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Original Article

Dynamics of Liver Development in Dandarawi Chicken

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ABSTRACT

The present work was carried out on 50 chick embryo of Dandarawi chicken collected from Assiut University Farm at a 3, 7, 9, 11, 13, 15, 17 and 19 day of prehatching life. At the 3rd day of incubation, the hepatic diverticulum gave dorsal and ventral parts in relation to the ductus venosus. At the 7th day, the dorsal and ventral parts became the left and right lobes respectively where the gall bladder was located on visceral surface of the right lobe and a transverse fissure dividing the left lobe into dorsal and ventral parts. Also, the vitelline veins caudal to the liver anastomosed together forming the portal vein, which gave off left portal branch to the left lobe of liver and continued as right portal branch to the right lobe. At the 9th day, the right lobe was longer and higher than the left one where the right lobe was in contact dorsally with the mesonephros and the left one was separated from the mesonephros by the glandular stomach. At the 11th day, the interlobar fissure was occupied mainly by the umbilical vein. At the 13th day, the parietal surface of the two lobes was related to the heart and body wall and the gall bladder increased in size and extended laterally. At the 15th day, the cranial end of the right lobe had three processes dorsal, middle and ventral but the cranial end of the left lobe had two processes dorsal and ventral. The duct system of the right lobe was hepatocystic and cystoenteric, but that of the left was hepatoenteric duct.

Keywords: Dandarawi Chicken, Development, Liver, Morphogenesis

INTRODUCTION

The liver is a large digestive organ and its development is very interest. The liver develops from the hepatic diverticulum, an out-pocket of ventral gut epithelium. The hepatic diverticulum gives rise to the liver, the gall bladder and bile ducts [1].

The vasculogenesis of the developing liver occurs through differentiation of the portal vein, the hepatic artery, and the sinusoids [2, 3]. The chick embryo represents an excellent model for developmental biology and gene expression analysis. It is also uses in recent researches applications for stem cell and cancer research [4]. Studies of liver development in the chick have not progressed well, causing a lack of the fundamental data now needed to initiate development studies. The development of liver in the chick embryo is similar to that of the mammalian embryo [5, 6]. Therefore, any knowledge about chick liver development will be applicable to humans and have medical relevance. Dandarawi chickens are characterized by highly resistance to diseases and heat stress [7].

The aim of the present work is to study and describe; primordial of the liver, the vasculogenesis of the vitelline veins, umbilical vein, portal vein, caudal vena cava and hepatic cavities.

MATERIALS AND METHODS

We collected 50 incubated eggs of Dandarawi chicken from Assiut University Farm of a 3, 7, 9, 11, 13, 15, 17 and 19 day of prehatching life. For gross anatomical studies, two embryos of 17 and 19 day old were used to study the gross anatomy of the liver. For microscopical studies, an embryo of all ages except 17 and 19 specimens of the liver were taken. All these specimens were immediately fixed in Bouin's fluid for 7-22 hours. The fixed materials were dehydrated, cleared and embedded in paraffin wax. Step serial sagittal and transverse sections were obtained at 4.5 -7 μm and stained with Harris's Haematoxylin and Eosin [8].

RESULTS

At the 3rd day of incubation, the hepatic divertiulum developed from the ventral aspect of terminal end of the duodenal part of the foregut **(Fig. A1).** Just caudal to the ductus venosus, the hepatic diverticulum began to divide into secondary

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diverticulum dorsal and ventral to vitelline veins, which these veins fused together cranially forming the ductus venosus. The dorsal diverticulum of the liver became dorsal to the ductus venosus, somewhat to the left but the ventral diverticulum was ventral to the ductus venosus, extended more to the right and was formed of hepatic cords. The parenchyma of the liver was consisted mainly of hepatic cords and some acini extended in the surrounding mesenchyme **(Fig. A2).**

At the 7th day of incubation, the liver was consisted of right and left lobes. The right lobe formed a transverse part, which separated from the left lobe dorsally by mesentery that connected the esophagus with the heart. This separating area was the primitive cranial interlobar fissure **(Fig. A3).** At the level of the glandular stomach, the two lobes were connected by transverse bridges dorsal and ventral to the ductus venosus. Also, the right lobe extended dorsally to become in contact with the right mesonephros, while the left one was separated from corresponding mesonephros by glandular stomach **(Fig. A4).** At the caudal end of the left lobe, a transverse fissure subdivided this part of lobe into small dorsal part and large ventral one. The right lobe was about double the size of the left lobe **(Fig. A5).** At the level of muscular stomach, the right lobe became four times the size of the left one and the two lobes were separated from each other by large caudal interlobar fissure, which occupied ventrally by the umbilical vein and dorsally by the gall bladder and right portal branch **(Fig. A6).**

At the 9th day of incubation, the cranial thoracic air sac appeared separating the liver from the corresponding lung on both sides. At the level of the esophagus and cranial interlobar fissure, a sagittal fissure appeared on the cranial end of left lobe. The dorsal aspects of both lobes were at the same level, the dorsal and ventral hepatic cavities were also observed **(Fig. A7).** At the level of glandular stomach, the dorsal cavity disappeared. The right lobe was related to right mesonephros and cranial thoracic air sac. The left lobe was related to corresponding air sac and separated from mesonephros by glandular stomach. The liver extended more ventrally surrounding the proximal two thirds of the heart **(Fig. A8).** At the level of the apex of the heart and the caudal end of glandular stomach, the liver became large and the right lobe occupied about the ventral two third of the body cavity but the left one was occupied only the ventral third. The caudal interlobar fissure was occupied by the apex of heart ventrally, the umbilical vein dorsally and ventral mesentry. The transverse fissure divided the caudal end of the left lobe into dorsal and ventral parts **(Fig. A9).** At the level of the isthmus, the right and left lobe gain the floor of body cavity. The gall bladder was observed on the visceral surface of right lobe and its lumen became wider **(Fig. B10).** The left lobe ended more cranial than the right one, where the left lobe terminated at the level of the body of the muscular stomach but the right lobe terminated at level of caudoventral blind sac **(Fig. B11).**

At the 11th day of incubation, the left lobe of liver extended from the level of the third rib to the midway between last rib and synsacrum. The lateral part of the left lobe contained a transverse fissure subdividing it into large caudodorsal part and small caudoventral part. The lateral part of left lobe of the liver is related dorsally to glandular stomach, the caudodorsal part of the left lobe related to the muscular stomach but the caudoventral part extended in the left ventral hepatic cavity (**Fig. B12).**

The medial part of the left lobe was compressed dorsally between the muscular stomach and the heart. This part on its visceral surface, the portal branch was located dorsal to the middle process and on its parietal surface, the terminal part of umbilical vein run to open into the caudal vena cava within its ventral mesentery **(Fig. B13).** The fissure between the two lobes was bounded dorsally by the transverse ridge and the extension of the left and right lobe ventrally within its corresponding ventral hepatic cavity that forming a ring around the umbilical vein. The transverse ridge between the two liver lobes is related craniodorsally to the base of the heart and glandular stomach **(Fig. B14).**

On the visceral surface of the right lobe, the middle process could be observed, also the gall bladder appeared ventral to the portal vein that contained wide lumen with few amount of secretion (**Fig. B15).** At the 13th day of incubation, the liver enlarged in size craniocaudally where it extended from the level of the fourth rib to the cranial border of the synsacrum **(Fig. B16).** The lateral part of left lobe was subdivided caudally by craniodorsal fissure into caudodorsal part and caudoventral one **(Fig. B17)**. The medial part of the left lobe was narrow as it located between the heart cranially and muscular stomach caudally and dorsally related to glandular stomach **(Fig. B18).**

The medial part of the right lobe extended from the floor of the body to the lung and mesonephros. Its middle process had a fissure caudally in which dorsal to it portal vein and gall bladder were located**.** The umbilical vein was located ventral to the middle process **(Fig. C19).** The dorsal hepatic cavity of the left side was continuous with the intestinal coelomatic cavity but the dorsal hepatic cavity of the right side was separated from the intestinal cavity **(Figs. C18 and 20).** The gall bladder was located transversally on the visceral surface of the right lobe. Its neck was located dorsal to the middle process with the right portal branch, hepatocystic and cystoenteric duct. The mucosa of both ducts were folded **(Fig.s. C19 and 20)**.

At the 15th day of incubation and at the level of the esophagus and cranial thoracic air sac, the cranial end of the left lobe was subdivided into small dorsal part and large ventral part separating by a fissure containing a left horizontal hepatic ligament. The left dorsal and ventral hepatic cavities appeared containing each corresponding end of the hepatic lobe **(Fig. C21).** At the level of junction of the esophagus and glandular stomach, the two left processes fused forming a mass connecting with body wall by left horizontal ligament laterally and with pericardium medially. The cranial end of the right lobe was subdivided into 3 processes, long dorsal, short middle and intermediate ventral. The dorsal and middle processes were located in right dorsal hepatic cavity and the ventral one in the right ventral hepatic cavity. The right dorsal and middle processes were separated by a fissure but the middle and ventral processes were separated by a fissure contained the right horizontal hepatic ligament **(Fig. C22).**

At the level of the isthmus, middle process of the left lobe was observed. The lobes of the liver reached highest thickness and separated ventrally from each other by falciform ligament containing umbilical vein **(Fig. C23).** At the level of isthmus and muscular stomach, the gall bladder could be observed on the visceral surface of the right lobe between the portal branch dorsally and middle process of the right lobe ventrally. The gall bladder had wide lumen filled by secretion. Lateral to the gall bladder, the hepatocystic duct was observed with wide lumen filled with secretion. On the medial aspect of the gall bladder, the cystoenteric duct was located with wide lumen **(Fig. C24).**

At the 17th day of incubation, the mean weight of liver was 0.32 gm and the color of liver was yellowish brown. The parietal surface of the liver was smooth and related to the floor and lateral wall of body cavity, while visceral surface was concave related on right lobe to intestine laterally and muscular stomach medially and on the left lobe related to muscular stomach. The right lobe was quadrilateral in outline and left lobe was heart in shape **(Figs. C25 and 26).** The middle processes of the two lobes were located at the same level. The free ends of the middle processes were opposite to each other. The middle third of the visceral surface of the right lobe was occupied by the gall bladder that filled with bile **(Fig. C26).** At the 19th day of incubation, the mean weight of liver was 0.52 gm. The lower two thirds of the visceral surface of the right lobe were occupied by the gall bladder filled with bile **(Fig. C27).**

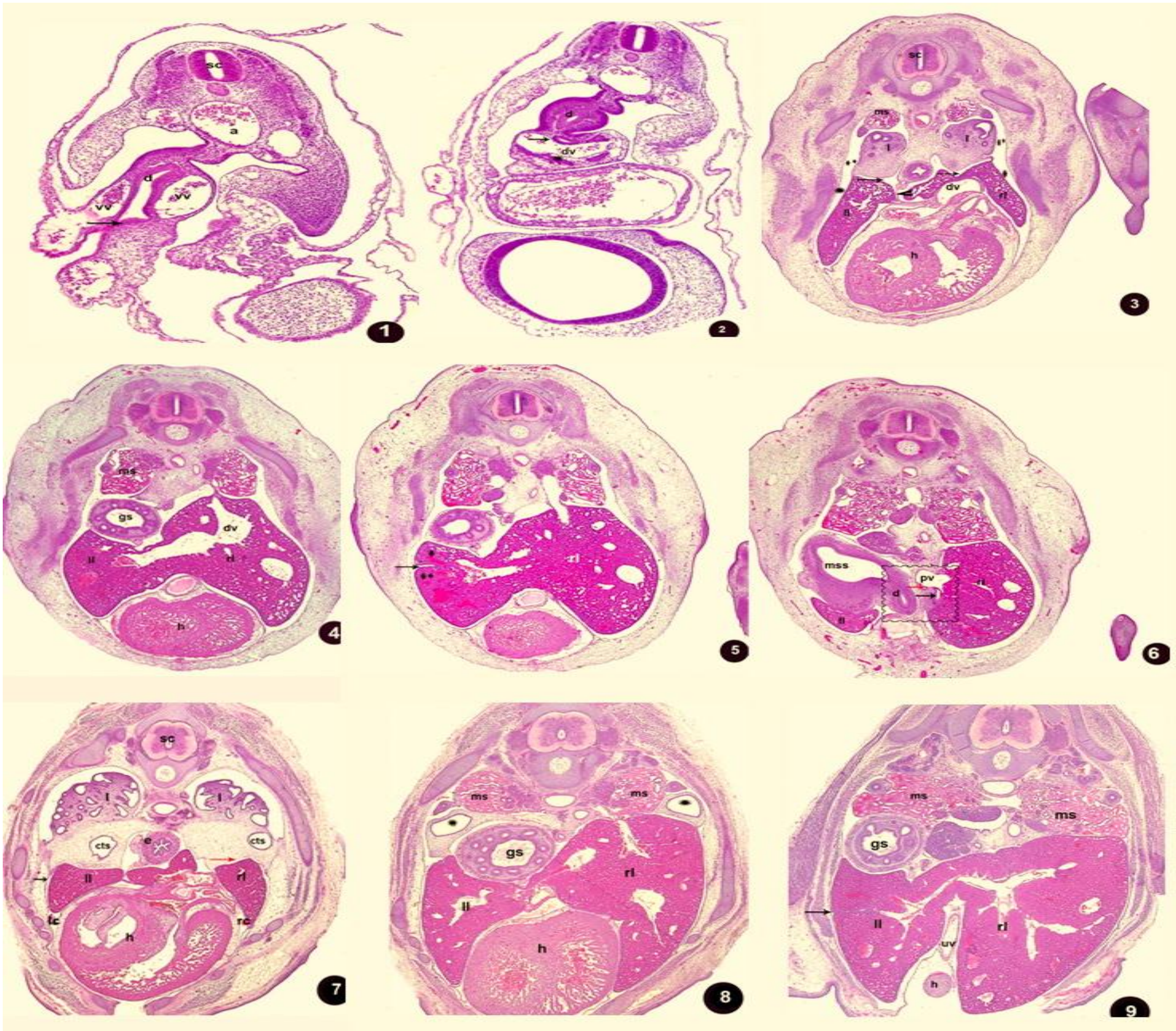

Figure (A): (Fig. 1: A 3rd day old chick embryo, X 40. Hepatic divertiulum (arrow) develops from duodenum. **Fig. 2:** Notice dorsal and ventral parts of the liver in relation to the ductus venosus. Dorsal hepatic diverticulum (arrow), ventral hepatic diverticulum (*). **Fig. 3:** A 7th day old chick embryo**,** X 12.5. Plural cavities (**) continuous with ventral hepatic cavity (*). Dorsal hepatic cavities (arrows) and mesentery (arrow head). **Fig. 4:** The two lobes connect by transverse bridge. **Fig. 5:** A transverse fissure (arrow) of left lobe (stars) subdividing it into small dorsal part and large ventral part. **Fig. 6:** The right lobe is about four times as left lobe and right portal branch dorsal to the gall bladder (black arrow), cystoentric duct (red arrow). **Fig. 7:** A 9th day old chick embryo, X 12.5. Notice right dorsal hepatic cavity (red arrow), left dorsal hepatic cavity (black arrow). **Fig. 8:** Right lobe of the liver expands more dorsally than the left one. Cranial thoracic air sac (*). **Fig. 9:** transverse fissure of the left lobe (arrow).

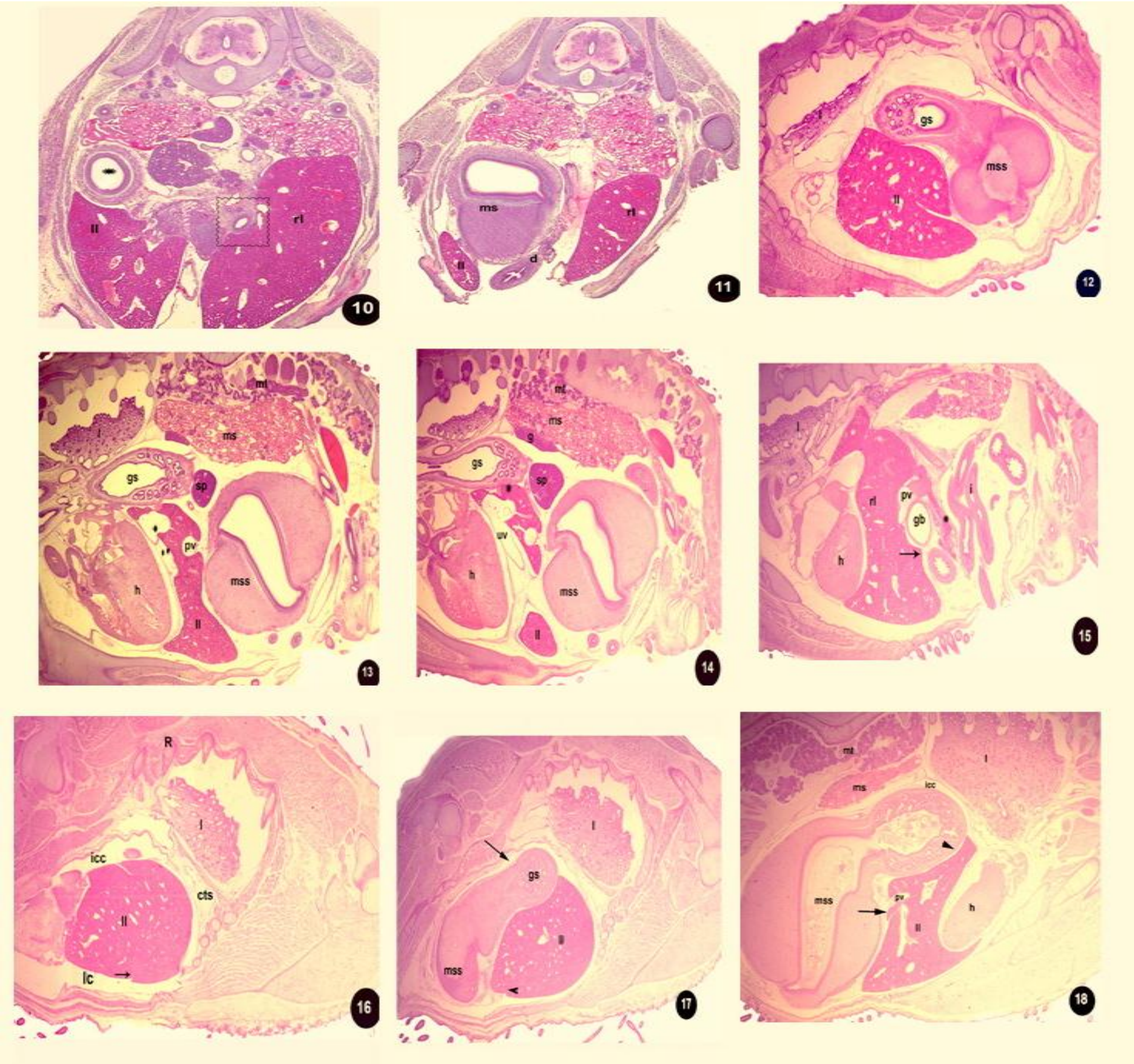

Figure (B): (**Fig. 10:** Isthmus (*) and gall bladder (squar). **Fig. 11:** The left lobe ends more cranial than the right one. **Fig. 12:** 11th day old chick embryo, X 10. The lateral part of the left lobe has a transverse fissure subdividing it into large caudodorsal part and small caudoventral part. **Fig. 13:** Portal vein located on visceral surface of the left lobe and umbilical vein (star) on its partial surface. Notice ventral mesentery (**). **Fig. 14:** The umbilical vein crossing the fissure between the two lobes of liver to gain the heart. Transverse ridge between the two liver lobes (*). **Fig. 15:** gall bladder appears ventral to the portal vein. middle process (arrow) and pancreas (*). **Fig. 16:** a 13th day old chick embryo**,** X 8. Left lobe of liver extends from the level of the fourth rib to the cranial border of sensecrum. Notice caudodorsal fissure of left lobe (arrow). **Fig. 17:** The left lobe is subdivided caudally by craniodorsal fissure (arrow head) into caudodorsal part and caudoventral one. Intestinal coelomatic cavity (arrow). **Fig. 18:** portal vein dorsal to middle process (arrow) of the left lobe. Dorsal hepatic cavity (arrow head).

Abbreviations on A, B & C figures:

duodenum (d). Spinal cord (sc), descending aorta (a), vitelline veins (vv). ductus venosus (dv), left lobe of liver (ll), right lobe of liver (rl), mesonephrose (ms), lung (l), portal branch (pv) muscular stomach (mss), heart (h). glandular stomach (gs), umbilical vein (uv) Ribs (R), synsecrum (sns)**,** spleen (sp), metanephrose (mt), gonad (g), gall bladder (gb) intestinal loops (i), intestinal coelomatic cavity (icc), cranial thoracic air sac (cts), esophagus (e), right ventral hepatic cavity (rc) and left ventral hepatic cavity (lc). Cystoenteric duct (cd) hepatocystic duct (hd).

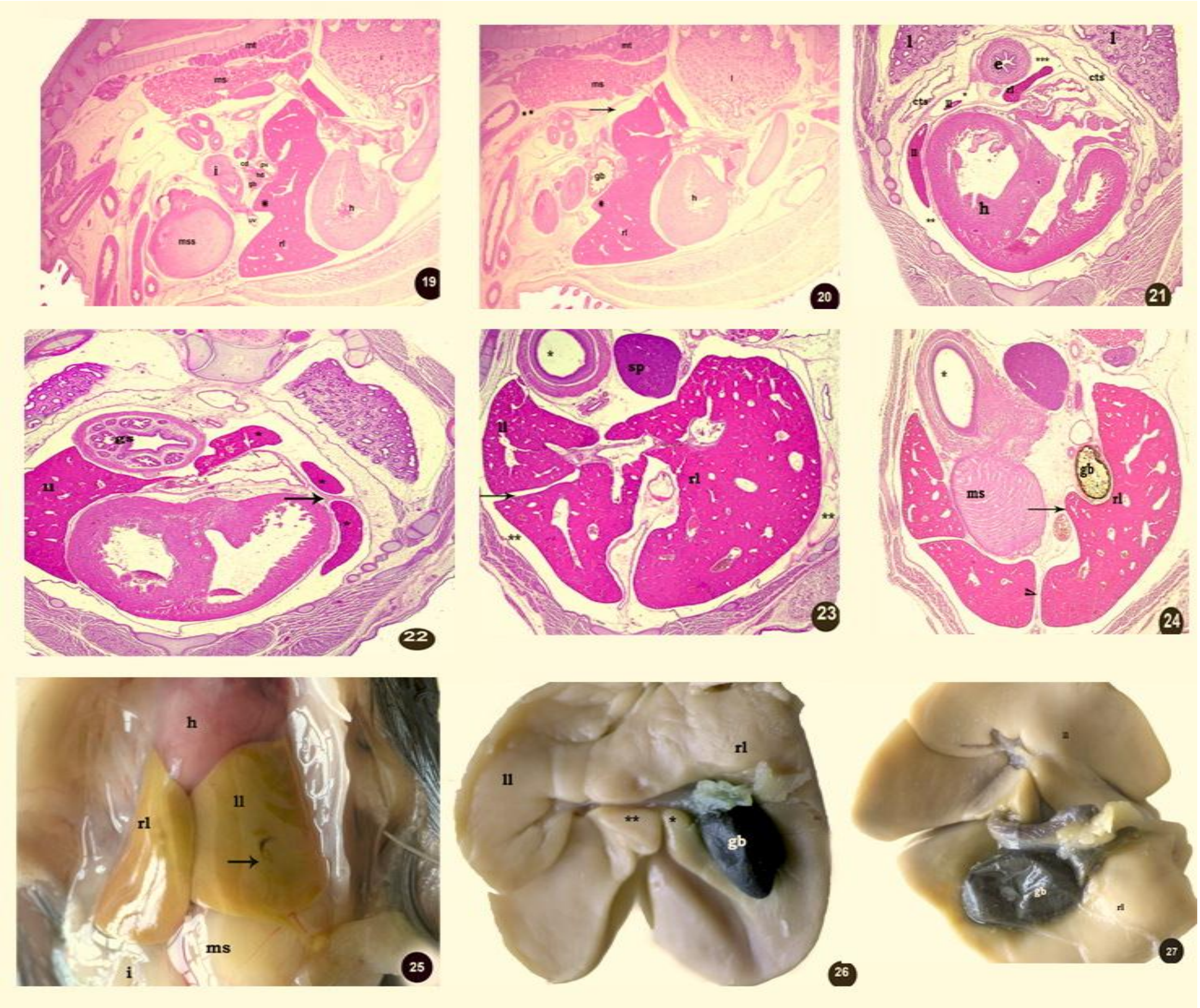

Figure (C): (Fig. 19: The middle process (*) between portal vein and umbilical vein. **Fig. 20:** Notice middle process of right lobe (*), dorsal hepatic cavity (arrow), intestinal coelomatic cavity (**). **Fig. 21:** a 15th day old chick embryo, X 12.5. Notice the cranial end of lobes of liver within its hepatic cavities. Left dorsal hepatic cavity (*), left ventral hepatic cavity (**), right dorsal hepatic cavity (***). **Fig. 22:** right lobe of liver (stars) and horizontal ligament (arrow). **Fig. 23:** the isthmus (*), fissure of the left lobe of liver (arrow) ventral hepatic cavities (**). **Fig. 24:** isthmus (*), falciform ligament (arrow head), middle process of right lobe (arrow). **Fig. 25:** a 17th day old chick embryo showing fissure of left lobe (arrow). **Fig. 26:** showing middle process of left lobe (**) and middle process right of lobe (*). **Fig. 27:** a 19th day old chick embryo liver.

Abbreviations on A, B & C figures:
duodenum (d). Spinal cord (sc), descending aorta (a), vitelline veins (vv). ductus venosus (dv), left lobe of liver (ll), right lobe of liver (rl), mesonephrose (ms), lung (l), portal branch (pv) muscular stomach (mss), heart (h). glandular stomach (gs), umbilical vein (uv) Ribs (R), synsecrum (sns), spleen (sp), metanephrose (mt), gonad (g), gall bladder (gb) intestinal loops (i), intestinal coelomatic cavity (icc), cranial thoracic air sac (cts), esophagus (e), right ventral hepatic cavity (rc) and left ventral hepatic cavity (lc). Cystoenteric duct (cd) hepatocystic duct (hd).

DISCUSSION

In the present work, the hepatic diverticulum developed from the ventral aspect of the duodenum and then extends cranially and subdivided into dorsal and ventral parts in relation to the ductus venosus. This result is similar to that mentioned by Patten [9] in all vertebrates and by Kingsbury, et al. [10] in chick embryo. We found that the diverticulum originated from the ventral part of the duodenum, but Kingsbury, et al. [10] stated that the diverticula originated from the intestinal portal in the chick embryo and Foster, et al., Fukuda and Fukuda-Taira from the foregut [11, 12, 13]. These records do not indicate that the origin of the liver differs but depends upon the time of examining of the embryo. In very young embryo the origin is the intestinal portal, in older embryo is the foregut and finally is the duodenum.

Romanoff [14] stated that in the chick embryo the secondary liver primordia appear in the form of diverticula or buds depend upon the primary analog is evaginated or proliferated. The present work showed that the secondary liver primordia are diverticula as they are evaginations of the hepatic diverticulum.

At 7th day chick embryo of incubation, the liver is formed of large right and small left lobes and an intermediate portion in between the two lobes, these results are similar to that observed by Abd-Elmagid et al. [15] in 8 day chick embryo and Romanoff [14] in 5th day. On other hand, Suksaweang, et al. [16] stated that the liver in the chick embryo had three lobes; the right lobe developed at the 4th day, by the 6th day the second lobe was formed and by the 7th day the third lobe was formed as a tiny bud ventral to the second lobe. At the 7th day chick embryo, the right lobe was larger than the left lobe as the right lobe extended dorsally to come in contact with the mesonephros but the left lobe separated from the mesonephros by the stomach. The results of Mclelland et al. [17] also confirm the right lobe is larger than the left lobe in adult chicken.

At the 13th day chick embryo, the left dorsal hepatic cavity was continued with the intestinal coelomatic cavity but that of the right side was separated from the intestinal coelomatic cavity. This finding is similar to that mentioned by Mclelland et al. [17] and Pal, et al. [18] who stated that the liver of the adult chicken has 4 hepatic cavities two dorsal and two ventral, the dorsal hepatic cavities were located craniodorsal to the ventral ones and the left dorsal hepatic cavity was continued with the intestinal coelomatic cavity but the right one was separated from this cavity. Also, at this age, the gall bladder was located transversally on the visceral surface of the right lobe, where its neck and body were located on the middle process. At the 17th day chick embryo, it was located obliquely where it occupied the middle third of the visceral surface of the right lobe. At the 19^{th} day chick embryo, it was longitudinally located on the visceral surface of the right lobe directed craniocaudally and occupying the caudal two thirds of right lobe and gain its caudal border. The bile secretion was observed in the chick embryo at the 9th day similar to that mentioned by Karrer [19] and Gheri, et al. [20] in the chick embryo. The bile secretion from the liver was carried to the duodenum by biliary ducts usually two in number, hepatoentric duct arised in the left lobe and hepatocystic and cystoentric duct arising in the right lobe, these ducts were directed towards the duodenum to open in it. Romanoff [15] in the chick embryo termed the duct of the left lobe hepatic or hepatoentric and that of the right lobe hepatocystic and cystoentric duct.

Concerning the vitelline veins, at the 3rd day chick embryo, these veins coursed cranially toward the heart on either side of the hepatic diverticulum. Near the heart these veins fused together forming the ductus venosus, which continued cranially with the sinus venosus. The mode of formation of the ductus venosus in this work is similar to that mentioned by Abd-Elmagid et al. [15] in chick embryo. On other hand, the parts of the vitilline veins caudal to the liver at the 7th day chick embryo anastomosed together forming the portal vein, which runs cranially and gave a left portal branch and continued as a right portal branch for the left and right lobes respectively. The mode of formation of the portal vein in this work was similar to that mentioned by Romanoff [14] in chick embryo.

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REFERENCES

1. Medlock, E.S., and Haar, J.L. (1983). The liver hemopoietic environment: I. Developing hepatocytes and their role in fetal hemopoiesis. Anat. Rec., 207: 31–41.
2. DeRuiter, M.C, Poelmann, R.E. Mentink, M.M. Vaniperen L. and Gittenberger-De Groot, A.C. (1993). Early formation of the vascular system in quail embryos. Anat. Rec. 235: 261–274.
3. Gouysse, G., Couvelard, A., Frachon, S., Bouvier, R,. Nejjari, M., Dauige, M.C., Feldmann, G. He´ nin, D. and Scoazec, J.Y. (2002). Relationship between vascular development and vascular differentiation during liver organogenesis in humans. J. Hepatol., 37:730–740.
4. Rashidi, H.& Sottile, V. (2009). The chick embryo: hatching a model for contemporary biomedical research. Bioessays, 31,459-465.
5. Wong, G.K. and Cavey, M.J. (1992). Development of the liver in the chicken embryo. I. Hepatic cords and sinusoids. J. Anatomical Record, 234: 555-567.
6. Sohal, G.S., Ali, M.M. Ali, A.A. & Bockman, D.E. (1999). Ventral neural tube cells differentiate into hepatocytes in the chick embryo. J. Cell. Mol. Life Sci., 55: 128–130.
7. Fathi, M.M., Zein El-Dein, El-Safty, M. and Lamiaa Radwan, S.A. (2007). Using Scanning Electron Microscopy to Detect the Ultrastructural Variations in Eggshell Quality of Fayoumi and Dandarawi Chicken Breeds. International Journal of Poultry Science., 6 (4).236-241.
8. Bancroft, J.D and Gamble, M. (2002). Theory and Practice of Histological and Histochemical Techniques. 3re Edn, Butter Worths.
9. Patten, B.M. 1920. The Early Embryology of the Chick. Philadelphia: P. Blakiston's Son and Co.
10. Kingsbury, J.W., Alexanderson, M. and Kornstein, E.S. (1956). The development of the liver in the chick. J. Anat. Rec., 124:165-187. Cited by Wong, G.K. and Cavey, M.J. (1992).
11. Foster, M., Balfour, F.M. Sedgwick, A. and Heape, W. (1883). The Elements of Embryology. 2nd Edn London: Macmillan and Co.
12. Fukuda, S. (1979). The development of hepatogenic potency in the endoderm of quail embryos. J. Embryol. Exp. Morph., 52: 49-62.
13. Fukuda-Taria, S. (1981). Location of pre-hepatic cells in the early developmental stages of quail embryos. J. Embryol. exp. Morph., 64: 73-85.
14. Romanoff, A.L. (1960). The avian embryo, structural and functional development. The Macmillan Company, New York.

15. Abd-Elmagid, B.F. and Fawzyah, A.A. (2008). Effect of Administration of Haloperidol on the Developing Liver of the Chick Embryo. J. Saudi Biological Sciences, 15 (2): 297-306.
16. Suksaweang, S., Lin, C. Jiang, T. Hughes, M.W. Widelitz, R.B. and Chuong, C. (2004). Morphogenesis of chicken liver: identification of localized growth zones and the role of β-catenin/Wnt in size regulation. J. Developmental Biology, 266: 109– 122.
17. Mclelland, J. and King, A.S. (1970). The gross anatomy of the peritoneal coelomatic cavities of Gallus domesticus. J. Anat. anz, 127:480-490.
18. Pal, A.K. Parmar, M.L. and Datta, I.C. (1991). Histomorphological studies on prehatch broiler chick liver. Indian Journal of Animals Science, 61 (5): 513-515.
19. Karrer, H.E., (1961). Electron microscope observations on chick embryo liver. Glycogen, bile canaliculi, inclusion bodies and hematopoiesis. J. Ultrastruct. Res., 5:116-141.
20. Gheri, B.S., Gheri, G. and Pacini, P. (1990). The development of the chick embryo gall bladder studied by scanning electron microscope. J. Anat. Anz, 171(5):297-305.