GASTRO-PANCREATIC FOLDS: THEIR RELATION TO THE MOVEMENTS OF THE STOMACH AND TO THE SUBDIVISIONS OF THE LESSER SAC.

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The frequency of operations on the posterior wall of the stomach, the difficulties in the diagnosis and treatment of subphrenic abscess, and the varying accounts given by radiographers of the position and shape of the stomach, suggest the importance of anatomical study of this region.

To assist the student in forming a mental picture of the lesser sac, a series of drawings, illustrating stages in its dissection, was made; and as this dissection revealed an arrangement of peritoneum different from the accepted description, a large amount of material was subsequently examined.

Material Investigated.

1 human embryo, 2nd month.
Several 6–9-month fœtuses.
35 adults.
6 rabbits.
1 cat.
3 pig embryos, 7 mm., 13·5 mm., 16 mm.

Method of Dissecting Adult Lesser Sac.

The abdomen having been opened by a crucial incision, a horizontal saw-cut is made through the thorax wall at the level of the ensiform cartilage.

The lower ribs can now be thrown outwards as lateral flaps. To expose the lesser omentum, the left lobe and a portion of the right lobe of the liver are removed.

Fig. 1 shows this stage.

Beginning at the free edge of the lesser omentum, one divides this structure in its whole length.

(*a*) The foramen of Winslow—the right orifice of the vestibule;
(*b*) The vestibule—the part of the lesser sac lying behind the hepato-duodenal ligament;

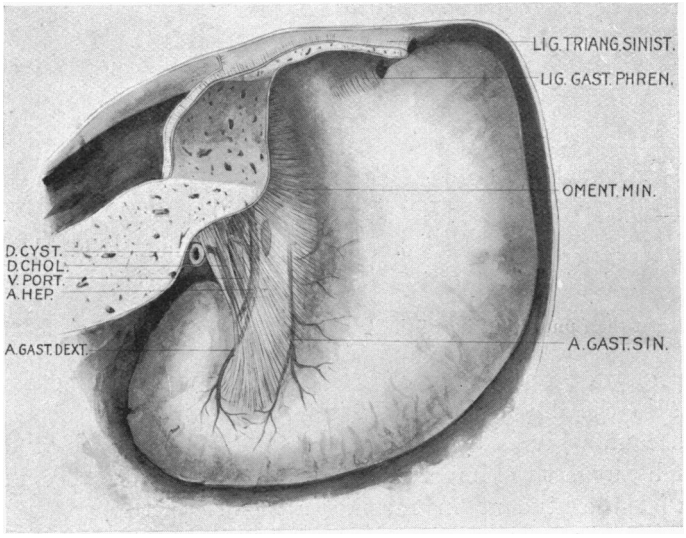

FIG. 1.—Dissection to expose lesser omentum.

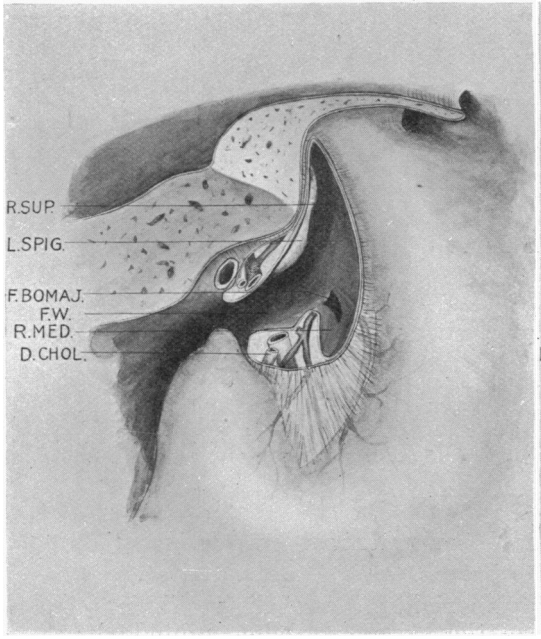

FIG. 2.

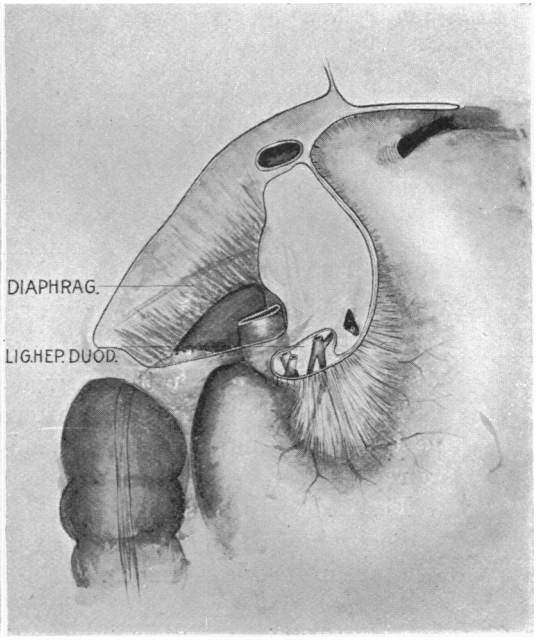

FIG. 3.

Dissection to expose superior recess.

(*c*) The superior recess—R. SUP.;
(*d*) The recessus medius—R. MED.;
(*e*) The foramen bursæ omenti majoris—F. BOMAJ., are exposed as in fig. 2.

The vestibule, the superior recess, and the recessus medius together form the bursa omenti minoris.

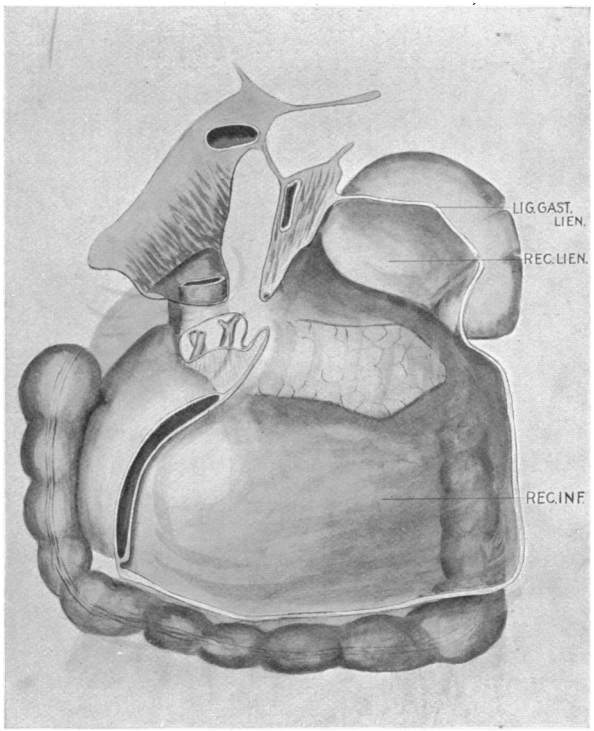

FIG. 4.—Shows subdivisions and relations of bursa omenti majoris.

The liver is now removed by dividing the ligamentum triangulare dexter, the ligaments bounding the bare area and the inferior vena cava.

Fig. 3 shows this stage.

The posterior wall of the superior recess is well seen.

In fig. 4 all the stomach, with the exception of a part near the pylorus which was closely adherent to the pancreas, has been removed.

The following peritoneal folds and structures were divided:—

Gastro-phrenic ligament.

Gastro-splenic omentum.

Gastro-colic omentum.
The œsophagus.
Right and left gastric arteries.
Right and left gastro-epiploic arteries.

The boundaries of the foramen bursæ omenti majoris in this subject are:—

Superiorly—a gastro-phrenic ligament enclosing the left gastric artery.
Inferiorly—a gastro-pancreatic ligament.

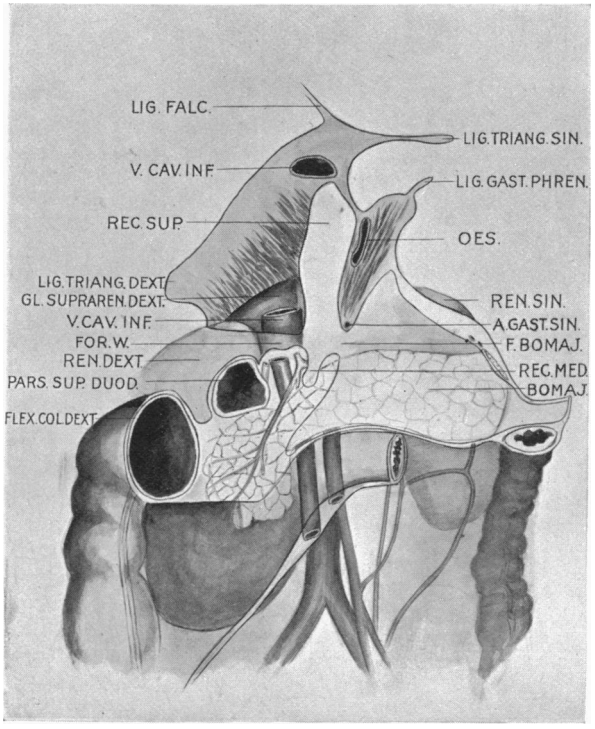

Fig. 5.—Final stage in dissection of lesser sac.

The foramen admitted a pencil. The lateral and vertical extent of the bursa omentum majoris and its splenic and inferior recesses are exposed.

Fig. 5 shows the final stage of the dissection. The transverse colon and meso-colon, the spleen, the remaining portion of the stomach, and the first inch of the duodenum have been removed. The gastro-pancreatic ligament has been divided, and is seen limiting, on the left, the recessus medius.

This description differs in the following particulars from the generally accepted view of the lesser sac :—

(*a*) The recognition of peritoneal ligaments more or less completely attaching the posterior border of the gastric lesser curvature to the diaphragm, pancreas, and transverse meso-colon.

(*b*) Placing the isthmus (foramen bursæ omenti majoris) in the plane of these ligaments and not on the threshold formed by the hepatic and left gastric arteries.

(*c*) The recognition of a recessus medius.

Gastro-Pancreatic Ligaments.

The term "plica gastro-pancreatica" appears in the *B.N.A.* as a fold of peritoneum containing in its free border the left gastric artery. Such a fold should be called gastro-phrenic, since it passes from the diaphragm to the stomach (see fig. 5).

The term "plica gastro-pancreatica" should be restricted to folds connecting the stomach and pancreas.

In twenty-three bodies these gastro-pancreatic ligaments were present, and in five of these a complete septum between the bursa omenti minoris and the bursa omenti majoris was present.

Seven bodies showed an absence of gastro-pancreatic ligaments.

Although marked variation in the arrangement of these ligaments exists, ranging from the formation of a complete septum bursarum to complete absence, yet one can very frequently distinguish a vertical or cardiac fold and a horizontal or pyloric fold, the opening left between the two folds being the foramen bursæ omenti majoris.

Fig. 6 shows the posterior aspects of nine stomachs, depicted as in erect posture. The black stippling indicates the attachment of gastro-phrenic and gastro-pancreatic ligaments.

For. indicates the foramen bursæ omenti majoris.

Bodies 20 and 27 show the vertical and horizontal folds.

42 shows a complete septum bursarum.

31 and 33 show absence of horizontal folds.

26 and 41 show double foramina.

The vertical fold attaches the posterior border of the lesser curvature to the diaphragm and pancreas. When of small vertical extent, its lower free border contains the left gastric artery, and it is a pure gastro-phrenic ligament (stomachs 26, 40, 41).

When the vertical extent is greater, it is attached posteriorly to diaphragm and pancreas, and its lower free border may lie $2\frac{1}{2}$ inches below the arch of the left gastric artery (stomachs 31, 33, 20, 27). Here

the ligament acts like a door hinge, permitting lateral movement of the cardiac stomach.

The horizontal fold is attached to the pyloric stomach along the lesser

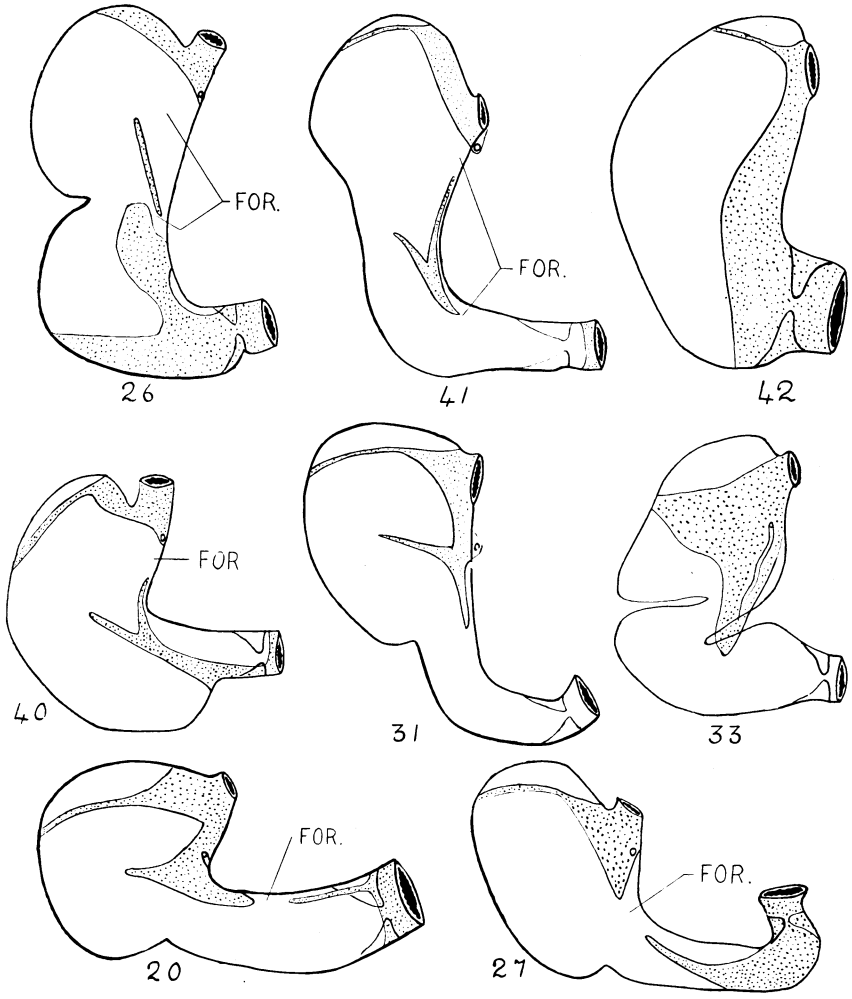

FIG. 6.—Posterior aspects of stomachs, showing attachment of gastro-phrenic and gastro-pancreatic ligaments.

curvature or along an oblique line passing downwards and to the right towards the greater curvature. The ligament becomes shorter as it is traced towards the right, so that most movement is allowed at its left or free border.

In stomachs 40, 20, 27 the fold is indicated.

When this fold is present the pyloric stomach is hinged transversely to the pancreas, and is only permitted up and down movement. When, as in fig. 7, there is a close adhesion between the posterior border of the lesser curvature and the pancreas, no movement of the lesser curvature is possible and no change of shape will be produced by a meal.

Relation of Gastro-Pancreatic Ligaments to Skiagraphy.

Skiagraphers are not agreed as to the normal appearance of a bismuth meal.

Holznecht (1) of Vienna has very frequently found in normal individuals the stierhorn magen (cowhorn stomach). The lesser curvature forms a gradual curve from cardiac orifice to pylorus, the pylorus forming the lowest point.

Groedel (1) and others describe as normal the hakenmagen. The lesser curvature descends vertically to the incisura angularis and there bends sharply upwards towards the right to terminate at the pylorus.

An explanation of these different appearances is furnished by the arrangement of the gastro-pancreatic ligaments.

A close adhesion between the lesser curvature and the pancreas will produce the stierhorn magen. The lesser curvature is immobile and uninfluenced by the bismuth meal.

The hakenmagen, on the other hand, is associated with a large foramen bursæ omenti majoris, as here the lesser curvature is free to descend below the level of the pylorus.

Foramen bursæ omenti majoris or epiploic foramen or isthmus of lesser sac is the communication between the recessus hepato-entericus and the recessus mesenterico-entericus (bursa omenti majoris).

Previous descriptions define this by the hepatic and coronary arteries, Wilhelm His, *B.N.A.*, p. 143:—

" Die Bursa omentalis zerfällt in das Vestibulum, den Recessus superior und den Recessus inferior. Vom Winslow'schen Loche aus führt ein schmaler Gang unter dem Processus caudatus des Spiegel'schen Lappens und über der Pars superior duodeni und dem Kopf des Pancreas vorbei medianwärts. Dieser Gang ist das Vestibulum Bursae omentalis, welches nach vorn durch das Lig. hepatoduodenale begrenzt wird. Die Lebergefässe, V. portae, A. hepat., und D. choledochus nehmen ihren Weg unter dem Boden des Vestibulums und über dem Pankreaskopf vorbei, um von der hinteren Bauchwand her zwischen die Blätter des Lig. hepatoduodenale zu gelangen. Vom Vestibulum zweigt sich hinter der Porta hepatis der Recessus superior ab, welcher, der Rückfläche des Spiegel'schen Lappens

entlang, vor dem Zwerchfell und theilweise vor der Aorta und dem unteren Ende des Oesophagus in die Höhe steigt. Von der Stelle aus, wo das Tuberculum omentale Pancreatis die kleine Magencurvatur überragt, gehen die beiden oberen Zweige der A. coelica, die A. coronaria ventriculi sinistra und die A. hepatica, divergirend auseinander, und indem besonders die erstere von den beiden die Rückwand des Netzsackes vor sich treibt, entsteht eine sichelförmig vorspringende Falte, die Plica gastropancreatica. Durch das rundliche, von dieser Falte eingeengte Loch hindurch verbindet sich das

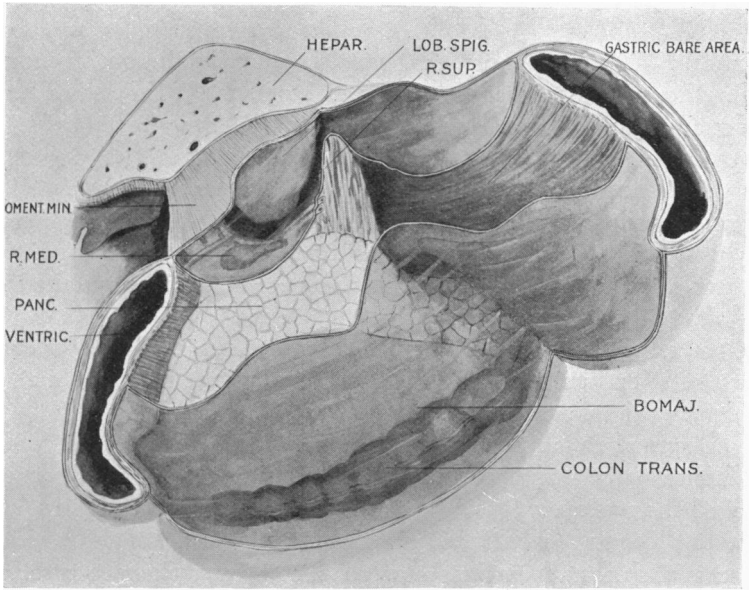

FIG. 7.—The stomach has been turned upwards and to the left by cutting across the pyloric canal and dividing the omenta and gastro-pancreatic ligaments. Shows recessus medius and complete septum bursarum.

Vestibulum des Netzsackes mit dem Recessus inferior, welcher nun vor dem Körper des Pankreas und hinter dem Magen herabsteigt. Die am weitesten nach links vortretende Ausbuchtung dieses Raumes ist der Recessus lienalis. Von oben her ragt der Processus Papillaris in die Oeffnung des Recessus inferior hinein und verengt dessen Zugang.

"Von Huschke ist seiner Zeit das Vestibulum des Netzsackes nebst dem Recessus superior als Bursa omenti minoris, der tiefer liegende Raum als Bursa omenti majoris bezeichnet worden. Die Verbindungsöffnung nennt dieser Anatom Foramen omenti majoris, die abgrenzende Falte das Septum bursarum S. Lig. gastropancreaticum. Ich selber hatte hierfür den Namen Diaphragma omentale vorgeschlagen."

It is evident from this description that His defines the foramen, connecting the two main divisions of the lesser sac, by the hepatic and left gastric arteries, and that he applies the term suggested by Huschke, "foramen omenti majoris," to this communication.

The objections to the above description are :—

(*a*) That when a marked constriction of the lesser sac is present, it is never in the plane of the hepatic and left gastric arteries, but always in the plane of the above described gastro-pancreatic ligaments.

(*b*) That when a complete septum bursarum exists, the septum has no relation to the hepatic artery (fig. 7).

(*c*) That it is wrong to divide the bursa omenti minoris from the bursa omenti majoris by the hepatic artery, because a portion of lesser sac (recessus medius), related to lesser omentum, lies inferior to hepatic artery (figs. 7, 8, and 9).

The alterations that I would suggest in the above description are :–

(1) To define the foramen bursæ omenti majoris as a communication between the bursa omenti minoris and bursa omenti majoris, its boundaries being the lesser curvature of the stomach, the pancreas, and the gastro-pancreatic ligaments.

(2) To apply the term "bursa omenti minoris" to that part of the lesser sac related to lesser omentum, and to describe it as consisting of three parts :

(*a*) Vestibulum ;

(*b*) Recessus superior ;

(*c*) Recessus medius.

(3) To apply the term "bursa omenti majoris" to that part of the lesser sac lying behind the stomach and great omentum.

Recessus Medius.

Erik Müller (2) :—"Links von der Vena Cava ist das Vestibulum und der Recessus sup. gut abgegrenzt ; nach links und unten von ihm hebt sich die sagittale Plica art. hep. vom Pancreas nach oben, um sich nach hinten, links und oben in die abgehobene Plica gastropancreatica fortzusetzen. Links von der Firste, resp. ihrer Fortsetzung, dem Lig. gastropancreat., kommt man in einen kleinen, gut abgegrenzten Raum, welcher sich etwas nach links, hinter den Magen erstreckt. Seine untere, hintere Wand wird von dem ausgehöhlten Pancreas gebildet, seine vordere von dem Magen und dem kleinen Netz. Ich nenne diesen Raum den Recessus medius Bursae omentalis." Such a recess is present in the adult and is very easily distinguished in the presence of extensive gastro-pancreatic ligaments. In

the absence of these ligaments it communicates so freely with the bursa omenti majoris that it is more difficult to define it. Its size varies directly with the extent of pancreas in contact with the lesser omentum.

In fig. 8 a dissection of a large recessus medius is shown. The portion of lesser omentum, bounding the recess anteriorly, has been removed. The pancreas, the hepatic, left gastric and splenic arteries form its posterior wall; gastro-phrenic and gastro-pancreatic ligaments completely separate it, on the left and inferiorly, from the bursa omenti majoris. Superiorly it

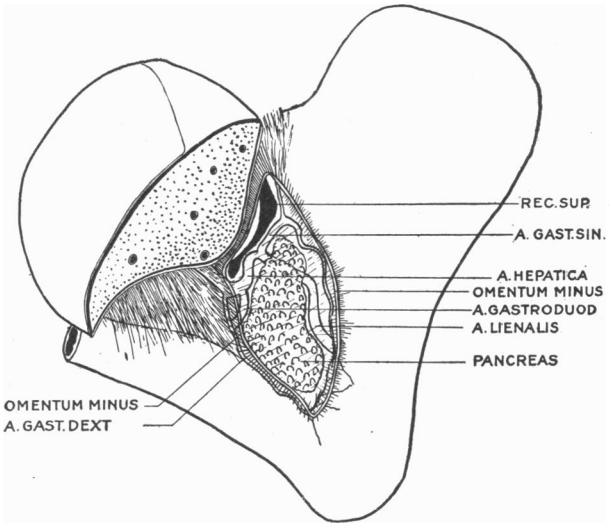

FIG. 8.—Posterior wall of lesser sac.

communicates freely across the threshold of hepatic and left gastric arteries with the superior recess.

Fig. 9 shows another large recessus medius. There is here a small communication (F. BOMAJ.) between the recessus medius and the bursa omenti majoris. The pancreatic attachments of the pyloric and cardiac gastro-pancreatic ligaments are shown. Here also the hepatic artery forms the boundary line between the recessus superior and the recessus medius. In this body the cardiac gastro-pancreatic ligament almost completely subdivided the bursa omenti majoris into upper and lower parts—recessus lienalis and recessus inferior.

In the fœtus the recessus medius is occupied by the processus papillaris of the spigelian lobe (see fig. 12).

In some cases the recessus medius is continued, upwards and to the

right, in front of the hepatic artery, common bile duct, and portal vein, so as to divide the hepato-duodenal ligament into four layers (see fig. 7).

The lesser sac of the rabbit supports the above view regarding the epiploic foramen and also throws light on the functions of the lesser sac and on the development of the stomach. In fig. 10 (1) a portion of liver has been removed to expose the lesser omentum.

The bursa omenti minoris is completely filled by a lobe of liver which is a large processus papillaris of the spigelian lobe. This condition

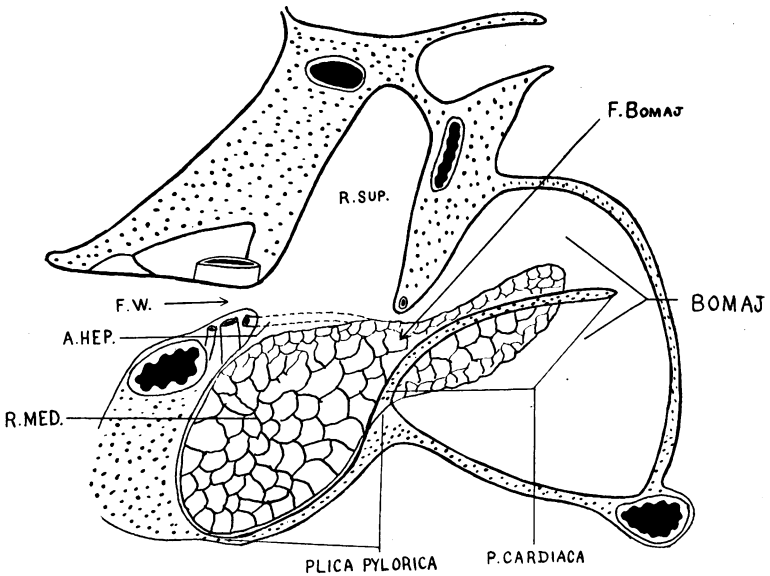

FIG. 9.—Portions of lesser omentum removed to expose recessus medius.

closely resembles the human fœtus, as in both the processus papillaris crosses the hepatic artery.

One may assume that the bursa omenti minoris exists to facilitate the movement of this liver lobe.

Owing to the diminished rate of growth of the spigelian lobe in man, this relation is not so evident.

In fig. 10 (2) the lesser omentum has been cut away and the enclosed liver lobe removed. The hepatic artery, the epiploic foramen (F. BOMAJ.), and the upper opening of the vestibulum are exposed.

In fig. 10 (3) the stomach has been thrown upwards and the great omentum divided. F. BOMAJ. is seen as a small opening in a fold of peritoneum connecting the lesser curvature of the stomach to the posterior

abdominal wall and the upper border of the pancreas. This fold of peritoneum contains the chief gastric blood-vessels and must be the dorsal

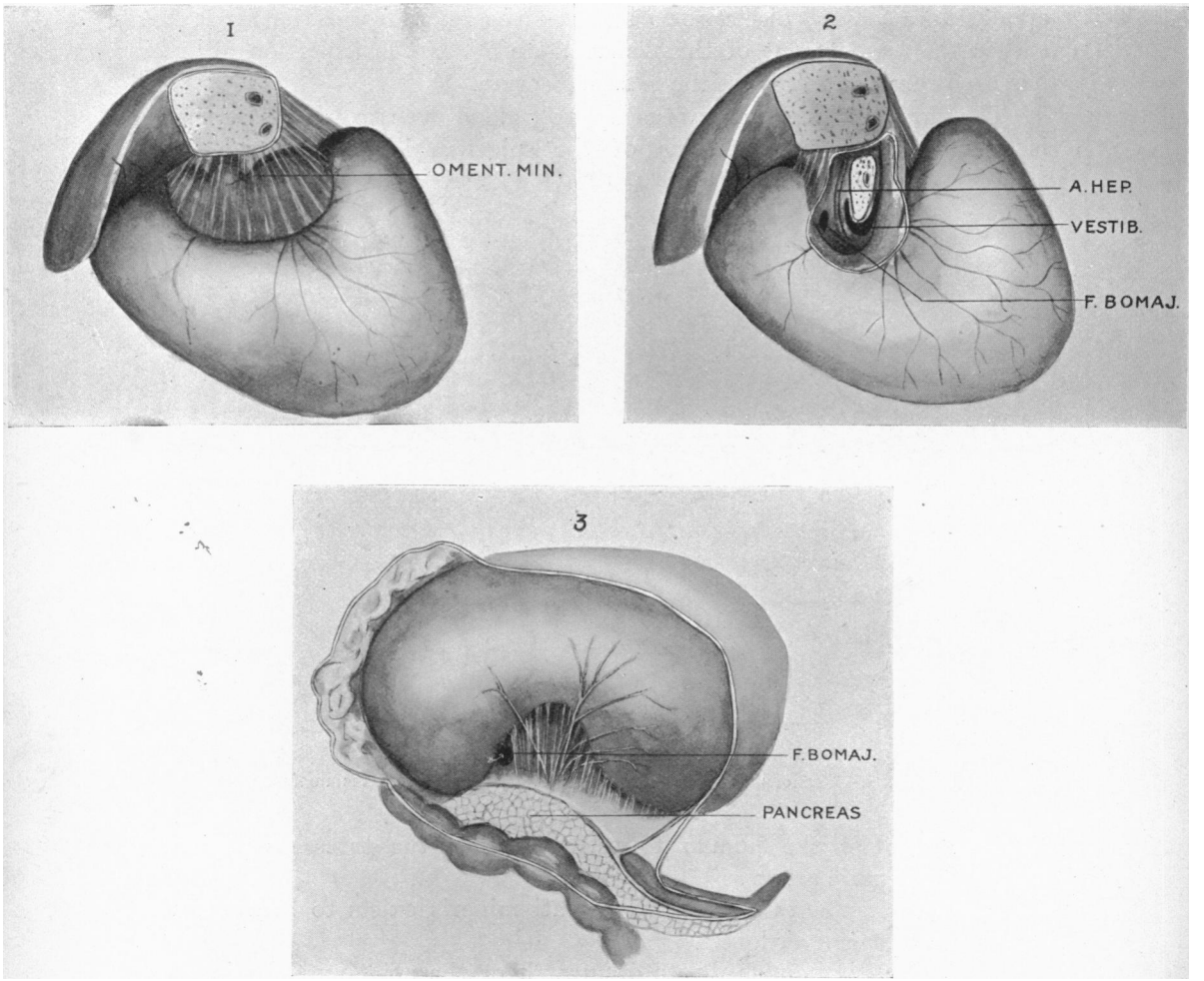

FIG. 10.—Dissection of lesser sac in rabbit.

mesogastrium. Therefore both the ventral and dorsal mesogastria are attached to the lesser curvature.

This leads to the conclusion that the rabbit stomach does not rotate during development. The bursa omenti majoris must develop as a cavity in the dorsal mesogastrium, the left wall of the cavity forming the great

omentum, the right wall passing to the lesser curvature forming the main dorsal mesentery of the stomach.

The great curvature is produced as a lateral outgrowth from the alimentary tube.

Rotation of the Stomach.

Broman (3):—"Bald nachher (bei etwa 4 mm. langen Embryonen) beginnt die Magen anlage sich um ihre verticale Achse nach rechts zu drehen, so dass ihre ursprünglich linke Fläche nach vorn, ihre ursprünglich rechte Fläche nach hinten zu liegen kommt.

"Diese Magen drehung ist bei 9·5–11·5 mm. langen Embryonen vollendet."

Drawings of reconstruction models of 5 mm., 8 mm., 8·3 mm., and 11·7 mm. embryos are shown, but they do not convince one of rotation. The appearances could be explained by growth of the stomach posteriorly and to the left produced by the attachment of the liver to the right side of the dorsal mesogastrium.

Fig. 11 is a series of sections of a 7 mm. pig embryo.

S. Stomach.

Œs. Œsophagus.

Rhe. Recessus hepato-entericus.

Bomaj. Bursa omenti majoris.

Hcr. Hiatus communis recessus (foramen of Winslow).

Sections 299 and 318 show how the attachment of the liver directs the growth of the stomach towards the left.

Broman, *Ergebnisse der Anatomie*, 1905, p. 390: "Bei den meisten Wirbeltieren erleidet der Magen keine nennenswerte Rotation; und die Bursa omenti majoris bleibt daher bei den meisten Wirbeltieren an der rechten Seite des Magens liegen."

Broman would evidently class the rabbit stomach with those which have undergone rotation, since in the rabbit the bursa omenti majoris lies behind the stomach.

How could one explain the appearance of fig. 10 (3) on the rotation theory? There are two possible explanations:—

(*a*) That the fold connecting the lesser curvature to the posterior abdominal wall and containing the chief gastric blood-vessels is formed by secondary adhesions.

(*b*) That the entodermal stomach anlage rotates within the surrounding mesoblast.

Neither of these theories, however, has anything to support it, and

it is unnecessary to entertain them in the presence of the following simple explanation:—

I.e., the rabbit's stomach undergoes no rotation during development. Its

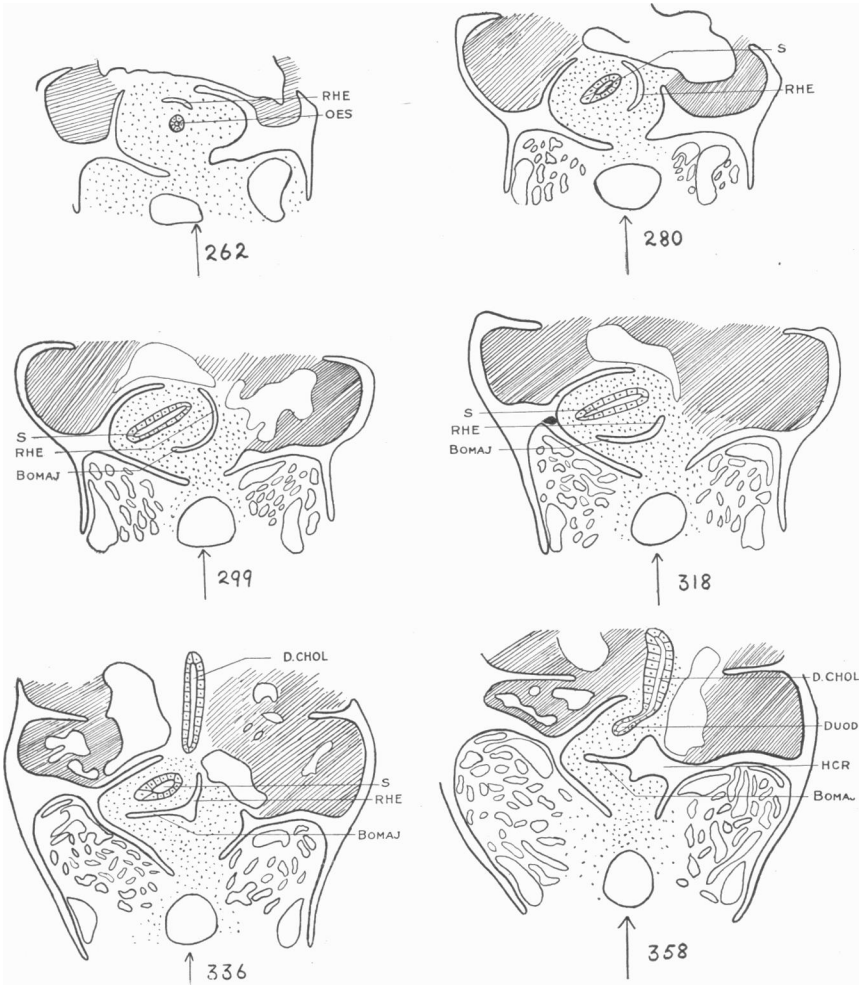

FIG. 11.—Sections of 7 mm. pig embryo.

great curvature and fundus are produced by a lateral outgrowth from the stomach tube.

The bursa omenti majoris develops as a cleft in the dorsal mesogastrium. The great omentum and the fold connecting the lesser curvature to the posterior abdominal wall are remains of the dorsal mesogastrium.

I believe that the same process of gastric development takes place in man and that the posterior gastro-phrenic ligament and gastro-pancreatic ligaments are either parts of the dorsal mesogastrium or indicate the position of the dorsal mesogastrium.

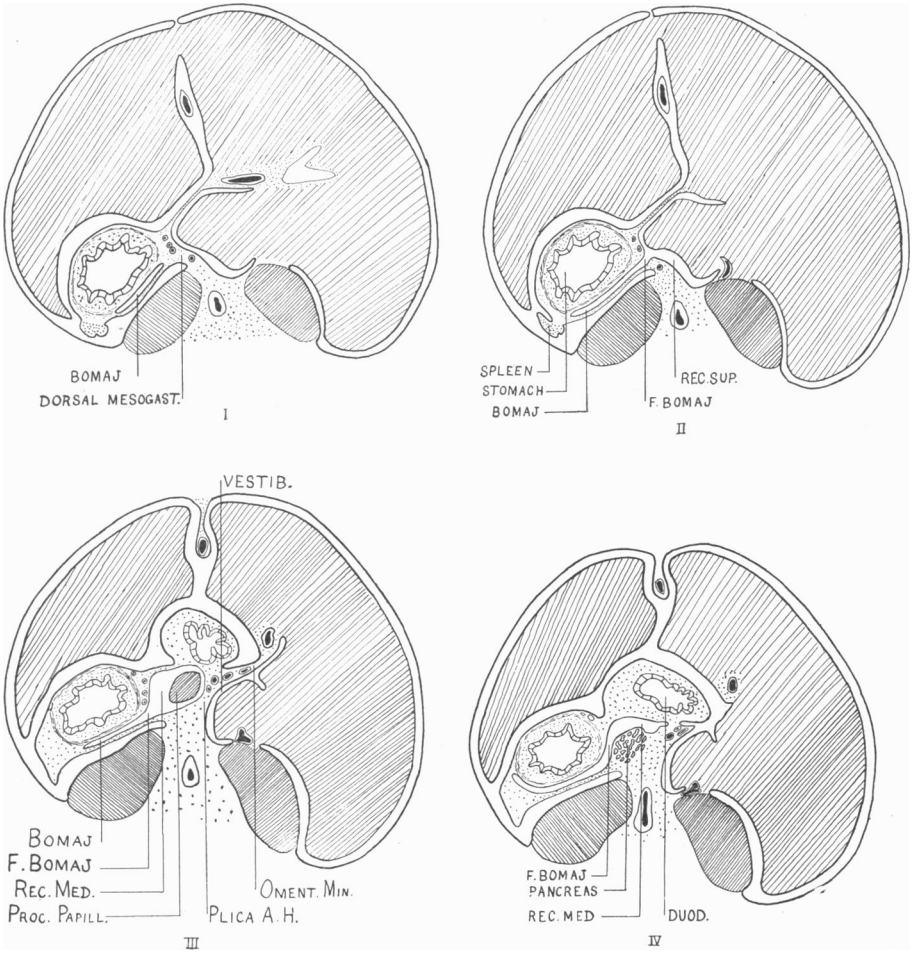

FIG. 12.—Sections of human embryo, second month, in region of lesser sac.

The latter possibility is mentioned because I have at present no embryological evidence to support the view that the bursa omenti majoris may develop separately from the remaining lesser sac, and that a complete septum bursarum is formed otherwise than by secondary adhesion.

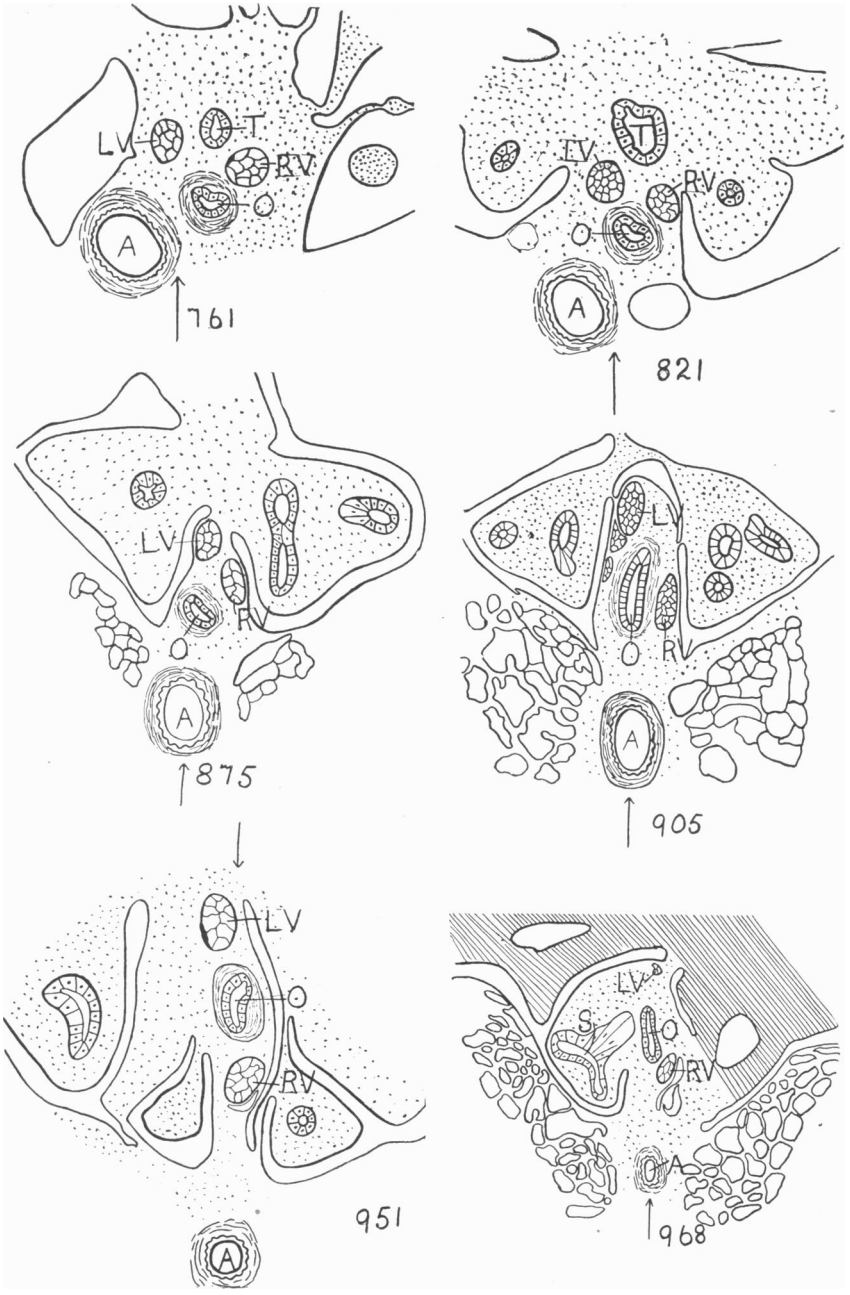

FIG. 13.—Sections of a pig embryo, 16 mm., to show the relations of the vagi to the œsophagus and stomach.

Fig. 12 shows a series of sections through a 2nd-month human embryo (Berry Hart).

1. Shows the dorsal mesogastrium subdividing the two main divisions of the lesser sac.

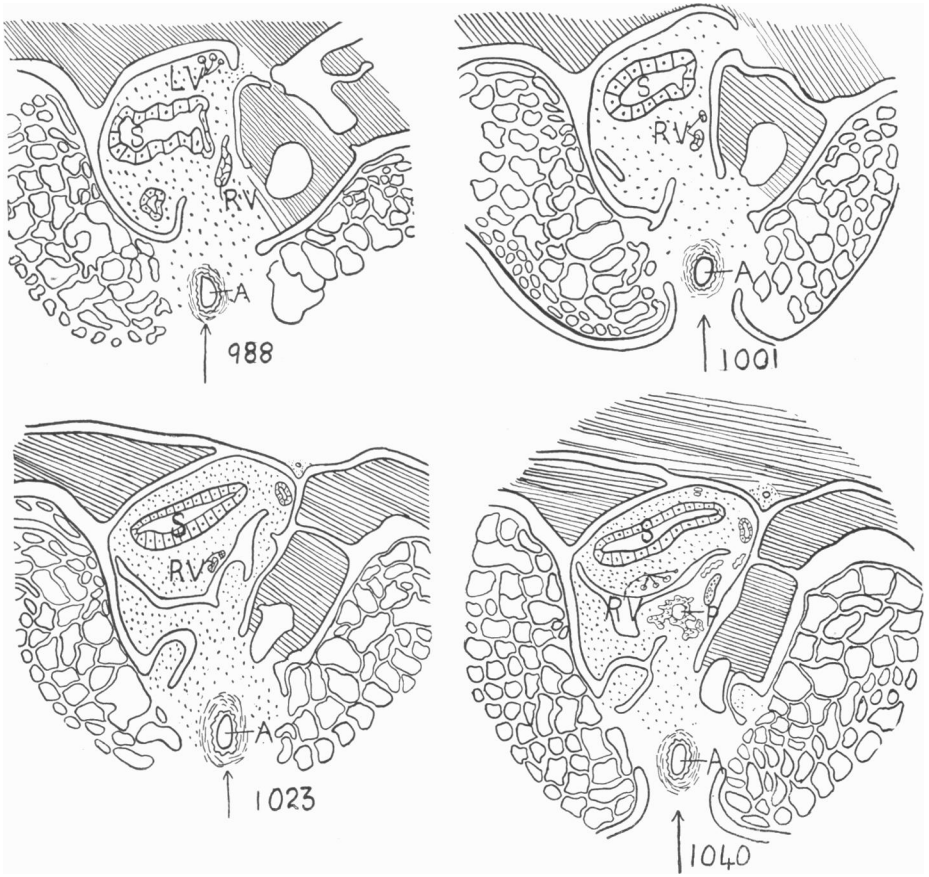

FIG. 14.—Sections of pig embryo, 16 mm., showing the relations of the vagi to the stomach.

2. This subdividing part of the dorsal mesogastrium has disappeared, leaving the foramen bursæ omenti majoris.
3. The recessus medius, containing the processus papillaris, is exposed. On the right it is bounded by the plica arteria hepatica and on the left it communicates through the foramen BOMAJ. with the bursa omenti majoris.
4. The pancreas and lesser curvature of stomach bound F. BOMAJ.

It is generally accepted that the vagi are laterally placed on the œsophagus and occupy the anterior and posterior surfaces of the stomach.

Figs. 13 and 14 are sections of a 16 mm. pig embryo showing the anterior and posterior position of the vagi on the lower part of the œsophagus (sect. 951). In the lower sections they maintain this position. Therefore the vagi bear out the view that the stomach does not rotate.

In conclusion, I should like to thank Professor Symington for the interest which he has taken in the work, and Mr R. L. Rea for the use of his pig embryo sections.

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