

THE ANOMALOUS PERSISTENCE IN EMBRYOS OF PARTS OF THE PERI-INTESTINAL RINGS FORMED BY THE VITELLINE VEINS

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FIVE FIGURES

While studying the development of the pancreas, Dr. Frederic T. Lewis found two embryos which present anomalies of the intra-embryonic portion of the vitelline veins. He has referred to one of these, a human embryo of 11.5 mm., in Keibel and Mall's Human Embryology (German ed., p. 421); the other, a pig embryo of 10 mm., has not been previously recorded. These specimens, which prove to be of considerable embryological interest, were placed at my disposal, and I have made a careful study of them at the Harvard Medical School, in coöperation with Dr. Lewis, to whom I am indebted for many valuable suggestions. Wax reconstructions have been prepared, both of the abnormal and of normal specimens, which show the course of the veins and the close correlation which exists between their arrangement and the form of the pancreas. The models have been deposited in the collection at the Harvard Embryological Laboratory, where they may be examined at any time.

The peri-intestinal rings formed by the vitelline veins were first made known by His. In a familiar figure, here reproduced as fig. 1, he showed that the right and left vitelline (or omphalomesenteric) veins anastomose with one another at three places, namely (1) ventral to the intestine within the liver; (2) dorsal to the intestine below the dorsal pancreas; and (3) ventral to the intestine above the yolk-stalk. Thus two venous rings are produced, each of which encircles the intestine. He showed, moreover, that the left half of the upper ring and the right half of the

lower ring degenerate, and that the remaining portions of the two vitelline veins form a single vein winding about the intestine.

These relations are correctly represented in fig. 1, but in one respect the drawing of His is subject to criticism. Two vessels are seen ascending along the intestine to fuse at the lower ventral anastomosis. Are these the right and left vitelline veins as Evans has labelled them in his copy of this figure (Keibel-Mall, German ed., p. 653) and as His designated them in the younger 'Embryo R' (5 mm.)? Or is the left vessel, *V.p.* in the figure, the superior mesenteric vein and the right vessel the fused pair of vitelline veins? If the model of His's 'Embryo A' (7.5 mm.), as reproduced by Ziegler, is examined, it will be found that both vessels shown in fig. 1, are continued beyond the loop of intestine along the yolk-stalk, thus representing the right and left vitelline veins respectively. This, however, is an error. The left vessel in an embryo of the stage in question does not extend beyond the intestinal loop. It is the superior mesenteric vein, and the right vessel represents the original pair of vitelline veins, which have fused.

The development of the single stem formed by the vitelline veins may be observed in rabbit embryos. At the time when the lower ventral anastomosis is formed, the yolk-sac is close to the intestine. The veins coming from the right and left halves of the sac meet and anastomose ventral to the intestine and immediately separate to encircle it. With the formation of the yolk-stalk the ventral anastomosis appears to be drawn out in a single stem, which increases in length with the formation of the primary intestinal loop. The prolonged ventral anastomosis becomes separated from the mesentery, so that it appears as a single vein which swings across the abdominal cavity with a peritoneal investment of its own. In this condition, in human embryos of the third month, it was observed by Luschka ('63).

The superior mesenteric vein apparently arises in human embryos of about 5 mm. Thus, in a 4.9 mm. specimen, Ingalls has found several small veins ascending behind the intestine to join the dorsal anastomosis of the vitelline veins, which, it should be noted, is plexiform. These ascending veins probably give rise to the superior mesenteric vein. In a 7 mm. human embryo,

Elze has shown that the superior mesenteric vein is a well-defined stem which empties into the spiral vessel formed from the peri-intestinal rings. The place of junction comes to lie on the left side of the intestine, both in human embryos (Elze) and in pig embryos (Lewis, Thyng). In other words it has shifted ventrally, and the mesenteric vein appears to join the left half of the lower peri-intestinal ring. Thus at the stage shown in His's figure, when the spiral vein has been formed from the peri-intestinal rings, the veins which unite near the intestine are the superior mesenteric vein and the fused vitelline trunk. On the other hand,

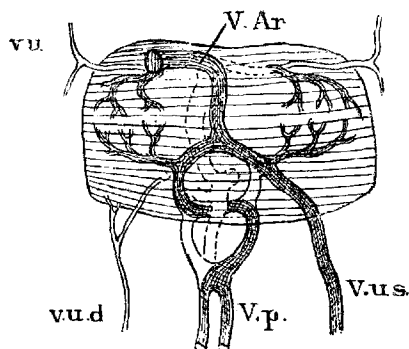


Fig. 1 His's diagram showing the formation of the portal vein, *V. p.* *V. u.* and *V. u. d.*, parts of the right umbilical vein. *V. u. s.*, left umbilical vein. *V. Ar.*, ductus venosus.¹

the place where the right and left vitelline veins unite is near the yolk-sac, as shown in the reconstructions by Lewis and Thyng; and this is far removed from the area included in His's figure.

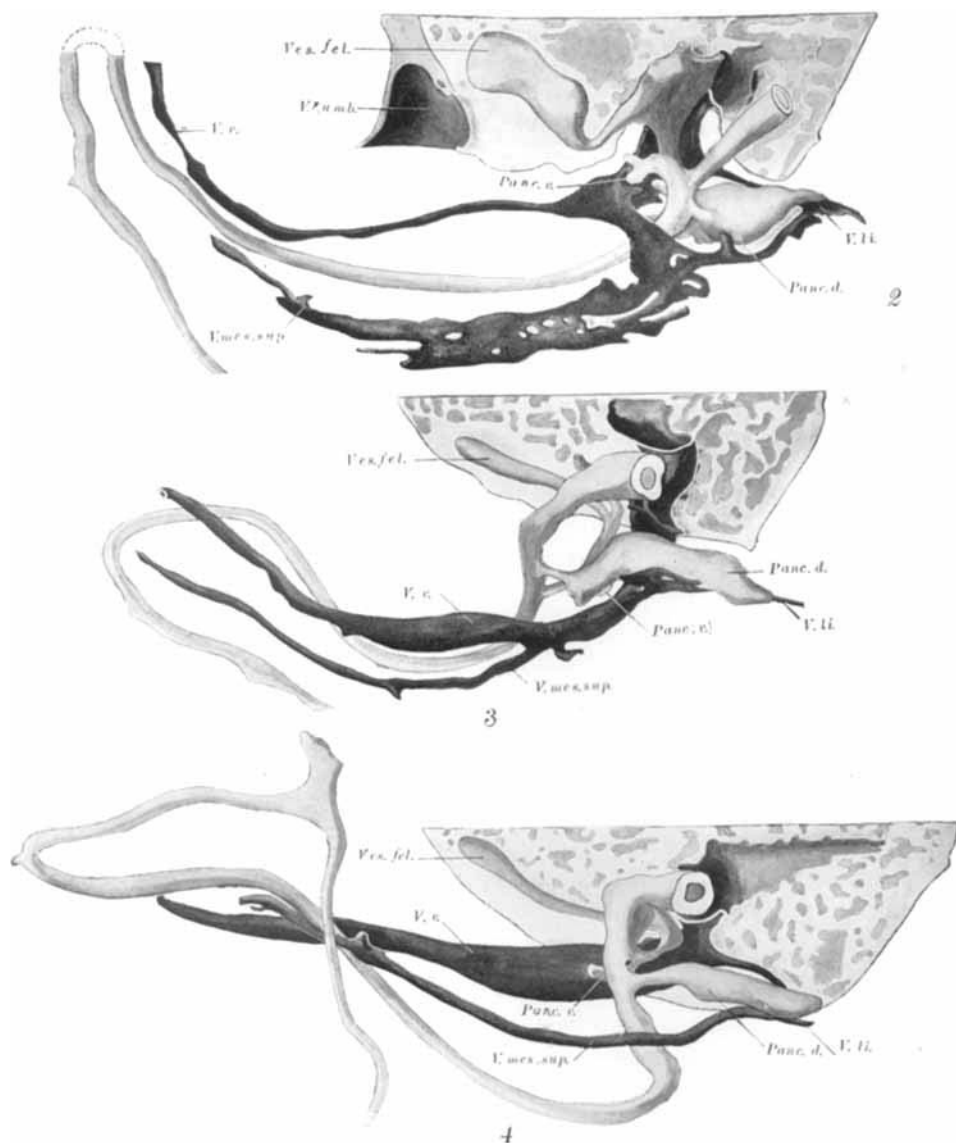
The true relations of these vessels, as here described, have doubtless been well understood by investigators of the venous system, but it is difficult to find an explicit account of them. Luschka recognized a vitelline vein coming from the yolk-sac and a mesenteric vein coming from the mesentery, but apparently he did not consider the possibility that the mesenteric vein might be derived from a left vitelline vein. This possibility, suggested

¹ For the use of the electrotype of this figure, and for many facilities for study and investigation during my stay at the Harvard Laboratory, I am deeply indebted to Professor Charles S. Minot.

by His's models and figures, was rejected by Dexter and Lewis, both of whom figured the elongated ventral anastomosis of the vitelline veins, and portions of the right and left veins of the yolk-sac which unite to produce it. Hochstetter, in his admirable résumé in Hertwig's Handbuch, neither figures nor describes the notable elongation of the ventral anastomosis, and Elze fails to recognize it, since he describes the vitelline trunk which crosses the abdomen as the *left* vitelline vein.

With the explanation which we have made, His's diagram (fig. 1) will make clear the nature of the anomaly shown in fig. 2. This figure represents a model of the veins of a pig embryo of 10 mm., viewed from the left side. In addition to the veins, it shows portions of the stomach and liver, including the gall-bladder, and also the dorsal and ventral pancreases and a large portion of the primary intestinal loop. The distal part of this loop and the yolk-stalk had been cut away before the embryo was sectioned. In reconstructing the organs, only the epithelial portion was included.

In this specimen the fused vitelline veins form a rather narrow vessel showing evidence of atrophy at several points. Within the umbilical cord it occupies a distinct fold of the mesentery. Upon reaching the abdominal cavity the vein leaves the intestinal mesentery and crosses, free from it, to the connective tissue about the duodenum. Ventral to the duodenum it suddenly enlarges and is joined by the superior mesenteric vein. The latter, throughout most of its course, forms part of a net-like system of channels lying in the mesentery. It is a large vein which passes backward and upward in a sweeping curve to join the vitelline vein. In joining the vitelline vein it passes ventral to the intestine instead of dorsal to it, and the main trunk formed by the union of these vessels is on the right side of the intestine instead of on the left. The embryo presents, therefore, a persistence of the right half of the lower peri-intestinal ring, which forms a portion of the main channel to the liver. In the 7.8 mm. embryo described by Thyng, the right half of the lower ring was not found, and it presumably atrophies normally in still younger embryos.



Figs. 2, 3 and 4 Wax reconstructions of parts of the liver, intestine, and adjacent veins. $\times 30$ diam. Fig. 2 Pig embryo: 10mm. Harvard Embryological Collection, Series 1698. Fig. 3 Human embryo: 10 mm. H. E. C., Ser. 1000. Fig. 4. Human embryo: 11.5 mm. H. E. C., Ser. 189. *Panc.d.*, *Panc.v.*, dorsal and ventral pancreases. *Ves.fel.*, gall bladder. *V.li.*, splenic vein. *V.mes.sup.*, superior mesenteric vein. *V.v.*, trunk formed by the fusion of right and left vitelline veins. *V.umb.*, umbilical vein.

The left half of the lower ring normally forms a large vessel which winds around the dorsal wall of the intestine just posterior to the duct of the dorsal pancreas, and then ascends to the liver. The glandular mass of the dorsal pancreas, in growing forward on the right side of the intestine, encounters this vein and becomes molded about it. It sends 'ventral processes' forward, usually on the right side of the vein, but sometimes on its medial side. In the abnormal embryo there are two ventral processes of the dorsal pancreas, both of which are shown in the figure. The normal course of the superior mesenteric vein, after being joined by the vitelline vessel, would be under the duct of the dorsal pancreas and upward on the medial side of these processes, and the shape of the pancreas in the abnormal embryo indicates that such a vessel was present at an earlier stage. It has, however, disappeared and the left half of the lower peri-intestinal ring, together with the dorsal anastomosis of the vitelline veins, is represented by a slender vessel which passes under the dorsal pancreas near its distal extremity. There it is joined by the splenic vein. Before the left limb of the lower ring receives the splenic vein, it presents a small branch directed toward another short branch across the top of the pancreas. These vessels may formerly have connected with one another. The unusual course of these representatives of the dorsal anastomosis of the vitelline veins may be explained by the plexiform nature of the original connection. The upper peri-intestinal ring has developed normally. Its left half has disappeared, and its right half persists as the portal vein.

Finally it should be noted that the ventral pancreas in this embryo is bi-lobed, and that it bifurcates over the upper edge of the abnormal vein. If its lobes correspond with those usually found (cf. Lewis, '11) it is evident that the entire ventral pancreas has been displaced to the right, since the ventral process of the dorsal pancreas approaches its *left* lobe. Its relation to the vein suggests that such a displacement has occurred.

The abnormal human embryo (11.5 mm.), which has been modelled in the same way as the 10 mm. pig, is shown in fig. 4. Above it, in fig. 3, a normal specimen of 10 mm. is presented for

comparison. The smaller embryo is somewhat younger and fails to show the rotation of the intestinal loop, but in regard to the veins the specimens are quite comparable. In the normal embryo the left half of the upper ring and the right half of the lower ring have disappeared. In the abnormal embryo the left half of the upper ring is absent, but the right half of the lower ring remains as the direct continuation of the fused vitelline veins. The ventral portion of the left half of the lower ring has disappeared, but its dorsal portion remains as the continuation of the superior mesenteric vein. Although this anomaly differs from that in the pig in many ways, there is a striking resemblance in the dorsal displacement of the mesenteric vein, which passes beneath the pancreas near its extremity. The explanation of this feature is not apparent.

In the normal human embryo the duct of the dorsal pancreas opens nearer the stomach than the common bile duct. The distance between the two outlets, calculated from the wax reconstruction, is 0.16 mm. In the abnormal embryo, however, the relative position of these outlets is reversed (as already recorded by Lewis) and I find that the duct of the dorsal pancreas opens 0.12 mm. below or caudal to the orifice of the common bile duct. It is possible that the abnormal arrangement of the adjacent veins led to this anomaly, but this cannot be affirmed. The small and rather rudimentary ventral pancreas in the 11.5 mm. specimen extends downward and forward in close relation with the left side of the abnormal vein.

As a summary of the observations which we have recorded, a diagram (fig. 5) is presented, in which the normally persistent portions of the peri-intestinal rings may be compared with the parts found in the pig and in man. In these figures the term portal vein is applied to the vessel formed by the union of the superior mesenteric and splenic veins, in accordance with anatomical usage, and is not extended to include the vessel made by the junction of the superior mesenteric and fused vitelline veins. It would be interesting to find adult specimens which had passed through the abnormal stages figured, but apparently such cases have not been recorded. In the human embryo which we have

described, after the obliteration of the vitelline trunk, essentially normal relations would be restored. But in the pig the superior mesenteric vein would cross in front of the duodenum, and it is probable that this condition will some time be found in adult animals.

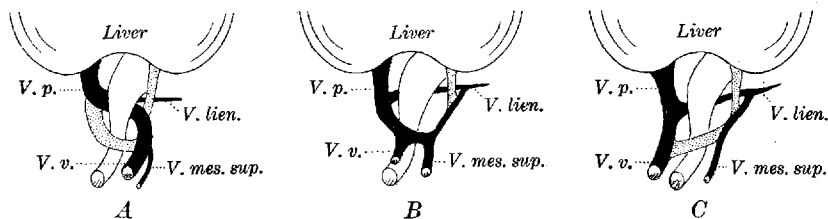


Fig. 5 Diagrams showing, in ventral view, the variations observed in the perintestinal venous rings. The probable position of the obliterated portions is indicated by stippled vessels. *A*, normal human embryo. *B*, abnormal pig embryo. *C*, abnormal human embryo. *V.lien.*, splenic vein. *V.mes.sup.*, superior mesenteric vein. *V.p.*, portal vein. *V.v.*, trunk formed by the fusion of the vitelline veins.

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