HISTOMORPHOLOGICAL STUDY OF MESONEPHRIC KIDNEY DEVELOPMENT IN PRENATAL STAGES OF RATS (*Rattus norvegicus Albinus)*.

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ABSTRACT

The development of mesonephros kidney study wasdone on the rats **(*Rattus norvegicus Albinus*)**, the study included detection of the timing of appearance of mesonephros kidney. The study revealed that the differentiation and development of the mesonephros kidney began in the rat at 13th day from pregnancy. The study showed that the mesonephros was poorly developed in rat,and the degeneration was began in 15th day of gestation period and end in 17 days gestation period to replace by metanephros (permanent kidney).

Key words: mesonephros ,rat ,prenatal .

INTRODUCTION

In mammals, kidney development is based on the formation of three successive structures: the pro-, meso- and metanephros. The first two are transient structures, whereas the third one will give rise to the definitive kidney .All these structures derive from a common nephrogenic territory in the intermediate mesoderm. They develop successively following a rostro-caudal pattern, the pronephros being the most rostral. During evolution, all these successive embryonic renal structures have been adopted to play a functional role. The pronephros is the functional kidney in the amphibious tadpole and in the fish larvae (Massa ,2012).

Mesonephros: The formation of mesonephros begins with the successive differentiation of solid cell clusters from the nephrogenic cord, caudally from pronephros (Čukuranović *and* Vlajković ,2005). after and just posterior to pronephros and develops in a very similar manner. However, mesonephric tubules may be functional during the embryonic life of mammals (Torres *et al.*,1995).

Received for publication 23 / 4 / 2014 .
Accepted for publication 28 /12 / 2014 .

The mesonephros and mesonephric ducts are derived from intermediate mesoderm from upper thoracic to upper lumbar. During regression of the pronephric system, the first excretory tubules of the mesonephros appear. They lengthen rapidly, form an S-shaped loop, and acquire a tuft of capillaries that will form the glomerulus at their medial extremity. Around the glomerulus the tubules form Bowman's capsule, and together these structures constitute the renal corpuscle. Laterally the tubule enters the longitudinal collecting duct known as the mesonephric or wolffian duct (Sadler, 2010).

The size of the mesonephros correlates to some extent with the type of placenta and how well the placenta cleans the blood. thus,it is largest in species with epitheliochorial placenta such as the pig and sheep,and smallest in carnivores with aendothelio chorial placenta(Krause *et al.*,1997).

The mesonephros is found in all mammals at some stage of their development, but the degree of maturation and duration varies in different species, the general morphology of the mesonephros has been described in a number of mammals (Tiedemann and Egerer,1984) including man, In species such as the rat and human it appears early and then rapidly degenerates. In the pig, sheep and cat the mesonephros becomes a prominent abdominal organ which persists until relatively late into the fetal period, In the opossum the mesonephros persists, apparently in a functional state, for at least the first 10 days of the postnatal period (Krause *et al*.,1979).

The mesonephros is functional in only some mammals (related to placental layers). However, the mesonephros becomes the functional kidney of adult fish & amphibians (Hammerman, 2004).

The mesonephros of the newborn opossum (14 cm) is a large, well developed organ consisting of several nephrons separated by delicate connective tissue, Four components of the mesonephric nephron can be recognised: a renal corpuscle, a proximal tubule, a distal tubule and a collecting tubule, Each mesonephric tubule generally forms a double loop with the medial portion connected to a renal corpuscle; the lateral end drains into the mesonephric duct (Krause *et al*. ,1979).

The mesonephros of the opossum persists for 3-4 weeks into the postnatal period. Based on our observations of its structure, and the vital dye experiments of others, it appears that the opossum mesonephros is functional during the first 10 days of the postnatal period (Hyttel *et al.*,2010).

The mesonephros in the camel embryo (*Camelus dromedarius*) at 0.9 cm crown vertebral rump length (CVRL),embryo is represented by a narrow strip along the roof of the thoracolumbar part of the vertebral column, while at 1.4 cm (CVRL), some of the mesonephric tubules are canalized but others are still solid and at 4.7 cm (CVRL) continuous regression of the mesonephros from cranialwards to caudalwards is observed and at 5.3-5.5 cm (CVRL), the cranial part of the mesonephros is divided into medial and lateral regions, and later the medial region completely disappears and is replaced by the primordium of the adrenal gland and finally the caudal part of the mesonephros completely disappears at 8.6 cm (CVRL**)** (Aly,2007).

MATERIALS AND METHODS

The study was performed on forty five rat embryo collected from uteri of the pregnant animals in estimated ages, five fetuses prepared for every stage beginning from 13, 14, 15, 16, 17 days by which gestation occurred. All fetuses ages were estimated according to the days assumed to have elapsed from copulation (Queenan, 1999). The crown-rump length (CRL) will measure for corrections. CRL (is the measurement from the vertex of the skull to the midpoint between the apices of the buttocks for prenatal only (Arthur, 1989). The CRLs at each stage are summarized in the table (Aly, 2007). The body weight was recorded for each prenatal fetuses by using sensitive balance. The body weight was recorded before the fetuses were sacrificed. The mean weight at each stage is summarized in the table (Arthur, 1989).

Procedure of samples preparation was done as follow : A-The samples were dissected and washed with normal saline solution (0.9%) NaCl and fixed immediately in 10% formalin at room temperature. B-Dehydration: this step was done to remove water from the histological specimens, by using a graded series of ethanol (50%, 70%, 80%, 90%, and 100%), two changes for each one, and 2 hours for each concentration. Clearing and embeding: the free water specimens were transferred from 100%alchohol to xylene. The penetration of xylene was indicated by the clearing effect which accompanies it. Then the specimen transferred to melted paraffin wax (M.P. 58-60 c), and put into the oven where it must remain until it has become completely infiltrated with paraffin. D-Cutting and staining: Sections measured 5-7micrometer thickness were cut by using the rotary microtome and stained routinely with hematoxylin and eosin (Massam, 2012).

RESULTS AND DISCUSSION

Mesonephric development:

At 13th day of gestation:

In the present study embryo had crown rump length about 3.4±0.2091 mm and with 0.084 ± 0.0044 mg body weight and number of somite about 40-48 , The parasagittal section of embryo appear the distal degenerated part of pronephric in cervical region found with narrow band of mesonephric had many vesicles, in the thoracic region just caudal to the regression of pronephros (Fig. 1). The mesonephros was located more caudally in respect to the pronephros, on the other hand the cross section of embryo shows nephrogenic cord blastema which differentiated from intermediate mesoderm as well as dark condensed cluster cells on the both side of aorta (Fig. 2).The mesonephric kidney (mesonephros) is a temporary organ that precedes the development of the permanent kidney in mammals,In the parasagittal section of embryo the mesonephros apperance is long, small in size and relatively narrows with crescent shaped body extend in thoracic region and its located positional in relation to the dorsal body wall. The mesonephros had spherical vesicles. The vesicles represented the formation of anlage of glomeruli in mesonephros, while the tubules were simple and no morphological differentiation connected to mesonephric duct (Fig.3). The cross section of embryo shows the Clusters of mesonephric tubules (and associated ducts) form swellings on either side of the embryo in the thoracic and lumbar region on each side of aorta which called nephrogenic cord (nephrogenic ridge), mesonephric duct was found in the lateral surface of the cord, this duct extend from the degenerated pronephric duct, some small vesicle also found and condense mesenchymal cells, vesicle form from aggregation of mesenchymal cells and later envagenated to form another shape such coma shape(Fig.3).

At 14th day of gestation:

Embryos difficult to be separated from the uterus; however, it proved to be difficult to take them out of the embryonic sac without damaging the tissues, the weight of the body was 0.124 ±0.0043 gm (Table,1), number of somites from 50-55 somites and crown rump length was about 3.7±0.3354 mm (Table,1). In cross-section, the mesonephros location was closely related to the developing organs in body embryos e.g. aorta, coelum, gut mesentery, posterior cardinal vein and subcardinal vein at the level of umbilical region (Fig. 4), the

mesonephroic cord had mesonephric duct (pronephric duct Previously), as well as the section emerge S-shape, from which glomeruli should develop, a tubular with tall cubic cell and central round nuclei also depreciated (Fig. 5).

The mesonephros glomeruli were vascularized by a very small capillaries which interlaced between the mesonephros tubules and arise from dorsal aorta where exchange of materials occur then the blood enter collecting veins which were located in the dorsal aspect of the mesonephros and more or less circularly disposed about it. These collecting veins terminate in the posterior cardinal vein forming anastomosing system by which the blood was eventually returned to the general circulation (Fig. 6). The fenestration of capillaries is a compensating abundance of capillaries was poor in the mesonephros.

The cross results of this study showed the parasagittal section of embryo in 14 day of gestation period, the mesonephros became more large and more broad and extended in the thoraco-lumber region with two extremity cranial and caudal one, mesonephros, the bulk, crescent mesonephros confined dorsally by the somit and ventrally by gonad ridge (Fig. 7), cranial mesonephros had well developed tubules and fully differentiated more than the caudal extremity, the mesonephric duct found in the end of the caudal extremity, a few mesonephric tubules emerge in the cranial part of mesonephros, Epithelial cells lining tubules was cubiodal to columnar cells, poorly development glomerulus (rudimentary glomeruli), small, with bowman's capsule, thin parietal layer and columnar visceral layer (Fig. 8). So the present work observed that the mesonephros was poorly development with very few glomerular which begin as vesicle and S-shapand tubules, and this tubules much in cranial part of the mesonephros, as well as very few tubules in the distal part.

At 15th day of gestation:

Embryo was more developed in this age, Embryos could be separated from the uterus, embryo crwon rump length about 9.8±0.2236, the weight of the body was 0.282 ± 0.0082 gm (Table,1), number of somites rengad from 59- 62 somites (Table 1), The present study was revealed that the mesonephros did not develop further and begins to undergo regression, and become shortened at anterior end (Fig. 9)While the caudal tubules were still differentiating, cranial tubules and glomeruli show degenerative changes, The mesenephric ducts regress in the female, but in male the mesonephric ducts plus a few modified mesonephric tubules persist and form parts of the male genital duct system. In cross section of embryo the light microscopic examination was revealed the

presence of cranial tubules of the mesonephric that undergo extensive regression, (Fig. 10), the caudal end regresses as well, but some of their cellular components contribute to the gonads. The mesonephric ducts largely regress in the female but form parts of the genital duct system in the male, the regression area appeared many apoptotic region and tubules with degenerated their epithelial lining.

At 16th day of gestation:

the body weight of rat embryo in present study about 0.452 ± 0.0065 gm (Table 1), number of somites from 10-12 and the body of the embryo was extremely curved, and the crown rump length was approximately 17.4±0.570 mm, (Table,1), microscopic examination in this study showed continuous regression of mesonephric tubule and converted to the connective tissue (Fig. 11), cross and para sagital section appear very small regress part of mesonephros,

At 17th day of gestation:

The body weight of rat embryo in present study was about 1.18±0.0086 gm (Table,1), number of somites renged from 10-12 somites and the body of the embryo was extremely curved, and the crown rump length was approximately 25.2±0.7416 mm, completely degenerated and disappear, in females regression leads to a total disappearance of the organ wheares in male the most caudal part of tubule and mesonephric duct will give rise to the genital organs. (Fig. 12)

Previous results showed that the mesonephros is functional only during a short period of time and rapidly degenerates. Only few vestigial tubular structures derived from the mesonephros were involved in the development of the male reproductive system, degenerated begin at 15 day gestation and finished in 17 day gestation.The mesonephros, located more caudally in respect to the pronephros, on the other hand the cross section of embryo showed nephrogenic cord blastema which differentiated from intermediate mesoderm as well as dark condensed cluster cells on the two side of aorta,This result the was same as Yokoo (2006) who said The mesonephron was the second system in rat which start to be differentiated at day 12.5, it develops caudally to the pronephron, but the result differ from Esquela (2003) who find The mesonephros appears at E9.5in mice when the pronephric duct (Wolffian duct) extends caudally to the cloaca and induces the adjacent mesonephric mesenchyme to condense and form a linear array of nephric tubules. Both the

pro- and mesonephros regress shortly after their formation, and same with Oda(1985) reported in bovine Caudal to the pronephros and at approximately the level of 9^{th} through 26^{th} somites, 70-80 pairs of mesonephric tubules develop. These tubules were temporarily functional and their formation is initiated by the existence of the pronephric duct.The cross section of embryo show the Clusters of mesonephric tubules (and associate ducts) form swellings on either side of the embryo in the thoracic and lumbar region on each side of aorta which called nephrogenic cord (nephrogenic ridge), This was similar to what mention Čukuranović and Vlajković (2005). the formation of mesonephros begins with the successive differentiation of solid cell clusters from the nephrogenic cord, caudally from pronephros, and these characters were mention earlier by Luna,(1968), in embryo rabbits the tubules were simple, S-shaped and show no morphological differentiation into segments.

This agreed with the Esquela and Lee (2003) who confirmed that the mesonephros was appears at E9.5in mice when the pronephric duct (Wolffian duct) extends caudally to the cloaca and induces the adjacent mesonephric mesenchyme to condense and form a linear array of nephric tubules, Both the pro- and mesonephros regress shortly after their formation, The formation of mesonephros begins with the successive differentiation of solid cell clusters from the nephrogenic cord, caudally from pronephros Čukuranović and Vlajković (2005).

The mesonephros glomeruli are vascularized by a very small capillaries which interlaced between the mesonephroi tubules and arise from dorsal aorta,This was the same with the Hyttel(2010) who statid that the major vessels supplying the kidney originate from the embryonic aorta through a process of angiogenesis.The mesonephroic cord had mesonephric duct (pronephric duct Previously), as well as the section emerge S-shape, from which glomeruli should develop, a tubular with tall cubic cell and central round nuclei also depreciated in mouse ,and agreed which Smith and MacKay (1991), in mouse who said Glomerulus-like structures were found very rarely at Stages 18 and 19, and consisted of little more than capillaries opposed to the ventral aspects of the tubules. The S-shaped bodies, from which glomeruli should develop, either degenerated at Stages 19 and 20 or remained as tubules. The mouse mesonephros may therefore be considered non-functional.

The mesonephros undergoes extensive regression begin in 15 days, These results were correspond with what earlier reported by Bard (2006). that in

mouse mesonephros develop in E10 gestation this epithelial tissue continues to proliferate and extend caudally contains mesenchymal cells into which extend epithelial branch tubules from the nephric duct and epithelial vesicles that are not branches off the nephric duct morphology remains unchanged but, while extending at its caudal part, it was starting to regress through apoptosis. This study result was not agreed with Aly, (2007) who report that mesonephros in camal regressed from cranial wards to caudal wards was observed and at 5.3-5.5 cm (CVRL), Mesonephros tubules degenerated in human in (4 -8) week, begun from anterior part, and, degenerated in (8-9)weak in horse and (10) weak in bovine just mention by Bernardini *et al*. (2001) and, Yokoo,(2006), in pigs at around 50 days and in dogs at approximately 36 days by Weichert (1951). Completely degenerated and disappeared in 17 days gestation period, in females regression leads to a total disappearance of the organ, Previous results showed that the mesonephros was functional only during a short period of time and rapidly degenerates. Only few vestigial tubular structures derived from the mesonephros are involved in the development of the male reproductive system, degenerated begin at 15 day gestation and finished in 17 day gestation, and this the same as Saxen,(1987), who found in that the mesonephric kidney regresses prenatally in mammals. The degradation was completed in rat by embryonic day 17and in mouse by day 15.Mesonephros of rat in the present study stays only for a short period with poorly glomerulus and tubules this is in the variane with pig, sheep and cat the mesonephros becomes a prominent abdominal organ which persists until relatively late into the fetal period and The mesonephros of the opossum persists for 3-4 weeks into the postnatal period this mentioned by Leeson and Baxter (1957).

Regresion of mesonephros in animals was diferent which found by many authors, Mesonephros tubules degenerated in human in (4 -8) week, begun from anterior part, and, degenerated in (8-9)weak in horse and (10) week in bovine found by Bernardini (2010), in pigs at around 50 days and in dogs at approximately 36 days which show by Mohamed (2005). These differences in the long period in which stay mesonephros kidney and then regressive due to variation in pregnancy periods length among the animals, physiological and functional differences and also variation in habits of environmental accommodation and coexist behavior in which animals lived, that's where pregnancy length in human 40 weeks, in sheep 150 days, guinea pig 63 days, spiny muose 40 days, mouse 20 days, rat 22 days, rabbit 32 days, pig 112 days which report by Sadler (2010).

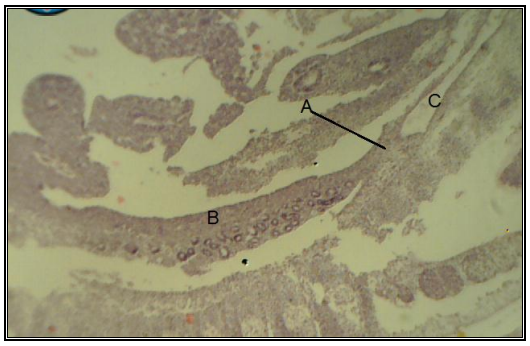

Figure 1: Parasagittal-section at 13th day of gestation in rat showing Pronephros and Mesonephros A- Degenerating pronephric tubules B-Mesonephros C-dorsal aorta (**H&E. 40X)**.

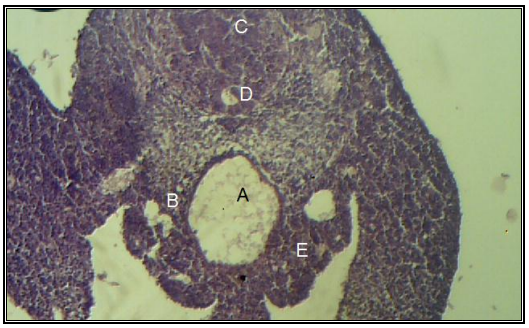

Figure 2:Cross-section of rat embryo at 13th day of gestation showing mesonephros. A-Dorsal aorta B-Posterior cardinal vein C-Neural tube D-Dermatome E-Myotome F-Sclerotome H-Notochord M-Mesonephric cluster cells **(H&E. X 100)**.

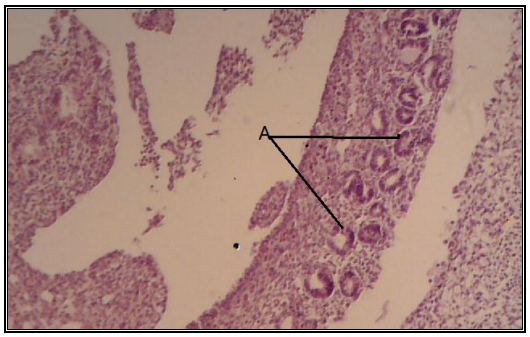

Figure 3: Parasagittal-section at 13th day of gestation in rat showing mesonephros A-mesonephros tubules (**H&E. 100X)**.

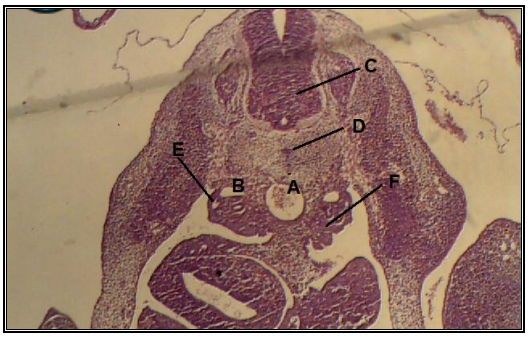

Figure 4: Cross-section of rat embryo at 14th day of gestation showing mesonephros ridge A-Dorsal aorta B-Posterior cardinal vein C-Neural tube D-noto chord E-mesonephric ridge. **(H&E. X 100)**.

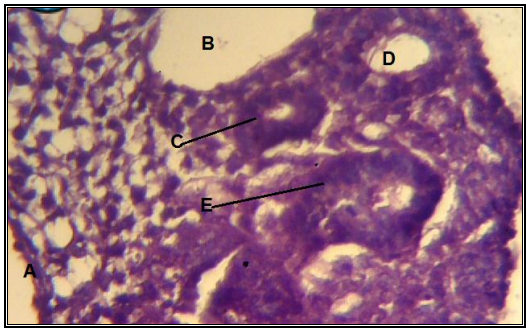

Figure 5: Cross-section of rat embryo at 14th day of gestation showing mesonephros ridge A-Dorsal aorta B-Posterior cardinal vein C-tubule D-mesonephric duct C- S-shape **(H&E. X 40)**.

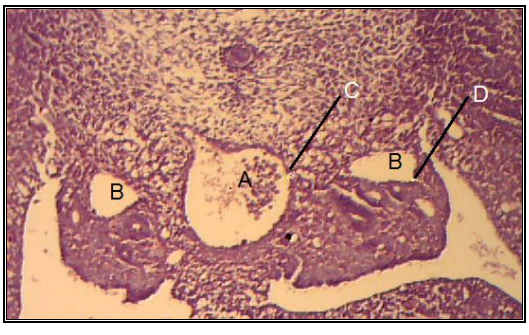

Figure 6: Cross-section of rat embryo at 14th day of gestation showing mesonephros ridge and their blood supply A-Dorsal aorta B-Posterior cardinal vein C- small capillaries from aorta D- small vein **(H&E. X 4)**.

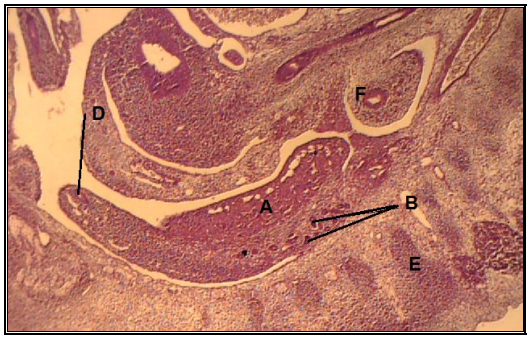

Figure 7: Parasagittal-section of Mesonephros at 14th day of gestation in rat. A- Gonadal ridge B- Mesonephric tubules D- Mesonephric duct E- Somites F- Intestinal loop **(H&E.X10)**.

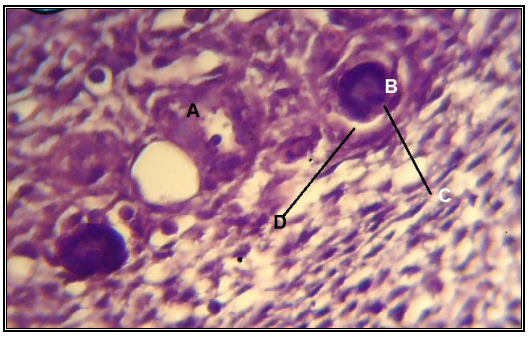

Figure 8: Shows parasagittal-section of Mesonephros at 14th day of gestation in rat. A- Proximal tubules B- Mature glomeruli of Mesonephros C- Parietal layer D- Visceral layer **(H&E.X40).**

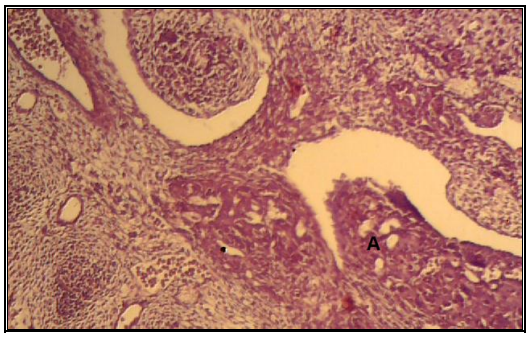

Figure 9: parasagittal-section of Mesonephros at 15th day of gestation in rat show the cranial degeneration of mesonephros tubules A- Proximal tubules **(H&E.X40)**.

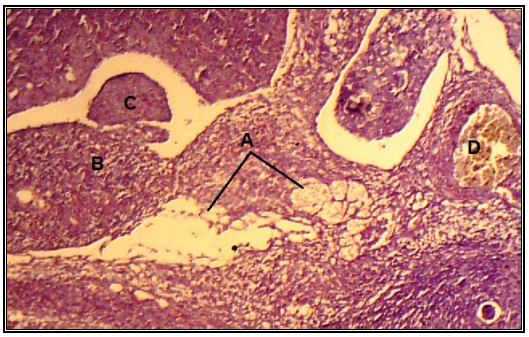

Figure 10: Cross-section at 15th day of gestation in rat showing degeneration of Mesonephros A- Degeneration of Mesonephros tubules B- Metanephros C- Gonadal ridge D- dorsal aorta **(H&E.X4)**.

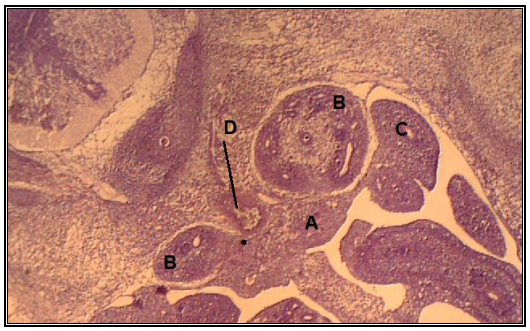

Figure 11: Cross-section at 16th day of gestation in rat showing continues degeneration of Mesonephros A- Degeneration of Mesonephros tubules B- Metanephros C- Gonadal ridge D- dorsal aorta **(H&E.X40).**

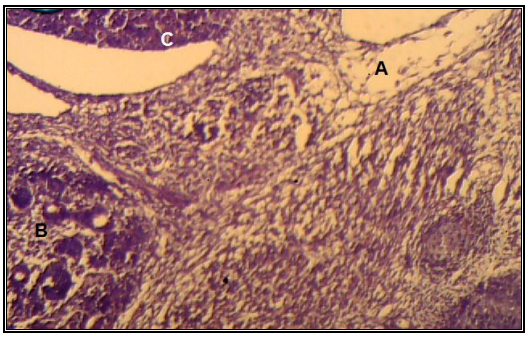

Figure 12: Parasagittal-section at 17th day of gestation in rat showing continues degeneration of Mesonephros A- Degeneration of Mesonephros tubules B- Metanephros **(H&E.X40)**.

REFERENCES

Aly, K. H. 2007. Development of the Mesonephros in Camel (Camelus dromedarius). Anatomia, Histologia. Embryologia. 1(36): PP58-61.

Arthur, G. H., D. Noakes, and H. Pearson. 1989. Veterinary Armed Forces Institute of Pathology". 3rd ed. McGraw-Hill Book Company. PP:3- 34.

Bard, J. 2006. CARO Use Case: The early development of the mouse urogenital system. University of Edinburgh.

Bernardini, N., L. Mattii, , F. Bianchi , I. Daprotta, and A. Dolfi . 2001. Gfalpha mRNA expression in renal organogenesis: a study in rat and human embryos. Exp. Nephro.vol (2)PP:90-98.

Čukuranović R. and S. Vlajković . 2005. Age related anatomical and functional characteristics of human kidney. Series: Medicine and Biology Vol.12, No 2, pp. 61 - 69.

Esquela A. F. and S. Lee .2003. Regulation of metanephric kidney development by growth/differentiation factor 11. Developmental Biology 257, pp356-370.

Flecknell, P. 2002.Sexual cycles in reproduction and Breeding Techniques for Laboratory Animals. E.S.E. Hafez, ed. Lea and Febiger, Philadelphia. pp: 107-122.

Hammerman, M. R. 2004 . Renal Organogenesis from Transplanted Metanephric Primordia. J Am Soc Nephrol. 15: 1126-1132. Heinemaun. Britain and oxford. pp:1- 18.

Hyttel, P., F. Sinowatz, , M. Vejlsted, and K. Betteridge, .2010 . Domestic animal embryology. Saunders Elsevier. New-York, London and Sydney. pp: 1-24.

Krause, W. J., J.H. Cutts, and C. Leeson . 1979 . Morphological observations on the metanephros in the postnatal opossum, Didelphis virginiana. Journal of Anatomy. 129(3): pp459-477.

Leeson, T.S. and J.Baxter, .1957. The correlation of structure and function in the mesonephros and metanephros of the rabbit. J. Anat. (Lond). 91:pp 383-390.

Luna, L.G. 1968 . "Manual of Histological Staining Methods of the armed forces institute of pathology .3 ed Mc Graw-Hill book company.pp:3-34.

Massa F. M. 2012 . The crucial roles played by HNF1β during kidney development. Université Paris-Descartes. Pp:30-105.

Mcgeady, T. A., P. Quinn, E. Fitzpatrick and M. T. Ryan .2010 . Veterinary embryology. Blackwell publishing Ltd. P: 233-243.

Mohamed A. 2005 . Glycohistochemical, Immunohistochemical and Ultrastructural Studies of the Bovine Epididymis. A thesis submitted for

the Doctor Degree in Veterinary Medicine Faculty of Veterinary Medicine Ludwig- Maximilians- Universität, München. Dakahlia-Egypt.

Oda, S. 1985 . Suncus Murinus. Tokyo: Japan Scientific.pp:102-11.

Queenan, J. 1999 . Fetal medicin. Harcourt brace and combany, second edition. Reproduction and Obstetrics. 6th edition. Bailliere. Tindall, London. pp: 59.

Sadler, T. W. 2010 . Langman's medical embryology. 11th ed. Williams and Wilkins, USA. pp: 247-280.

Saxen L. 1987. Organogenesis of the kidney. Developmental and cell biology 19. Cambridge University Press, Cambridge, Mass.

Smith, C. and S. MacKay. 1991 . Morphological development and fate of the mouse mesonephros. J. Anat. 174: 171-184.

Tiedemann, K. and G. Egerer.1984. Vascularization and glomerular ultrastucture in the pig mesonephros. cell tissue Rea. 238: pp:165-175.

Torres M., E. Gomez, G. Dressler and P. Gruss.1995 . Pax-2 controls multiple steps of urogenital development. University of Michigan, Ann Arbor, MI 48109, USA. Development 121, 4057-4065.

Weichert, C. K. 1951 . The anatomy of the chordates. McGraw-Hill Book Company, INC. New-York, Toronto, London. P: 295-314.

Yokoo T., Akira A.Fukui, T. Ohashi, Y.Miyazaki, Y.Utsunomiya, T.Kawamura, T. Hosoya, M. Okabe and E.Kobayashi, 2006. Xenobiotic Kidney Organogenesis from Human Mesenchymal Stem Cells Using a Growing Rodent Embryo. J. Am. Soc. Nephrol. 17: pp:1026-1034.

دراسة نسيجية لتطور الكلية المتوسطة في مراحل قبل الولادة في الجرذان *(Rattus norvegicus Albinus)*

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المستخلص

أجريت الدراسة على الجرذان من نوع (*Rattus norvegicus Albinus*) للتعرف على نشوء الكلية الوسطية، وقد تضمنت الدراسة تحديد موعد ظهور الكلية الوسطية بعمر 13 يوماً من الحمل، وأظهرت الدراسة أن الكلية الوسطية ضعيفة النمو في الجرذان ، وعملية التنكس للكلية الوسطية تبدا بعمر 15 يوماً وتنتهى بعمر 17 يوماً لتستبدل بالكلية البعدية (الكلية الدائمية).

الكلمات المفتاحية : الكلية الوسطية ، الجرذان ، قبل الولادة.