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Original article

Anatomical and Morphometric Parameters Study of Human Neonatal Liver in Kirkuk City

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Abstract:

- ***Background*:** The liver, situated in the upper right abdomen, is vital for detoxification, protein synthesis, bile production, and nutrient storage. This study aims to investigate the anatomical and morphometric characteristics of neonatal livers in Kirkuk city.
- ***Methods:*** Between November 2022 and June 2023, an autopsy of 31 cadavers (aged 1-28 days, 40-55 cm in length, 2.9-5.4 kg) was performed in Kirkuk governorates. After cleaning with tap water, the bodies were placed supine with an elevated chest. A longitudinal midline thoracoabdominal incision allowed examination of the liver's anatomical position and surrounding structures.
- ***Result:*** The neonatal liver displayed a rubbery, solid consistency and had a reddish-brown color. It occupied the upper portion of the abdominal cavity in the right hypochondrium. Anatomically, it consisted of the right and left lobes, with small caudate and quadrate lobes present in the right lobe. The right lobe constituted approximately half to two-thirds of the total liver volume. Gross inspection revealed that the left lobe was smaller and more flattened compared to the right lobe. Its upper surface was slightly convex and conformed to the diaphragm. The weight of the neonatal liver was 108.366 ±32.11 grams, with maximum dimensions of 4.85-6.45 cm in height and 5.7-7.8 cm in length. The transverse and anteroposterior dimensions of the right and left lobes measured (5.72, 3.15, 3.57, 2.93 cm) respectively.
- ***Conclusions:*** This study offers evidence on the anatomical features, location, shape, weight, and morphometric parameters of the neonatal liver, utilizing caliper measurements to provide dependable estimates of normal liver volume. It may serve as a valuable reference for future research endeavors.
- **Keywords:** Neonates, liver, anatomy, parameters, morphometric.

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INTRODUCTION

The liver is the largest organ in the newborn body; it is a dark reddish-brown organ that weighs around 120g at birth and accounts for approximately 4 percent of the total weight (compare of 2 percent in adult) [(1)].

It is located in the upper portions of the abdominal cavity, immediately below the diaphragm between the ribs and the costal cartilage, with the majority of it located beneath the right costal border and extending to the left to reach the left hemi-diaphragm [(2)].

The diaphragmatic and visceral surfaces are the two primary surfaces of the liver. The diaphragmatic surface is convex, with anterior, lateral, superior, and posterior sides; it is located underneath the diaphragm [(3)].

Visceral surface, this surface is enclosed by visceral peritoneum except at the porta hepatis, and the gallbladder is connected to organs such as the stomach, intestine [(2)].

By morphologic and functional anatomy, the liver is split into two lobes, a right lobe & left lobe. The right lobe is further separated into the caudate and quadrate lobes, which are functional components of the left lobe [(4)].

The visceral peritoneum covers the inferior, lateral, superior, and anterior surfaces of the liver, with the exception of a small area (bare area) surrounded by reflections of the peritoneum forming coronary ligaments. The liver is encased in a fibrous capsule (Glisson capsule), and the peritoneal reflections form the coronary ligaments. The livers secured to the diaphragm by a number of ligaments; These include the right and left triangle ligaments, the falciform ligament, and the coronary ligament. The liver is attached to the abdominal wall by the falciform ligament [(4)].

Porta hepatis and recesses of the liver:

Porta hepatis is located on the posteroinferior surface of the liver, which is also known as the visceral surface. It is responsible for separating the caudate & quadrate lobes of the liver. It is the site of entry and departure for a number of essential structures, including the (portal vein- the hepatic arteries- the hepatic ducts-the hepatic nerve plexus- and a small number of lymph vessels) [(4)].

Liver recess

- **subphrenic recess** is a depression that may be seen between the inferior surface of the diaphragm and the diaphragmatic surface of the liver; it is divided into right and left portions by the falciform ligament [(4)].
- **hepatorenal recess** a depression that may be seen on the lower right side of the liver, in addition to the right kidney and suprarenal gland.

Blood supply of the neonatal liver:

The newborn liver is supplied with blood by two vessels, the portal vein delivering blood from abdominal organs. (Intestine, spleen, stomach, pancreas) which their products are high with substances that must be processed &detoxified, it contributes about (70-75 percentage) of

liver's blood supply. The portal vein is generated by the splenic vein joining the superior and inferior mesenteric veins, which drain into the splenic vein, and proper hepatic artery supply blood rich in oxygen, which contributes 25% to 30% of the blood supply that is necessary for the maintenance of vital activity of hepatocytes and for their functional performing [5,6].

In the almost of cases, the common hepatic artery is a branch of the celiac artery along with the splenic and left gastric arteries, sometime the hepatic artery has accessory or replaced vessels supplying the liver. The accessory or replaced right hepatic artery is a branch of the proximal superior mesenteric artery, while the accessory or replaced left hepatic artery is a branch of the left gastric artery [7,8].

venous drainage and innervation of neonatal liver:

Venous drainage is Similar to adults, venous drainage in neonates occurs largely through right & left hepatic veins, which join the inferior vena cava [9], the liver is innervated by sympathetic (sympathetic hepatic plexus), parasympathetic (vagus nerve), and peptidergic nerve fibers [10,11].

Despite extensive research on the adult human liver, there is a notable lack of comprehensive studies focusing on the neonatal liver. This scarcity of previous research warrants a closer examination of the anatomical and morphometric features of neonatal livers in the city of Kirkuk. Therefore, the primary aim of this study is to shed light on the specific characteristics of neonatal livers and compare these findings with existing knowledge. By conducting a detailed investigation, this research seeks to contribute valuable insights into the understanding of neonatal liver structure and function in the context of Kirkuk city.

PATIENT and METHOD

Between November 2022 and June 2023, an autopsy of thirty-one cadavers from Kirkuk governorates, aged 1-28 days, measuring 40-55 cm in length, and weighing 2.88-5.45 kg, was conducted at the forensic medicine unit. The study received approval from the Medical Ethics Committee of Tikrit University College of Medicine (code number IQ.TUCOM.REC.3/7/450), and ethical agreements were obtained from the families in accordance with the World Medical Association Declaration of Helsinki (revised in 2000, Edinburgh). The cadavers were grossly inspected to study anatomical features, position, width, length, and weight, while causes of death included congenital heart diseases, kernicterus, septicemia, and hematological disorders. Data collection was treated confidentially and adhered to ethical guidelines.

Anatomical study:

A. Dissecting techniques:

To approach the abdominal cavity and view the liver in its anatomical position, after cleaning the cadaver with tap water, the body was placed in a supine position with the chest elevated by a stent under the shoulders to facilitate the visibility of abdominal viscera. Next, a longitudinal midline thoracoabdominal (midsagittal) incision was made through the skin, subcutaneous fat, linea alba, and peritoneum [12].

B. Gross measurements of the neonatal liver:

study the position, and relation of liver and its connection:

After dissecting the abdominal cavity and examining the liver's form, location, and connection by various ligaments and structures using a knife, the liver was released from its surrounding arrangements and cleansed for further examination.

C. Measurements of the neonatal liver:

Dimensions of liver:

lengths, widths, and thicknesses of the right &left lobe of the neonatal liver were determined. All measurements were taken using a Vernier caliper for studying vertical dimensions, and in the case of curved and bulge parts and circumferences, a flexible figured tape was used for measurements. Additionally, the liver's gross size was determined by immersing it in a figured tube filled with water at a fixed level, then sinking the liver into the tube and measuring the water displacement.

Measurement of liver Weight:

After delivering of the liver from its connected tissues at intra-abdominal cavity. It was washed formerly then dried with soft tissues prepared for weighting as a single bulk by means of an electronic balance (10 kg – 1 g SF-400 plastic Tray LCD Digital Scale Balance). As in (figure 1)

Figure 1. depicts the measurement of liver weight using an electronic balance.

RESULTS

A.The location, shape, covering and weight of the liver;

In the infant (first postnatal month), the liver was a rubbery, firm, reddish-brown consistency, was positioned in the upper abdominal cavity, and occupied the right hypochondrium. Its bottom boundary extended up to 4 cm below the costal edge at the mid-clavicular line. These lower extremities were seen in live newborns by percussion and palpation, and in postmortem by direct examination (autopsy). It is located superiorly under the ribs and costal cartilage.
The liver was grossly totally enclosed by a capsule, and an exterior layer of peritoneum partly covers the liver. The peritoneum generates the outer serous layer, which covers the whole liver. Except bare area of the liver. A fibrous inner layer covers the whole liver including the bare area, the hepatic artery, portal vein, and bile duct). The weight of neonatal liver was mean ± SD was 108.366 ±32.11 gram.

The anatomical relation of the liver: liver's upper surface was convex dome shaped, and related with right and left costal margin, right and left pleura, lower margin of both lung and anterior abdominal wall. The visceral surface or inferior surface of the liver was concave,

directed downward, backward, and to the left. Deep fissures and the impressions of the adjacent organs make this surface uneven. These two surfaces were joined antero-laterally in acute angle forming the inferior margin. This surface was related to the abdominal esophagus, fundus of stomach, duodenum, right colic flexure, right kidney, right suprarenal gland and gallbladder. (Figure 2).

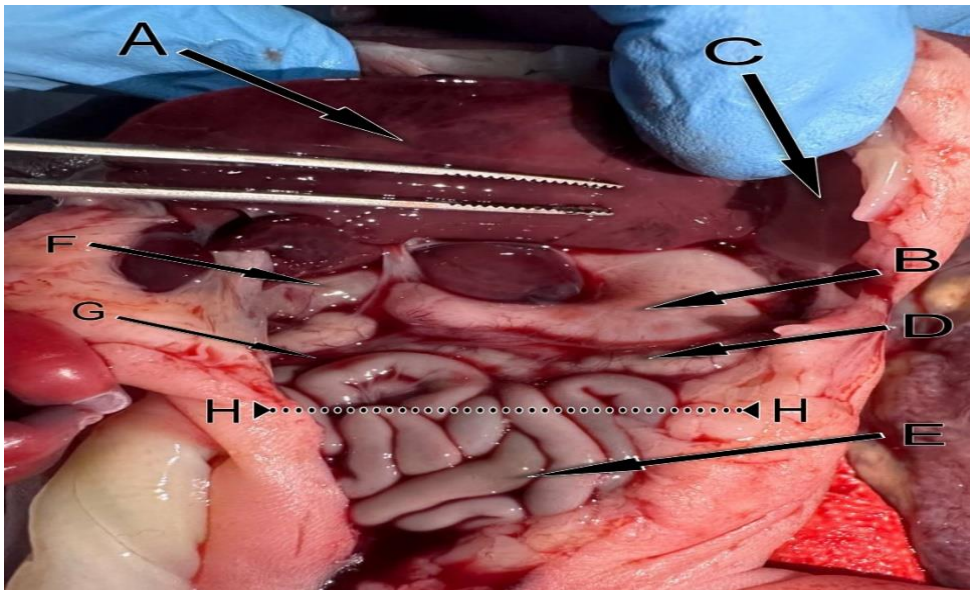

Figure 2: Reflected abdominal wall shows anatomical relation of the liver.

Liver, B. Stomach, C. Diaphragm, D. Transvers colon, E. Small intestine, F. Gallbladder, G. Right colic flexure, H-Abdominal wall

Liver lobes and ligaments ; The present study revealed that the liver was divided into two parts when viewed into a right bigger lobe and a left smaller lobe by its attachment to the falciform ligament (which were represent two layers of peritoneum extended from anterior abdominal wall at its free edge found the ligamentum teres) anteriorly and superiorly, and at its posterior, the two layer of peritoneum were separated to form the bare area (free from peritonium) and from the right and left triangular ligaments which will border the bare area ,in the inferior surface of the liver the ligamentum teres (the remanent of umbilical vein round ligament of the liver) and the ligamentum venosum (remanent of ductus venosus) which connect the left portal branch to the inferior vena cava. (Figure 3) showing anterior side of the liver.

liver visceral surface was showing several fissures, four parts when viewed from below, the right lobe was partially subdivided into caudate and quadrate lobes which together with the ligaments divide the liver into four lobes: Left and right lobes, separated by the falciform ligament, which connects the liver to the abdominal wall. Caudate and quadrate lobes, delimited

by the fissures of the visceral surface. It has right, anterior, posterior, superior and inferior surfaces. As show in (figure 4)

- **Caudate lobe** – situated on the upper portions of the visceral surface. It lies between the inferior vena cava and a fossa produced by the ligamentum venosum. It was partially a fibrous remnant of the ductus venosus of the fetal circulation. It is attached to the left branch of the portal vein within the porta hepatis and extend to the left side of caudate lobe.

- **Quadrate lobe** - situated on the lower portions of the visceral surface. It lies between the gallbladder and a fossa produced by the ligamentum teres. the quadrate lobe, was in relation with the superior portion of the duodenum, and the transverse colon

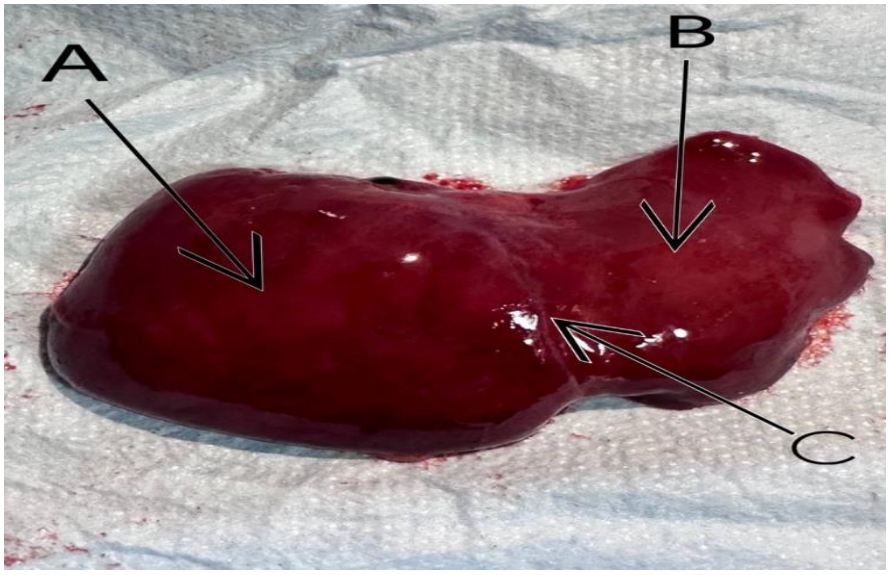

Figure 3 illustrates the main features of anterior side of the liver.

A. Right lobe of the liver, B. Left lobe of the liver, C. Falciform ligament

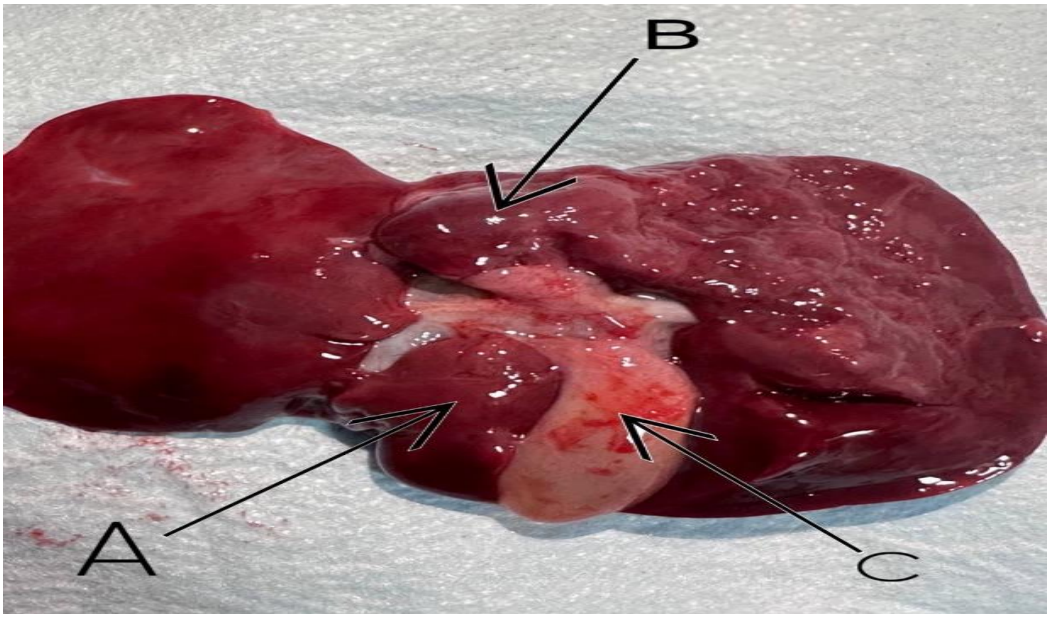

Figure 4. shows main feature of posterior side of liver.

A. Quadrate lobe, B. Caudate lobe, C. Gallbladder

B. Morphometric Measurement of the neonatal liver dimensions using caliper (length-thickness-width(cm))

In this study the mean length-width and thickness of the neonate livers were calculated by using caliper (Table 1 and Figure 5).

The transverse and anteroposterior dimensions of the right and left lobe of the liver were 5.72, 3.15, 3.57, 2.93 cm respectively as in (figure 6)

Figure 5: shows Measurement of liver dimensions by caliper

Figure 6: shows dimension measuring of right lobe of the liver by caliper.

Table 1: Means ± standard deviations of the length, width, thickness and weight of the neonatal liver.

Baby age (1-28) day	length	width	Thickness	Weight
Baby no	Cm	Cm	Cm	Gram
1	9.38	7.18	4.20	113
2	9.56	7.36	4.24	115
3	9.76	8.76	4.29	118
4	9.25	7.23	4.22	114
5	5.90	6.36	4.10	106
6	8.20	6.87	4.15	111
7	7.55	6.28	4.12	109
8	7.15	6.19	3.90	108
9	8.70	6.11	3.70	105
10	8.58	6.14	3.78	105
11	8.45	6.12	3.60	104
12	8.76	6.78	4.13	110
13	9.80	9.64	5.20	120
14	4.55	3.89	3.70	100
15	5.68	4.78	3.10	103
16	10.38	8.63	5.10	117
17	4.38	4.15	3.14	102
18	9.30	8.36	4.17	115
19	9.40	7.23	4.13	114
20	8.90	7.10	3.90	110

21	8.60	6.25	3.11	108
22	5.58	4.36	2.40	100
23	6.80	5.23	2.90	105
24	7.66	5.45	3.50	107
25	7.34	6.26	3.30	104
26	6.48	4.89	2.80	102
27	3.44	3.33	1.60	90
28	10.86	10.46	5.38	125
29	11.40	11.63	5.47	128
30	3.15	2.46	1.10	85
31	6.18	4.30	2.20	102
Mean ± SD	7.98±1.78	6.44±2.00	3.66±0.98	108±32.11

DISCUSSION

The current study showed that the neonatal liver is located in the upper portions of the abdominal cavity, below the ribs and costal cartilage, occupies right hypochondrium this agree with *Svensson JF et al.* [13], in the present study the liver was irregular- wedge shaped, the liver's upper surface lies underneath the right hemidiaphragm. The livers visceral surface is in contact with the abdominal esophagus, stomach, duodenum, right colic flexure, right kidney, and gallbladder, this agrees with *Abdel-Misih SR et al* [14].

In the present study anatomically, the liver was divided into two lobes left &right lobe in addition to the quadrate & caudate lobes in the visceral surface, situated between the right and left lobes. The porta hepatis, or liver hilus separate the quadrate lobe from the caudate and this agree with *Kekis P, Kekis BJL et al* [15].

The mean weight of liver was found in neonates to be (108.366 ±32.11 gram) with statistically highly significant relation between livers weight and age. *Mirzaali o'g'li AJ et al* [16], which demonstrated that the weight of the liver in the neonates is on average 135 g.

Shankle W et al [17] & *Evetts A-AM* [18] these studies proved that the livers weight in the same ages was respectively 124.52 ± 0.425, 146.51 ± 38.65 gram.

In the present study the liver of the neonate was grossly completely covered by a capsule and external to this capsule a layer of peritoneum covers the liver partially. The outer layer covers the whole liver except bare area, and the inner layer of glisson capsule., that covered the entire liver with the bare area, and this agree with *Bazira PJJS* [19], *Jones MW et al* [20].

In this study the right lobe was demonstrated that, the transverse dimensions and anteroposterior dimensions of right lobe was respectively 5.72±0.42, 3.15±0.72 cm, this agree

with *Di Serafino M et al* [21], that mentioned the longitudinal dimensions of right lobe of liver in the same ages was 6.4 cm.

The current study demonstrated that, the transverse and antero-posterior dimensions of the left lobe was 3.57±0.34, 2.93± 0.55cm respectively, this agree with *Modi K et al* [22], who mentioned that the transvers and antero-posterior dimension of the left lobe in the neonate was 3.56 ±0.90, 2.31± 0.50 cm respectively.

In this study anatomically the liver of the neonate was fixe in its normal position by these ligaments (coronary ligaments and right and left triangular ligaments falciform ligament and ligamentum teres), this agree with *Mahadevan VJS [23], and Garbar V [24]*.

The right lobe of the neonatal liver in current study was partially subdivided into caudate and quadrate lobes this agree with *Srimani P et al* [25], and *Sharma PN [26]*.

CONCLUSION

Our comprehensive study of neonatal liver anatomy has yielded significant insights, underscoring the critical role of understanding this organ in diagnosing liver disorders. The liver is situated in the upper part of the abdominal cavity, protected by the Glisson capsule, and its gross appearance and precise measurements of volume, length, and weight are essential for identifying various liver conditions.

We have identified two distinct parts within the neonatal liver—the right lobe and the left lobe. Additionally, the right lobe is further subdivided into caudate and quadrate lobes, contributing to the intricate structure of this vital organ.

Furthermore, the liver's stability is ensured by several ligaments, including the falciform ligament, left and right coronary ligaments, lesser omentum, hepatogastric and hepatoduodenal ligaments, as well as the ligamentum teres and ligamentum venosum. Understanding the roles of these ligaments is crucial for comprehending the liver's overall function.

Overall, this research highlights the significance of accurately assessing neonatal liver anatomy in clinical practice. Such knowledge serves as a fundamental basis for diagnosing and treating liver-related disorders, underscoring the liver's complexity and its vital role in maintaining overall health and well-being.

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Nil.

Conflicts of interest:

There are no conflicts of interest**.**

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