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Original Research Article

Histological Study of Juxtaglomerular Apparatus Development in Sheep: Comparative Study during Embryonic Period and Postpartum

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Abstract: The present work was designed to investigate the characteristic features of histological changes that occurred in juxtaglomerular apparatus development of local domestic Iraqi sheep embryo and lambs Awasi sheep (Ovis aris) at different during gestation stages until birth. To conduct this goal, firstly the prenatal specimens from sheep embryo collected from 12 female's pregnant ewe at three different ages of 40 and 120 days prenatal and 30 day postnatal (four fetuses, lamb for each group), then used Routine histological stain haematoxyline and Eosin stain (H&E). Result show the juxtaglomerular apparatus development in the current study appeared in the Microscopic examination of kidney samples at 40 day age the juxtaglomerular apparatus was not developed in first trimesters of gestation in renal corpuscles and the embryo at 120 day age show The juxtaglomerular apparatus evolution became clear and relatively complete that consists of macula densa cells as row of cell in position in distal tubules and juxtaglomerular cells become clear and large nuclei and the lacis cell (mesangial cells) become more prominent in renal corpuscle that formed firstly histological. While the juxtaglomerular apparatus at 30 days postnatal of sheep it Very clear histological differentiation with higher cells that content elongated nuclei of macula densa cells, The presence of more mature juxtaglomerular cells near the entrance of the glomerulus was noted.

Keywords: Histology, Embryology, Sheep, Juxtaglomerular Apparatus, Development.

INTRODUCTION

The juxtaglomerular apparatus in the kidney specialized histological structure, that plays a crucial role in fluid homeostasis keeping and cardiovascular through functional capabilities and structure of cellular histology (Castrop *et al*., 2010; Sequeira-López and Gomez, 2010). The juxtaglomerular apparatus consist of three part the macula densa cells in the distal convoluted tubule and lacis cells (extraglomerular mesangial cells) and the juxtaglomerular cells (granular cells) Figure 1. (Taugner and Hackenthal, 1989; Sabeh, 2025). During development this cells undergo progressive morphological changes and transitioning from undifferentiated cells in to mature (Gomez *et al*., 1997). Because of its fundamental significance in comprehending renal maturation and functional capacity, the developmental histogenesis of the JGA has attracted a lot of attention. Mid-gestation marks the beginning of cellular differentiation, which continues throughout the perinatal period. The formation of JGA components during embryonic development follows a highly coordinated temporal sequence. (Gomez and Norwood, 1995; Sequeira-López and Gomez, 2011). Detailed histological studies of the JGA's developmental progression from embryonic stages through parturition are still scarce, especially in sheep animals, despite a wealth of research on the functional aspects of the JGA's. therefore the aims of study was designed to describe the sequential histological development of ureter JGA's during Prenatal stage until postpartum at Awassi sheep to provide detailed understanding of development of the urinary system for comparative model for other mammals.

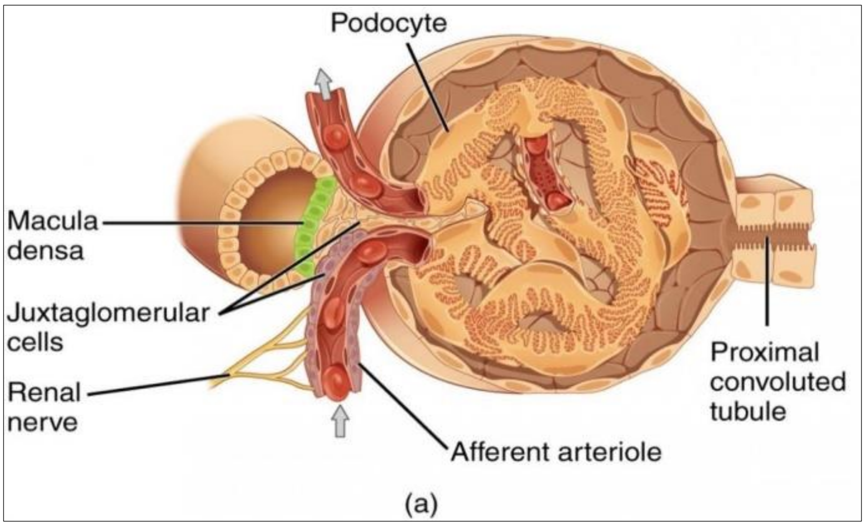

Figure 1: The juxtaglomerular apparatus with glomerular. (Betts *et al.,* 2022).

MATERIAL AND METHODS

The research is done on 12 sheep fetuses and lamb each at prenatal stage that come from healthy pregnant ewes that were slaughtered in an abattoir. The sheep fetuses at prenatal stages are divided into two groups according to the gestational age each group 4 animals, which was assessed based upon their crown-rump length with restrict to formula (Y=2.74X+ 30.15) where 'Y' is the developmental age of fetus in days and 'X' is the crown-rump length in cm (Gall *et al*., 1994). And postnatal group 4 animals after collection of the fetuses from pregnant females, the Fetuses in different stages were used and removing the kidney, Collecting the samples kidney was Fixing in the formalin (10) % then processing of histological technique **(**Suvarna *et al*., 2018**)**. For the Histological Study by Light Microscope.

RESULT

The current study appeared the Microscopic examination of kidney samples of sheep embryo at 40 day age shows, that juxtaglomerular apparatus was not developed in first trimesters of gestation in renal corpuscles (Figure 2, 3). While the Microscopic examination of kidney samples of sheep embryo at 120 day age show the juxtaglomerular apparatus The evolution became clear and relatively complete that consists of macula densa cells as row of cell in position in distal tubules and juxtaglomerular cells become clear and large nuclei with eonded and the lacis cell (mesangial cells) become more prominent in renal corpuscle that formed firstly histological (Figure 4, 5). and the Microscopic examination of kidney samples of sheep at 30 day age postnatal show the juxtaglomerular apparatus Very clear histological differentiation with higher cells that content elongated nuclei of macula densa cells, The presence of more mature juxtaglomerular cells near the entrance of the glomerulus was noted (Figure 6).

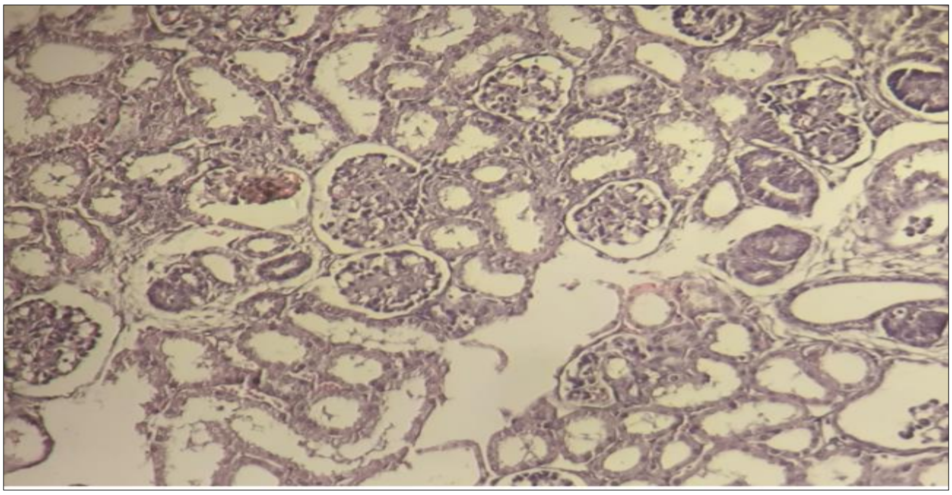

Figure 2 :The Microscopic section of kidney of sheep embryo at 40 day age shows, that juxtaglomerular apparatus was not developed (H and E stain 10X)

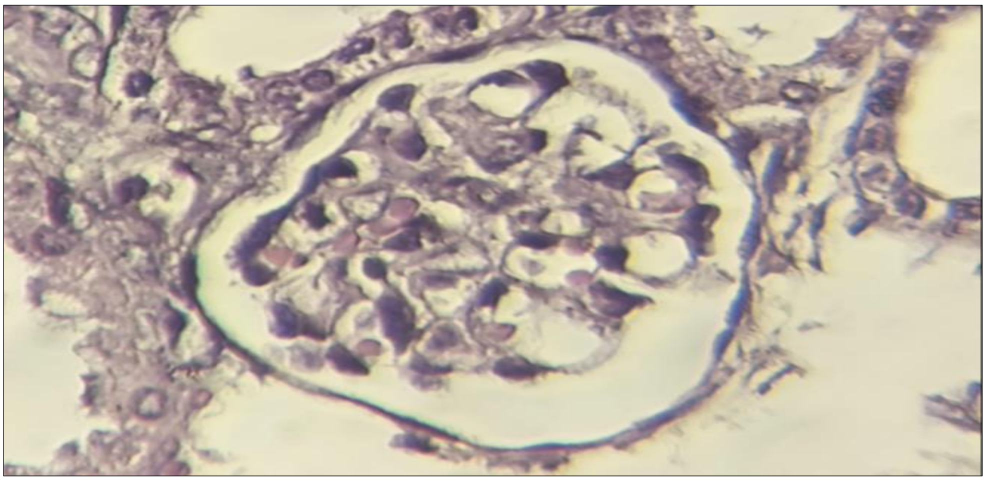

Figure 3 :The Microscopic section of kidney of sheep embryo at 40 day age shows, that juxtaglomerular apparatus was not developed (H and E stain 40X)

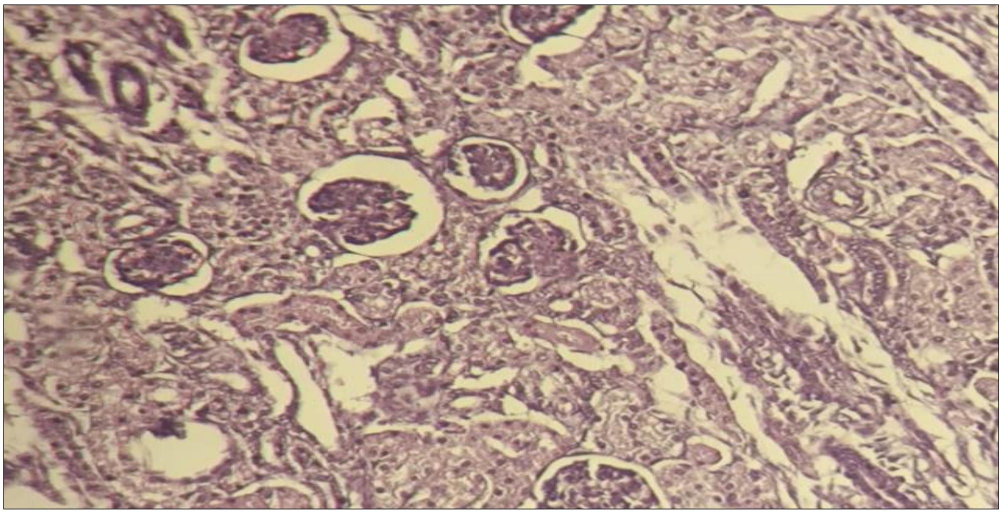

Figure 4: The Microscopic Section of kidney of sheep embryo at 120 day age show the juxtaglomerular apparatus The evolution became clear and relatively complete that consists of macula densa cells as row of cell in position in distal tubules (H and E stain 10X)

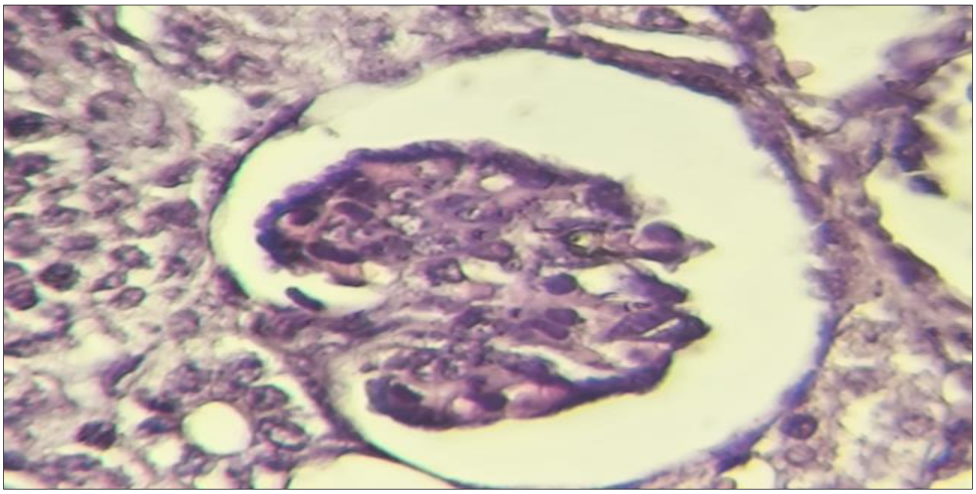

Figure 5: The Microscopic Section of kidney of sheep embryo at 120 day age show the juxtaglomerular apparatus The evolution became clear and relatively complete that consists of macula densa cells as row of cell in position in distal tubules and juxtaglomerular cells become clear and large unclei with eonded and the lacis cell (mesangial cells) (H and E stain 40X)

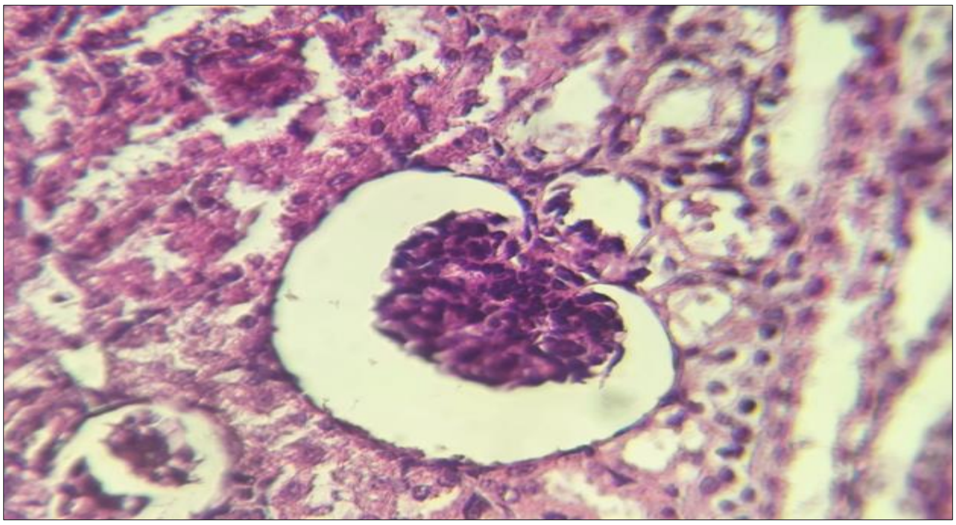

Figure 6: The Microscopic section of kidney of sheep at 30 day age postnatal show the juxtaglomerular apparatus Very clear histological differentiation with higher cells of macula densa cells, the presence of more mature juxtaglomerular cells near the entrance of the glomerulus was noted (H and E stain 40 X)

DISCUSSION

This study provides support that the juxtaglomerular apparatus (JGA) of the sheep develops continuing to develop in a linear fashion, and that there is significant morphometric change at three pinpoint development time frames, embryonic day 40, 120 and 1 month postnatal. These findings are significant and provide us with the opportunity to date the functional maturation of the blood pressure regulation, and relate these findings to already established patterns of mammalian kidney development. The finding that juxtaglomerular apparatus structures did not appear in sheep until embryonic day 40 was not unexpected as at this point in gestation renal structure is still undergoing rudimentary organizational change, these are findings consistent with Mitchell *et al*., (1982), Groscurth and Inagami, (1985). They established juxtagllomerular apparatus Tissue definition should be established at embryonic day 45 of gestation. At this stage of gestation, the fetus is primarily dependent on maternal regulatory systems, extensive vascular networks were still in the gross and rudimentary phase of vascularization of germinating glomeruli that redefine and form the complex dynamic features of pressure-sensing needed for JGA function. At this point, the integrated and dynamic features of pressure-sensing were not yet critical for the homeostatic regulation of osmotic balance (Robillard *et al*., 1988). Cellular microscopic structure of the juxtaglomerular apparatus at Embryonic Day 120 of gestation At Day 120, the JGA, developmental morphology reflects the maturity of the three components; (1) macula densa of distal tubule, (2) juxtaglomerular cells of the afferent arterioles, and (3) extraglomerular mesangial cells (lacis cells) that bridge these features (Mitchell *et al*., 1982 and Taugner, & Hackenthal, 1989). The arrangement identified at 120 days is implying that the components of the renin-angiotensin system are now co-ordinating the structure and function of a regulatory response to blood pressure instead of progressing toward more or less differentiation to fulfil a need, or developing toward maturity and specialization as observed in the 1 month post-natal sheep that observed advance cellular maturity and development to fully differentiated cellular histological categories under standard H&E staining indicates metabolic requirements as they started modify metabolic requirements still achieve blood pressure homeostasis without placental support (Alcorn, *et al*., 1984), The Juxtaglomerular cells development to synthesis and store renin, it is the enzyme that converts angiotensinogen in to angiotensin I, which ends up producing angiotensin II which is used in blood pressure control (Jennings and Premanandan, 2017 and Rosendorff, 1996). And the findings of this study are that the temporal progression of the juxtaglomerular apparatus in sheep occurs in a sequentially definite way that regards the functional requirements of the developing animal. The time line of the absence of the apparatus at forty days, its conspicuous appearance at 120 days, and its total maturation one month postnatal, are generous evidence supporting that the renal developing takes place in a reasonably smooth and well-coordinated manner. This work ultimately increases our understanding of normal renal development.

CONCLUSION

The juxtaglomerular apparatus in Awassi sheep develops progressively during gestation. It is absent at 40 days of fetal age, but begins to appear clearly by 120 days. At this stage, macula densa, juxtaglomerular, and lacis cells become distinguishable. By 30 days postnatal, the apparatus reaches full histological maturity.

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Conflict of Interest: The authors declare that there is no conflict of interest regarding the publication of this research.

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