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THE SPIRAL DIRECTION OF THE VESSELS OF THE UMBILICAL  
CORD IN THE HUMAN FŒTUS.

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In a recent number of the *Edinburgh Medical Journal*,\* the writer proposes a most ingenious and plausible theory to account for the spiral direction of the vessels in the umbilical cord of the human fœtus. After a *resumé* of the anatomical peculiarities of the fœtal circulation, and the opinions held by different writers and investigators upon the subject, he proceeds to state his own theory "that the twist is dependent on the structure and distribution of the arterial system of the fœtus, and the action of the heart upon the fluid within its tubes."

Many explanations have been given by various writers as to the cause of this, but Mr. Simpson alludes to two only as worthy of notice—Velpeau and Schroeder Van Der Kolk: the former of whom attributes it to the rotary motion of the child in the liquor amnii, produced by the movements of its limbs; while the latter, on the contrary, considers that it is due to the greater pressure of the blood in the arteries than in the veins, causing it to turn to one side or the other according as they are placed to the right or left side of the umbilical vein in the umbilical ring. By Velpeau's theory, the direction of the twist is owing entirely to chance. By that of Van Der Kolk, while the force producing the twist is a constant one, and therefore not casual or accidental, the relative position of the vessels with respect to each other at the ring is entirely a matter of chance, and therefore, chance, even under his theory, must, after all, determine it equally as under Velpeau's theory.

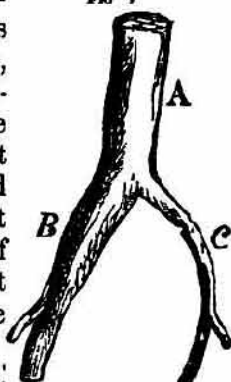
\* On the Cause of the Spiral Direction of the Umbilical Vessels, and the Convulsions of the Cord in the Human Fœtus. By John Simpson, Esq., F.R.S.C., L.R.C.P., Surgeon, Royal Naval Hospital, Haslar. *Edin Med. Journal*, July, 1859, p. 22, et seq.

The evidence upon which Mr. Simpson relies to substantiate his position, is found in the marked difference between the right and left common iliacs, both as to the angle they form with the axis of the aorta, and their unequal capacity. In proof of this, he cites eleven preparations in the museums of the University and the College of Surgeons, Edinburgh, and one made by himself, in all of which the axis of the right iliac coincided more nearly with the axis of the aorta than that of the left, and its capacity was much greater. This anatomical peculiarity corresponds with what is found in the preparations in the Cabinet of the Medical College in this city, and in the specimen before me, taken from a full-grown, stillborn male. (Fig. 1.) In this last the inequality between the two is very great, the left iliac looking like "an insignificant branch," and affording but a slight antagonism to the current flowing through the right. The fact, therefore, of this irregularity, and consequently of the great preponderance of circulating fluid in one of the arteries, is not to be doubted.

In three of the specimens cited—Nos. 393, 394, and the one prepared by himself—the twist in the cord was to the left, or in the usual way. In one—No. 395—the spiral twist in the cord was to the right, and the arteries, on issuing from the ring, passed to the left, *below* the umbilical vein, to which arrangement the reversed twist, according to Mr. Simpson, was due. The reason for this result is given (*Edinburgh Medical Journal*, p. 29) in the following words:

"The current of blood in the two common iliac arteries is unequal; the right, independently of its frequently larger calibre, will receive more force and energy from each pulsation of the foetal heart than the left, and this inequality will also be carried into their respective hypogastric branches. When the two hypogastric arteries, having the remains of the urachus between them, converge towards the umbilicus, each will tend to cross above the umbilical vein from its own side. But owing to the manner in which these vessels are surrounded by the sheath of the amnion, they would counterbalance each other; but from the circumstance of their forces being unequal, the result will be that the weaker will give way, and the composition of their forces, instead of forming a line the diagonal of the two, will incline more or less in the direction of the stronger. The consequence of this will be, that the right or stronger current, in ordinary circumstances proceeding in the direction from below upwards on the right side of the umbilical vein, will pass over and round it in the direction of the usual umbilical twist, carrying with it also the left hypogastric artery. The cord being fixed at one end by its attachment to the placenta, cannot yield, by twisting, to the pulsating force conveyed through these arteries; but the foetus, floating freely in a fluid of its own specific gravity, readily gives way to the recoil acting on its pelvis; and from the position of the vessels at the umbilicus, the vein

FIG. 1



A. Aorta.  
B. Right common iliac.  
C. Left common iliac.



will represent the pivot on which it will move, while the right artery, having the greatest power of recoil, will determine the direction of the rotary motion which ensues. Thus, supposing the placenta to be attached to the fundus of the uterus, and the fœtus floating with its face towards the placenta, then its rotary motion will be by its cephalic and pelvic ends passing in succession, with regard to the uterus, from right to left anteriorly, and from left to right posteriorly."

From this extract it will be seen that the cause assigned for the twist is altogether a mechanical one; its application must therefore be criticised upon mechanical grounds alone.

The first objection to this explanation is, that if there exists this constantly preponderating force on the right side of the pelvis, derived from the greater amount of blood coursing through the right iliac and hypogastric arteries, by every principle of mechanics its recoil would be in a direction opposite to the current of blood—*i. e.*, supposing the fœtus to be suspended in the water of the amnios, with its cephalic extremity next the observer, the head would pass from right to left, and the feet from left to right, and therefore when the right common iliac is the largest, the recoil being in the direction just stated, the twist would be from right to left, forming a right hand spiral, or what is called the reversed or unusual twist. And, indeed, with this in mind, it is difficult to perceive how the twist could ever occur in the direction it usually takes. And yet, against all this preponderating influence, the twists to the left outnumber those to the right in the proportion of five to one. Of 54 instances noted, 42 were twisted to the left, 8 to the right, 3 were not twisted at all, and one was twisted in both directions.

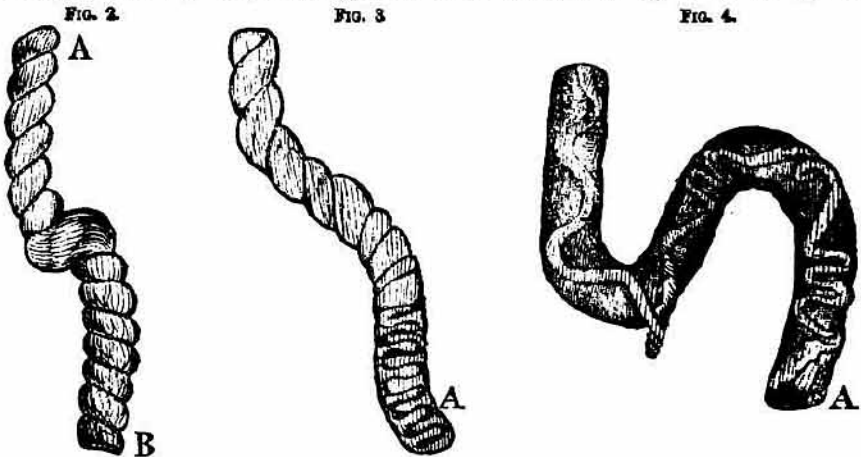
The second objection is, that if "from the circumstance of their forces being unequal, the result will be that the weaker will give way, and the composition of their forces, instead of forming a line the diagonal of the two, will incline more or less in the direction of the stronger" (see ante), in every case where the right iliac very much exceeds the left in capacity, and is nearer the axis of the aorta, the arteries ought to cross the umbilical vein *above* it. But in every case where the relative size of these arteries has been ascertained, the right is the largest; while the position of the arteries at the umbilical ring, with one single exception, is exactly the reverse of what Mr. Simpson's theory assumes that it ought to be.

The third objection is, that this explanation of Mr. Simpson will not in any way account for the occurrence of two opposite twists in the same cord, a fact noticed by Dr. Hunter, nor for that species of twist which is found for a few inches nearest the placenta, while all the rest of the cord is without any twist at all. In the specimen on the table may be seen a marked example of two opposite twists in the same cord, with the added complication of a knot between. (Fig. 2.) The direction of the spiral is to the

right from the umbilical end to the knot, and in the opposite direction—to the left—from that point to the placenta. The cord in this instance was twenty-eight inches in length.

I am indebted to Dr. C. E. Buckingham for a curious example of the other form of exceptional twist. In the case communicated by him, the umbilical portion of the cord was entirely free from twist. At the placental portion, for about twelve inches, the spiral formed by the vessels was strongly marked, and turned to the right. The case is also interesting, as it disproves the assertion made by various authors, and particularly Dr. R. Lee (*Lectures on Midwifery*, London, 1844, p. 120) that the "Spiral course of the umbilical arteries round the vein, and twisting of the whole cord, always commences and exists in the highest degree at the umbilicus of the embryo."

Besides the two exceptional twists already alluded to, there are other forms which the vessels of the cord assume, which are equally inexplicable by any theory like that advanced by Mr. Simpson.



A. Umbilical end of funis.  
B. Placental portion.

A. Umbilical end of funis.

A. Umbilical end of funis.

One of these exhibits the vessels running across the cord (Fig. 3) like the threads of the filling in a bit of narrow ribbon, for instance, and in this way taking up three or four inches of its length next the umbilicus, before they start in their spiral course. Another arrangement (Fig. 4) shows the artery forming kinks at short intervals, alternating with the cross-bar arrangement already mentioned, throughout its whole length, with hardly a single turn of the vessels from the umbilicus to the placenta. Instances of both these have occurred under my own observation within a short time.

The length which the cord acquires early in pregnancy—earlier even than the date at which writers say that the twist begins to form—is also an objection to the assumption that the body of the fœtus floats so freely in the liquor amnii as to be readily influenced by the recoil of the blood in the vessels of its own system. We



see, in the specimen on the table—an abortion of three and a half months—an instance of this. The length of the cord here is so great as to render it certain that, instead of being suspended in the water of the amnios, whatever may have been the position of the mother, whether erect or reclining, the fœtus must have rested on the walls of the uterus, sinking to its lowest point from the effect of its own weight.

In a specimen of an unruptured ovum of two months, in the possession of Dr. C. G. Putnam, of this city, is to be seen another proof of the validity of this objection. In this preparation the embryo is dimly visible through the semi-transparent walls of the sac, lying on the bottom, whatever way the sac is held, showing that the free, floating condition of the fœtus, assumed by Mr. Simpson, does not always exist.

And, finally, Mr. Simpson has himself furnished the best and most complete refutation of his own theory in the illustration he brings forward to prove it. He says:—

“There are several ways in which might be illustrated the recoil of a force acting as the pulsation of the fœtal heart does; and among them is one I may mention, a continental modification of what used to be called in this country a philosophical toy. It consists of a hollow piece of glass made into the shape of a devil or imp, with the usual appendages of horns and a tail. The latter is conveniently coiled round his body out of harm's way, and being also hollow, forms a communication with the interior of the body of the imp. This is placed in a tall, wide-mouthed glass bottle, filled to the brim with water, and covered over with a membrane having some elasticity; and when pressure with the hand is applied above, the water is forced into the cavity of the imp, which, as the air within it is compressed, descends to the bottom of the bottle. If the pressure of the hand be removed quickly, the sudden expansion of the air within the imp expels the water through the hollow tail, and meeting the resistance of the surrounding fluid, causes a recoil upon the body of the imp, and produces a rotary motion in it in a direction opposed to that of the stream. By alternate pressure and relaxation of the hand, a series of jets can be produced from the tail, simulating the beats of the heart in the fœtus and illustrating its force in causing rotation.”

But in this illustration the recoil is supposed to be produced by the force of the fluid, acting to throw the body of the imp in a direction opposite to its current. And, indeed, it does so. Now applying this principle to the fœtus, the recoil of the body ought to be in a similar direction; *i. e.*, as the blood flows in a circular direction, from the branching of the aorta to the umbilical ring, the recoil ought to be in an opposite direction, and turn the body that way, in a direction exactly opposite to what is assumed in the first part of the paper, in which a left hand twist in the cord is attributed to the greater size of the right branch of the common iliac artery.

Whether, therefore, we take the facts and endeavor to make

his theory agree with them, or, *vice versa*, attempt to reconcile the theory with the data upon which it is based, the result in both cases will be a failure. Not only is it not a general fact that there is any correspondence between the twist and the particular enlargement of the iliacs, but it seems also probable that the position of the two arteries with reference to the umbilical vein as to their passing out of the ring above or below it, is the *result* of the twist rather than *its cause*. No matter what may have been the relative location of the three vessels when they converge to enter the ring from the pelvic side, a single revolution of the body of the fœtus from right to left, or the contrary, will bring them into the position they are found at birth.

Indeed, it is to be doubted whether Mr. Simpson's proposition "when the hypogastric arterics, having the remains of the urachus between them, converge towards the umbilicus, each will tend to cross above the umbilical vein from its own side," is sound. Supposing a perfectly free course to the current of blood, and no obstruction presenting either from the surroundings of these vessels, or by any contraction of their calibre, upon what principle of mechanics can it be predicted that they will not pass along side by side, with no twist at all, as we see in the specimen before us—an abortion of three and a half months, an age at least much greater than that at which the twist is assumed to begin, and which is set down as commencing from the tenth to the twelfth week.