

MORPHOMETRIC STUDIES ON EMBRYONIC LIVER OF GADDI SHEEP

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ABSTRACT

The present study was conducted on 40 Gaddi sheep foetii of either sex. The foetii were grouped in four groups viz., group-I (1-60days), group-II (61-90days), group-III (91-120days) and group-IV (121-full term). During very initial stages of development, the liver occupied major space of the abdominal cavity. The mean body weight of sheep foetii increased significantly from group-I to group-IV. The foetii body weight ranged from 0.38 gm to 37.48 gm in group-I, 40.00 gm to 275.00 gm in group-II, and 362.00 gm to 775.00 gm in group-III and 925 gm to 2000 gm in group-IV. On an average the liver constituted 9.07 % of total body weight between gestational periods of 1-60 days. In group-II, II and IV liver accounted 8.45 %, 6.15% and 5.49 % respectively of the total body weight in Gaddi sheep foetii. Liver constituted only 3.20 % of the total body at CRL 42.4 cm (146 days of gestation). The weight, maximum length, total width and volume of liver were measured. The mean statistical differences of these parameters increased significantly with advancing gestational age. The volume of liver increased significantly with gestation and its minimum (0.10 ml) and maximum (75.0 ml) values were recorded at CRL 2.50 (35 days of gestation) and 38.50 (135 days of gestation) respectively. Relative weight of liver decreased with advancement of gestational age. Caudate lobe appeared at CRL 5.5cm (45 days of age). Renal fossa was formed because of lodgment of right kidney in it. Its size varied and depended upon the change in size of right kidney under normal conditions. The length of renal fossa increased but no significant difference was found between group-I and II. There was significant increase in length and width of right and left hepatic ducts with advancement of age

Key words: Sheep, Foetus, Morphometry, Liver.

INTRODUCTION

The liver is one of the most complex and vital organ. Its primary function is detoxification of absorbed substance from the digestive system before their distribution into the circulatory system (Moawad *et al.*, 2014). The liver constitutes 10%

of the total body weight in intrauterine 10th week and 5% of the total body weight at birth (Moore *et al.*, 1998). A linear increase in the size of left and right lobes of liver between 18-41 weeks was observed using obstetric ultrasound (Murao *et al.*, 1989). Similarly, Murao *et al.*, (1988) in another study compared the liver size and other parameters

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used to monitor fetal growth between the 19th week and full term and found a high correlation between them and concluded that liver size can be used to assess fetal growth as well. The liver with distinct lobes occupied almost whole of the abdominal cavity at 47 days of gestation and at 126th day of gestation, the liver occupied about two third part of abdominal cavity and its long axis was extended from long axis was extended from 7th to 13th rib in goat (Singh *et al.*, 2012). Singh *et al.*, (2013) reported that prenatal goat liver occupies almost all space in the abdominal cavity during initial stages of development and also revealed a positive correlation between weight, CRL and age of foetus with length, width, thickness and weight of liver. Marecki *et al.*, (1989) evaluated the size of the liver, besides other organs, in postmortem fetuses. The liver continues to grow throughout a normal pregnancy.

MATERIAL AND METHODS

This study was carried out on 40 fetuses with no external anomaly. Gravid uteri were collected in and around slaughter houses of Palampur region of Himachal Pradesh, India. Foetii were then extracted out immediately from uterus, washed properly and dried up. CRL (crown rump length) of foetii were recorded for age estimation by using the following given formula,

$$Y = 2.74X + 30.15 \quad (\text{Hijazi } et al., 2011)$$

Where, Y= age of foetus in day

X= Crown Rump Length in cm

The foetii were grouped as: 1-60days (group-I), 61-90days (group-II), 91-120days (group-IV) and 121 –full term (group-V). The liver was then exposed with fineness and following values were measured as described;

Weight of liver: the liver weight was measured by using an electronic monopane balance. Volume of liver: the volume of liver

was measured by water displacement method. Maximum length of liver: the distance between transverse planes passing through the upper and lowermost points of the liver. Total width of liver: distance between parallel vertical planes touching the extreme margins of the liver on left and right sides. Maximum thickness: Sagittal distance between parallel vertical tangents at the anterior and posterior poles of liver. Shape index of liver = length of liver / width of liver x 100 (Barnwal and Singh, 1981). The relative weight of liver = liver weight of foetus / total body weight of foetus x 100 (Mandal *et al.*, 2001). The width of right lobe: the transverse distance between the outermost points of the right to the point where the umbilical vein joins the porta hepatis. The width of left lobe: the transverse distance between the outermost points of the left lobe to the point where the umbilical vein joins the porta hepatis. Width of caudate lobe: the transverse distance between the outermost points on both sides of this lobe. Length of right, left and caudate lobe: the vertical distance between the most superior and inferior point of this lobe. The length and width of renal fossa were measured from extreme margins of fossa across vertical and transverse directions respectively. Depth of renal fossa, length and width of extrahepatic ducts were also taken with the help of vernier caliper.

The mean of the parameters with respect to gestational age and groups were computed using the SPSS statistical package. The values of each group were expressed by Univariate ANOVA at 5% level of significance. All analysis was done by using SPSS-17. Statistical calculations (mean \pm standard error) were recorded according to the standard statistical procedures recommended by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

i. Biometry of foetal liver

The mean body weight of sheep foetii increased significantly from group-I to group-IV

(Table. 1). The foetii body weight ranged from 0.38 gm to 37.48 gm in group-I, 40.00 gm to 275.00 gm in group-II, and 362.00 gm to 775.00 gm in group-III and 925 gm to 2000 gm in group-IV. On an average the liver constituted 9.07 % of total body weight between gestational periods of 1-60 days. It was 10 % of total body weight at CRL 2 cm (35 days of gestation) and 6.8 % of total body weight at 5.5 cm (45 days of gestation). Moore and Persaud (1998) stated that liver constituted 10 % of total body weight at the end of first trimester in human foetii. In group-II, II and IV liver accounted 8.45 % , 6.15% and 5.49 % respectively of the total body weight in Gaddi sheep foetii. Liver constituted only 3.20 % of the total body at CRL 42.4 cm (146 days of gestation). Albay *et al.*, (2005) reported that liver comprised 6-7% of the body weight in 1st and 2nd trimester and the ratio drops down to 3-4% near the term in human foetii. The weight, maximum length, total width and volume of liver were measured. The mean statistical differences of these parameters were recorded for each group (Table. 1). The mean value of all these parameters increased significantly with advancing gestational age (Table. 1). Weight of liver was minimum (0.04 gm) and maximum (80.35 gm) at CRL 2.0 cm and 38.50 cm respectively. Among all the age groups studied, the minimum (0.01 cm) length of liver was at CRL 2.0 (35 days of gestation) and maximum (9.40 cm) was at CRL 9.40 (42 days of gestation). The total width of liver was minimum (0.20 cm) at CRL 2.00 cm (35 days of gestation) and maximum (9.80 cm) at CRL 38.50 cm (135 days of gestation). The volume of liver increased significantly with gestation and its minimum (0.10 ml) and maximum (75.0 ml) values were recorded at CRL 2.50 (35 days of gestation) and 38.50 (135 days of gestation) respectively. Maximum thickness of liver showed significant difference between group-I, II and III, but no significant difference was observed between group- III and IV (Table. 1). The significant increase in basic biometrical parameters of liver was also reported by Mandal (2004), Kumar *et al.*, (2007), Singh *et al.*, (2012) in goat foetii, Doley *et*

al., (2006) in buffalo foetii and Albay *et al.*, (2005) in human foetii. Relative weight of liver decreased with advancement of gestational age (Table. 1) and a significant difference of group-I and II with group-III and IV was recorded. The minimum (3.49) and maximum (52.05) relative weight of liver was recorded at CRL of 24.50 cm (97 days of gestation) and 5.50 cm (45 days of gestation) respectively. Singh *et al.*, (2013) stated that decrease in relative weight of liver with advanced gestation was because the body weight of foetii exhibited a much faster inclination as compared to weight of liver. Same explanation for this was also given by Doley *et al.*, (2006). Shape index of liver lowered with advancing age (Table.1), this finding was contrary with the findings reported by Singh *et al.*, (2013) in goat foetii. The length and width of right and left lobe of liver increased significantly from group-I to group-II (Table. 2). The maximum width (8.0 cm) of right lobe of liver was observed at CRL 28.50 cm (108 days of gestation). The right lobe was larger than the left one (Table. 2) as reported by Mandal (2004) in sheep and goat foetii and Kumar *et al.*, (2007) in goat foetii. Caudate lobe appeared at CRL 5.5cm (45 days of age). Singh *et al.*, (2012) observed the caudate lobe at 47 days of gestation goat foetii. The length of caudate lobe increased significantly with advancement of gestation in Gaddi sheep foetii (Table. 2). Its minimum (0.20 cm) length was recorded at CRL 5.5 cm and maximum (6.60 cm) at CRL 38.80 cm. The width of caudate lobe showed no significant difference between group-II and III. The maximum (2.70) width of this lobe was observed at 136 days of gestation. Renal fossa was formed because of lodgment of right kidney in it. Its size varied and depended upon the change in size of right kidney under normal conditions. The length of renal fossa increased but no significant difference was found between group-I and II (Table. 3). Significant difference was observed between the groups for the width of renal fossa liver (Table. 3). The maximum width (2.30 cm) of renal fossa was observed at CRL 33.50 cm and 34.20 cm. The depth of renal

fossa also increased with gestational age but no significant difference was found between group-III and IV. The maximum (1.33) depth was observed at CRL 38.50 cm (135 days of gestation). Singh *et al.*, (2012) observed the increase in length, width and depth of renal fossa with advancement of gestation in goat foetii.

ii. Duct system (extrahepatic ducts) of liver

In this study, the extrahepatic ducts seemed to be the continuation of right and left hepatic ducts from interior of liver. The left and right hepatic ducts came out from their respective lobes and joined to form the common hepatic duct; this duct afterward united with the cystic duct (of gall bladder) and formed the common bile duct or bile duct. Same pattern of extrahepatic duct formation and drainage was reported by Khalil *et al.*, (2004) and Gosh (2012) in sheep and goats. Khalil *et al.*, (2004) observed that the right and caudate lobe were drained by right hepatic duct and the left

lobe of liver is drained by left hepatic duct. The extrahepatic ducts (left and right hepatic duct and common hepatic duct) were partially or completely embedded within the hepatic tissue or remained attached to the connective tissue of portal fissure. The ducts were excised along their respective routes for biometrical measurements. In group-I these ducts were not formed in earlier stages and were indistinguishable for measurements in later stages. The length of left and right hepatic duct was measured from their visible origin at hilus of liver up to their union at common hepatic duct. There was significant increase in length and width of right and left hepatic ducts with advancement of age (Table. 4). The length of common hepatic duct was measured from its origin at the union of right and left hepatic ducts to its attachment with the cystic duct and its length increased with the gestation (Table. 4). Khalil *et al.*, (2004) in domestic animals and Cachoeira *et al.*, (2012) in humans also reported increased in length of extrahepatic ducts with advancement of age.

Table 1

Biometrical parameters of Foetii and Liver in different age groups of prenatal Gaddi sheep.

Parameters	Group-I (1-60 days)	Group-II (61-90 days)	Group-III (91-120 days)	Group-IV (121-Full term)
Age of foetus (days)	47.20 ^a ±1.35 (35.00- 58.00)	78.41 ^b ±1.91 (62.00-88.00)	103.28 ^c ±1.46 (97.00-115.00)	131.12 ^d ±1.58 (121.00-146.00)
Weight of foetus (gm)	10.47 ^a ±2.13 (0.38-37.48)	156.92 ^b ±17.17 (40.00- 276.00)	537.95 ^c ±31.04 (362.00-775.00)	1246.05 ^d ±58.29 (925.00-2000.00)
CRL (cm)	6.22 ^a ±0.49 (2.00-10.20)	17.51 ^b ±0.74 (14.00-21.20)	26.67 ^c ±0.53 (24.50-31.30)	36.85 ^d ±0.57 (33.40-42.40)
Weight of liver (gm)	0.95 ^a ±1.73 (0.04-2.27)	13.27 ^b ±1.15 (5.67-24.59)	33.13 ^c ±2.11 (19.22-48.73)	68.51 ^d ±1.71 (50.30-80.35)
Maximum length of liver (cm)	1.81 ^a ±0.24 (0.01-3.50)	4.94 ^b ±0.19 (3.80-6.50)	6.68 ^c ±0.14 (5.80-8.00)	8.76 ^d ±0.10 (7.90-9.40)
Total width of liver (cm)	1.44 ^a ±0.15 (0.20-2.50)	4.37 ^b ±0.25 (2.50-6.00)	6.68 ^c ±0.14 (4.00-7.90)	8.29 ^d ±0.16 (7.40-9.80)

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Maximum thickness of liver (cm)	0.56 ^a ±0.05 (0.17-0.88)	1.22 ^b ±0.07 (0.59-1.61)	1.45 ^c ±0.04 (1.12-1.74)	1.53 ^c ±0.05 (1.06-1.76)
Volume of liver (ml)	1.47 ^a ±0.25 (0.10-3.60)	14.50 ^b ±1.91 (5.00-23.00)	30.68 ^c ±2.37 (15.00-50.00)	60.15 ^d ±2.15 (52.00-75.00)
Relative weight of liver.	12.03 ^a ±2.08 (6.33-52.05)	11.04 ^a ±1.77 (3.82-30.00)	6.22 ^b ±0.26 (3.49-8.49)	5.66 ^b ±0.22 (3.60-7.35)
Shape index of liver.	125.79 ^a ±6.48 (64.70-170.00)	116.75 ^b ±5.09 (60.66-150.65)	111.40 ^c ±3.59 (60.00-129.35)	106.23 ^d ±1.89 (58.55-121.33)

Values having different superscripts in each the row differ significantly (P<0.05).

Values within parenthesis denote the range.

Table 2

Biometrical parameters of right, left and caudate lobe of liver in different age groups of prenatal Gaddi sheep.

Parameters (cm)	Group-I (1-60 days)	Group-II (61-90 days)	Group-III (91-120 days)	Group-IV (121-Full term)
Length of right lobe	1.76 ^a ±0.24 (0.20-4.00)	5.23 ^b ±0.12 (4.00-6.00)	6.65 ^c ±0.15 (6.00-8.00)	8.56 ^d ±0.16 (6.50-9.40)
Width of right Lobe	1.18 ^a ±0.11 (0.20-2.10)	3.74 ^b ±0.14 (3.00-5.00)	6.55 ^c ±0.18 (4.60-8.00)	5.71 ^d ±0.16 (4.50-6.50)
Length of left Lobe	1.25 ^a ±0.14 (0.20-2.50)	4.35 ^b ±0.09 (3.80-5.50)	5.68 ^c ±0.15 (4.30-6.50)	8.04 ^d ±0.09 (7.30-8.60)
Width of left Lobe	0.95 ^a ±0.09 (0.20-1.50)	3.32 ^b ±0.15 (2.40-4.50)	4.27 ^c ±0.13 (3.50-4.80)	7.15 ^d ±0.32 (4.10-8.60)
Length of caudate lobe	0.77 ^a ±0.09 (0.20-1.50)	3.08 ^b ±0.05 (2.70-3.50)	3.47 ^c ±0.07 (3.00-4.00)	5.50 ^d ±0.10 (4.50-6.60)
Width of caudate lobe	0.41 ^a ±0.04 (0.10-0.80)	1.34 ^b ±0.06 (1.00-1.70)	1.27 ^b ±0.05 (1.00-1.90)	1.98 ^c ±0.07 (1.50-2.70)

Values having different superscripts in each the row differ significantly (P<0.05).

Values within parenthesis denote the range.

Table 3**Biometrical parameters of liver renal fossa in different age groups of prenatal Gaddi sheep.**

Parameters (cm)	Group-I (1-60 days)	Group-II (61-90 days)	Group-III (91-120 days)	Group-IV (121-Full term)
Length of renal fossa	0.44 ^a ±0.05 (0.10-0.70)	2.00 ^b ±0.08 (1.40-2.50)	2.22 ^b ±0.11 (1.40-3.10)	3.46 ^c ±0.16 (2.60-4.80)
Width of renal Fossa	0.34 ^a ±0.05 (0.05-0.80)	1.30 ^b ±0.08 (1.00-1.90)	1.35 ^c ±0.09 (1.00-2.50)	1.89 ^d ±0.05 (1.50-2.30)
Depth of renal fossa	0.11 ^a ±0.02 (0.05-0.30)	0.52 ^b ±0.02 (0.40-0.70)	0.69 ^c ±0.06 (0.50-1.00)	0.74 ^c ±0.03 (0.50-1.33)

Values having different superscripts in each row differ significantly (P<0.05).

Values within parenthesis denote the range.

Table 4**Biometrical parametrs of the extrahepatic ducts of liver in different age groups of prenatal Gaddi sheep.**

Parameters (cm)	Group-I (1-60 days)	Group-II (61-90 days)	Group-III (91-120 days)	Group-IV (121-Full term)
Length of right hepatic duct	-	0.81 ^a ±0.04 (0.41-0.78)	1.03 ^b ±0.04 (0.92-1.00)	1.21 ^c ±0.04 (0.99-1.16)
Width of right hepatic duct	-	0.10 ^a ±0.02 (0.05-0.12)	0.13 ^a ±0.02 (0.09-0.13)	0.15 ^a ±0.03 (0.10-0.13)
Length of left hepatic duct	-	0.72 ^a ±0.0 (0.38-0.68)	0.91 ^b ±0.05 (0.71-0.87)	1.10 ^c ±0.04 (0.89-1.07)
Width of left hepatic duct	-	0.10 ^a ±0.01 (0.02-0.5)	0.11 ^a ±0.03 (0.06-0.11)	0.13 ^a ±0.03 (0.9-0.11)
Length of common hepatic duct	-	0.96 ^a ±0.03 (0.74-0.92)	1.33 ^b ±0.01 (1.21-1.28)	1.68 ^c ±0.04 (1.41-1.58)

Values having different superscripts in each row differ significantly (P<0.05).

Values within parenthesis denote the range.

CONCLUSION

It may concluded from the study, that the data acquired in this study will facilitate the diagnosis of anomalies, pathologies and variation of the fetal liver and may contribute to further studies in fetal pathology, obstetrics, midicine and fetal pathology.

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