On the Anatomy of the Umbilical Cord

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a Graduation Thesis

by

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Anatomy of the Umbilical Cord.

Much as has been written regarding the Funis Umbilicalis — on the Knots, true & false, that may form upon it — on its circumvolutions round the fœtus, & their consequences — on the necessity or propriety of ligaturing it after birth — on the prolapsus of it — and the impediments which it offers during labour to the safe delivery of the child — yet its anatomy has only been studied & spoken of incidentally — by the way, as it were; & has never been made the subject of such

a strict & careful investigation as its great importance to the intra-uterine fœtus would seem to require. True! the presence or absence of nerves & lymphatics in the cords has been long & eagerly debated by anatomists & accoucheurs; but independently of the fact that this subject is open to discussion, the cord still presents an interesting field of investigation in regard to the structure & disposition of its vessels, the relations of its cellular tissue, the nature of its investment, & the source of its nutrition. Now, since we know that the cord is liable to be affected with diseases & injuries of various descriptions, & since a knowledge of its textural elements is necessary to the right understanding of its pathological conditions, we cannot doubt but that a careful study of its anatomy will lead to important results with respect to the health & life of the fœtus. For we never know in commencing any

scientific enquiry, to what useful end we may attain; & moreover, from the study of such simple textures as are found in the funiculus umbilicalis we may glean some facts which shall be of service to us in the examination of more complex structures. To fill up this void in the history of intra-uterine fatal existence is more than this essay makes pretensions to do; but if any deep-rooted errors have been cleared away, any new facts established, or any old ones placed in a clearer light, then it has not been altogether written in vain.

By way of opening the subject, I shall refer I, to the Development of the Cord; II, to its Connections; I shall treat III of the Constituents of the cord - its vessels, covering, cellular tissue, & more doubtful contents; IV, I shall Consider its Nutrition; & V, endeavour to determine its normal Dimensions.

We commence, then, with the

[1] Manuel d'Anatomie; Tom. III. p. 761

[2] System of midwifery p. 35.

[3] Embryologie, ou Ovologie Humaine ch: III, §2.

Developement of the Umbilical Cord.

Its existence in the first month after conception has been altogether denied by some writers, as Meckel[1], Rigby[2], &c.; the fœtus being connected, according to them, immediately with the membranes. On the other hand we find Velpeau[3] saying "it is by grounding on false analogies, hypothetical data, or imperfect observations, that authors have stated that the cord does not begin to be defined till after the first month of gestation. The youngest embryoes", he continues, "that I have dissected had an umbilical cord." The truth is, both parties are right, & they all, doubtless, mean the same. That ropelike arrangement has not yet been assumed which has gained for the organ the name funis, & the Amnios has not yet closely invested its rudiments; but, nevertheless, the elementary parts are there, although still of less importance in the economy of the Embryo than certain other parts which have a temporary function to perform, & which, when this has been

[1] Loc. citat.
[2] Etudes sur l'Oeuf.
[3] Traité des Accouchements, p. 216 (1856).

fulfilled, are found as accessories to the true cord.

During the earlier stages we finde in the situation of the future funis the Umbilical Vesicle with its duct & the Omphalo-Mesenteric vefels, and the allantois with its pedicle-the Urachus & vefels. In the course of the second month the vefsels are seen to pafs in nearly a straight direction along the cord, which at this period presents a series of enlargements. These swellings, which have been described & figured by Velpeau[1], Brechet[2] & Cazeaux[3], disappear in the course of the third month. The amnios invests them closely, & upon their removal, the vefsels afsume the spiral arrangement which they ever after retain, & become supported by the deposition of a substance known as "the Gelatine of Wharton."

Connections.

In its relation to the fœtus on the one hand & the placenta on the other, as forming the medium of vascular communication & continuity between them, the cord has been not inaptly likened

[1] Velpeau - L'art des accouchements p. 167 + Meckel - loc. cit.

[2] Operative Midwifery, p. 272.

to the stem of a tree — the radicles of its vein, which abstract nutriment from the maternal system corresponding to the roots, & the continuation of its vessels in the body of the fœtus holding the position of the branches. We have to consider to what part of the fœtus it is attached, & what is its point of connection with the placenta.

The cord is connected with the abdomen of the Fœtus at a point which varies according to the period of gestation. In the earlier stages it is closer to the pubes, but gets higher in the course of development, & at the full term generally occupies a position which corresponds to the space intermediate between the vertex & the soles of the feet.[1] But sometimes, as a rare variety, the funis is attached to some other part of the child's body. Thus Dr Churchill[2] notices a case of an acephalous Fœtus, born at the Dublin Western Lying-in Hospital, which had formed adhesions by the back of the neck to the placenta, from which the funis arose, & passing round the right side of the neck, was inserted into the depression between

[1] Embryologie f. 63.

[2] Loc. cit.

[3] Anatomia secundinæ Humanæ (1675)

the face & neck, just about the spot where the angle of the jaw should have been, had there been no malformation. The vessels of the cord passed behind the clavicle & ribs down into the chest & abdomen, & were there lost. There was a cul-de-sac about the proper situation of the umbilicus." The accuracy of those descriptions in which the cord is represented as attached to unusual parts of the fetus may well be questioned, since Velpeau[1] has shewn that when folded it may acquire adhesions to the inner surface of the membranes & the skin of the child at the angles of the folds, & so come to present the appearance of a number of cords.

Whilst the fatal extremity is so constant in regard to its point of connection with the abdomen, the maternal extremity is liable to extreme variation with respect to its place of origin from the placenta. Rigby[2] indeed says that it usually terminates in the centre of the placenta; but the observation is at least as old as the time of Hoboken[3], & has been confirmed by

Suite des Observations sur les Accouchemens laborieux §6.

authors of all succeeding dates, ~~that the cord~~ arises in most cases, not from the centre, but from some point between the centre & the circumference. Levret says that nothing is so rare as to find the cord attached to the centre of the placenta, & supposes that this depends upon the situation of the placenta in the uterus. His theory (hypothesis, rather - for there seems to be no facts ~~from~~ which he can ~~deduce~~ found a theory) is ~~that~~ when the placenta is connected to the fundus uteri, centre for centre, then the cord is central; & according as the placenta is situated lower down in the wall, owing to its tendency to develope itself upwards the cord is left at a point which is nearer the circumference in proportion as the placenta approaches the os uteri. The observation I have made upon a placenta in situ is of itself almost sufficient to negative this very improbable hypothesis:- The placenta in this case is connected to the upper part of the posterior wall of the uterus, reaching a short distance on the fundus. The cord, according to Levret's view,

[1] Elementa Physiologiæ Corporis Humani. Tom. VIII. p. 216.

[2] A very interesting case illustrative of this difficulty is related by Perfect in his "Cases in Midwifery" Vol. I. p. 21, where a placenta was retained for several hours, & when it was at length extracted the only traceable cause of retention was this centric attachment of the cord. In commenting on the case he states that "midwives are frequently obliged to wound such a placenta with their fore-finger, in order to make it separate".

[3] Traité du Developpement de l'Homme et des Mammifères, p. 163.

should have here been inserted a little below the centre of the placenta, whereas, in fact, its point of insertion was somewhat more than an inch above & to the left of the centre. Haller[1] notices the eccentric attachment of the cord, saying that this insertion suits Nature best. He adds that the central attachment is not without danger on account of the equable force applied in such cases to the placenta throughout its whole extent in delivery[2]. But the more philosophical explanation of Bischoff[3] is, doubtless, the correct one, viz., that all the variations "depend on the manner in which the allantois in the first stages contracts adhesions with the point of the ovum in contact with the uterus; for the vessels always tend towards the situation of the placenta, even although they have originally taken a different course, in the same way that the roots of a plant always spread in the direction from which they receive most nourishment abundant nourishment". Sometimes the cord is attached to the very margin of the placenta, forming what is called the

[1] Observationes Anatomico-pathologicæ. 1779. Lib. II, Cap. 9 – Tab. VII.
[2] Commentationum medici &c = Volumen I p. 38 (1800)
[3] A practical treatise on Midwifery (D^r Bedford's Transl:) p. 57.
[4] Cours Complet d'Accouchement p. 117.

[5] De Hemorrhagia inter partum D^r. Robertus Benckiser, 1831; or an abstract of it in Archives Gen: de Med: 1833, Vol. I. p. 156.

[6] September, 1848.

Battledore Placenta. Occasionally the vefels ramify for a considerable space in the membranes before reaching the placenta. Sandifort & Wisberg[2] each describe & figure such a case. Chailly d'Honoré[3] says he has twice seen this arrangement; & Flatin[4] as well as many others have put on record similar instances. Such an arragement of the vefels claims our attention on account of the danger which is apt to accrue when one or more of the branches traverse the presenting portion of the membranes, for they are then liable to rupture, & danger or death of the infant may ensue. An extremely interesting & instructive case in which the child died from this cause occurred at Heidelberg, in 1830, in the practice of Professor Nägele, & is recorded in an essay written on this subject by one of his pupils, which I can only allude to, as it is too long for insertion here.[5] A similar case has been recorded in the Archives Generales de Medicines,[6] by M. Lamastre, where it is stated that of all the anomalies in the mode of insertion in the placental

extremity of the cord this is the rarest & most curious.

Constituents

Turning now our attention to the constituents of the cord, we naturally begin with the most important structures in it, viz. the blood-vessels. These are, indeed, the essential elements of it, & its function being the establishment of a communication between the mother & fatus it is to convey these vessels to & from the fatus that the funis exists, to support them is the cellular tissue with its "gelatine" added, & to supply them with nervous influence do those nerves enter of which we shall hereafter speak. They are three in number, - two arteries & a vein.

1. The vein is formed by the co-alition of the several vessels which arise from the several lobules of the placenta, whence it paſses along the cord to the umbilicus of the fatus. Arrived there, it perforates the abdominal wall, & paſsing upwards, enters the longitudinal fisure of the liver, which it traverses, & after sending a

communicating branch to the vena portæ, throws itself into the vena cava ascendens. Its course along the cord is by no means so constant as the statements of many writers would lead us to suppose. It is generally represented as occupying a position in the middle of the cord, & serving as a sort of axis for the circumvolutions of the arteries. But, I apprehend, this very regular arrangement of the vessels will be found to obtain only in a limited proportion of cases, & among all the cords which I have examined I have not observed one in which they were arranged throughout their whole extent. On the contrary I have found the course of the vein very irregular; for even in the same cord it may be seen to be at one part confusedly convoluted, & at another parallel with the arteries, or having the arteries rolled round it in an almost regular manner. Sometimes also the three vessels pass spirally round an ideal axis, & even then the arteries will be found for the most part to surround the vein.

[1] Traité Complet des accouchemens. Observ. 207.

[2] accouchement. p. 168.

It not unfrequently presents varicose enlargements in different parts of its extent. Over these sinuses the cellular tissue of the cord is usually very attenuated, & they appear sometimes to be unsupported by it, & merely invested by the amnion. The extreme tenuity of the wall in such instances may be judged of from a case related by De La Motte, in which labour was complicated by hemorrhage from an opening, which "appeared" says he "to like an excoriation occurring on one of those species of knots which we meet with on the umbilical vein, through which the blood evidently passed by transudation rather than by rupture".

As to the existence of valves in the vein, Velpeau[2] says "it is altogether incorrect to say with Reufs & other anatomists that there are valves in the umbilical vein", adding that he has convinced himself to the contrary a hundred times by careful dissections. But though there is no evidence of the existence in it of perfectly formed valves such as are

Op. cit.: pp. 89, 139.

found constantly in many other veins, yet such a summary disposal of the matter is not altogether warrantable. For we do find, as was clearly pointed out by Hoboken' that frequently duplicatures of the lining membrane extend into the vein so as to occlude it more or less. And these pseudo-valves must have some effect in preventing the retrograde flow of the blood, when in any of the evolutions of the fœtus its circulation is impeded; nor can I otherwise account for the obstructions we sometimes encounter in injecting fluids along the vein from the fœtal extremity. Corresponding depressions are frequently met with on the surface, which become more distinct when the vein is inflated & dried: sometimes their inclination is oblique or tending to spiral.

The coats of this vein, though arranged on the same plan as in other veins, present peculiarities which are worthy of notice. Like other veins it is lined with a layer of pavement

epithelium, smooth, shining, & having even a glistening aspect in a fresh cord when the vein is laid open. This rests on a very fine longitudinally reticulated layer of fibrous texture, corresponding with the fenestrated coat. Then follows the middle coat which constitutes the most considerable part of the thickness of the wall & consists chiefly of unstriped muscular fibres having for the most part a circular arrangement: a longitudinal layer, however, lies innermost, & others parallel to it or somewhat oblique are interspersed among the annular strata. In the very great developement of this muscular coat in proportion to its other coats, the umbilical vein presents a marked contrast to all the veins throughout the body, in most of which the muscular fibres are very sparingly distributed — so sparingly, indeed, that their existence except in the very largest has long been a matter of doubt. The presence in this vein of fibres professed

[1] The Works of John Hunter, Edited by J. F. Palmer, 1837, Vol. III, p. 159.

[2] Edin^r Monthly Medical Journal, May 1857, p. 494.

of muscular contractility was first demonstrated by John Hunter[1] who found that the vein contracted, though to a much less extent than the arteries on exposure to the air. The action of this coat may be demonstrated even more satisfactorily in a cord in which the circulation is still going on than after it has been tied & cut, as Hunter's was. By pinching or otherwise irritating such a cord, "the irritated vessel will sometimes almost entirely close its tube."[2] The amount of muscularity seems to vary in different instances, for we sometimes find it acting so powerfully as to overcome that tendency to collapse which is one of the ~~veins~~ distinguishing characteristics of the venous tube, & causing it to present for a longer or shorter periods an open extremity. There is but little elastic tissue in the umbilical vein; & the outer coat is not of the tough fibrous consistence of other veins. It is composed of a white fibrous layer with a few yellow elastic

fibres scattered here & there on its inner surface; & externally it is continuous with a quantity of loose areolar tissue; the whole being enclosed in a distinct compartment of the cord, separated from the beds of the arteries by a stratum of very condensed areolar tissue. No vasa vasi can be injected or microscopically detected in its walls.

The arteries are of smaller calibre, each of them being about half that of the vein. They arise on each side of the pelvic division of the common iliacs, known in the adult as the internal iliacs, of which they are by far the largest branches; being, in fact, the proper continuation of the aorta in the first months of gestation. Whilst yet in the cavity of the abdomen, they bear the name Hypogastric, & their course is represented in the adult by the two rounded cords which pass upwards from each side of the fundus of the bladder, converging towards the umbilicus. Here they meet the vein, & pass out with it at the

[1] Vide Velpeau (Accouchemens; loc. cit.)

[2] Traite d'Anatomie Vol. III. p. 760.

[3] Vt supra.

[4] Anatomical Description of the Human Gravid uterus.
2nd Edition ? Dr Rigby 1841 p. 29

umbilical arteries to pursue their way along the cords. Their direction in the funis is in almost every instance more or less spiral; & I know of no case in which they are recorded to have been straight in all their extent. Whatever be the direction of the vein, the arteries generally coil round it with wider or narrower intervals, although the converse occasionally takes place. At times they run parallel with it for some distance: and a case is recorded by Morlanne[1] where the vein & one artery coiled round the other artery. The course of the spiral would appear to be generally from left to right. Meckel[2] states that the proportion of cases in which this obtains is as 9 to 1:- Velpeau[3] says it occurs 10 times in 12:- William Hunter[4] says, "in most which I have attended to, the twisting of the navel-string has been in the same direction; viz., such as would be produced by turning the child round upon the navel as a centre, by pushing its head towards the right

a - At the fetal extremity
b - At the placental extremity
c - In the middle.

[1] Embryologie, p. 60.

side & its feet to the left. In two & thirty preparations now before me, four only are twisted in the contrary way; & of the twenty eight which are twisted in the common way, three have the contrary twist for some inches at the extremity which was nearest the fœtus." In twenty eight cords which I have injected, the arrangement is as follows: —

Left to right	15.
Right to left	4.
[a] Left to right; [b] right to left	1
[a] Right to left; [b] left to right	5
[a] Right to left; then [c] left to right; then [b] right to left	3

Here two interesting questions arise: What is the cause? & What the meaning of, this so constant arrangement of the vessels of the cords?

As to the production of the evil. shall we attribute it to mechanical & physical causes, or refer it to some more recondite origin? - Velpeau supposes that it depends on the rotatory movements, active or passive, which the embryo can execute in the cavity of the amnios, & he believes

that the uncertainty of these revolutions explains satisfactorily all the irregularities & varieties met with in different instances. In particular, he thinks that on this view it is easy to account for those cases in which the spire is turned first in one direction & then in another. But such cases clearly militate against this hypothesis; for the effect of a counter-revolution of the fœtus would be to untwist the coil which a previous rotation had induced. Furthermore, if this theory were correct, we should expect to find that all the constituents of the cord should participate in the twist; whereas, if due attention be given to the subject it will be found that the amnion pafses free & uninterrupted from the fœtus to the placenta, & where it does seem to follow the spiral course of the vefsels, the appearance is owing to the distension of the vefsels & especially of the vein. At the same time it is true that cords are occasionally met with, in which not only the vefsels but their

Waarneminjen over het Maaksel van dee Menschelijke Placenta, en over haren Bloedsomloop: Amsterdam, 1851, p. 69.

coverings also are wholly or partially twisted, & such may possibly be due to fatal motions. A still stronger objection to this hypothesis is found in the very constant course of the spiral from left to right, which these chance movements of the child can never account for. And again, the vein ought to have as great a share in the formation of the twist as the arteries; but, as I have already stated, the vein commonly presents nothing further than a wavy appearance, & is always surrounded by the arteries.

Schrader Van der Kolk attempts to explain it by supposing that from the stronger pressure of the blood in the arteries than in the vein, a considerable recoil must occur in them, & react on the pelvis of the floating Embryo, so as to cause it to turn to the right or to the left according as they are placed to the left or right side of the vein in the annulus umbilicalis. He says that when the arteries lie there to the right, the recoil on the right side of the body must be the most

Elementa Physiologiæ – Lib. ~~XXIX~~, Sect. iii. § XVII.

powerful, & consequently the child will
turn to the left, & the reverse will take
place when the arteries are situated to
the left of the vein, which, says he,
"seems to happen less frequently." Taking
for granted (cum grano salis, however,) the
statement as to the relative frequency of
the different relations of the vessels at the
navel, & the recoil of the blood, the rotatory
movement thus impressed on the fœtus
would have the effect of producing —
not the usual spiral, but the very opposite.
And this theory, while it meets the ob=
jection which we adduced against
Velpeau's drawn from the uniformly
sinistrorsal turn of the spire, does not
answer those in reference to the mutual coiling
of the vessels & the arrangement of the
coverings. Finally, the argument sup=
plied by the occasional & undoubtable
change of the twist already referred to
is of itself sufficient to forbid the
acceptance of Van der Kolk's hypothesis.

The explanation first propounded by
Haller, that the winding is due to a

1

※ This remark does not apply, for the effect of gravitation is neutralized by the pressure of the surrounding liquor amnii almost wholly, and what remains attributable to gravitation is only the amount of difference between the specific gravity of the blood in the artery ~~out~~ and that of the liquor amnii without—

very rapid longitudinal increase in the arteries, although countenanced by the frequent occurrence of loops & aberrations in their course is equally unsatisfactory. For since the cord is fixed at both extremities, if the arteries had to find room for themselves in a short sheath by coiling round the vein, they would be obliged to arrange themselves so that at one end the spire would be in one direction & reversed at the other. But such cases, as we have seen, are very exceptional.

At first when the child hangs free in the amniotic cavity suspended by the cord, the blood has to flow upwards in the arteries to reach the placenta; & that they should then take on a spiral course is in keeping with the observation of Sir Charles Bell, that arteries which carry the blood upwards against the power of gravitation, have a much greater degree of curvature than those which carry the blood downwards. Sir Charles has also shewn that an artery assumes a tortuous form, when from the

growth of a tumour &c an additional supply of blood is required, & wherever the part is subject to occasional increase of activity: but he does not attempt an explanation. It is curious to remark in reference to this matter, that the appearance of the spiral arrangement in the funis is synchronous with the formation of the inter~~auricular~~ ventricular septum of the fatal heart; which would almost seem to point to the circulation of the blood as an agent in the production of the coil.

But since all attempts at explanation founded on physical causes are so unsatisfactory, perhaps the safer & more philosophical course would be to refer the phenomenon, as we are assuredly entitled to do, to the morphological law according to which we find a tendency to spirality impressed upon so many organs & systems & even entire organisms, & more or less strongly marked in all. Here it is to be observed, however, that the direction of the spiral of the blood-vessels of the cord is contrary to that of

the circulation in the body; for in the latter it is from right to left, whereas in the former it is from left to right as has been already demonstrated.

I have asked what is the meaning of this coiling of the umbilical vessels? & have to say in reply that whatever other purpose it may subserve, this indication it will fulfil, viz. - to diminish the danger which threatens the child from obstruction of the circulation when, on the one hand, true knots are formed on the cord; for the vessels will be far less liable to be completely compressed where the vessels are twisted than where they are straight - or when, on the other, the cord is subjected to strong traction; for the extending force will be so far expended on the straightening of the coil that all risk of obliteration from this cause is completely obviated. There is reason to believe also that the spiral flow of the arterial blood will impart to the cord a rigidity which could not be obtained by other means compatible with the degree of flexibility

* See note p 23.

1 Anat. Corpor. Hum: Lib. I, Cap. XXXI.

required; & the effect will be the counter=
action of the tendency to prolapse of the
funis during labour, which is so fre=
quently attended with untoward cir=
cumstances. I am inclined to think
that not only a passive rigidity will
be imparted, but even an active tendency
to forward motion; & if it be so we
can more readily understand how the
funis when lying loose in the amniotic
fluid (whose specific density is lighter than
that of the cord) is kept up in opposition
to the force of gravitation. If Sir C.
Bell be right in saying "that an artery
in proportion to its tortuosity becomes
less dependent on the force of the blood
transmitted from the heart, & more on
the excitement of the organ which it
serves", then the placenta beyond all
other organs & tissues exercises a control
over the amount of blood which cir=
culates in it in all its various con=
ditions.

We have already seen that
Diemerbroeck & others were wrong in

[1] Nouveaux Elemens de la Science et de l'art des accouchemens; Paris. 1817; Tom. I. p. 145.

[2] System of Midwifery, 1825, p. 63.

[3] System of Midwifery. transl: by J. Heath, 1790. Vol. I. p. 287.

describing the vein as professed of true valves; & in connection with this it is curious to find Maygrier[1] saying that "the arteries have valves whilst the veins have none", & Dewees[2] concurring with him so far as to say that "the veins rarely have valves, while they are frequently found in the arteries". & Baudelocque[3] also says "there are no valves in the vein, but we find some in the arteries, if not always, at least generally". Upon what foundation they rest this statement they do not tell us, & as all the other authorities are silent on this point, we must suppose it to be a mistaken observation. Certainly I have seen nothing confirmatory of the statement in any which I have examined.

As regards the structure of the walls of the umbilical arteries, they are composed of the same textural elements as those of other similar arteries, but in different proportions. They contract much more strongly on the application of stimuli, but are almost

or, I might say, entirely destitute of the physical property of elasticity which is so strongly marked in other arteries of the same calibre; so that on division of the cord, while the orifices close very rapidly, they are not retracted within their sheath, but are seen rather to project prominingly beyond the cut surface of the cord. Accordingly, when a section of the arterial tunics is submitted to to the microscope we find a large preponderance of the muscular over the other layers: & the fully developed yellow elastic fibres are so thinly distributed throughout that they are very liable to be mistaken for nervous filaments.

The existence of Nerves in the umbilical cord has long furnished a subject of debate to anatomists & accoucheurs.

"Et adhuc sub judice lis est."

"At first sight it might appear surprising to us to find so many

Dublin Quarterly Journal of Medical Science,
(1836) Vol. X. p. 257.

conflicting opinions & those of such distinguished men on a matter apparently of such narrow limits as the anatomy of the navelstring. One would suppose that half an hour's careful examination with the scalpel would anticipate all future inquiry, & terminate all future doubt! But while none who have made the attempt have found any difficulty in dissecting & tracing out fibres running longitudinally or spirally in the course of the vessels, all have not come to the same conclusion in regard to their nature. For whilst some have erroneously described & delineated them as nervous filaments, others have more correctly looked upon them as bundles of the ordinary fibrous tissue of the cord lying parallel with the vessels & made to assume the appearance of nerves at the touch of the anatomist's knife. Not only with the unassisted eye has the search been instituted, but

[1] Philosophical Transactions, 1825.

[2] Die Controversie über die Nerven des Nabel-
strangs und seine gefäße &c. 1836.

[2] Die Vrucht van der Mensch en van die
Zoogdieren - Amsterdam 1849, Jab. VIII. Fs. 4 & 5.

the aid of the microscope has also been called in to decide the question; yet hitherto with equally unsatisfactory results. It is true, Sir Everard Home[1] has stated that with the assistance of Bauer he has found nerves not only in the cord but even in the placenta. The representations he has given of the objects however, & the accompanying descriptions are of little weight & fail to carry conviction. Most of the authorities & arguments, pro & con, have been collected together in an essay by Dr. A. B. Schott[2] of Frankfort, who has given plates in which nervous filaments are shewn to pass along the vein from the Hepatic, & to the arteries from the Hypogastric plexuses. The correctness of these figures receives the sanction of Vrolik[3] Professor of Anatomy at Amsterdam, who states that the twigs of the sympathetic only pass for a short distance beyond the umbilicus, & never penetrate to the

[1] Traité de neurologie; traduite de l'Allemand par A. L. Jourdan, Paris 1843, p. 625.

How true! As if a microscope was not a means of research of which the author has not availed himself —

* Certainly nothing can be more independent as to fact or mode of expression —

placenta. They are supported also by the statement of Valentin' that very strong grey filaments may be traced in the adult from the round ligament of the Liver to the Coeliac ~~&c~~ plexus. But these observations are open to the objection that their correctness has not been confirmed by the use of the microscope; & those who, perhaps justly, are unwilling to believe in the existence of nerves in the cord until their presence has been so verified, must be content, I fear, to remain sceptics still. I have applied this test (of the microscope) with a view to discover the characteristic appearances of nerve-fibres; & tho' I have seen objects which strongly incline me to believe in their existence, yet I am not prepared to say definitely that they are present.

Pending anatomical research, let us see what are the arguments in favour of their existence furnished by physiology. Schott has discussed these at

Ulsupra-

By no means –

!

× how so?

× Not at all

length, & I quote a summary of them from a review in the Dublin Journal:-

1. The irritability of any part (it will be admitted, says D'Schott) is in direct proportion to the nervous power allotted to it. + Now of all arteries, those in the umbilical cord appear to be the most irritable, therefore they must have a supply of nerves.

2. Osiander sen. considered, & D-S. agrees with him, that the arteries of the cord have in some degree a power of independent action, - an opinion founded upon his observing pulsation in the cord after the heart had ceased to beat. Vägele relates a similar fact. But independent action involves necessarily the presence of nerves. +

3. The nutrition of any part must essentially depend on nervous influence: Now the arteries themselves increase with the elongation and augmentation of the cord, & must necessarily be thus influenced.

× What nonsense !

× All these propositions are erroneous —

× How so ?

[1] Aphorisms, 204.   [2] Vol. I, p. 292.

Here —

4. Secretion is undoubtedly the result of nervous action; × now if, as is believed by Monro & others, the liquor amnii be secreted by the terminations of the umbilical arteries, they must, doubtless, be well supplied with nerves. ×

It would assuredly be a strange anomaly to find the great muscular × energies of these vessels called into action by the direct stimulus of the contained fluid, & not, as in all other instances, by the intervention of the nervous influence. × The objections adduced by Mauriceau,[1] Baudelocque[2] & others - that the cord is insensible is obviated by the consideration that the filaments are derived from the sympathetic system, & are not endowed with acute sensory properties. Schott also brings forward analogies (E.g. of the lung & liver) & pathological phenomena in support of his view: but these I cannot enter upon, & would close this very imperfect notice of one of the most interesting points connected with the subject

† But why have not research been instituted to determine the matter

[1] Et supra.

[2] Disputatio inauguralis sistens observationes circa placentæ et funiculi umbilicalis vasa absorbentia — Göttingen

with the very just observation of his reviewer, that "it is in the highest degree probable, from physiological evidence, that these vessels of the cord are endowed with nerves: that analogy supports this view of the matter; & that anatomy, while it furnishes but little for, furnishes nothing against this supposition."

The existence of Lymphatics in the cord has furnished the subject of another quæstio vexata, which must be even more briefly indicated. Diemerbroek[1] describes lacteals as existing in the cord, & conveying a milky fluid from the uterus to the contents of the amnion. Godfrey Michalis, a pupil of Wrisberg, wrote a thesis in 1790[2] where he states that his master had discovered lymphatics furnished with valves in the cord, which he believed to contain a fluid at first like lymph, but afterwards resembling chyle. More lately, Fohmann has attempted to establish their existence by

[1] In Dublin Quarterly Journal for 1834, Vol. V — pp. 292, 482.

[2] Manuel d' Anatomie Vol. III. p. 760.

means of injections; & he is supported by Drs West & Montgomery of Dublin,[1] the former of whom tells us that nothing is more easy than to inject them; for they are so numerous that if a fine tube be passed through the covering, mercury very readily fills all the lymphatics which anastomose freely & are unprovided with valves. He describes the funis as consisting, with the exception of its bloodvessels "solely of a tissue of absorbents." He says that "on reaching the abdominal ring, they become somewhat larger, & some of them run into the dense tissue of absorbents between the epidermis & cutis of which the sheath of the funis is only a continuation. The rest unite into branches which proceed under the cutis & at the distance of some lines from the umbilical ring generate a lymphatic trunk, which running in a circular direction forms another ring." On the other hand Meckel[2] made researches with a view to discover

How certainly? It is not so easy to distinguish symptoms in it is never under the microscope.

lymphatics here, & failed: & West him=
self tells us that Hunter, Hewson,
Cruickshank, Mascagni, & others in
vain endeavoured to demonstrate them.
And, moreover, the whole tenour of his
descriptions leads to the conviction that
what he takes for lymphatic vessels
are merely the areolæ of the fibrous
tissue, which are of varying dimensions
in different parts of the cord, but all
connected freely with each other, so
that mercury or any fluid would
pass readily from one to another through
all its extent. And certainly very
careful microscopical examination re=
veals in no part of it any structure
which can at all be referred to the
lymphatic system.

In the cord, as in all
other parts of the animal frame, we
find the contour preserved by the de=
velopement therein of a quantity of
areolar tissue, which serves to separate
the vessels from each other, & to fill
up the intervening depressions. It

differs in no essential respect from the cellular tissue elsewhere deposited; but is made up of the ordinary white areolar fibres, interspersed with a few pale yellow elastic ones, all interwoven together in such a manner as to leave cells, or rather areolæ or cavities within the meshes. The areolæ are larger or less according to the greater density or rarity of the "textus cellulosus." A transverse section of the cord shews it to be very much condensed in the centre, particularly towards the fœtal extremity. From this three less strongly marked bands radiate towards the circumference to be connected with the investing membrane, through which they can generally be detected following the course of the vessels, & their track is sometimes marked by a superficial ridge, more or less distinct, but by no means constant. They form septa between the vessels of which they may be looked upon as the sheaths. They are the structures prefixed into the

Is it gelatine or serum?

service of those who are anxious to manufacture nerves in the funis, the appearance of which they may very readily be made to assume, because of the longitudinal direction of the fibrous bundles of which they are composed.

The areolæ contain a variable quantity of a glairy, viscid, tenacious substance named "Gelatine of Wharton". It is on the degree of distension of the areolæ by this substance rather than on the amount of the cellular tissue, or the size of the vessels, that the thickness of the cord for the most part depends. On being exposed to the atmosphere, it seems to be partially decomposed, becomes more fluids; & as the areolæ all communicate, a thick cord after exposure for a few days is reduced to the dimensions of an ordinary sized one. Even in the fresh state it flows pretty freely from the cut ends, & hence the important indication of extreme care

Burns refers to a case by M. Deglando in Recueil Period.
Tom. II p. 343, where the child died of hæmorhage
from shrinking of the cord after ligature.

11

in tying such a cord that the ligature be tightly applied, for if this caution is not attended to, the noose will slacken as the "gelatine" escapes, & a haemorrhage, fatal even, may be the consequence. Towards the surface the areolæ diminish in size, & the fibrous network becomes more & more compact, until the spaces disappear, & the texture puts on a membranous aspect. This is continuous with the amnion at the placenta, & abuts on the cutis vera at the fœtus. It is shewn to be amniotic from its development, & from it's being surmounted by a delicate but very well marked layer of pavement epithelium like the rest of that membrane. The cord is almost always spoken of by those who have written on the subject as being covered also by a layer of the chorion: a statement which only serves to illustrate the tendency of compilers to propagate error, by the servile transcription from previous authors of careless & unfounded remarks.

Neither the study of the anatomy of the cord, nor the history of its development, furnish any data in support of this notion. For it is quite impossible even by the most minute & careful examination to dissect more than the one covering already spoken of; and those who speak of the chorion as furnishing a second investment, seem to forget that this membrane has never, throughout the whole course of fetal development, any such union with the child as the amnion has, but is only connected with it by means of the umbilical vessels which issue from the fetus to dip at their other extremity into the substance of the chorion. The only sense in which it can be supposed to enter into the composition of the cord at all, is that its proper tissue may be prolonged along the vessels to become continuous with that derived from the amniotic reflexion.

Nutrition.

In the tissues whose function

Carpenter's Principles of Comparative Physiology, 1854.
p. 352, et seq.

is simply physical, the proceses of nutrition are but little active, & consequently they need only a small supply of blood. Accordingly, the common fibrous tisue of the body is one of the least vascular of structures, & the vesels that ramify in it are destined for the supply of the fat cells & other structures. The observation is still more strikingly exemplified in the fibrous tisue of the funis; for, excepting the permeating blood-vesels, no capillary or trace of nutritive vesel can here be seen. We can scarcely suppose that nourishment is supplied to it through the thick walls of the arteries & vein, although the fluid traversing may possibly serve to support their coats. & the liquor amnii, besides that it is in all probability a fetal secretion, is possesed of solid constituents in far too minute a proportion to induce us to suppose that nutritive material is imbibed from it through the serous-like surface, although the existence

'Anatomical & Pathological Observations, pp. 62, 63.

of villi or papillæ on the cords of many of the lowers animals would seem to indicate such a process. We must look, therefore, for the source of its nourishment to the fœtal or the placental extremity. And here there is a difficulty. Is it derived from the capillaries around the abdominal ring? Very probably it is. But I am rather inclined to believe, (though it would be extremely difficult to prove it) that aliment is derived from the placenta where the tissue takes continuously along the vessels as far as the terminal villi, in which it meets a quantity of nutritive material taken up by cells from the maternal blood, & deposited around the capillaries, as shewn by Mr Goodsir. From either end the fluid material could pass with ease from space to space along the cord, supplying nutriment to all; & the refuse which would here be very little would be taken up by the venous radicles at the other extremity.

[1] Dissertatio inauguralis de Nodis veris Funiculi Umbilicalis.

[2] Adversariorum Anatomico-medico-Chirurgicorum, Decas II. Obs. X, p. 29.

[3] Memorial de l'Art des accouchemens, p. 139.

Dimensions

As regards thickness the cord may be stated in general terms to have an average diameter of ½ an inch. It is subject to much variation, however, in accordance with the enlargements & tortuosities of the vessels, and still more with the measure in quantity of the Whartonian gelatin. Dr Delius' states, on the authority of Osiander that it is thicker during the 7th & 8th months than before or afterwards. Hoboken, in the curious work already referred to, describes & figures a cord no thicker than a swan's quill. Ruysch[2] tells that he had a preparation of a fœtus whose navelstring was slender like a filament; most probably the patient had aborted at an early period of pregnancy. Madame Boivin[3] relates that she has seen a fœtus at the fifth or sixth month with a cord no bigger than a cotton thread & twisted as tightly, which died in consequence of the obstruction of the circulation.

[1] Cases in Midwifery, Vol. II, p. 302.

[2] Vol. I, p. 19.

Perfect[1] also gives a case in which the cord "appeared twisted like a jack-screw, & almost as hard: the circumference of it did not exceed two-thirds of an inch". The greatest thinness of the cord, however, compatible with the full nutrition of the embryo must be much short of this: & accordingly, we find such extreme twisting & tenuity to be commonly associated as in all these cases with abortions. I have twice seen cords of this description & in both instances they were attached to fetuses born one towards the close of the 2nd month, the other between the third & fourth months of gestation. Had we data sufficient it might be of some importance to ascertain how far this contraction of the funis & the death of the child stood in the relation of cause & effect.

On the other hand, the cord not unfrequently presents a great increase of bulk. Thus the author last cited[2] mentions another case where the funis was found to be 2 inches in circumference.

[1] Midwifery, p. 144

[2] Ut supra p. 34

[3] Observations sur la grossesse et l'accouchement
obs. 406

[4] Op. cit. Vol. I, p. 147.

[5] Manuel des accouchemens &c Vol. I. p. 267.

Dr Burton[1] takes notice of one which was twice as thick as his thumb. Wrisberg[2] records a case where the cord was 2½ inches in diameter at one part, & 6 inches in circumference: & Mauriceau[3] relates the case of a large female child whose navelstring was as thick as its arm, & so short that the placental vessels had been ruptured by its movements 12 or 15 hours before birth, causing its death. The shortness of the cord was also remarkable in the other case that I have quoted: in this also contrasting with the attenuated cords, which are for the most part of unusual extent in proportion to the length of the infant. According to Mayer,[4] the cord is not strong in proportion to its thickness: but in making traction for the removal of the placenta a thick cord gives way as easily as a thinner one.

In respect of length, also, the cord is liable to extreme variation. It is said by Meckel, Jacquemier[5], & others to have in general a greater

[1] Obs. 640. Observations 5184 & 678 have also reference to shortness of cords, & its risks.

[2] Opera Medico-chirurgica Cent: II, obs. L.

[3] p. 138

[4] System of Midwifery, p. 182.

[5] Tab. LXIII. fig. I, V Tab. XLV.

[6] Vide Baudelocque's Midwifery, Vol. I. p. 293

[7] Obs: 401. [8] Lancet 1829. Vol. I p. 448

[9] In a note to Hunter on the Gravid uterus p. 218.

[10] p. 485.

relative length from the third to the sixth month than at any other period during pregnancy. At birth it may be shorter than the child or very much exceed it in length. — Mauriceau[1] has recorded a case where the funis was six inches long: Hildanus[2] has a notice of one which was four inches & a half: Mad. Boivin[3] has seen a cord at the full time only three inches long: Rigby[4] records one of two inches in length: and Vrolik[5] in the work already referred to figures two children, one of whose cords was half an inch, & the other only two lines in length. — On the other hand, L'Heritier[6] has seen it fifty seven inches in length: Mauriceau[7], sixty-one: Carus[8], sixty-five: Rigby[9], sixty-eight: & in the Edinburgh Monthly Journal of Medical Science for May 1850,[10] there is a notice of a cord which measured 6 ft 3/4 Schlesw. inches, & was believed by Dr Saugebauer, in whose profession it was, to be the largest on record. The only statistics bearing on the ordinary

$15166.X\ 700 = 21.66.$

more correctly $21\frac{2}{3}$

length of the cord are those of Dr Churchill who has given a table of the lengths of 500 cases, from which he found that "the most frequent length was eighteen inches, the next twenty-four, & the next to that twenty inches."

From the records of the Royal Maternity Hospital of this city I have made out the following table of 700 cases, from which it appears that the average length is 21½ inches; & that the most frequent length is 21 inches, the next 24, the next 20, & then 18 inches.

The cord was	9	inches long in	1	instance =	9 inches.
—" —	10	—	3	—" —	30 "
—" —	11	—	2	—" —	22 "
—" —	12	—	12	—" —	144 "
—" —	13	—	14	—" —	182 "
—" —	14	—	20	—" —	280 "
—" —	14½	—	1	—" —	14½ "
—" —	15	—	25	—" —	375 "
—" —	15½	—	3	—" —	46½ "
—" —	16	—	21	—" —	336 "
—" —	17	—	32	—" —	544 "
—" —	18	—	56	—" —	1008 "

The cord was 18½ inches long in 1 instance = 18½ inches.

"	19		37	"	703 "
"	20		70	"	1400 "
"	21		81	"	1701 "
"	22		41	"	902 "
"	22½		3	"	66½ "
"	23		47	"	1081 "
"	24		79	"	1896 "
"	25		11	"	275 "
"	25½		1	"	25½ "
"	26		19	"	494 "
"	27		45	"	1215 "
"	28		9	"	252 "
"	29		11	"	319 "
"	30		15	"	450 "
"	31		3	"	93 "
"	32		10	"	320 "
"	33		10	"	330 "
"	34		2	"	68 "
"	35		2	"	70 "
"	36		6	"	216 "
"	37		2	"	74 "
"	37½		1	"	37½ "
"	40		2	"	80 "
"	43		1	"	43 "
"	44		1	"	44 "

The total length of the cords in the 700 cases was 15166 inches

[1] Vide Churchill p. 265

Osiander has stated that male children have generally longer cords than females'. I made a series of calculations with a view to determine the correctness of this remark, the result of which is exhibited in the subjoined table:-

No of CORDS	FEMALES.		MALES.	
	TOTAL LENGTH	AVERAGE LENGTH	TOTAL LENGTH	AVERAGE LENGTH.
30	672 inches	22¼ inches	652 inches	21½ inches
25	512 "	20½ "	499 "	20 "
25	502 "	20 "	495 "	20 "
40	885 "	22 "	906 "	22½ "
40	949 "	23½ "	922 "	23 "
40	809½ "	20¼ "	905 "	22½ "
200	4329½ "	21½ "	4379 "	21⅔ "

This table shews us that the average length of the cords of 200 girls is so nearly equal to that of the cords of as many boys that the difference may be looked upon as nil. It points out, moreover, the probable source of the fallacy which gave rise to Osiander's observation - I mean the examination

of a limited number of cords. For example, in the first 30 of each, the cords of the females exceeded those of the males in length by about ~~one~~ inch, while the the last forty the ~~total~~ average length of the boys' cords exceeded that of the girls' by fully two inches: & so with regard to other such small numbers we find sometimes those of the one sex, & sometimes those of the other predominating. Whereas, if the sum total of our careful calculations be correct, we are justified in holding that the sex of the child bears no relation to the length of its navelstring.

With the view of determining whether there subsisted any fixed relation between the lengths of the fetus & its funis, I made calculations from 100 cases, the result of which I shall merely give as they are too extensive to be inserted in a condensed tabular form. The total length of the children - male & females - was 1862 inches, giving an average of 18½ inches to each, while the sum of the

total length of their cords was 20 15 inches, or 20 inches on an average (an extent lower, as it so happens, than usual): so that the average length of the umbilical cord exceeds that of the child by 1½ or 2 inches. But while the great majority of cords have the proportion to the children of 20 or 21 inches to 18 or 18½ in length, great deviations from this standard are sometimes seen owing to the liability of the funis to vary in its extent, being sometimes twice or thrice as long as the fœtus, at other times much shorter, or, as was found in 6 cases of the 100, the fœtus & funis may be of equal lengths.