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Original Article

Histological differenciation of the prenatal development of bovine kidney

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Abstract

A Histomorphological study was conducted on the kidney of 25 fetuses of the African zebu cattle collected from the Sokoto metropolitan abattoir, over a period of one month at different gestational ages. The approximate age of the fetuses was estimated from the crown vertebral rump length (CVRL) and samples were categorised into first, second and third trimester. Out of the twenty five (25) fetuses at different gestational age used for the study, twelve (48%) were females while thirteen (527%) were males. 10(40%) fetuses belong to first trimester, 10(40%) belong to second trimester and 5(20%) belong to third trimesters of pregnancy respectively. The mean crown vertebrate-rump length (CVRL) ranged from 14.60 ± 2.0 cm at first trimester to 100.50 ± 3.0 cm at third trimester. Histological observation shows that the kidney appeared to have two zones via cortex and medulla right from first to third trimester. The development of renal tissues were found to be in succession, from the stage of mesenchyme cells, developing glomerulus and finally to fully developed glomerulus with advancement of gestational age among the three groups. The duct system also followed the same trend of development from immature to matured duct system. The cortex of the first trimester kidney was found to have numerous mesenchymal cells and connective tissues with few developing glomerulus. At second trimester few fully developed glomerulus were found, moderate number of mesenchyme cells and immature developing duct system. Numerous developed glomerulus and matured duct system with moderate developing glomerulus and connective tissue were seen at third trimester. The medulla at first trimester shows only various types of connective tissue (collagen, reticular and elastic) fibers and mesenchyme cells. At second trimester the medulla was found to have numerous developing collecting ducts, few developed collecting ducts and few mesenchyme cells. Developed collecting ducts were predominant in the medulla at third trimester with few mesenchyme cells. The histological differentiation of the Bovine kidney is similar to that of ovine, caprine, equine, Llama, and guanaco but differs from that of the feline, canine and porcine. Mean while, considering the histological features observed in the study, the Bovine kidney may become fully matured and functional at post-natal age.

1. Introduction

Cattle, common term for the domesticated herbivorous mammals that constitute the genus *Bos,* of the family Bovidae, and that are of great importance to humans because of the meat, milk, leather, glue, gelatin, and other items of commerce they yield [1]. Modern cattle are divided into two species: *B. taurus,* which originated in Europe and includes most modern breeds of dairy and beef cattle, and *B. indicus,* which originated in India and is characterized by a hump at the withers. The latter are now widespread in Africa and Asia, with lesser numbers imported to North America (primarily in the southern United States), Central America, and northern and central South America [1].

Cattle are widely distributed throughout the world. The total world cattle population is estimated to be more than 1.4 billion head, with about 35 percent in Asia, 23 percent in South America, 17 percent in Africa, 12 percent in North and Central America, 10 percent in Europe, and 3 percent in Oceania [2].

Histomorphological studies of pre-natal development of various organs in Bovine spp has been carried out extensively [1,3-8], but little of such studies have been conducted on the developmental changes of the bovine fetal kidney in this area. However, there is thus, paucity of information on the prenatal development of bovine kidney [9]; hence the present study was undertaken to bridge the gap of the existing information.

2. Materials and method

The study was carried out on 25 fetuses of the zebu cattle collected from the metropolitan abattoir, Sokoto at different gestational ages. The collected fetuses were then taken to the Veterinary Anatomy laboratory of Usmanu Danfodiyo University, where the weight and age of the fetus were determined. The fetal body weight was measured using electrical (digital) weighing balance for the smaller fetuses and compression spring balance (AT-1422), size C-1, sensitivity of 20kg X 50g in Kilogram for the bigger fetuses. The approximate age of the fetuses was estimated by using the following formula as adopted by Soliman 1975.

GA = 28.666 + 4.49X [for fetuses less than 20cm]
GA = 73.544 + 2.256X [for fetuses greater than 20cm] ……Where GA is in days

The kidneys of each fetus were collected by placing the fetus on dorsal recumbency and a mid-ventral skin incision was made via the abdomino-pelvic region down to the thoracic region. The abdomino-thoracic content was removed entirely to gain access to the position of the kidneys.

$1cm^2$ thick of sample from each group was collected and fixed in 10% formalin solution. After fixation was achieved, the tissue sample was processed for paraffin blocks preparation. The sections of 5µm were subjected to haematoxylin and eosin for routine morphology [10]. The standard sections were examined under light microscope and micrographs taken using Sony camera with 12.1 mega pixel.

3. Result and Discussion

Out of the twenty five (25) fetuses at different gestational age used for the study, twelve (48%) were females while thirteen (527%) were males. 10(40%) fetuses belong to first trimester, 10(40%) belong to second trimester and 5(20%) belong to third trimesters of pregnancy respectively. The mean crown vertebrate-rump length (CVRL) ranged from 14.60 ± 2.0 cm at first trimester to 100.50 ± 3.0 cm at third trimester as shown in table 1.

From the study, the result shows that with the advancement of gestation the morphometric data were increasing progressively. This is in accordance with the finding of Hena *et al* [11], on pigeon and Bello *et al [12]* on camel digestive tract.

Histological observation shows that the kidney appeared to have two zones via cortex and medulla right from 1st trimester as shown in figures 1-6. The development of renal tissues were found to be in succession, from the stage of mesenchyme cells, developing glomerulus and finally to fully developed glomerulus with advancement of gestational age among the three groups as shown in figures 1-6. The duct system also followed the same trend of development from immature to matured duct system.

The cortex of the first trimester kidney was found to have numerous mesenchymal cells and connective tissues with few developing glomerulus (Fig 1). At second trimester few fully developed glomerulus were found, moderate number of mesenchyme cells and immature developing duct system (Fig 2). Numerous developed glomerulus and matured duct system with moderate developing glomerulus and connective tissue were seen at third trimester. This is in agreement with Onarlioglu *et al.,* (1997) that observed no developed glomeruli in the kidneys where dense mesenchymal tissue take place in early stage of development in rat foetus. The number of mesenchyme cells reduced in the second trimester, together with few fully developed glomerulus and immature developing duct system. There was slight coiling of the duct system at the cortex of the kidney (Fig 3). This is in line with that observed by El-Salmi and Amri (2012) on Sudanese sheep.

The medulla at first trimester shows only various types of connective tissue (collagen, reticular and elastic) fibers and mesenchyme cells (Fig 4). At second trimester the medulla was found to have numerous developing collecting ducts, few developed collecting ducts and few mesenchyme cells (Fig 5). Developed collecting ducts were predominant in the medulla at third trimester with few mesenchyme cells (Fig 6). This is also in line with that observed by Franco *et al.,* (2004) on Llama and El-Salmi and Amri (2012) on Sudanese sheep. At third trimester the kidneys showed predominant developed collecting ducts and few mesenchyme cells, which showed the kidneys, were still developing. This trend of growth was in accordance with the findings of Bello *et al* [12], who reported that variable growth and structural diversities at different stages of development of an organ is a normal phenomenon for accommodating and molding of the organ.

All kidneys were found to be irregularly elongated and reddish-brown in colour. Both kidneys are externally lobulated, in which the intensity of the lobulation increases with the advancement in gestation. The surface was covered with a thin fibro-muscular capsule. This is in accordance with the reports of Smuts and Bezuindenhout [13], Dyce [14], Abdalla *et al* [15], Bello *et al* [12].

Both kidneys were located below the transverse processes of lumbar vertebrae of each side, with the right one being more cranial in all groups. Abdalla *et al* [15] reported that right kidney is situated under the first three lumbar vertebrae while the left one is found under the last three lumbar vertebrae. Bello *et al* [12] also reported that the right kidneys shifted rostrally more than the left in camel embryos. Malik and Vais (1998) also reported that the right and left kidneys shifted rostral with advancement of age in ruminants. This cranial positioning of the kidneys might be due to relative variation in growth of different organs in the abdominal and pelvic cavities during various stages of embryonic development.

Adipose tissue was found at the hilus of each kidney in the third trimester fetuses. Dyce, 1995 reported similar finding in small ruminant, the fat sometime enough to hide the kidney completely. The fat protects against distorting pressures from neighbouring organs. Salehi *et al.,* (2012) also reported that adipose tissue surrounded the hilus and sides of the kidney.

A distinct renal pelvis with a well developed ureter originating from the middle of the renal pelvis was found in all kidneys, similar to Pratt [16], Sarma *et al.,* (2007) and Salehi *et al.,* (2012). This confirms the development of renal pelvis and ureter in early phase of the gestation period in Bovidae embryos (*Salehi and Morovati, 2012*). The right ureter was found to have higher length than the left one in all foetuses. Abdalla *et al [15]* also reported that the right ureter of the camel is longer than the left considering the positions of the kidneys and the bladder in adult kidneys.

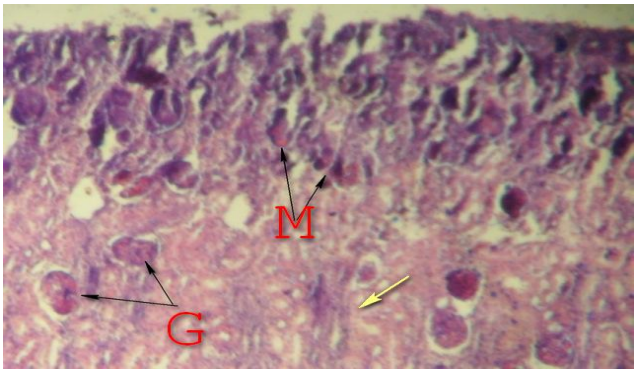

Fig. 1: Photomicrograph of Bovine kidney (cortex) at 1st Trimester showing premature glomerulus (G) and mesenchyme cells (M) H&E x200

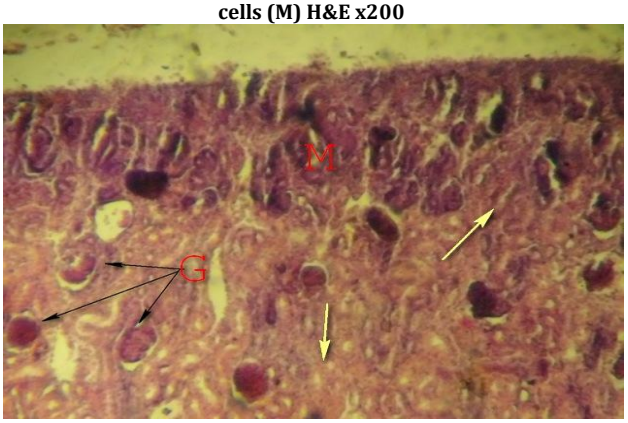

Fig. 2: Photomicrograph of Bovine kidney (cortex) at 2nd Trimester showing premature glomerulus (G), undifferentiated connective tissues (yellow arrows) and mesenchyme cells (M) H&E x200.

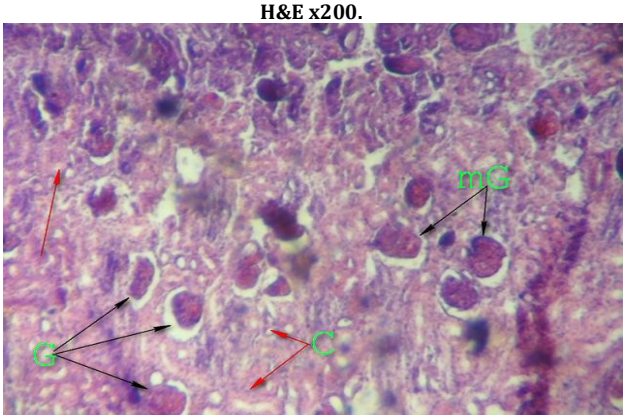

Fig. 3: Photomicrograph of Bovine kidney (cortex) at 3rd Trimester showing mature glomerulus (mG), pre-mature glomerulus (G) collecting ducts (C) and mesenchyme cells (Red arrows) H&E x200.

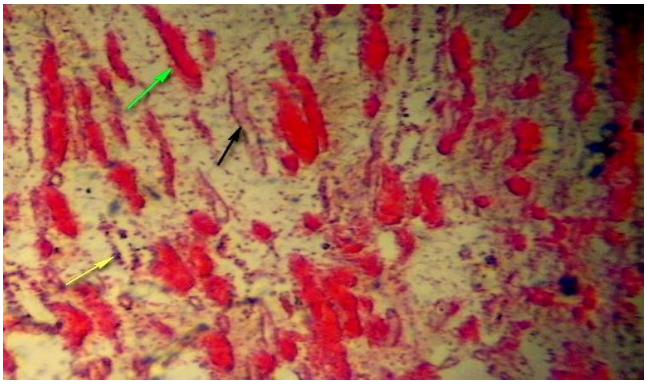

Fig. 4: Photomicrograph of Bovine kidney (medulla) at 1st Trimester showing connective tissues collagen (green arrow), reticular (Black arrow), elastic (blue arrow) and mesenchyme cells (yellow arrows) H&E x200.

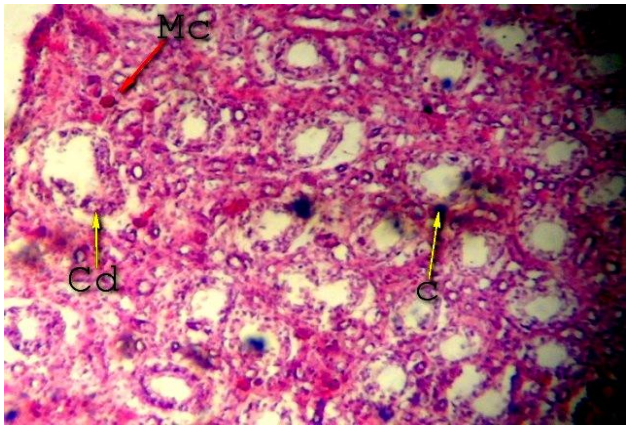

Fig. 5: Photomicrograph of Bovine kidney (medulla) at 2nd Trimester showing developing collecting ducts (Cd), developed collecting ducts (C) and mesenchyme cells (Mc) H&E X200

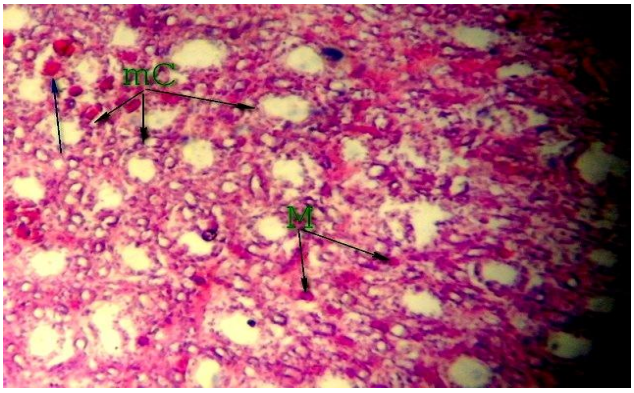

Fig. 6: Photomicrograph of Bovine kidney (medulla) at 3rd Trimester showing developed collecting ducts (mC) and mesenchyme cells (M) H&E X200.

4. Conclusion

In conclusion, the histological differentiation of the Bovine kidney is similar to that of ovine, caprine, equine, Llama, and guanaco but differs from that of the feline, canine and porcine. Mean while, considering the histological features observed in the study, the Bovine kidney may become fully matured and functional at post-natal age.

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References

[1] Reece, W. O. Physiology of domestic animals. Williams and Wilkins. CH. 11, 1997: pp. 334.

[2] Abd-Elmaksoud, A.,(2005). Morphological, glycohistochemical and immunohistochemical studies on the embryonic and adult bovine testis. Ph.D. Thesis, Ludwig-Maximilians-Universitat.

[3] Asari M., Oshige H., Wakui S., Fukaya K., Kano Y. Histological development of bovine abomasus. *Anat. Anz*. 1985; 159: 1-11.

[4] Wilson R. T. Araya, A. and Melaku, A,(1990): The One-Humped Camel: An Analytical and Annotated Bibliography 1980-1989. UNSO Technical Publication. Bartridge Partners, Umberleigh, North Devon EX379AS U.K.

[5] Bustinza, A.V. South American Camelids. In: IFS Symposium Camels. Sudan. 1979: Pp 73–108.

[6] Franco A, Masot A.J, Gómez L, Redondo E. Morphometric and immuno histochemical study of the rumen of red deer during prenatal development. *Journal of Anatomy* 2004; 204: 501–513.

[7] Belknap, E. B.(1994). Medical problems of llamas. In: The Vet. Cl. of North American food and Animal Practice, Update on Llama Medicine. Johnson, L. W. (Editor). Philadelphia, W. B. Saunders Co.

[8] Butler WR, Smith RD (). Symposium: interactions of nutrition and reproduction. *J. Dairy Sci.,* 1989; 72: 767-783.

[9] Luciano, L., Voss-wermbter, G., Behnke, M., Engelhardt, W. V. and Reale, E. Die Struktur der Magenschleeimhaut beim Lama (Lama guanacoe and Lama llama) I. Vormagen. Gegenbauers *Morphol. Jahrb*. 1979; 125: 519-549.

[10] Luiz C. J. and Jose C. (2005): Basic Histology Text and Atlas 11th ed. McGraw-Hill

[11] Hena S.A, Sonfada M.L., Onyeanusi B.I., Kene R.O.C, Bello A. (2012); Radiographic studies of developing calvaria at prenatal stages in one-humped camel. *Sokoto Journal of Veterinary Sciences.* 10(1): Pp13-16. http://dx.doi.org/10.4314/sokjvs.v10i1.3

[12] Bello A., Onyeanusi B.I., Sonfada M.L; Adeyanju J.B., Umaru M.A. A biometric study of the digestive tract of one-humped camel (camelus dromedarius) fetuses, *Scientific Journal of Zoology* 2012; 1(1).Pp 11-16.

[13] Smuts, M.M.S. and A.J. Bezuidenhout. Anatomy of the Dromedary. 1st Edition, Clarendon Press, Oxford, 1987; pp: 129-132.

[14] Dyce, K.M., W.O. Sack and C.J.G. Wensing. Textbook of Veterinary Anatomy. 1st Edn., W.B. Saunders Company, Philadelphia, 1987; pp: 130-133.

[15] Abdel-Raouf, M., M.A. El-Naggar and M.R. Fateh El-Bab. The development of the fetal testis in the buffalo. *Z. Anat. Entwikcl*. Gesch, 1974; 144: 227-236.

[16] Pratt, P.W. Laboratory Procedures for Veterinary Technicians. 2nd Edn., American Veterinary Publications, Inc., California, 1992; pp: 111-116.

