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THE ANATOMICAL BEARINGS OF THE SEROUS COVERING OF THE VISCERA.

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[Read November 4, 1885.]

In my remarks I shall deal only with the anatomical difficulties that perplex the student, and shall be content if I can present him with so clear a description of them, that he will remember them, because he understands them. I shall make few allusions to the works of embryologists, simply stating at the outset, that all that is known about the subject is due to their tireless researches.

At a very early stage of development, the intestinal canal consists simply of a straight tube, extending the whole length of the body of the embryo, and lying in front of that which subsequently becomes the vertebral column. It is closed at both ends, but communicates with the umbilical vesicle V, Fig. 10, which is external to the body. It is covered throughout its entire length by a continuous serous membrane, since at this stage of existence there is no horizontal partition, the diaphragm, to divide the body into two sections. At this period, the intestine antedates all the viscera, save the heart, and a cross section of any part of the body of the embryo,

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whether through the thoracic or abdominal portion, will represent a tube (the body walls) enclosing a tube (the alimentary canal).

But this simple anatomical expression does not long continue. Soon at certain points of the *intestine* a budding process is manifest, and the *lungs*, *liver*, and *pancreas*, make their appearance, whose development with

Fig. 1.

In this sketch of the anatomy of the embryo, I have represented both tubes as complete, and the serous membrane as continuous. It forms a parietal layer to every part of the body of the embryo, and a covering to the viscera, which push forward into it. The *cavity*, which at first extends the whole length of the embryo, is called the pleuro-peritoneal, and the *serous membrane* the pleuro-peritoneal.

that of the diaphragm converts the simple expression in Fig. 1, into a labyrinth, every path of which the student feels, ends in fog, or leads to impenetrable darkness.

At a very early date the diaphragm makes its appearance. Nothing positive of its development has as yet been established. Being a muscular organ, it is likely that it springs from the body plates, and grows from the periphery toward the centre. Its appearance, it would seem, must be prior to, or coincident with that, of the liver, which can be clearly defined by the middle of the third day. Although all the various processes of development are moving on together, it will be simpler to speak of some of them as complete in advance of others. Thus, by the formation of the diaphragm, we may look upon the pleuro-peritoneal cavity, already described, as separated into two distinct apartments, an upper, thoracic, or pleural; a lower, peritoneal, or abdominal.

It has already been stated, that in the early hours of development there are no lungs, and when these make their appearance, it is as buds or offshoots from the œsophagus, Fig. 10, L. A simple diagram, suggested by Balfour and Foster, will illustrate the steps of this process. At the site of the œsophagus where the lungs are to be developed, a cross section would show an elongation, Fig. 2 (A), later a double constriction (B), and

Fig. 2.

still later the lungs as independent structures (C), connected at first by separate tubes with the œsophagus; these soon fuse, and a single permanent trachea is formed.

In the demonstration of the pleural membrane, only the lungs and heart concern us, since these alone receive a covering from it, and by it are enclosed in separate apartments. In the description of this process, it will be simpler to regard the thoracic boundaries as complete in advance of their contents, and to represent the heart and lungs by three dots resting behind the serous membrane, Fig. 3. Thus we have the simple expression of a single cavity, lined by a single and continuous membrane. Little by little these structures grow forward into the pleuritic cavity, and, as they do so, push the lining membrane before them. Though destined to

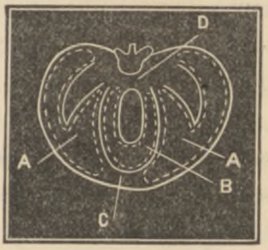
Fig. 3.

occupy nearly the whole of the thoracic space, they do not advance with equal rapidity. The heart exhibits functional activity in advance of every other viscus, and its rapid development and great importance give it at first much greater space than that required for the lungs, whose function in the higher orders is never called into action prior to birth. In Fig. 4 I have rep-

Fig. 4.

resented the lungs, and the heart with its pericardium, pushing forward and filling up the cavity of the chest, and just as I have represented the chest-walls as developed in advance of their contents, so I have represented, diagrammatically, the pericardium, in advance of the heart. Note that the viscera have not as yet separate compartments; that the serous lining in Fig. 3, can still be traced as a single continuous structure in Fig. 4. A little later the pericardium meets and unites over the heart, while at the same time it unites with the sternum in front, and the diaphragm below, thus effectually isolating the heart and lungs, and creating three distinct serous cavities, A, A, B, Fig. 5. Were we now to

Fig. 5.



regard these processes—*i. e.*, the development of the chest-walls, the diaphragm, the heart, lungs, and pericardium—as all advancing together, it would be easy to conceive how the pericardium by its relations to surrounding parts—*i. e.*, the diaphragm and sternum—becomes the principal factor in constructing the partitions of the chest cavity.

At the outset the œsophagus was, in common with the entire intestine (Fig. 1), covered with a serous membrane. But for this circumstance and the one already mentioned, that the lungs sprout from the œsophagus, neither the lungs nor heart would have a serous covering. How, then, does the œsophagus lose its covering? Simply enough—*i. e.*, by the advancement of the heart and lungs. These structures *push the thin, delicately attached serous membrane before them, stripping it off from the œsophagus, trachea, and large vessels,* and appropriating it to themselves. Hence a space just in front of the vertebra is formed that has no serous envelope, a space between the roots of the lungs and back of the heart (Fig. 5, D). This space is called the *posterior mediastinum*, and the only remark that I wish to make in regard to it is to *contrast its formation* with that of the *anterior mediastinum* (Fig. 5, C), which latter is formed by the *fusing* of the serous covering of the pericardium with that of the sternum and diaphragm. If this view is correct, then in cases of so-called congenital absence of the pericardium there can be no anterior mediastinal space, and no separate cavities for the heart and lungs, while the presence of these chambers and the isolation of their contents, must prove the statement of the so-called congenital absence of the pericardium to have been an error.

I will now pass to the abdominal portion, and take up the stomach and duodenum. It is from the *duodenum* that the *liver* and *pancreas* are formed, and it is by changes that take place, as development advances in these structures, that the foramen of Winslow, the posterior or lesser cavity of the peritoneum, and the four

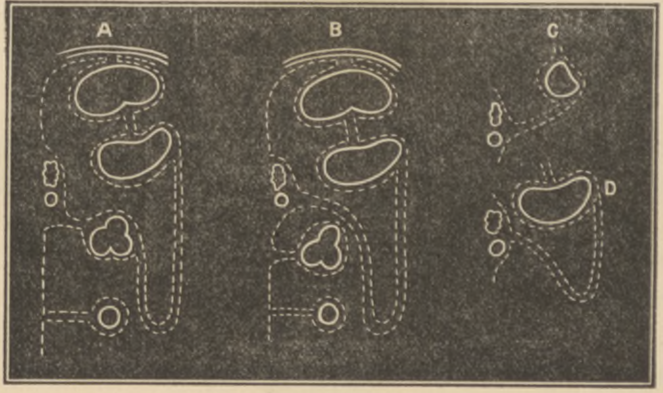
FIG. 6.

layers of the great omentum are formed. Again, let me refer to the embryological fact, that in early life the intestine lies as a straight tube along the vertebral column, covered by the peritoneum. In order to represent the bowel as straight, I am forced to represent the liver and pancreas (see dots, Fig. 6) as widely removed from the diaphragm. The liver, however, lies immediately beneath the diaphragm to the right of the median line, and, as it increases rapidly in size and weight, draws the lighter and less stable stomach and duodenum with it. Thus the liver, stomach, and duodenum, instead of continuing to look directly forward, with a layer of peritoneum on either side of them, gradually, so to speak, turn upon their right side, so that the liver lies in the right hypochondrium, and that which was at first the left side of the stomach becomes its anterior surface

Fig. 7.

(Fig. 7). For a time we may suppose all these structures to remain free and unattached, and that the hand can be passed freely beneath the duodenum, pancreas, stomach, and liver; but soon the transverse duodenum fuses with the serous membrane upon which it lies, and now a small cavity is formed behind these viscera, which communicates freely with the general peritoneal cavity along the free (right) border of the liver and descending duodenum. The opening is large at first, extending as it does from the level of the pancreas (Fig. 7) to the diaphragm, but as the liver and duodenum increase in size, and approach each other, and fuse more with surrounding parts, the opening is narrowed to a foramen, which bears the name of Winslow. The space behind the stomach and liver now is limited above by the diaphragm, below by the transverse duodenum, upon the left by the original mesenteric attachment, and at its free border closed, except at the foramen of Winslow. Although these viscera have changed their position, and lie, as it were, upon their sides, yet they still, in the main, retain the same relation to their serous covering —*i. e.*, they lie between its two layers (Fig. 7), one layer being in front and another behind. The two that connect the liver with the stomach are called the gastro-hepatic omentum; the two that connect the stomach and pancreas, the gastro-pancreatic omentum; the two that connect the stomach and spleen, the gastro-splenic omentum. Let us now suppose the stomach, finding

Fig. 8.



A. Incorrect; the great omentum encloses the transverse colon, and forms its mesocolon. B. Correct; the great omentum, sends its two posterior layers over the transverse colon to the pancreas and duodenum. C, D. Successive steps in the formation of the great omentum.

itself hemmed in within too narrow boundaries, to begin a struggle for more freedom. It cannot free itself from the diaphragm and liver, nor from its original mesenteric attachment; but finding the two layers that pass from its greater curvature, to the spleen and pancreas, more yielding, tugs away at these until both layers stretch and hang down into the abdominal cavity (Fig. 8, C, D, B). This constitutes the greater omentum, which is nothing more than a stretching or bulging forward of the two layers (C) of the gastro-pancreatic omentum. As they increase in depth they may not inaptly be compared to two sacs (Fig. 9), one within

FIG. 9.

the other, the anterior layers of which, if followed upward, would enclose the stomach and proceed up upon the liver, and whose posterior layers will embrace the pancreas and duodenum. The space within the inner sac communicates, of course, with the space behind the stomach and liver, and may be regarded as merely an annex. Should these sacs fuse, it is plain the single membrane thus formed ought to be considered as consisting of four layers, just as the great omentum is described in the text-books.

I have been particular to describe the formation of the great omentum without mentioning the transverse colon, and this is the way it should be understood.[1]

[1] First accurately described by J. Muller, 1830: Cruveilhier and Sée, Splanchnologie, p. 537.

Upon this head most of the text-books are in error—not only in their diagrams but in the text. I have examined about a dozen text-books, and of these, Quain, Holden (1868), Cruveilhier, and Sée, are the only ones correct. The prevailing error has been occasioned by observing that the omentum is, in the adult, usually attached to the transverse colon, but while attached it does not surround it as in Fig. 8 (A), or form its mesocolon, but passes in front and above it (B) to the pancreas and duodenum, from which it in fact sprung (C, D). When correctly represented, as in B, the colon, as Professor Chapman states, gets upon its anterior and upper surface five layers of peritoneum—*i. e.*, its own mesocolic layer and four from the great omentum. In the text-books the same portion of the colon (A) gets only three layers. In other words, the upper surface of the transverse colon has five serous layers—its lower surface but one.

With the foramen of Winslow and the great omentum the chief difficulties of the peritoneum disappear, though some points about the colon are not without

Fig. 10.

interest. Of the early embryonic condition of the intestine, that depicted in Fig. 10 is very frequently given. I employ it to call attention to the growth of the bowel and its extending forward, thus elongating its mesenteric attachment; soon a twist takes place of the *lower part* of the intestine *upon the upper*, by which, that which is to constitute the cæcal end of the colon comes to lie in the right iliac fossa, and that which is to constitute the sigmoid flexure to lie in the left iliac fossa, and the entire colon to form three sides of a square where it becomes attached to the periphery of the abdominal cavity (Fig. 11). This twist of the colon to the right, like that

FIG. 11.

of the stomach, is probably due to the change of position of the liver—*i. e.*, to the right, and to the early fixation of the duodenum. At first the colon has, in every part, quite an extensive *mesocolon*, but by degrees this shortens until its ascending and descending portions are so closely bound in their respective lumbar fossæ that they lose their serous covering, except in front; not so with the transverse colon; its mesocolon is usually long enough to permit the colon to reach the body wall in front, and to lie just beneath the great border of the stomach. This length of the transverse mesocolon serves many purposes; it forms a roof to the entire bowel below the duodenum; it also gives great freedom of motion to the transverse colon, so that it can accommodate itself to the varied changes in the conditions of the surrounding viscera. In cases of stricture of the rectum and consequent extreme distention of the large intestine with gas, the middle of the transverse colon will often descend to the pelvis, giving the entire colon an appearance not unlike the capital letter M. I am careful to repeat that the colon has its own transverse mesocolon, and that it does not depend upon the great omentum for it. The latter is asserted by some authors, much to their discredit. As the colon twists upon itself, and comes to lie across the duodenum, its mesocolon (Fig. 11) furnishes a fixed point for the commencement of the mesentery of the small intestines, which begins at the left border of the second lumbar vertebra and proceeds downward to the right iliac fossa. This base of the mesentery is scarcely longer than six inches, while its periphery, encircling the bowel, is nearly eight times the length of the body. The coiling of the small intestine is greatly facilitated by the looseness of its connection with its serous envelope. This is especially noticeable in fœtuses and young infants. In all such cases the entire small intestine can be drawn from its peritoneal sheath, leaving the mesentery unbroken save at the opening through which the gut is extracted. By the disposition of the small intestine within the borders of the colon a mutual benefit accrues. The small intestine is placed beneath the abdominal muscles, where every exertion will excite peristaltic motion, and therefore aid in carrying its contents to the colon. By the same muscles the same pressure through the small intestines is exerted upon the colon, which cannot escape its influence, and as its contents cannot revert to the small intestine they are carried forward to their destination.

It is interesting to examine the various portions of the alimentary canal with reference to their relation to the serous covering. Thus, from the œsophagus, it has been stripped off and appropriated by the lungs and heart. The latter had need of it as organs of ceaseless activity; while the œsophagus, being but a mere conduit for articles of alimentation, was better off without such a covering; but with the stomach it is far otherwise: this is more than a receptacle for food; it must have capacity for liquids, taken often with great rapidity and in great quantity. To be equal to all the emergencies that the stomach may be called upon to meet, the great omentum is formed (Fig. 8, B, C, D). This permits large bloodvessels to course along both curvatures of the stomach, a circumstance only present in this organ, and make a vascular network about it, which, in case of thirst, will abstract water from the stomach with wonderful rapidity. The disappearance of covering from the transverse duodenum, the formation of the mesentery and the mesocolon, have already been touched upon.

It remains briefly to speak of the portal circulation. The blood to the digestive tract comes from the abdominal aorta from three principal vessels, viz., the cœliac axis, the superior and inferior mesenteric arteries. Now, the aorta lies *behind* the peritoneum in its entire course, and consequently receives no covering from it; not so with the three large branches to the digestive tract. These, as well as all the blood from the digestive tract to the liver, lie throughout their entire course between two layers of serous membrane. The cœliac axis (Fig. 12) supplies the liver, stomach, pancreas, spleen, and duodenum, but none of its vessels pass in *front of* *the stomach* to reach their destination. A peculiarity in the venous blood from the digestive tract is, that it, like the arteries, passes behind the stomach. If the mesenteric vein had passed beneath the duodenum, it would have been obliterated; if it had passed in front of the pancreas, the weight of the omentum would have dragged upon it; had it gone in front of the stomach,

FIG. 12.

Diagrammatic. Introduced to show the course of the venous blood of the digestive apparatus to the liver.

then a full stomach or acts at vomiting would have interfered with its function; in its course to reach the portal vein it passes between the pancreas and duodenum, and under the stomach; the portal vein thus comes to lie anterior to the foramen of Winslow; but neither it nor the hepatic arteries have any hand in creating this foramen, as stated in at least one prominent text-book.[1]

[1] For a description of the formation of the tunica vaginalis and descent of the testes, as related to the peritoneum, see Annals of Anatomy and Surgery, Nov. 1883.

[After the reading of the preceding paper:—]

Dr. Chapman said : I have listened with much interest to the paper of Dr. Allis. There are several facts which confirm what he has said about the disposition of the peritoneum. Examining the abdomen of an adult, it seems that the disposition of the peritoneum is as given in Gray, but that is not so. If the abdomen of a fœtus at eight months or term is opened, the peritoneum will be found as described by Dr. Allis.

If you take a net, making one sack, and spread it over a number of objects on a table, representing the liver, kidneys, and the other abdominal organs, and then invaginate the net, we shall have a representation of the greater and smaller sack of the peritoneum. There is then no difficulty in placing the net over the different objects, as the peritoneum is disposed over the viscera.

In the body of the fœtus, you can raise the sack and demonstrate that it consists of four layers. By inserting a pipe in the foramen of Winslow, the sack may be distended. If the sack is raised, you find the transverse colon covered as it is in this drawing. In the adult, the sack becomes adherent to the covering of the transverse colon, and we then have five layers, instead of four as shown in Gray.

In almost all the mammalia (at least of several hundred that I have examined), I find the peritoneum disposed as here represented. The transitory stage through which the peritoneum passes in the human animal, is retained as a permanent condition in the lower animals. This is true, not only of the peritoneum, but of the other organs of the body. In the other mammals, this sack can be lifted, leaving the transverse colon covered with peritoneum. The only exceptions that I have found, have been in the gorilla, the chimpanzee, and ourang. In all these animals, the transverse colon adheres to the greater sack, as it does in man. It, therefore, seems that the facts of comparative anatomy, and the facts of embryology thoroughly bear out what has been said by Dr. Allis. It is no longer a question of theory, but it is exactly what is represented here.

There are one or two other points in connection with the development of the peritoneum that may be mentioned. The peritoneal and pleural cavities may be regarded as simply large lymphatic sacks. If milk is thrown into the peritoneal sack, in a few hours the lymphatics of the diaphragm will be filled and the fluid may even pass to those of the pleura. This will serve to explain the fact why you may coincidently find the peritoneal cavity filled with fluid or pus, and at the same time the pleural cavity. The peritoneum is nothing but a large dilated lymphatic sack placed around the abdominal organs.

In regard to the development of the pleura, Dr. Allis begins by saying that there is one general cavity. It seems to me that it would be better to consider the pleura as consisting of two sacks in the beginning, and that the lungs are thrust between these, thus producing the same thing as represented here. This will account for there being no communication between the two. There is one reason for not considering the pericardium as a part of the pleura, and that is, the fact that the phrenic nerve runs between the pericardium and pleura.

Another point as regards the peritoneum is one which is of interest to surgeons, and that is, that the viscera being pushed forward, carrying the peritoneum before them, can have no peritoneum behind. Hence in hernia occurring between the quadratus lumborum and latissimus dorsi muscles, there will be no peritoneal covering to the bowel.

Dr. W. H. Pancoast: I agree with Dr. Allis in his demonstration of the development of the peritoneum. While really the diagram in the text-book of Gray may not be correct, yet practically it is correct. When these different layers become adherent, they practically constitute one layer and they may be demonstrated as one layer.

I may add one interesting fact. Year after year in making this demonstration, I have represented the layers of the peritoneum by a mosquito-netting, and this has shown that the ordinarily described arrangement of the peritoneum is not correct. You cannot take a membrane like that and take the different viscera and place them in the proper position and demonstrate the great omentum at the same time. You must pin up the netting to represent the omentum.

I might mention one point in regard to the pericardium. We find that this membrane is firmly attached to the diaphragm and extends upward, surrounding the heart and passing up over the great vessels and mingles with the deep fascia. In violent exercise, as in athletes, a full inspiration precedes the effort and this might seriously affect the heart, if it were not for this support passing through the cavity of the thorax and to the deep fascia of the neck.