**Morphological Studies on the Liver of
Japanese Fetuses in relation to
Age and Sex.
(The Change of External Form of the Liver in
the Latter Half of the Embryonal
Period.)***

By

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Preface

There are many reports on the liver such as those by Rex, Burlet, Thomson and others, but those dealing statistically with the external form are comparatively few.

Ruge, Kudo, Amano, Aoki and some others have reported on that of the adults' but we can only quote Kudo, Morikawa and others for reports on that of the fetus.

In the past students have included all fetuses in the different months of pregnancy in the single category of "fetus" and the results of their studies are compared with those of the adults and the difference discussed.

However a certain period of time is required for any organ to develop fully, although the length of time required varies according to the nature of different organs. Therefore the form of an organ should be considered to vary with the time. Especially the changes during the embryonal period, although it is only during a short period of months, is rapid and marked. Accordingly, when the form of an organ is discussed, its relation to age can not be disregarded. The method

* Reported on the Annual Meeting of the Anatomical Society of Japan. 1952

of former students, disregarding pregnancy months and giving the same value to the organs of the fetus in the 5th and 10th month of pregnancy, can not be considered to be right or particularly significant. The present report deals with a study of the change of form of the liver in the latter half of the embryonal period, with special regard to the change of form which accompanies progress during pregnancy, and comparing the results with those obtained by former workers on fetuses and adults.

Material and Method

The material used for the present study was 200 livers (male-100, female-100) of the fetuses, varying from the 5th to the 10th month of pregnancy, that had been used for the previous "Supplement to morphological studies on livers of Japanese fetuses in relation to age and sex."* (Table 1)

Table 1

	V	VI	VII	VIII	IX	X	Total
♂	10	10	20	20	20	20	100
♀	10	10	20	20	20	20	100
♂ + ♀	20	20	40	40	40	40	200

The materials were fixed by injecting 10% formalin solution through the umbilical vein of the fetus. The liver was removed when it had hardened. Special care was taken to preserve the shape in the abdominal cavity. Fetuses with deformation, or from mothers in whom syphilis was proved, were excluded.

Results and Discussion

It is said that, in the liver of the human fetus, the differentiation of left and right lobes is noticeable as early as 3rd week of pregnancy and that, by the 3rd month, the Spigelian and quadrate lobes are formed and discrimination of the four lobes becomes quite clear. However the form of the left and the right lobes decides the shape of the liver as a whole; or, in other words, the combined form of the

* T. Takahashi, Nagasaki Igaku. Z. Vol. 27, No. 12 (1952)

two lobes determines the form of the liver, while the Spigelian and quadrate lobes have almost no relation to the liver shape.

Therefore, the form of the left and right lobes was studied in relation to the duration of the pregnancy. The liver shape formed by the combination of the two lobes was created and its variation investigated.

I. The form of the left and right lobes.

1. *The left lobe.*

Kudo follows Ruge in the classification of the livers of adults and divides them into four types, as do Amano, Aoki and others. (Fig. 1) viz :

Type I. Viewed from the intestinal side, those livers rhombic or square in shape and having three edges i.e. ventro-lateral, dorso-lateral, and dorso-medial edges.

Type II. Those with ventro-lateral and dorso-medial edges only and from which the ventral angle has disappeared.

Type III. Those with obtuse dorso-lateral and ventro-lateral angles and roughly forming an obtuseangled triangle.

Type IV. Those with ventro-lateral and dorsomedial edges with a strongly extended dorso-lateral angle.

Following this classification, and disregarding the age of fetuses as did Morikawa and others, the frequency of each type was worked out and the result was compared with those reported on the fetus and adult by former workers. (Table 2) In this paper's cases the greater part of the fetuses were type I, followed in order by types II, IV, III, although types IV and III were very few in number.

Fig. 1

In Morikawa's cases, type I was more frequent than type II, but the difference between the two was very small. This, and the fact that type III was more frequent than type IV differ from the cases in this paper.

Among the adults, the frequency of type II does not differ much from that of type I but it is noteworthy that type I decreases remarkably and type IV increases, instead, to the same extend or even more.

Table 2

Material	Investigator	Number of Cases	Type I	Type II	Type III	Type IV
Fetus	Takahashi	200	73%	25%	0.5%	1.5%
	Morikawa	77	45.5	38.9	13.0	2.6
Adult	Kudo	137	27.0	30.7	8.8	33.6
	Amano Ishii	58	24.1	32.8	12.1	31.0
	Aoki Ishii Yo	108	28.7	35.2	12.0	24.1

According to Ruge and Kudo, type I is peculiar to primates and is called the primitive form, but it also appears in the human liver during the embryonal period. Type II, III, and IV are said to be found generally among the anthropoids and humans. Table 2 shows that, during the embryonal period, the type I amounts to more than half of the total, but that this type decreases markedly among the adults and that type IV appears instead, backing Ruge's opinion in calling type I the primitive form.

Viewing the frequency of each of the four types according to pregnancy months in this instance, almost all are type I in the 5th pregnancy month, but the number decreases rapidly with the progress of the pregnancy until it becomes approximately one half by the 10th month.

On the other hand type II shows just the opposite tendency, increasing from zero in the 5th month to approximately 40% by the 10th month. (Fig. 2, Table 3)

Type III was noticed at the 8th month but only 1 example.

Type IV appears in the 9th and 10th months but the frequency cannot even be considered.

Considering the fact that type I predominates around the 5th month of pregnancy, type II gradually increases then, and type IV appears towards the end of the period, it is assumed that the form of the left lobe follows the following course of change: type I-II-(III), IV.

But even the frequency of each type at the 10th month differs considerably from that of the adults. This is considered to mean that

a change occurs in the postnatal stage, approaching the form as seen in the adults.

Therefore, if one accepts the opinion of Ruge and Kudo in a

Table 3.

Type	Sex	Fre- quency	Month						Total
			V	VI	VII	VIII	IX	X	
I	♂	Cases	10	9	16	15	11	13	74
		%	100	90	80	75	55	65	74
	♀	Cases	10	10	17	13	12	10	72
		%	100	100	85	65	60	50	72
	♂ + ♀	Cases	20	19	33	28	23	23	146
		%	100	95	82.5	70	57.5	57.5	73
II	♂	Cases	0	1	4	5	7	7	24
		%	0	10	20	25	35	35	24
	♀	Cases	0	0	3	6	8	9	26
		%	0	0	15	30	40	45	26
	♂ + ♀	Cases	0	1	7	11	15	16	50
		%	0	5	17.5	27.5	37.5	40	25
III	♂	Cases							
		%							
	♀	Cases				1			
		%				5			
	♂ + ♀	Cases							
		%							0.5
IV	♂	Cases					2		
		%					10		
	♀	Cases						1	
		%						5	
	♂ + ♀	Cases							
		%							1.5

Fig. 2

comparative-anatomical view that type I is a primitive form and type IV a progressive form, it would not be a mistake to assume that the process of phylogenesis is repeated in the short human embryonal period.

The difference in the frequency of each type of fetus noted by Morikawa may therefore be considered to be due to the materials selected, whether they were mature or immature. Also the remarkable differences in the frequency between the fetuses, when the pregnancy month is neglected, and that of the adults, is considered to be not an essential difference arising from the different categories of fetus and adult, but a

difference arising from the comparison of frequencies computed without taking into consideration whether the fetus was mature or immature.

2. *Right lobe.*

Concerning the form of the right lobe, there is only a classification comparing the livers of twins by Morikawa, but not of adults.

It is divided into 4 types, as follows:

Type I. The dorsal, ventral, and lateral edges cross almost at right angles to each other, and, viewed from the intestinal side, it is roughly square.

Type II. The dorsal and lateral edges cross at right angles as in type I, and the ventral edge arches forward.

Type III. Though the ventral edge is longer than the dorsal edge and the lateral edge leans to right, the ventral and dorsal edges are almost parallel, therefore, viewed from intestinal side, the shape is trapezoid.

Type IV. The dorsal and lateral edges are such as type III, and ventral edge arches forward. (Fig. 3)

Following this classification, the frequencies are in order by type

II, IV, I, III in these cases (Table 4), and there is no difference in comparing male to female. In Morikawa's cases, not only frequencies of each type are almost equal, but there is a clear difference on sex. The cases in this series do not bear that out. It is considered that this arises from the difference in number of cases in each pregnancy

Table 4

Investigator Material	Number of Cases	Type		I	II	III	IV
		Sex					
Fetus	Takahashi	200	♂	26%	37%	9%	28%
			♀	24	32	12	32
			♂ + ♀	25	34.5	10.5	30
	Morikawa	77	♂	29.2	18.7	27.1	25
			♀	17.3	27.6	24.1	31
			♂ + ♀	24.7	22.1	25.9	27.3

Fig. 3

month as discussed under the left lobe.

Viewing the frequencies of the four types according to the pregnancy months in these cases, it is noteworthy that types I and II are almost all around the 5th month of pregnancy, but with the advancement of pregnancy months, the frequencies decrease rapidly, and in opposition, type IV being zero in 5th month increases to half of the total by the 10th month. Type III appears in the 6th month for the first time, but the frequency does not show a remarkable change afterwards. (Fig. 4, Table 5)

According to these facts, i. e. that type I and II predominate in the immature fetus, type IV increases toward the end, and type II tends to keep a high frequency longer than type I towards the end, it is assumed that the form of the right lobe follows the following course of change: type I-II-III-IV; namely, from square to trapezoid; although no conclusions can be drawn prior to the

5th month of pregnancy, as no research has been done about it.

Fig. 4

Fig. 5

This same fact was proved by the measurement of the increase in breadth of the right lobe, especially on the ventral edge, with the advancement of the months.

Research into the change of form of the left and right lobes of the fetal liver shows that these two lobes have almost symmetrical forms and volume in the early period, but as the pregnancy advances, the left lobe reduces in volume, relative to the right lobe, and the balance in the rate of increase is altered.

There is no settled opinion about the time when this relative reduction begins and ends, viz: beginning in embryonal period or at latest in the neonatal period and ending in old age (Ruge); or beginning in the neonatal period (Sobotta); or in infancy (Merkel).

However, according to this present morphological research and the previous report, it can be considered that the reduction begins gradually after the mid-term of the embryonal period and continues into the postnatal.

II. Liver type. (combined form of these two lobes)

In the preceeding pages, it has been shown in what manner the form of the left and right lobes change with the advancement of pregnancy, and that the form of the liver as a whole is shaped by

Table 5

Type	Sex	Month Fre- quency	V	VI	VII	VIII	IX	X	Total
I	♂	Cases	4	4	4	5	5	4	26
		%	40	40	20	25	25	20	26
	♀	Cases	5	3	6	2	4	4	24
		%	50	30	30	10	20	20	24
	♂ + ♀	Cases	9	7	10	7	9	8	50
		%	45	35	25	17.5	22.5	20	25
II	♂	Cases	6	4	10	7	6	4	37
		%	60	40	50	35	30	20	37
	♀	Cases	5	6	8	7	3	3	32
		%	50	60	40	35	15	15	32
	♂ + ♀	Cases	11	10	18	14	9	7	69
		%	55	50	45	35	22.5	17.5	34.5
III	♀	Cases	0	2	2	2	2	1	9
		%	0	20	10	10	10	5	9
	♀	Cases	0	0	3	4	3	2	12
		%	0	0	15	20	15	10	12
	♂ + ♀	Cases	0	2	5	6	5	3	21
		%	0	10	12.5	15	12.5	7.5	10.5
IV	♂	Cases	0	0	4	6	7	11	28
		%	0	0	20	30	35	55	28
	♀	Cases	0	1	3	7	10	11	32
		%	0	10	15	35	50	55	32
	♂ + ♀	Cases	0	1	7	13	17	22	60
		%	0	5	17.5	32.5	42.5	55	30

the combination of these two lobes, as mentioned above. Therefore it can be considered that theoretically, there must be 16 types formed by the combination of each type of the two lobes, however, as a matter of fact, there are only 8 types combined from type I and II of

the left lobe and the 4 types of the right lobe, since the relative reduction of the left lobe is slight, and less in the embryonal period than in the postnatal, and types III and IV are noticed only occasionally at the close of the embryonal period and need not even be considered.

Type I. (L. I.—R. I.)

Type II. (L. I.—R. II.)

Type III. (L. I.—R. III.)

Type IV. (L. I.—R. IV.)

Type V. (L. II.—R. I.)

Type VI. (L. II.—R. II.)

Type VII. (L. II.—R. III.)

Type VIII. (L. II.—R. IV.)

(Besides these types, a type of L. III.—R. IV. and L. IV.—R. III., and two types of L. IV.—R. IV. were noticed as rare examples.) (Fig. 5)

Fig. 6

Table 6

Type	Sex	Month Fre- quency	V	VI	VII	VIII	IX	X	Total
I	♂	Cases	4	4	3	4	4	3	22
		%	40	40	15	20	20	15	22
	♀	Cases	5	3	5	2	3	2	20
		%	50	30	25	10	15	10	20
	♂ + ♀	Cases	9	7	8	6	7	5	42
		%	45	35	20	15	17.5	12.5	21
II	♂	Cases	6	4	9	6	3	3	31
		%	60	40	45	30	15	15	31
	♀	Cases	5	6	7	6	2	3	29
		%	50	60	35	30	10	15	29
	♂ + ♀	Cases	11	10	16	12	5	6	60
		%	55	50	40	30	12.5	15	30
III	♂	Cases	0	1	1	1	1	1	5
		%	0	10	5	5	5	5	5
	♀	Cases	0	0	3	3	2	0	8
		%	0	0	15	15	10	0	8
	♂ + ♀	Cases	0	1	4	4	3	1	13
		%	0	5	10	10	7.5	2.5	6.5
IV	♂	Cases	0	0	3	4	3	6	16
		%	0	0	15	20	15	30	16
	♀	Cases	0	1	2	2	5	5	15
		%	0	10	10	10	25	25	15
	♂ + ♀	Cases	0	1	5	6	8	11	31
		%	0	5	12.5	15	20	27.5	15.5
V	♂	Cases	0	0	1	1	1	1	4
		%	0	0	5	5	5	5	4
	♀	Cases	0	0	1	0	1	2	4
		%	0	0	5	0	5	10	4
	♂ + ♀	Cases	0	0	2	1	2	3	8
		%	0	0	5	2.5	5	7.5	4
VI	♂	Cases	0	0	1	1	3	1	6
		%	0	0	5	5	15	5	6
	♀	Cases	0	0	1	1	1	0	3
		%	0	0	5	5	5	0	3
	♂ + ♀	Cases	0	0	2	2	4	1	9
		%	0	0	5	5	10	2.5	4.5
VII	♂	Cases	0	1	1	1	1	0	4
		%	0	10	5	5	5	0	4
	♀	Cases	0	0	0	1	1	1	3
		%	0	0	0	5	5	5	3
	♂ + ♀	Cases	0	1	1	2	2	1	7
		%	0	5	2.5	5	5	2.5	3.5
VIII	♂	Cases	0	0	1	2	2	5	10
		%	0	0	5	10	10	25	10
	♀	Cases	0	0	1	4	5	6	16
		%	0	0	5	20	25	30	16
	♂ + ♀	Cases	0	0	2	6	7	11	26
		%	0	0	5	15	17.5	27.5	13

Table 6 shows the frequencies of the liver types formed by combination of the two lobes in each pregnancy month.

Types I and II are almost equal around the mid-term of pregnancy, but decrease gradually with progression of the pregnancy.

Since the form of the right lobe alone changes from type I to type II as above-mentioned, and type II of the liver type continues at a considerably higher frequency until a later period than type I, it is assumed that the form of the combined liver type also changes from type I to type II, but it must be decided later whether type I is more primitive than type II or not. No research has yet been done prior to the 5th month of pregnancy. The other types appear during the 6th or 7th months for the first time, but the frequencies are low and they seem to disappear gradually during the embryonal or postnatal period. (Fig. 6)

Summarizing the change in liver types: types I and II predominate toward mid-term of the period, but gradually type VIII appears instead, after type IV.

Conclusion :

Studying the external form of the livers of 200 fetuses, varying from the 5th to the 10th month of pregnancy, according to age, the following conclusions are made :

Comparing the frequencies of each type of left and right lobe with those obtained by former workers who disregarded the pregnancy months, there are several differences. This may be due to the number of cases having been all in the same month of pregnancy. On the other hand, the difference in the frequency of the fetus, when the pregnancy months are neglected, and that of the adult, is considered to be not an essential difference arising from the different category of fetus an adult, but a difference arising from the comparison of frequencies computed without taking into consideration whether the fetus is mature or immature.

Thus, the method of former students, disregarding the pregnancy months, and giving the same value to the organ of the fetus in different periods must be considered to be an error.

Finally, investigating the variation of liver types formed by combination of the left and right lobes, they are classified into 8 types and change with the progress of pregnancy months from type I and II to type VIII gradually, after type IV.

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