

A STUDY OF ASYMETRICAL GROWTH OF LOBES OF LIVER IN HUMAN FETUSES

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ABSTRACT

330 specimens of liver were dissected from fetuses of varying gestational age at dissection hall of NKPSIMS & RC. Nagpur for a period of three years. The livers were dissected out & dimensions of right & left lobe were recorded according to the Anatomical & Physiological classification along with CR length & abdominal circumference of respective fetuses. The various dimensions, i.e., vertical, transverse & anterior posterior length showed similar growth pattern in both right & left anatomical & physiological lobes. The regression in growth rate of left lobe either anatomical or physiological was seen to be much more significant than right lobe. The study showed a definite increase in growth rate at 6th & 7th month of intra uterine life in both the lobes indicating maximum haemopoietic activity.

Key Words :- Liver, right lobe, left lobe, caudate lobe, quadrate lobe, gall bladder.

INTRODUCTION

The liver, the largest & important organ in the body develops as a ventral out growth from gut endoderm in the embryo at 17 somites stage.¹ The right & left lobes of the liver are initially of equal size.² The rapid multiplication of liver cells, perhaps due to rich blood supply, causes the organ to increase in size. This increase in size is at relatively greater rate than that of body until about 35 mm. stage (about 9 weeks) when liver is about 10% of the body weight. After this stage the hepatic growth rate gradually diminishes so that at birth liver is only 5% of the body weight. This diminution of the growth rate affects the left lobe more than the right lobe. The right lobe becomes larger after third month. The portal vein which is formed at about 9 mm. CR. length, does not carry any nutrition to the liver nor the hepatic artery carry any oxygenated blood at that stage.

Livers from variety of mammals were studied, following

which the liver was considered to be primarily divided by the remains of umbilical vein & ductus venosus in to right & left parts.³

It was also recognized that lobes are developed in conjunction with the vessels and right & left lobes are distinct in their biliary drainage. Cantile injected the portal vessels of several livers & found that gall-bladder occupies the central position & right & left lobes on each side of it.⁴ It has been reported that liver is primarily a bilobed organ clearly separate & independent.⁵ Jackson while working on human fetuses, demonstrated the decline in relative weight of liver because of shift in haemopoiesis from liver to skeleton.⁶

His work was supported by other authors.⁷ The studies by Hjortsjo on the intra hepatic segmental branching of bile ducts, hepatic artery & portal vein have emphasized that primary anatomical & physiological lobulation are better defined as the territories of the right & left hepatic ducts.⁸ Anterio-superiorly the line of demarcation in right & left lobe is same for anatomical & physiological lobulation. But postero- inferiorly the division extends from fossa for gall bladder towards the inferior vena cava, making quadrate & caudate lobes part of physiological left lobe instead of right lobe except for the caudate process which is drained by right hepatic duct. The plane of division is not quite sagittal but being tilted in the horizontal & vertical planes. Many authors have confirmed Hjortsjo classification by caste corrosion method, dissection & radiology.⁹⁻²⁰ and mentioned about the asymmetrical growth taking in to consideration the gall bladder as a center.

The functional classification of the lobes of the liver has been stressed upon by some authors.¹²⁻¹⁴ The workers in the field of ultra sonography have taken abdominal circumference of fetus & liver length as parameter to know the gestational age and have shown relationship between fetal liver length & gestational age.¹⁵ According

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to the anthropologists the character of food, configuration of stomach & diaphragm, posture of animal & moulding effects of other organs are the divergent reasons. Embryologists & morphologists agreed that profound influence which pressure both from intra abdominal organs & from fetal structures, plays in the external form of the organ.

So in this work an attempt is made to know exact data for various dimensions of anatomical & physiological right & left lobes & their correlation with weeks of gestation.

MATERIALS & METHODS

Materials :-

In all 330 aborted fetuses of varying Gestational age were collected from Gynae & Obst. Dept. of NKP Salve Institute of Medical Sciences, Nagpur from July 2008 to July 2011.

The Ethical committee clearance was obtained on 15-12-2000.

The fetuses showing congenital abnormality & maceration were discarded. History & the age of the fetuses were recorded & immediately sent for dissection. Prior to dissection the C.R. Length & Abdominal circumference was measured. The liver was dissected out & stored in 5% formaldehyde solution.

MEHODS EMPLOYED FOR VARIOUS OBSERVATIONS

The parameters which were used in this work are as follows :-

- 1) Gestational age in weeks (as per history from mother & USG findings.)
- 2) Crown Rump length in mms.:- The distance from vertex to breech is measured. The first point was taken at highest convexity of skull & other point was taken at maximum lowest border of gluteal fold. The distance was measured with white thread & then by measuring scale in mm. (as shown in Table No. 1)
- 3) Abdominal circumference in cms. :- It was measured at the tip of 9th costal cartilage ie. At trans pyloric plane. (as shown in Table No. 1)
- 4) Various dimensions for Anatomical classification of liver lobes.(in mms.)
 - l) Transverse length of Right lobe :- A mid point was fixed on falciform ligament between superior & inferior borders of liver. From this

point three readings were taken up to the lateral border of right lobe (as shown in diagram No. 1) & the mean was calculated.(as shown in table No. 2)

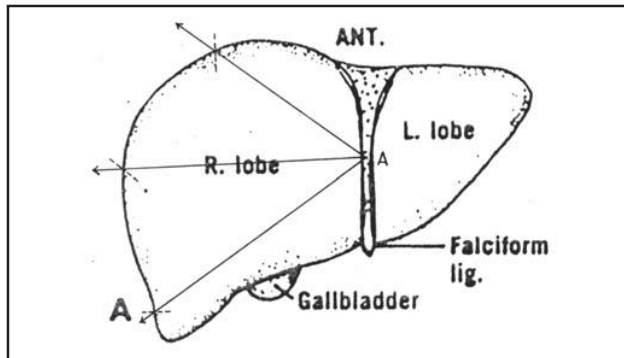


Fig. no. 1 showing measurement of Transverse length of Right lobe of Liver (Anatomical)

- ii) Vertical length of Right lobe :-The distance from superior border to the inferior border of right lobe at three sites (as shown in diagram No. 2) & the mean was calculated.(as shown in table No. 2)

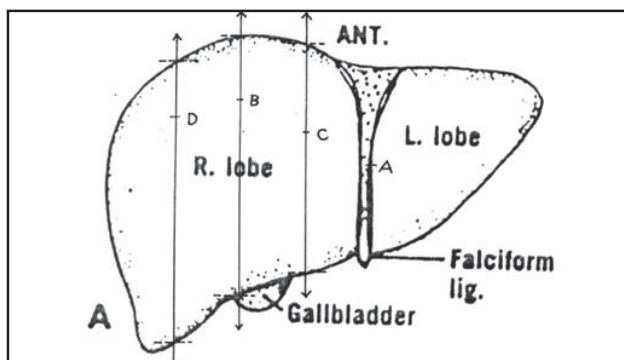


Fig. no. 2 showing measurement of Vertical length of Right lobe of Liver (Anatomical)

- iii) Anterio – posterior length of Right lobe :- The Anterio posterior thickness was measured at the points C, B, & D. (as shown in diagram No. 2) & the mean was calculated.(as shown in table No. 2)
- iv) Transverse length of left lobe :- A mid point was fixed on falciform ligament between superior & inferior borders of liver. From this point three readings were taken up to the lateral border of left lobe (as shown in diagram no.3 no.3) & the mean was calculated.(as shown in table No. 2)

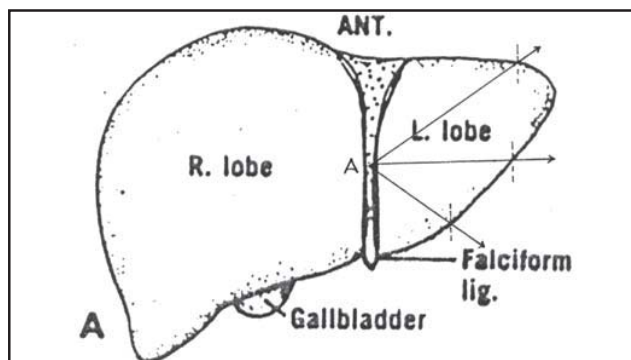


Fig. no. 3 showing measurement of Transverse length of Left lobe of Liver (Anatomical)

Vertical length of left lobe :- The distance from superior border to the inferior border of left lobe at three sites (as shown in diagram No.4) & the mean was calculated. (as shown in table No. 2)

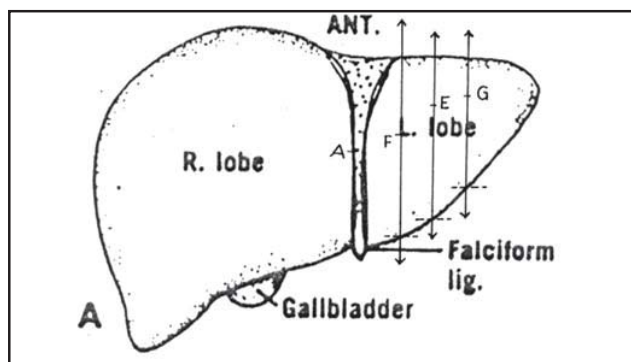


Fig. no. 4 showing measurement of Vertical length of Left lobe of Liver (Anatomical)

v) Antero - posterior length of left lobe of liver :- The Anterio posterior thickness was measured at the points F, E, & G. (as shown in diagram No. 4) & the mean was calculated. (as shown in table No. 2)

5) Various dimensions for Physiological classification of liver lobes. (in mms.)

i) Transverse length of caudate lobe :- Three measurements were taken. first at the superior border, 2nd at middle & 3rd at post. margin of porta hepatis. (As shown in fig. no.5) The mean was calculated. (as shown in table no.3)

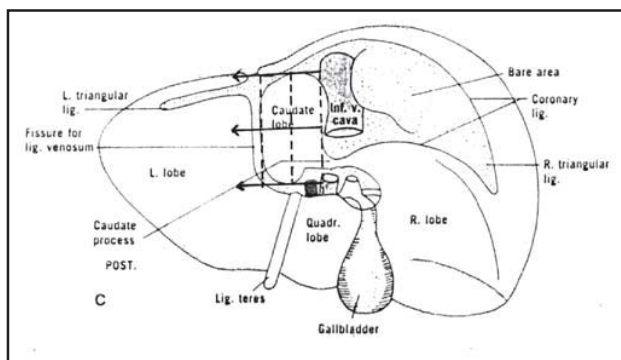


Fig.no. 5 showing measurement of Transverse length of caudate lobe

ii) Vertical length of caudate lobe :- Three measurements were taken. first at the fissure for for ligamentum venosum, 2nd at middle of the caudate lobe & 3rd from groove for inferior vena cava.. (As shown in fig. no.6) The mean was calculated. (as shown in table no. 3)

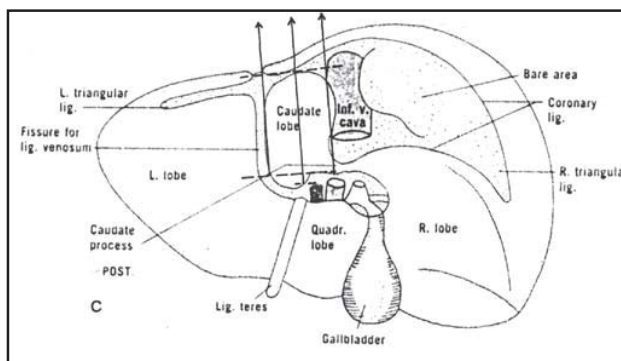


Fig. no. 6 showing measurement of Vertical length of caudate lobe of Liver

iii) Transverse length of quadrate lobe :- Three measurements were taken. first at the inferior border of liver from fissure from ligamentum teres to left border of fossa for gall bladder, 2nd at middle of quadrate lobe to left border of fossa for gall bladder & 3rd at anterior border of porta hepatis to the neck of gall bladder (As shown in fig. no.7) The mean was calculated. (as shown in table no. 3)

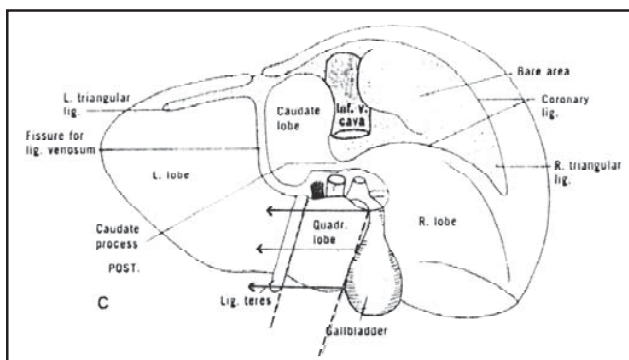


Fig. no. 7 showing measurement of Transverse length of Quadrate lobe

- iv) Vertical length of quadrate lobe :- Three measurements were taken. first from the inferior border of liver to anterior border of porta hepatis, 2nd at middle of the quadrate lobe to anterior border of porta hepatis & 3rd from inferior border of liver at the left border of fossa for gall bladder to the anterior border of porta hepatis. (As shown in fig. no. 8) The mean was calculated. (as shown in table no. 3)

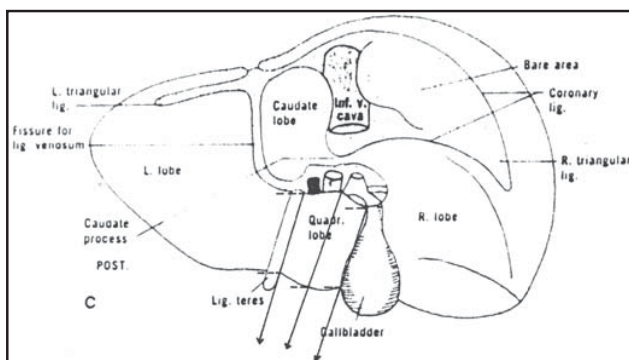


Fig. no. 8 showing measurement of Vertical length of Quadrate lobe of Liver

- v) Transverse length for fossa for gall bladder :- Three measurements were taken. first at the inferior border of liver from right border of fossa to the left border, 2nd at the junction of body with the fundus from right to left border & 3rd at the anterior border of anterior border of porta hepatis. (As shown in fig. no. 9) The mean was calculated. (as shown in table no. 3) This reading was further divided in to two as half of the fossa for gall bladder belongs to Physiological right & left lobe.

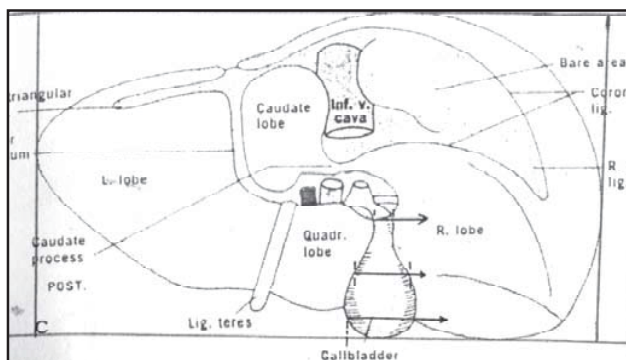


Fig. no. 9 showing measurement of Transverse length of fossa for Gall bladder

- Vertical length of fossa for Gall bladder :- Two measurements were taken. First at the right border of fossa for gall bladder to the anterior border of porta hepatis & 2nd at left border of fossa for gall bladder to the anterior border of porta hepatis. (As shown in fig. no.10) The mean was calculated. (as shown in Table no. 3)

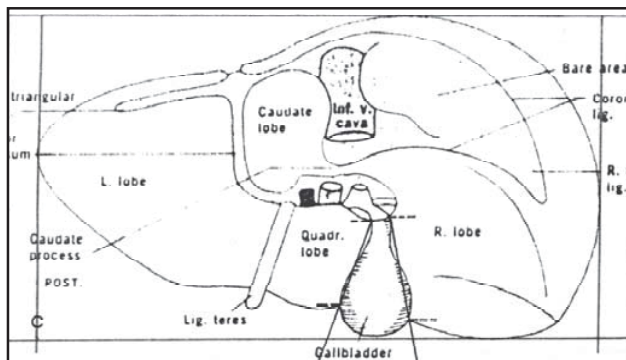


Fig. no. 10 showing measurement of Vertical length of fossa for Gall bladder

- Transverse length of right lobe (physiological) :- The transverse length was derived by following equation :-

- 1) Transverse length of right anatomical lobe - (Less) Transverse length of quadrate lobe = A,
- 2) Transverse length of right anatomical lobe - (Less) (transverse length of quadrate lobe + ½ transverse length of fossa for gall bladder) = B
- 3) Mean length of these two values i.e. $A + B / 2 =$ Transverse length of the physiological right lobe.

Note :- As the measurements of the caudate process were found to be quite insignificant up to 30 weeks, the measurements were not taken in to consideration for calculation of dimensions of physiological right lobe.

vi) Vertical length of right lobe (physiological):-
The vertical length of right anatomical lobe will represent the vertical length of right physiological lobe.

vii) Transverse length of left lobe (physiological) :-
Following method was employed. Transverse length of Anatomical left lobe + (mean of Trans. Length of caudate lobe + Trans. Length of quadrate lobe + $\frac{1}{2}$ mean of trans. Length of fossa for gall bladder)

viii) Vertical length of left physiological lobe :-
Following method was employed. Vertical length of anatomical left lobe + (vertical length of caudate lobe + quadrate lobe) / 2 = vertical length of physiological left lobe i.e. mean vertical length of left lobe + mean of sum of vertical length of caudate and quadrate lobe.

The lengths were measured with the help of caliper & micrometer. Three readings were taken for each parameter & mean was calculated to minimize the error. The caudate lobe, quadrate lobe & half of the fossa for the gall bladder is included in physiological left lobe, where as the caudate process is drained by right cystic duct hence it is a part of right physiological lobe. The variations in length for caudate process were insignificant & hence not considered.

The lines separating the lobes of the Liver
Line A – A separates the Right & Left Anatomical Lobes.

Line F – F separates the Left & Right
Physiological lobes.

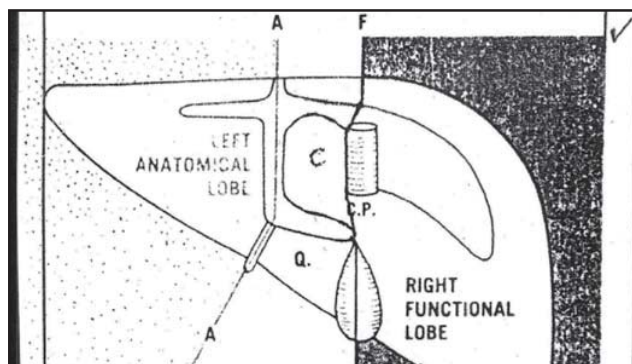


Fig no. 11

OBSERVATIONS & RESULTS :- The data was recorded in tabular form

Table No. 1 : Chart showing number of fetuses examined as per week Gestation, Mean C.R. Length & Abdominal Circumference				
Sr. No.	Weeks of Gestation	No. of Specimens	Mean CR. Length in (mms)	Abdominal Circumference in (cms)
01	10	10	48	5
02	11	9	54	5.9
03	12	10	67	7.3
04	13	11	85	8.7
05	14	11	97	9.8
06	15	11	105	10.8
07	16	12	122	12.7
08	17	11	134	14
09	18	10	145	15.1
10	19	11	158	16.3
11	20	12	169	17.5
12	21	11	180	18.5
13	22	10	198	19.7
14	23	10	209	20.8
15	24	11	218	22.0
16	25	12	230	23.1
17	26	12	240	24.3
18	27	12	252	25.5
19	28	11	263	26.4
20	29	12	275	27.5
21	30	11	288	28.6
22	31	10	299	29.4
23	32	10	308	30.2
24	33	11	315	31.1
25	34	12	325	31.9
26	35	12	336	32.9
27	36	10	347	33.8
28	37	10	352	34.8
29	38	11	360	35.7
30	39	12	366	36.4
31	40	12	372	37.8
Total No. of Fetuses		330		

Table No. 2 : Co-relation between Gestational age & various dimensions of Anatomical Right & Left lobe of the Liver (in mms.)

Weeks of Gestation	Right Lobe			Left Lobe		
	Vertical	Transverse	Ant-Post.	Vertical	Transverse	Ant.-Post.
10	13.4	10.6	6.2	13.2	10.5	5.2
11	14.8	11.2	7.1	14.6	11.1	5.9
12	16.1	12.3	8.2	15.9	11.9	6.5
13	17.7	13.8	9.3	17.5	13.4	7.1
14	19.2	15.4	10.2	18.6	14.6	7.7
15	20.3	17.1	10.8	19.7	15.2	8.1
16	21.6	18.5	11.4	20.2	16.3	8.5
17	23.2	20.3	11.9	20.9	17.4	8.9
18	24.3	21.4	12.3	21.8	18.2	9.4
19	25.5	22.6	12.9	22.7	18.9	9.8
20	26.7	23.8	13.3	23.6	19.3	10.2
21	27.8	24.7	13.9	24.5	19.9	10.8
22	29.4	26.6	14.2	25.7	20.2	11.3
23	32.1	28.2	14.8	26.5	20.9	11.8
24	34.3	29.4	15.3	27.6	21.3	12.4
25	36.1	31.2	15.9	28.7	22.2	12.9
26	37.3	32.6	16.3	29.5	22.9	13.4
27	38.2	34.1	16.8	30.6	23.4	13.8
28	38.9	35.3	17.3	31.1	23.9	14.2
29	39.4	36.6	17.9	31.3	24.3	14.8
30	40.2	37.5	18.4	33.4	24.5	15.3
31	41.4	38.6	18.9	34.6	25.2	15.7
32	42.5	40.1	19.3	35.7	25.9	16.1
33	43.4	41.3	19.9	36.1	26.3	16.5
34	44.5	42.5	20.4	36.8	26.9	16.9
35	45.3	43.6	20.9	37.7	27.4	17.4
36	46.5	44.8	21.3	38.5	27.9	17.8
37	47.8	46.1	21.9	38.9	28.3	18.2
38	49.1	47.8	22.5	40.2	28.9	18.7
39	50.7	48.9	23.1	40.7	29.4	19.1
40	52.3	49.6	23.7	41.2	29.8	19.6

Table No. 3 : Table showing co-relation between Gestational age & various dimensions of Caudate Lobe, Quadrate Lobe & Fossa for the Gall bladder. (in mms.)

Weeks of Gestation	Mean Length for Caudate Lobe		Mean Length for Quadrate Lobe		Mean Length for Fossa for Gall Bladder	
	Transverse	Vertical	Transverse	Vertical	Transverse	Vertical
10	4.7	5.9	3.1	6.8	1.8	6.8
11	5.1	6.3	3.6	7.6	2.2	7.6
12	5.4	6.7	4.2	8.7	2.5	8.7
13	5.9	7.1	4.9	9.8	2.8	9.8
14	6.3	7.5	5.5	10.9	3.1	10.9
15	6.7	7.9	6.1	12.1	3.5	12.1
16	7.1	8.3	6.6	12.9	3.9	12.9
17	7.5	8.7	7.2	13.7	4.3	13.7
18	7.9	9.1	7.8	14.4	4.6	14.4
19	8.3	9.5	8.4	15.2	4.9	15.2
20	8.7	9.9	9.1	15.9	5.2	15.9
21	9.1	10.3	9.5	16.7	5.6	16.7
22	9.5	10.7	9.9	17.4	5.9	17.4
23	9.9	11.1	10.4	18.1	6.3	18.1
24	10.3	11.5	10.9	18.8	6.6	18.8
25	10.7	11.9	11.5	19.5	6.9	19.5
26	11.1	12.3	12.1	20.2	7.3	20.2
27	11.5	12.7	12.7	20.9	7.6	20.9
28	11.9	13.1	13.2	21.6	7.9	21.6
29	12.3	13.5	13.8	22.3	8.3	22.3
30	12.7	13.9	14.2	23.1	8.6	23.1
31	13.1	14.3	14.7	24.7	8.9	24.7
32	13.5	14.7	15.1	25.4	9.2	25.4
33	13.9	15.1	15.4	26.1	9.5	26.1
34	14.3	15.5	15.8	26.8	9.8	26.8
35	14.7	15.9	16.1	27.5	10.1	27.5
36	15.1	16.3	16.4	28.2	10.4	28.2
37	15.5	16.7	16.9	28.9	10.7	28.9
38	15.9	17.1	17.3	29.5	11.1	29.5
39	16.4	17.5	17.8	30.1	11.5	30.1
40	16.8	17.9	18.2	30.8	11.9	30.8

Table No. 4 : Table showing the Comparison of Mean Growth rate of Right & Left Lobe.(Anatomical)

Gestatio nal Age in Weeks	RightLobe Vertical Length in mms.	Left Lobe Vertical Length in mms	RightLobe Transver. Length in mms.	Left Lobe Transver. Length in mms	RightLobe A.P. Length in mms	Left Lobe A.P. Length in mms
12-16	1.375	1.075	1.55	1.1	0.8	0.5
17-20	1.275	0.85	1.325	0.75	0.675	0.425
21-24	1.533	1.0	1.4	0.5	0.5	0.55
25-28	1.15	0.87	1.475	0.65	0.5	0.45
29-32	0.90	0.8	1.2	0.5	0.5	0.475
33-36	1.0	0.7	1.175	0.5	0.5	0.475
37-40	1.25	0.67	1.2	0.47	0.475	0.45

STATISTICAL ANALYSIS

- 1) Co relation between Gestational Age & C. R. Length. :-The C.R. Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded .The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation is, C.R. length = $52.6 + 11.0 \text{ G.A. weeks}$, $S = 10.91$, $R.Sq.=98.4\%$, highly significant.
- 2) Co relation between Gestational Age & Abdominal circumference. :-The Abdominal circumference of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Abd. Cir.- $4.47+1.02 \text{ G.A. weeks}$, $S = 1.139$, $R.Sq.=98.6\%$, highly significant.
- 3) Co relation between Gestational Age & Vertical Length of Anatomical Right lobe :-The Vertical Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Rt. .L. VT. length = $-5.04 + 1.64 \text{ G.A. weeks}$, $S = 5.410$, $R.Sq.=84.4\%$, quite significant.
- 4) Co relation between Gestational Age & Transverse Length of Anatomical Right lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Rt. .L. TR. length = $-2.81 + 1.61 \text{ G.A. weeks}$, $S = 4.636$, $R.Sq.=87.7\%$, quite significant.
- 5) Co relation between Gestational Age & Anterio. Posterior Length of Anatomical Right lobe :-The Anterio Posterior Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is, Rt. .L. AP. length = $-6.03 + 0.674 \text{ G.A. weeks}$, $S = 2.169$, $R.Sq.=85.4\%$, quite significant.
- 6) Co relation between Gestational Age & Vertical Length of Anatomical Left lobe :-The Vertical Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Lt. L. VT. length = $-0.12 + 1.16 \text{ G.A. weeks}$, $S = 3.989$, $R.Sq.=83.4\%$, quite significant.
- 7) Co relation between Gestational Age & Transverse Length of Anatomical Left lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Lt. .L. TR. length = $1.02 + 1.15 \text{ G.A. weeks}$, $S = 3.999$, $R.Sq.=87.1\%$, quite significant.
- 8) Co relation between Gestational Age & Anterio. Posterior Length of Anatomical Left lobe :-The Anterio Posterior Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Lt. .L. AP. length = $-6.50 + 0.578 \text{ G.A. weeks}$, $S = 2.063$, $R.Sq.=82.2\%$, quite significant.
- 9) Co relation between Gestational Age & Transverse Length of Caudate lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks,17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks , 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Lt. .L. TR. length = $-2.81 + 1.61 \text{ G.A. weeks}$, $S = 4.636$, $R.Sq.=87.7\%$, quite significant.

- weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , CAU. .L. TR. length = $0.661 + 0.402 \text{ G.A. weeks}$, $S = 0.02789$, $R.Sq. = 100\%$, highly significant.
- 10) Co relation between Gestational Age & Vertical Length of Caudate lobe :-The Vertical Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , CAU. .L. VT. length = $1.90 + 0.400 \text{ G.A. weeks}$, $S = 0.01235$, $R.Sq. = 100\%$, highly significant.
 - 11) Co relation between Gestational Age & Transverse Length of Quadrate lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , QRA. .L. TR. length = $-1.41 + 0.506 \text{ G.A. weeks}$, $S = 0.3705$, $R.Sq. = 99.4\%$, highly significant.
 - 12) Co relation between Gestational Age & Vertical Length of Quadrate lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , QRA. .L. VT. length = $-0.206 + 0.788 \text{ G.A. weeks}$, $S = 0.4032$, $R.Sq. = 99.7\%$, highly significant.
 - 13) Co relation between Gestational Age & Transverse Length of Fossa for Gall Bladder :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , G.BLD. TR. length = $-1.42 + 0.332 \text{ G.A. weeks}$, $S = 0.3912$, $R.Sq. = 99.9\%$, highly significant.
 - 14) Co relation between Gestational Age & Vertical Length of Fossa for Gall Bladder :-The Vertical Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , G.BLD. VT. length = $-0.206 + 0.788 \text{ G.A. weeks}$, $S = 0.4032$, $R.Sq. = 99.7\%$, highly significant.
 - 15) Co relation between Gestational Age & Transverse Length of Physiological Right lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Ph.Rt. .L. TR. length = $-2.12 + 0.799 \text{ G.A. weeks}$, $S = 0.3650$, $R.Sq. = 99.8\%$, highly significant.
 - 16) Co relation between Gestational Age & Vertical Length of Physiological Right lobe :-The Vertical Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Ph. Rt. .L. VT. length = $1.55 + 1.28 \text{ G.A. weeks}$, $S = 1.101$, $R.Sq. = 99.1\%$, highly significant.
 - 17) Co relation between Gestational Age & Transverse Length of Physiological Left lobe :-The Transverse Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is , Ph.Lt. .L. TR. length = $5.50 + 0.977 \text{ G.A. weeks}$, $S = 0.9312$, $R.Sq. = 98.9\%$, highly significant.
 - 18) Co relation between Gestational Age & Vertical Length of Physiological Left lobe :-The Vertical

Length of all fetuses ranging from Gestational age of 10 to 40 weeks have been recorded. The mean Growth rate from 12 to 16 weeks, 17 to 20 weeks, 21 to 24 weeks, 25 to 28 weeks, 29 to 32 weeks, 33 to 36 weeks & 37 to 40 weeks were calculated. The regression equation for this measurement is, Ph.Lt. .VT. length = 3.24 +1.07 G.A. weeks, S= 0.4125, R.Sq.=98.8%, highly significant.

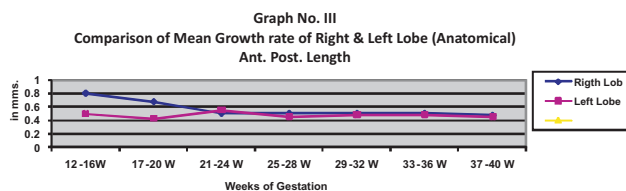
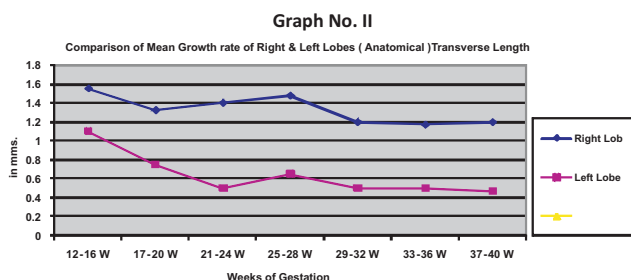
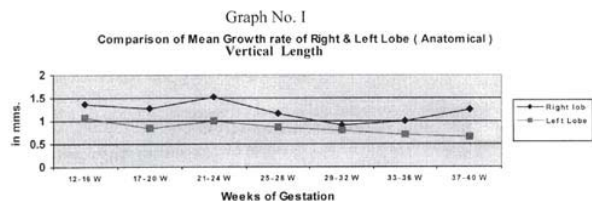


Table No. 5 : Table showing Comparison between Mean Growth rate of Right & Left Lobe (Physiological)

Gestational Age In Weeks	Right Lobe Vertical Length In mms.	Left Lobe Vertical Length In mms.	Right Lobe Transverse Length in mms.	Left Lobe Transverse Length in mms.
12-16	1.375	1.26	0.95	1.53
17-20	1.275	1.18	0.72	1.15
21-24	1.19	1.1	0.875	1.04
25-28	1.15	1.05	0.925	1.025
29-32	1.09	1.0	0.675	0.85
33-36	1.1	0.9	0.725	0.79
37-40	1.2	0.82	0.7	0.82

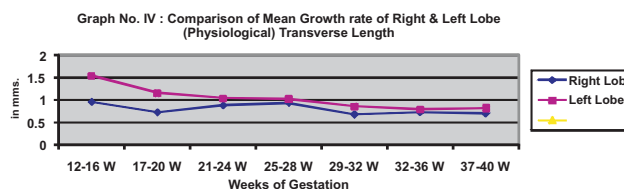


Table No. 6 : Table showing Value of R. Sq. after applying regression equation for Gestational age from 10 to 40 weeks

Sr. No.	PARAMETER	REGRESSION EQUATION	S. VALUE	R.Sq.	REMARK
1	C.R.Length	-52.6 + 11.0 G.A.	10.91	98.4 %	Significant
2.	Abdominal Circumference	-4.47 + 1.02 G.A.	1.139	98.6%	Do
3.	Anatomical RightLobe				
	a) Vertical	-5.04+ 1.64 G.A.	5.410	84.7%	do
	b) Transverse	-2.81 + 1.61 G.A.	4.636	87.9%	do
	c) Anterio- Posterior	6.03 + 0.674 G.A.	2.169	85.4%	do
4.	Anatomical Left Lobe				
	a)Vertical	0.12 + 1.16 G.A.	3.989	83.7%	do
	b) Transverse	1.02 + 1.15 G.A.	3.999	87.3%	do
	c) Ant. Post.	6.50 + 0.578 G.A.	2.063	82.6%	do
5.	Caudate Lobe				
	i) Transverse	0.661 + 0.402 G.A.	0.02789	100%	do
	ii) Vertical	1.90 + 0.4 G.A.,	0.01235	100%	do
6.	Quadrate Lobe				
	i)Transverse	-1.41 + 0.506 G.A.	0.3705	99.4 %	do
	ii) Vertical	-0.206 + 0.788 G.A.	0.4032	99.7%	do

7.	Fossa for Gall Bladder				
	i) Transverse	-1.42 + 0.332 GA	0.3932	99.91%	do
	ii) Vertical	- 0.206 + 0.788 GA	0.4032	99.7%	do
8.	Physiological Right Lobe				
	a) Transverse	- 2.12 + 0.799 GA	0.3650	99.8%	do
	b) Vertical	1.55 + 1.28 GA	1.101	99..1%	do
10.	Physiological Left Lobe				
	a) Transverse	5.50 + 0.977 GA	0.9312	98.9 %	do
	b) Vertical	3.24 + 1.07 GA	0.4125	99.8%	do

RESULTS

- 1) The mean growth rate (mgr.) for vertical length of Anatomical left lobe shows steady reduction when compared with right lobe.
- 2) The mgr. for Transverse length of Anatomical left lobe shows more reduction when compared with right lobe.
- 3) The mgr. for Anterio – posterior length for both the lobes (Anatomical) do not show any significant reduction.
- 4) The caudate lobe does not show significant reduction in mgr. for vertical length & transverse length.
- 5) The vertical length of quadrate lobe shows significant reduction in mgr when compared with transverse length.
- 6) The mgr. for vertical length for fossa of Gall bladder shows significant reduction where as transverse length does not show any reduction.
- 7) The physiological Right & Left lobes shows similar patterns.
- 8) It has been observed that the right & left lobes show initial reduction in mgr. but during 21 to 24 weeks show significant rise in mgr. which may be attributed to increased haemopoietic activity of liver.

DISCUSSION

Most of the previous workers started the study of the liver in man & other animals by trying to find out missing links of development & functional aspects of the

lobulation of the liver. As the new techniques developed the exact demarcation of the functional right & left lobe was possible, which does not correspond with anatomical right & left lobe.

Observations recorded in table no. 1 to 6 have been correlated with observations of others workers. Findings for anatomical right & left lobe correlated with Gross B.H.¹³ Observations for caudate lobe correlated with Elias H and Hutchins G.M. & Moor G.W.¹⁴ Although the caudate lobe is part of physiological left lobe, it did not show any regression in growth rate in any of its dimensions in foetal life. Observations for quadrate lobe slightly differed from findings of Thompson A.¹⁶ It showed significant regression in both dimensions up to 32 weeks. Observations for fossa for gall bladder deviated from the observations made by Hutchins G.M. & Moor G.W.¹⁴ The transverse length was divided in to right & left physiological left lobe and did not show any type of regression but showed significant steady growth. Observations for both anatomical right & left lobes coincided with Cantile J⁴; Hutchins G.M. & Moor G.W.¹⁴ The vertical length showed initial decline from 12 to 20 weeks, followed by marked elevation in 21 to 24 weeks and again showed decline in 24 to 32 weeks. Right lobe showed significant rise in growth from 32 to 40 weeks. The increase between 20 to 24 indicate there is increase haemopoietic activity. The decline from 25 to 32 weeks can be explained from the fact that haemopoietic function is transferred to skeleton. Increase after 32 weeks for right lobe can be explained by the fact that there is more space available for right lobe (by pushing

the right kidney inferiorly, as right kidney shows hepatic impression) than the left lobe as the space is restricted by developing stomach and spleen (left lobe do not show any renal impression). The transverse length & antero- posterior length show similar features. The physiological right & left lobes showed similar growth patterns as of anatomical right & left lobes. The division of left lobe either anatomical or physiological showed similar growth patterns after 12 weeks.

So in a nut shell it can be concluded that the morphogenesis of the lobes of liver depends upon the haematopoietic activity & the availability of the space to grow showing significant similar growth patterns irrespective of their anatomical & functional discrimination.

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