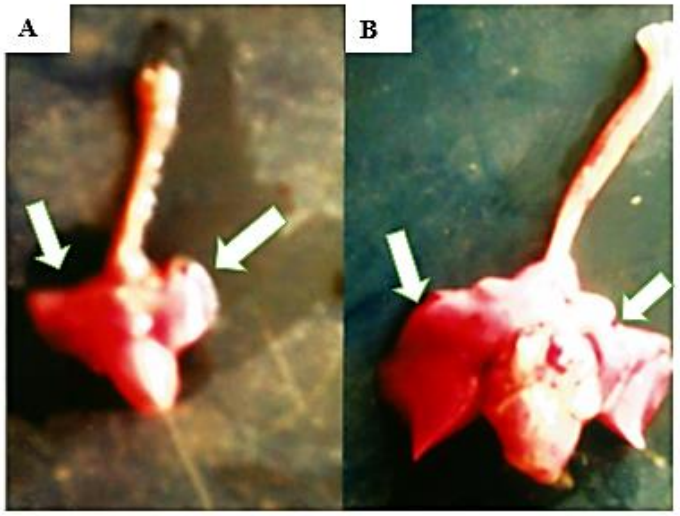

Plate 2. A cross section of the left and right lungs (white arrows) of red Sokoto goat fetuses at 6-7 weeks (A) and 14-15 weeks (B) of gestation.

RESULTS

Grossly, at six weeks of gestation, sub-divisions of the right and left lungs (Plate 2) were identifiable as well as the paraconal and subsinusal interventricular grooves of the heart. The great vessels at the base and pointed apex of the heart were observed. Similar structures were observed in the two-day-old kids. Histologically, the bronchiolar apparatus and alveolar stages of the developing lungs were observed (Plates 3, 4, and 5) at different gestational ages. Cardiac fibers, arranged in branching fashion with centrally located nuclei, were recognized. Large perimysial spaces were seen in progressive fashion (Plate 8). By 14 weeks, the cardiac muscles fibers were well developed recognized with cross striation and with greatly reduced perimysial spaces (Plate 9). In addition, longitudinal intercalated disk of the heart and well-developed bronchiolar system were both observed in the 14 weeks old fetus and the day-old kid (Plates 6, 7 and 10).

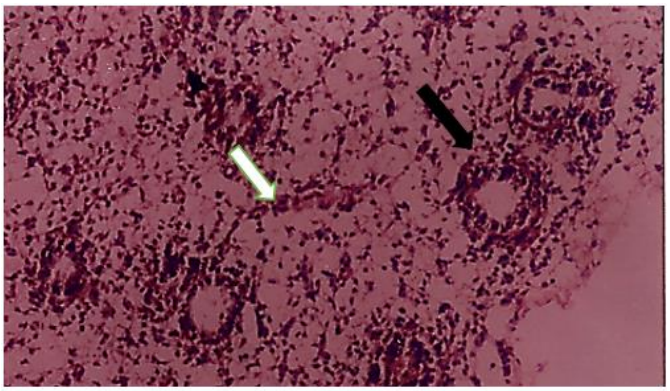

Plate 3. A transverse section of the lung tissue of red Sokoto goat fetus at 6-7 weeks of gestation, showing developing bronchiolar apparatus (white arrow) and alveoli system (black arrow) H and E (x400).

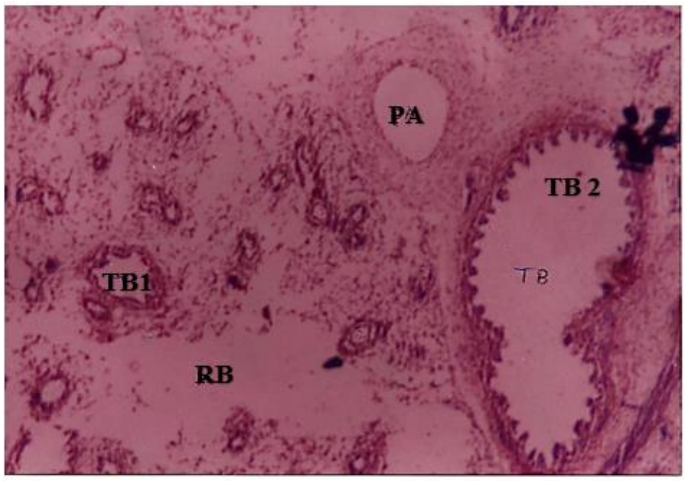

Plate 4. Transverse section of the lung tissue of red Sokoto goat Fetus at 8–9 weeks of gestation, showing developing bronchiolar system: respiratory bronchiole (RB) and terminal bronchiole (TB1) organizing Pulmonary artery (PA) and Tertiary bronchus (TB2) already elaborate H and E (x400).

DISCUSSIONS

In this study, the gross findings of the internal morphology of the heart shows the paraconal (left) and the subsinusal (right) inter ventricular grooves, superficially separates the heart into left and right ventricles and the coronary groove, separating the atria (left and right) from the ventricles were clearly seen at 6 to 7 weeks of gestation as those seen in full term and after birth (day-old kid). The pulmonary veins from the two lungs that entered the heart through separate opening into the left atrium were observed at 6 to 7 weeks of gestation. Kwari et al. (2003) observed the same structure in the Sahel goat at 5 to 6 weeks of gestation. This could be attributed to the similarity in the specie or

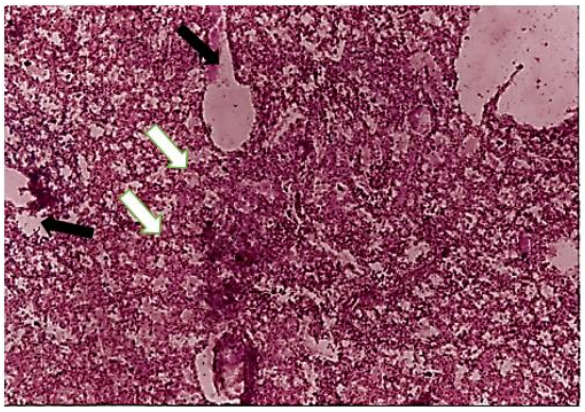

Plate 5. Transverse section of the lung tissue of red Sokoto goat fetus at 14-15 weeks of gestation, showing well developed alveolar cells (white arrows) and respiratory bronchiole (black arrows) H and E (x400).

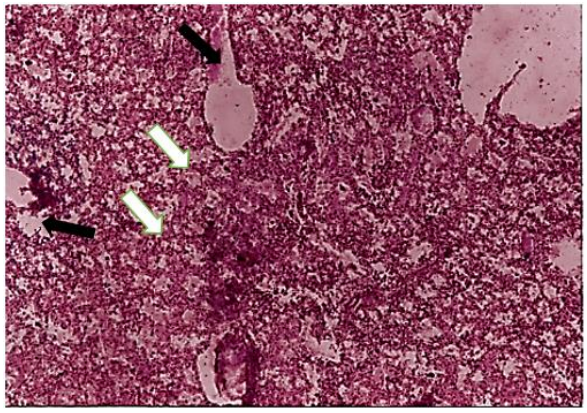

Plate 5. Transverse section of the lung tissue of red Sokoto goat fetus at 14-15 weeks of gestation, showing well developed alveolar cells (white arrows) and respiratory bronchiole (black arrows) H and E (x400).

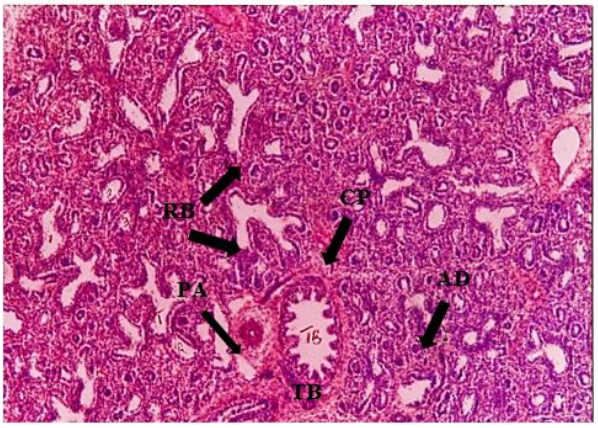

Plate 6. Transverse section of a fully developed lung tissue of a day old red Sokoto goat terminal bronchiole (TB), respiratory bronchioles (RB), alveoli duct (AD), pulmonary artery (PA) and capillary (CP) H and E (x200).

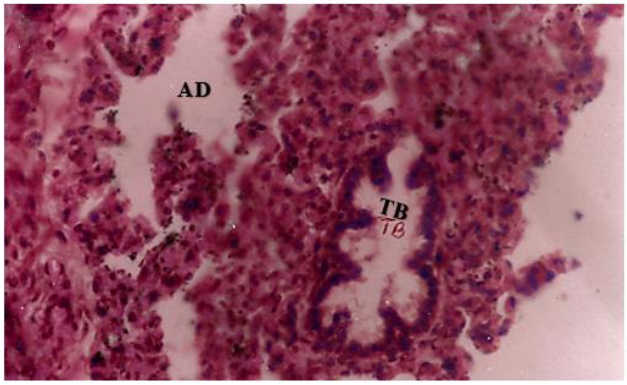

Plate 7. Transverse section of a fully developed lung tissue of a day-old Red Sokoto goat, showing alveoli duct (AD) and terminal bronchiole (TB) H and E (x400).

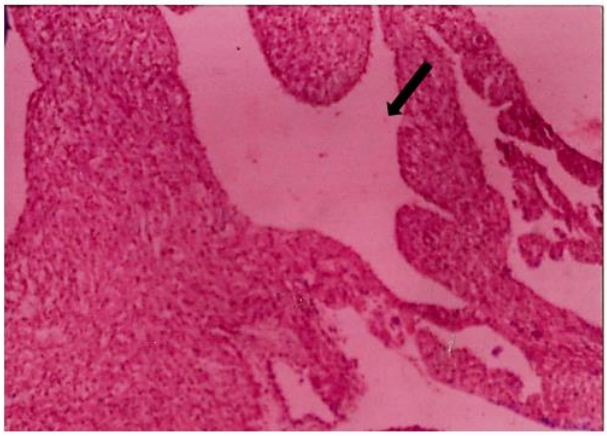

Plate 8. Longitudinal section of the cardiac muscles of red Sokoto goat fetus at 6 to 7 weeks of gestation. The fibres are arranged in a branching fashion with centrally located nucleus and large perimysial space (black arrow) H and E (x400).

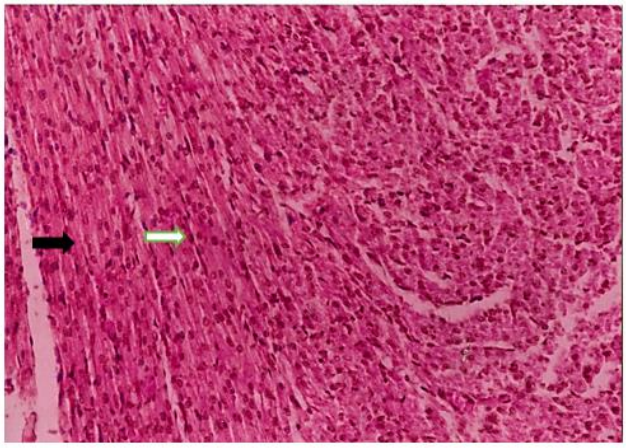

Plate 9. Longitudinal section of the cardiac muscle of red Sokoto goat fetus at 14-15 week of gestation showing cardiac muscle fibres (black arrow) and their nucleus (white arrow) H and E (x400).

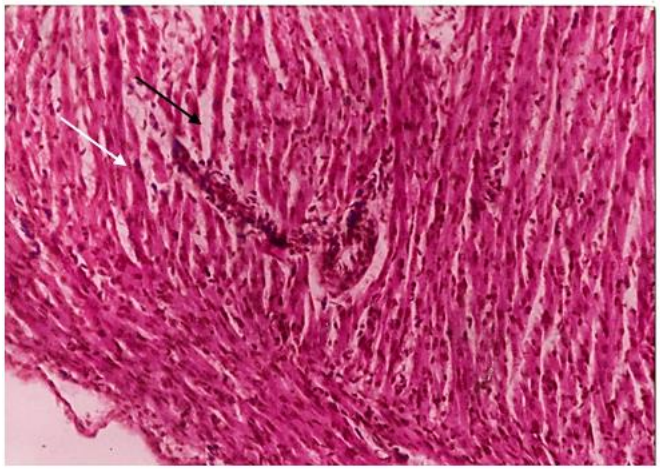

Plate 10. Longitudinal section of the cardiac muscle of a day-old red Sokoto goat, showing fully developed cardiac fibres with centrally located nucleus (white arrow) and reduced perimysial space (black arrow) H and E (x400).

genetic factors. Likewise at 6 to 7 weeks of gestation to the terminal tracheal branches (Primary bronchii) entered the substance of each lung at the hilus and coursing downward, they divided into two small bronchii on the left and three on the right which arose directly from the trachea entered the cranial (apical) lobe of the right lung. The sub-division of the right and left lungs were identified at 6 to 7 weeks too. The right lung showed divisions into cranial (apical), middle (cardiac) and caudal parts, accessory lobe was attached to the medial surface of the middle lobe. These lobations were observed throughout the remaining gestation stages and in the day-old kid. The divisions of the lungs were similar to that observed by Kwari et al. (2003) in Sahel goat, from 5 to 6 weeks of gestation up to the day-old kid. Furthermore, Aspinall and Cappello (2015) and Dyce et al. (2004) observed similar findings in an adult goat.

At 6 to 7 weeks of fetal development, the cardiac muscles fibres were arranged in a branching fashion, with centrally located nuclei. Kwari et al. (2003) observed the same at 5 to 6 weeks of gestation in Sahel goats. In the fetal lung, the bronchiolar apparatus appeared at 6 to 12 weeks; respiratory apparatus at 13 to 15 weeks; and alveolar apparatus at 15 and16 weeks.

Conclusion

The study showed that the lung and heart of the red Sokoto goat fetus, at day old were matured enough for terrestrial life. Furthermore, the fetal lung had reached an advanced stage with the formation of alveolar and respiratory structures that were capable of performing respiratory function at 14 to 15 weeks of gestation. Therefore, in the event of premature birth, the red Sokoto goat fetus can

survive extra uterine life at 14 to 15 weeks of gestation where veterinary care is adequate.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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