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# CHANGES IN THE TOPOGRAPHY OF THE LIVER OF ONE-HUMPED CAMEL DURING THE PRENATAL LIFE

(With 13 Figures)

By

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## تغيرات الوضع التشريحي للكبد في أجنة الجمل وحيد السنام

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أجريت هذه الدراسة علي خمسة وأربعين من أجنة الجمال تراوحت أطوالها من ٢,٤ سم ألي ١٢٥سم، وقد تم تشريح بعض الأجنة وإجراء أشعة مقطعية علي البعض الآخر. أظهرت الدراسة أن الكبد في الأعمار الأولي يحتل أغلب التجويف البطني الذي يمتد من الحجاب الحاجز وحتي مدخل الحوض ، وبعد ذلك يتراجع للأمام نتيجة لاختلاف معدل النمو بينها وبين باقي أحشاء التجويف البطني ويكون التراجع علي الناحية اليسرى أكثر من الناحية اليمني حيث يتوقف التراجع عند الضلع الأخير(الثاني عشر) في الناحية اليمني ولكن في الناحية اليسرى يصل الي مستوي الضلع السادس حيث يتراجع ضلع واحد للأمام مع كل ١٠ سم زيادة في طول الجسم حتى يصل ألي الضلع السابع عند عمر ٧٠سم ثم يتقدم ألي الضلع السادس ويتوقف عنده بقية فترة الحمل والوضع الذي تولد به الأجنة كاملة النمو والتي يبلغ طولها ١٢٥سم ، ومن الجدير بالذكر فإن الكبد في الجمل نتيجة لتواجد جزء منه علي الناحية اليسرى فإنه يحول بين المعدة الشبكية والحجاب الحاجز الأمر الذي يختلف تماما عن الوضع في الحيوانات المجترة. وقد اشتملت الدراسة أيضا علي علاقة الكبد بالأعضاء المجاورة وكذلك التغير في شكلها وحجم فصوصها بالإضافة لوزنها بالنسبة لوزن الجسم.

## SUMMARY

The present work was conducted on forty five camel fetuses aged (represented in CVR length) from 2.4 cm to 125 cm (full term). The specimens were subjected to dissection and computed tomographical studies. This study revealed that the liver occupied most of the abdominal cavity from the diaphragm to the pelvic inlet in young

subjects. Then after it retreated more cranialwards on the left side than on the right one. On the right side, it advanced cranially from the pelvic inlet to just the last rib (12th rib). While, on the left side it retreated cranially from the pelvic inlet in 12 cm fetus to the 7th rib in 70 cm fetus (i.e. one rib per each 10 cm increase in CVR length). In the rest of gestation period the rate became slow, where the liver eventually ended at the 6th rib. Unlike the ruminant animals, the liver of camel came across to keep the reticulum from being in contact with the diaphragm. The surface dissection of the youngest fetuses exposed nothing besides the liver in both sides except the kidneys and the gonads, which means that all of the abdominal organs were sandwiched between the right and left lobes of the liver. The left side-organs and the right side-ones made their appearance later. The changes in outline of the liver, its lobation and the impressions made by the contagious organs were included. The weight of the liver and its percentage to the weight of the fetus were also recorded.

***Key words:*** *Topography, computed tomography, liver, prenatal life, camel.*

## INTRODUCTION

Studies on the one-humped camel have been in the circle of concern of many Egyptian authors for many years. A lot of researches have been done on the development of the fetuses of this animal. The available literature, however, lack data about the changes in the topography of the organs, which are more prominent, in the prenatal life.

Computed tomography (CT) is steadily becoming more accessible in the veterinary theater. Application in large animals, so far, has been limited to some parts like the head and limbs of horse and cattle (Ottesen and More, 1998). Its wide application was on the small animal species such as dog (Ottesen and More, 1998) and goat (El-Nady, 1999). The current study aims to record the topographical changes of the liver of one humped camel in the prenatal life and to introduce the CT technique as instructive and diagnostic technique in the field of embryology.

## MATERIALS and METHODS

The present study was conducted on 45 one-humped camel fetuses aged (in CVR length) from 2.4 to 125 cm (Full term). The description of fetuses, on a time, was very difficult so that they were classified into groups. Group (1) included 3 fetuses up to 10 cm CVR

length; Group (2) included 4 fetuses up to 20 cm. Group (3) inlcuded 6 fetuses up to 30 cm. Group (4) included 5 fetuses up to 40 cm. Group (5) included 4 fetuses up to 50 cm. Group (6) included 5 fetuses up to 60 cm. Group (7) included 5 fetuses up to 70 cm. The rest of the fetuses up to the full term (125 cm) were includded in group (8). These fetuses were obtained from Assiut and Cairo slaughter houses. They were fixed by perfusion of a solution containing 10% formaline, 4% phenol and 1% glycerin throughout the umbilical as well as common carotid arteries.

The specimens were subjected to the regular dissection as well as computed tomography (CT). Computed tomography was carried out in Assiut University Educational Hospital on four chosen fetuses (32, 65, 80 and 108 cm). They were positioned according to that described by Stickle and Hatchcock (1993). The scanning proceeds at 1cm interval. The cross and sagittal lines of the red light were to pass perpendicular along the longitudinal axis (Coronally) or parallel to that axis (sagitally). The livers of some selected fetuses were taken out to study its weight, lobation as well as its shape.

## RESULTS

**Group 1 (up to 10 cm CVR length fetuses):**

The liver occupied almost the whole abdominal cavity from the diaphragm and nearly to the pelvic inlet. Its parietal surface was related to the diaphragm, the abdominal wall and rested on the abdominal floor from the 7$^{th}$ costal cartilage to the prepubic region. Surface dissection showed that the liver in these fetuses was extended on both right and left sides far beyond the last rib (Fig. 1).

**Group 2 (up to 20 cm):**

The liver was still occupying most of the abdominal cavity. Relatively, it started to decrease in size and retreated cranially particularly on the left side. On the right one (Fig. 2/A), it was related to the right kidney and the gonad. On the left side (Fig. 2/B), the liver was related caudodorsally to the spleen and advanced forward to the level of the last rib (12$^{th}$).

**Group 3 (up to 30 cm):**

The liver extended along the abdominal floor to a level caudal to the umbilical cord. On the right side, it was still related to the right kidney and gonad (Fig. 3/A). On the left side, the caudal edge of the left lobe retreated to the level of the 11$^{th}$ rib and was related to the jejunum, spleen and part of the rumen started to appear cranially (Fig. 3/B).

**Group 4 (up to 40 cm):**

On the right side, the liver was related only to the right kidney (Figs. 4/A, 11A& B). On the left side, the left lobe ended caudally at the level of the 10th rib and its visceral surface was related to the small intestine and the intestinal disc (Fig. 4/B).

Up to these ages the livers were sandwiching most of the abdominal viscera (stomach, part of the intestinal disc and part of the small intestine) between its right and left lobes.

**Group 5 (up to 50 cm):**

On the right side (Fig. 5/A), the liver was related dorsally to the right kidney. On the left side (Fig. 5/B), it reached the level of the 9th rib and behind it part of the rumen and the intestinal disc were appeared.

**Group 6 (up to 60 cm):**

On the right side, the right lobe was still related to the right kidney. On the left side (Fig. 6) the caudal edge of the left lobe reached the level of the 8th rib and was related to the rumen. The retreat of the liver left a room to the rumen, intestinal disc, left kidney and spleen to appear on the left side.

**Group 7 (up to 70 cm):**

On the right side (Figs. 7/A &12A), the liver was related to the right kidney. On the left side (Fig. 7/B), it reached the level of the 7th rib and was related to the rumen.

**Group 8 (up to 125 cm):**

On the right side (Figs. 8A &9/A), the surface dissection showed, besides the liver, the right kidney, descending duodenum and jejunum. On the left side (Figs. 8B & 9/B) the surface dissection showed the rumen, spleen, the intestinal disc and part of the descending colon. The limit of the caudal edge stayed at the 6th rib until the end of the gestation period.

As revealed by the regular dissection (Figs. 10A&B) and computed tomography (Figs. 11A&B and 12A&B), during the prenatal life, part of the liver passed to the left of the median plane. This means that the liver in camel came across to keep the reticulum from direct contact to the diaphragm, the case that is different from other ruminant species. At first, most of the abdominal viscera were hidden between the two lobes of the liver. With the advancing in age, the relative size of the liver begins to decrease. Consequently the liver retreated cranially and in turns the organs started to appear on both sides caudal to the liver.

The liver of camel (Figs. 13/A, B) was characterized by lack of the gall bladder and by minute fissures. Its right basic lobe was the largest, and with the advancement of age it remarkedly increased on the expense of the quadrate lobe and showed abomasal impression. The left lobe was divided by short fissure into left lateral and left medial parts and related to the rumen. As the age goes on, the left lobe became relatively smaller due to the retreat that has been described on the left side. The quadrate lobe was related to the omasum. It decreased until became very narrow, compressed between the right and left lobes and projected more ventrally. The caudate process was pyramidal in shape with its base dorsally. It concurred with right lobe to form a deep cavity for the right kidney. The papillary process was circular in outline and concave at its centre. Its peripheral border was grooved, thick and raised above visceral surface of the liver. The concavity of the center was for the reticulum and the groove on the border was for the omasum. The papillary process was relatively large all over the gestation period. The livers of the fetuses were J-shaped when it is looked upon at its parietal surface (Fig. 13/B).

The weight of the liver in the smallest available fetuses (2.4 cm) was 3.6 gm forming 0.7% of the body weight. In full term fetus (125 cm), the weight of the liver reached 391 gm forming 0.2% of the body weight.

## DISCUSSION

Application of computed tomography in veterinary medicine is still restricted to small animals (Ottesen and More, 1998: in dog; El-Nady, 1999: in goat). In the present work we used this tool to study the camel fetuses and we started with the liver. Moore (1993) stated that the liver grows rapidly and soon fills most of the abdominal cavity. This count for the hemopoietic activity in the early ages. This comes in consistence with the finding under investigation.

The present study showed that the liver of full term fetuses is to some extent similar to that of the adult reported by Ibrahim (1983). The study also revealed the difference in shape, lobation and position from that of cattle (Mcleod, 1958); buffalo (Sengar and Singh, 1971); sheep (McCartly, 1981) and goat (Garret, 1988). Nevertheless the shape was more or less similar to that of the horse, where it was J-shaped particularly in the early stages. Part of the liver of camel at full term was found on the left of median plane as that recorded by Abdalla, Arnautovic and Fahmy (1971), Ibrahim (1983) and Smuts and Bezuidenhout (1987) in the camel, Schummer and Nickel (1979) in the

ruminants as well as, EL - Hagri (1967) and Rooney, Sack and Habel (1967) in horse. The position of the liver prevents the reticulum to be in direct contact with the diaphragm, the case that is totally different from that of other ruminant described (Habel, 1989). This fact agrees with that recorded by Hegazi (1954) and Purohit and Rathor (1962) who added that the reticulum of camel was very small, and Ibrahim (1983) who stated that the reticulum of the camel was related to the papillary process.

Like that of ruminants (Habel, 1989), the present study showed that the liver of camel has the same basic lobes. The shape, however, is totally different due to the difference in sizes of these lobes and irregularities of the borders and also the left lobe was divided in camel. The papillary process of camel was large and prominent, as that mentioned by Ibrahim (1983). Moreover, in accordance with Ibrahim (1983), the liver of camel is distinguished from that of ruminant by the minute fissures on its surfaces. Leese (1927) in camel counted the readily visible hepatic lobulations in this animal is due to the high content of interlobular connective tissue.

Impressions of the rumen, omasum, abomasum, reticulum, right kidney, duodenum and jejunum on the visceral surface of the liver were similar to that described by Ibrahim (1983).

Similar to equine species (Rooney et al., 1977) and different from ruminant species (Habel, 1989) the liver of camel lacks gall bladder, which was never observed even in the youngest available fetuses.

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## LEGENDS

**Figs 1-9:** Photographs showing the topographical position of the liver of one-humped camel fetuses. Liver (L); kidney (K); gonad (arrow); spleen (S); jejunum (J); duodenum (D); intestinal disc (Id); rumen (Id), umbilical cord (Uc).

**Fig. 1:** 12 cm fetus (Left side)

**Fig. 2/A:** 16 cm fetus (Right side). **Fig. 2/B:** 16 cm fetus (Left side).

**Fig. 3/A:** 27 cm fetus (Right side). **Fig. 3/B:** 27 cm fetus (Left side).

**Fig. 4/A:** 35 cm fetus (Right side). **Fig. 4/B:** 35 cm fetus (Left side).

**Fig. 5/A:** 45 cm fetus (Right side). **Fig. 5/B:** 45 cm fetus (Left side).

**Fig. 6/A:** 53 cm fetus (Right side). **Fig. 6/B:** 53 cm fetus (Left side).

**Fig. 7/A:** 68 cm fetus (Right side). **Fig. 7/B:** 68 cm fetus (Left side).

**Fig. 8/A:** 93 cm fetus (Right side). **Fig. 8/B:** 93 cm fetus (Left side).

**Fig. 9/A:** 125 cm fetus (Right side). **Fig. 9/B:** 125 cm fetus (Left side).

**Fig.10A&B:** Photographs showing the topographical relation of the liver (L) to the reticulum (asterisk) and diaphragm (arrow) of full term fetus. Rumen (R); omasum (O); intestinal disc (Id); spleen (S); Sternum (arrowhead)
A- Reflected rumen (dorsally)
B- Reflected rumen (dorsally) and omasum (caudo-dorsally).

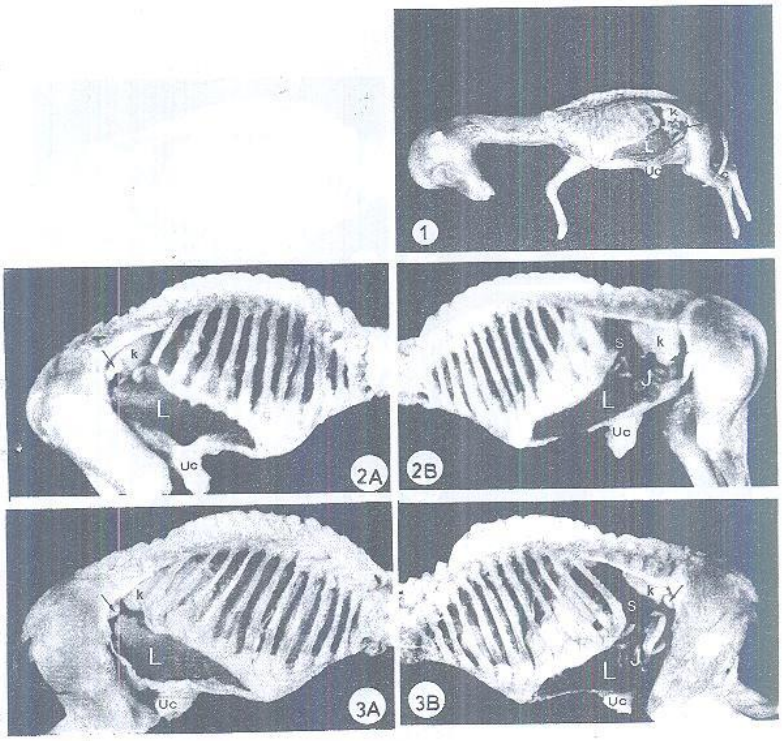
**Fig. 11/A:** Sagittal CT of 32 cm camel fetus showing liver (L); right kidney (K); diaphragm (d); heart (arrow) and lung (asterisk).

**Fig. 11/B:** Axial CT of 32 cm camel fetus showing right lobe of the liver (Rl); left lobe of the liver (Ll); rumen (R); reticulum (arrowhead); omasum (O) and right kidney (K).

**Fig. 12A:** Sagittal CT of 65 cm camel fetus showing liver (L); rumen (R); omasum (O); reticulum (arrowhead); intestine (I) diaphragm (d); heart (arrow); lung (asterisk) and right kidney (K).

**Fig. 12B:** Axial CT of 80 cm camel fetus showing right lobe of the liver (Rl); left lobe of the liver (Ll); esophagus (E); rumen (R); reticulum (arrowhead); omasum (O) and right kidney (K).

**Figs. 13A& B:** Photographs showing the visceral (13A) and parietal surfaces of the livers (13B) of 18, 36, 53, 60 & 76 cm camel fetuses. Right lobe (1); left lobe (2); quadrate lobe (3); caudate process (4); papillary process (5); reticular impression (astersik) omasal impression (arrow); abomasal impression (thick arrow); renal impression (thick arrowhead); caval impression (arrowhead); hepatic veins (small arrow).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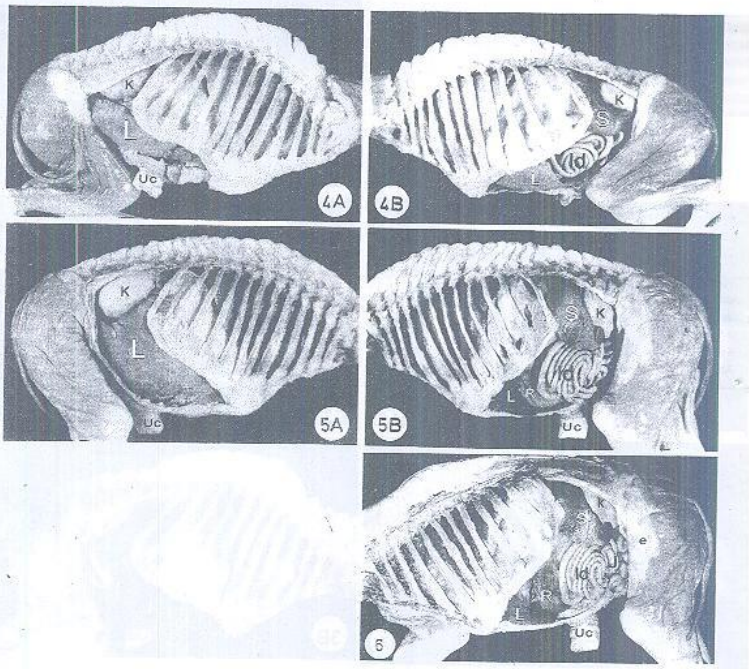
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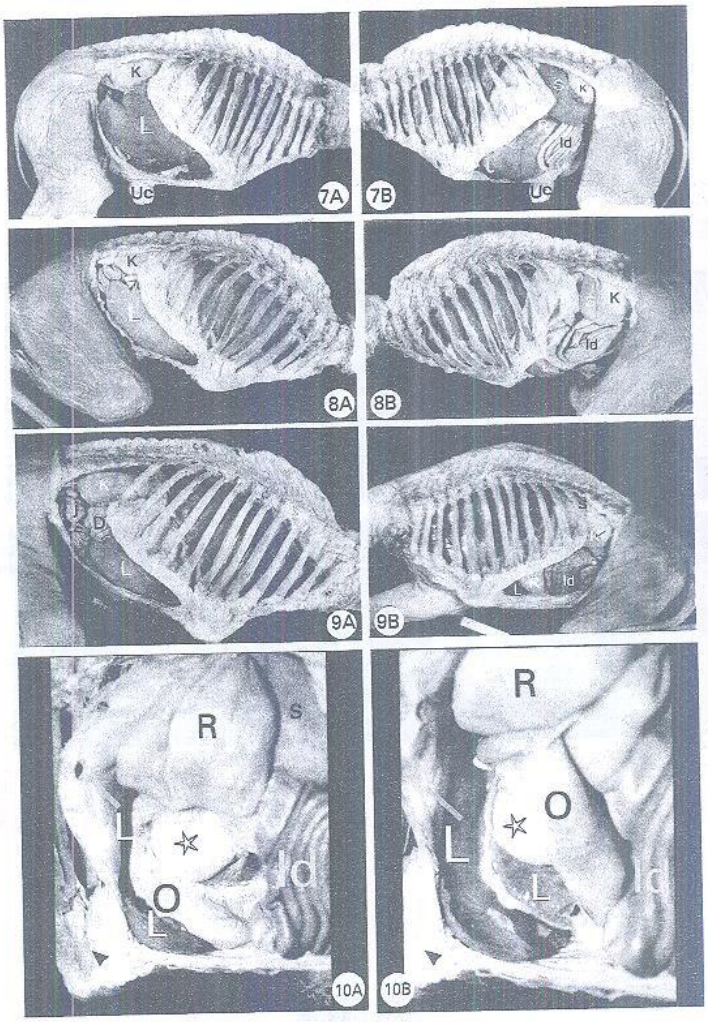
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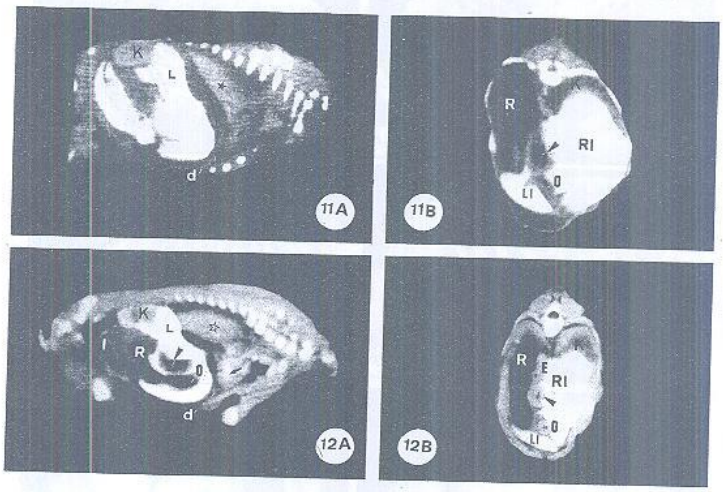
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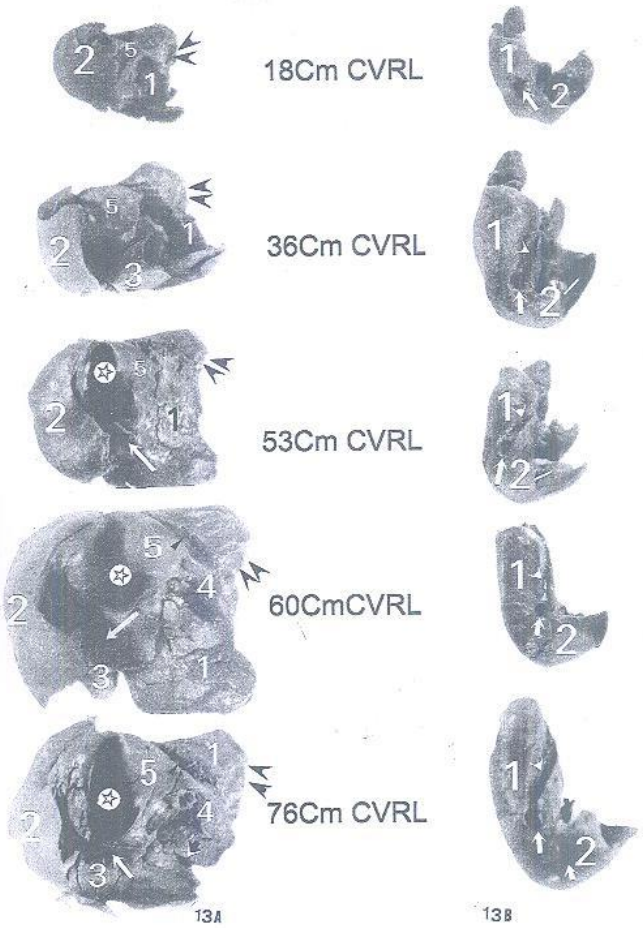
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