On the Anatomy of the Umbilical Cord

a Graduation Thesis

by

Alex-R. Simpson

1856
# Table of Contents

- **Introduction** 1
- **Development of the navelstring** 4
  - connections 5
  - with the Fetus 6
  - with the Placenta 7
- **constituents** 11
  - the vein  ibid.
  - the arteries 17
  - nerves 28
  - lymphatics 34
  - cellular tissue 36
  - gelatine of Wharton 38
  - covering 39
- **Nutrition** 40
- **Dimensions** 43
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 fetus, & their consequences—on the necessity or impropriety of ligaturing it after birth—on the prolapse 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 I wrote, it has never been made the subject of such
a strict and careful investigation as its great importance to the intra-uterine fætus would seem to require. True, the presence or absence of nerves and lymphatics in the cord has been long and eagerly debated by anatomists and accoucheurs; but independently of the fact that this subject is still open to discussion, the cord still presents an interesting field of investigation in regard to the structure and 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 and injuries of various descriptions, it seems 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 and life of the fætus. For we never know in commencing any
scientific enquiry, to what useful end we may attain, and 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 fetal 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. 161
2. System of midwifery p. 35
3. Embryologie ou Zoologie Humaine ch. III, s. 2.
Development of the Umbilical Cord.

Its existence in the first month after conception has been altogether denied by some writers, as Meckel, Wright; the fetus being connected, according to them, immediately with the membrane. On the other hand, we find Velpaeus 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 definite till after the first month of gestation. The young embryos", he adds, "continue, that I have defects had an umbilical cord." The truth is, both parties are right. They all, doubtless, mean the same. That spikelike arrangement has not yet been assumed which has gained for the organ the name fenuis, if 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, of which, when this has been
1. Loc. citat.
2. Études sur l'Auf.
fulfilled, are found as accessories to the true cord.

During the earlier stages we find in the situation of the future funis the Umbilical Vesicle with its duct, the Omphalo-Mesenteric vessels, and the Allantois with its pedicle the Vascular vesicles. In the course of the second month the vesicles are seen lying 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 Belflead, Brechet, & Cazeaux, disappear in the course of the third month. The amnios invests them closely, & upon their removal, the vesicles assume the spiral arrangement which they ever after retain, & become supported by the deposition of a substance known as the Gelatine of Wharton.
"Vellpeau - L'art des Accouchements, p. 167+
Meekel - loc. cit.

"Operative Midwifery, p. 272."
to the stem of a tree - the radicles of its vein which absorb nutriment from the maternal system corresponding to the roots, the continuation of its vessels in the body of the fetus holding the position of the branches.

We have to consider to what part of the fetus it is attached, and what is its point of connection with the placenta.

The cord is connected with the abdomen of the fetus at a point which varies according to the period of gestation. In the earlier stages it is closer to thepubes, but gets higher in the course of development, at the full term generally occupies a position which corresponds to the space intermediate between the vertey and the toes of the feet.

But sometimes, as a rare variety, the funis is attached to some other part of the child's body. Thus Dr. Churchill² notices a case of an acetalous fetus, 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. Tracing round the right side of the neck, it was inserted into the depression between
Embryologie p. 63.

Loc. cit.

Anatomia secundinæ Rumanæ (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 cords 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 Valpeau has shown that, when folded, it may acquire adhesions to the inner surface of the membranes of the skin of the child at the angles of the folds, & so come to present the appearance of a number of cords.

Whilst the fetal 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. Rigley\(^2\) 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 Accouchements laborieux.
authors of all succeeding dates, that the cord arises in most cases, not from the centre, but from some point between the centre of the circumference. Levetz say, that nothing is so rare as to find the cord attached to the centre of the placenta, and suppose that this depends upon the situation of the placenta in the uterus. This theory (hypothesis rather for there seem to be no facts upon which he can found his theory) is that when the placenta is connected to the fundus uteri, the centre for centre, then the cord is central. As it is situated lower down on the wall, owing to its tendency to develop itself upwards the cord is left at a point which is nearer the circumference in proportion as the placenta approaches the uterine. The observation I have made upon a placenta in situ is by itself almost sufficient to negative his 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 Levetz's view,
A very interesting case illustrative of this difficulty is related by Perfect in his "Cases in Midwifery," Vol. 7, p. 21, where a placenta was retained for several hours, after which 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.

Traité du Développement 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 and to the left of the centre. Haller 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 equal distribution of force applied in such cases to the placenta throughout its whole extent in delivery. But the more philosophical explanation of Bischoff is doubtless the correct one, viz., that all the variations depend on the manner in which the allantois in the first stage contracts adhesion 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. Sometimes the cord is attached to the very margin of the placenta, forming what is called the
Observations Anatomico-pathologicae, 1779, lib. II, cap. 9 - Tab. III.
Commentationum medicarum, vol. I, p. 38 (1786)

A practical treatise on midwifery (C. Bedfort's Transl.) 15s.

Cours Complet d'Accouchement, p. 117.


September, 1848.
Battledore Placenta. Occasionally the velae ramify for a considerable space in the membranes before reaching the placenta. Sandifort & Wesberg each describe a figure such a case. Ghailly d'Hemore says he has twice seen this arrangement; Thatin as well as many others have put on record similar instances. Such an arrangement of the velae 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 Seidel. It 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. A similar case has been recorded in the Archives Generale de Medicine, by M. Lainostre, where it is stated that of all the anomalies in the mode of insertion in the placenta...
Turning now our attention to the constituents of the cord, we naturally begin with the most important structure in it, viz. the blood-vessels. These are indeed the essential elements of it, and its function being the establishment of a communication between the mother and fetus it is to convey these vessels to and from the fetus that the human exists to support them is the cellular tissue with its "gelatine" added, and to supply them with nervous influence as these nerves enter of which we shall hereafter speak. They are three in number, two arteries & a vein.

1. The vein is formed by the coalition of the several vessels which arise from the several lobules of the placenta, whence it passes along the cord to the umbilicus of the fetus. Arrived there, it perforates the abdominal wall, passing upwards, enters the longitudinal fissure of the liver, which it traverses, and after sending a
communicating branch to the vena portae. throws itself into the vena cava ascending. Its course along the cord is by no means as 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, and among all the cords which I have examined I have not observed one in which they were so 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 are spirally wound an ideal axis, and then the arteries will be found for the most part to surround the vein.
Traité Complet des Accouchemens. Observ. 207.

Accouchement p. 168.
It not unfrequently presents various en-
largements in different parts of its extent.
Over these sinuses the cellular texture of the
cord is usually very attenuated, they ap-
ppear sometimes to be unsupported by it,
and merely invested by the amnion. The
extremity density of the wall in such in-
stances may be judged of from a case
related by de la Porte, in which labour was
complicated by hemorrhage from an opening,
which "appeared" says he, "like an excri-
ation 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,
Vulpian says it is altogether incorrect
to say with Beuf and other anatomists
that there are valves in the umbilical
vein," adding that he has convinced him-
self 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
found constantly in many other veins, yet such a summary disposal of the
maker 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-values must
have some effect in preventing the retrograde flow of the blood, when in
any of the evolutions of the fetus its circulation is impeded; nor can I
otherwise account for the obstructions we sometimes encounter in injecting
fluids along the vein from the fatal extremity. Corresponding depressions are
frequently met with on the surface, which become more distinct when the
vein is inflated and 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
William smooth哪里在a piece
end when the men is laid open this
physiological effect in a plant.

or a very fine longitudinal corresponding
considerably part of the thickening of the
wall & corky tissue, corresponding
the middle cork which constitute the an

body in most of medical. The

all vessels are one another. In this

as always except among the

the smooth where the middle

line of passage for the much

of muscular contractility was first demonstrated by John Hunter, 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, as Hunter's was. By puncturing or otherwise irritating such a cord, "the irritated vessel will sometimes almost entirely close its tube." 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 most distinguishing characteristics of the venous tube, and causing it to present for a longer or shorter period 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 and there on its inner surface; and 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 vasorum 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 month of gestation. Whilst yet in the cavity of the abdomen, they bear the name hypogastric, and 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 and pass out with it as the
"Note Velleian (Accouchement, loc.cit.)"

"Traité d'Anatomie Vol. III. p. 160."

"Not supra.

Anatomical Description of the Human Trunk returns.
2nd Edition & D Rigby 12/3/3 29"
umbilical arteries to pursue their way along the cord. Their direction in the fetus 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, where the vein and one artery coiled round the other artery. The course of the spiral would appear to be generally from left to right. Mekel states that the proportion of cases in which this obtains is as 9 to 1; Velpeau says it occurs 10 times in 12; — William Hunter 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.

Embryologie, p. 60.
side of its foot 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 fetus. In twenty eight cords which I have injected, the arrangement is as follows:

Left to right  ---------------  15.
Right to left  -----------------  4.
"Left to right; right to left ----  1
"Right to left; left to right ----  5
"Right to left; then left to right; then right to left 3

These two interesting questions arise:
What is the cause? And what the meaning of this constant arrangement of the fibers of the cord?

As to the production of the evil, shall we attribute it to mechanical or physical causes, or refer it to some more secondary origin? Vulpinus supposes that it depends on the rotary movement, active or passive, which the embryo can execute in the cavity of the amnios, the believes
that the uncertainty of these revolutions explains satisfactorily all the irregularities and 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 and then in another. But such cases clearly militate against his hypothesis, for the effect of a counter-revolution of the fetus would be to untwist the cord 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 makes free and uninterrupted from the fetus to the placenta, and where it does seem to follow the spiral course of the vessels, the appearance is owing to the distension of the vessels, especially of the vein. At the same time it is true that cords are occasionally met with in which not only the vessels but their
Maar neminijen over het Maatschappelijk Placentum en over haren Bloedstroom. Hoop: Amsterdam, 1857, j. 69.
covering 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 wavering appearance, it is always surrounded by the arteries.

Schrader Vander Poll 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, 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 Physiologiae Lib. XIX. Sect. III. § XVII.
powerful, and consequently the child will turn to the left; of 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 (sum grans falsis, however,) the statement as to the relative frequency of the different relations of the vessels at the navel, and the record of the blood, the rotary movement thus impinged on the fetus would have the effect of producing not the usual spiral, but the very opposite. And this theory, while it meets the objection which we adduced against Velpeau's drawn from the uniformly sinistrorsal turn of the spine, does not answer those in reference to the covering of the vessels and the arrangement of the coverings. Finally, the argument supplied by the occasional inextinguishable change of the twist already referred to is of itself sufficient to forbid the acceptance of Van der Holte's hypothesis.

The explanation first propounded by Haller, that the winding is due to a
This remark does not apply, for the effect of gravitation is neutralized by the pressure of the surrounding ligament amnii almost wholly, and what remains attributable to gravitation is but a small amount of difference between the specific gravity of the blood in the artery and that of the ligament amnii without —
very rapid longitudinal increase in 
the arteries, although countenanced by 
the frequent occurrence of loops & ob-
servations in their course is equally unsa-
satisfactory. 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 spine would be 
in one direction reversed at the other. But 
such cases as we have seen are very exception.
At first when the child hangs free in 
the amniotic cavity suspended by the 
cord, the blood has to flow upward 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 shown that an artery 
assumes a tortuous form, when from the
growth of a tumour and 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 interventricular septum of the fetal 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 and 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 and even entire organisms. It may or may strongly mark 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? I have to say in reply that whatever other purpose it may subsist, this indication it will fulfill—by diminishing 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—on when, on the other, the cord is subject 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 either means compatible with the degree of flexibility
* See note p. 23.
required; the effect will be the counter-action of the tendency to prolapse of the fumis during labour, which is so frequently attended with untoward circumstances. I am inclined to think that not only a passive rigidity will be imparted, but even an active tendency to forward motion; if so we can more readily understand how the fumis 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 B. 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, if more on the excitation of the organ which it serves; then the placenta beyond all other organs and tissues exercises a control over the amount of blood which circulates in it in all its various conditions.

We have already seen that Diemerbroeck and others were wrong in


describing the vein as professed of true valves; + in connection with this it is curious to find Pajagier saying that "the arteries have valves whilst the veins have none". + Dewees concurring with him as far as to say that "the veins rarely have valves, whilst they are frequently found in the arteries". + Baudeloque 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, for 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 protrudingly beyond the cut surface of the cord. Accordingly, when a section of the arterial tunics is submitted to the microscope we find a large preponderance of the muscular over the other layers: these fully developed yellow elastic fibres are so thinly distributed throughout that they are very liable to be mistaken for nervous filaments.

The existence of arteries in the umbilical cord has long furnished a subject of debate to anatomists and accouchers.

"It aduc sub judice lites.

At first sight it might appear surprising to us to find so many
Dublin Quarterly Journal of Medical Science.
conflicting opinions those of such distinguished men on a matter apparently of such narrow limits as the anatomy of the mamil string. One would suppose that half an hour’s careful examination with the scalpel would anticipate all future inquiry & terminate all future doubt. But while many 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 unaided eye has the search been instituted, but
1. Philosophical Transactions, 1825.


3. *Die Frucht von der Menseh en van die Zoogdieren - Amsterdam. 1849, Seft VIII. Fig. 575.
the aid of the microscope has also been called on to decide the question; yet hitherto with equally unsatisfactory results. It is true, Sir Everard Home has stated that with the assistance of x-ray, Bauer has found nerves not only in the cord but even in the placenta. The representation he has given of the objects, however, and the accompanying description are of little weight and fail to carry conviction. Most of the authorities and arguments, problem, have been collected together in an essay by Dr. A. B. Schott of Frankfurt, who has given plates in which nervous filaments are shown to pass along the vein from the aorta, to the arteries from the hypogastric plexuses. The correctness of these figures received the sanction of Vanoli, Professor of Anatomy at Amsterdam, who states that the twigs of the sympathetic only reach for a short distance beyond the umbilicus, and never penetrate to the
This list! As if a microscope was not a means of research, yet the author has not availed himself.

Certainly nothing can be more injurious to the fruit of this plantation.
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 Celiac oesophaeus. 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; this I have seen object which strongly inclines me to believe in their existence, yet I am not prepared to say definitely that they are present.

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

By no means.

? How so?

That is we.
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 Döderlein) 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. Oeiander sen. considered, V. B. 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, it must necessarily be thus influenced.
Is there a museum?

All men are fœtuses and women.

Apologies, 2044.

4. Secretion is undoubtedly the result of nervous action, now if, as is believed by Moro and others, the liquor amniicum is secreted by the terminations of the umbilical arteries, they must, doubtless, be well supplied with nerves.

It would appear that a strange anomaly to find the great muscular and nervous forces called into action by the direct stimulus of the contained fluid, not as, as in all other instances, by the intervention of the nervous influence. The objections adduced by Mauriceau, Baudeloque, and others— that the cord is insensitive is obviated by the consideration that the filaments are derived from the sympathetic system, and are not endowed with sensory properties. Schott also brings forward analogies (e.g. of the lung and liver) pathological phenomena in support of his view, but these I cannot enter upon, it would close this very imperfect notice of one of the most interesting points connected with the subject.


Disputatio inauguralis sistent observationum

cred a placentis et funiculium libitualis acra

absorventia - 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; and 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 question debated, which must be even more briefly indicated. Diemerbreck describes lacteals as existing in the cord, and conveying a milky fluid from the uteri to the contents of the amnion. Godfrey Michalis, a pupil of Wrisberg, wrote a thesis in 1790, 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, Johmann has attempted to establish their existence by
In Dublin Quarterly Journal for 1834, Vol. V.
pp. 292, 482.

means of injections, he is supported by Dr. Watt & Montgomery of Dublin, 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 funic as consisting, with the exception of its bloodvessels “solely of a tissue of absorben’t.” He says that “on reaching the abdominal ring, they become somewhat larger, & some of them run into the dense tissue of absorben’t between the epidermis & cutis of which the sheaths of the funic 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 Steele made researches with a view to discover
Are you really? It is not so easy to
be triggered lymphatic as it is nervous under
the mouth.
lymphatics here. He failed. It seems to me, if we really pay any attention to what the writers say about it, they all agree in this: that Hunter, Heveson, Bruickshank, Mascagni, and 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 areola 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 throughout all its extent. And certainly, very careful microscopic examination reveals 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 development therein of a quantity of areolar tissue, which serves to separate the vessels from each other, to fill up the intervening depressions.
defers in no essential respect from the cellular tissues 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 areola, or cavities within the meshes. The areola are larger or less according to the greater density or rarity of the testis cellulara. A transverse section of the cord shows it to be very much condensed in the centre, particularly towards the fotal extremity. From this three distinctly 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 structure prefixed into the
In a vacuum?
service of those who are anxious to manufacture nerves in the fund, 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 areola contain a variable quantity of a glairy, viscid, tenacious substance, named "P Matine of Wharton." It is on the degree of distention of the areola by this substance rather than on the amount of the cellular tissue, or the stage of the process, that the thickness of the cone, for the most part depends. On being exposed to the atmosphere, it seems to be partially decomposed, becomes more fluid, and as the areola all communicate, a thick end 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 end, and hence the important indication of extreme care.
Burns refers to a case by W. Degland inrecioe Period: Tom. IV p. 343, where the child died of haemorrhage from shrinking of the cord after ligature.
in trying such a cord that the ligature be tightly applied, for if this caution is not attended to, the horse will slacken as the "gelatine" escapes, & a haemorrhage, fatal even, may be the consequence. Towards the surface the areola 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 fetus. It is shown the amniotic from its development, & from its being surmounted by a delicate but very well marked layer of pavement epithelium like the rest of that membrane. The cord is almost always spokenly thin, who have written on the subject as being covered also by a layer of the chorio: 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. But it is quite impossible ever, by the most minute and careful examination, to dissect more than the one covering already spoken of, and these who speak of the chorioamnion as furnishing a second investment, seem to forget that this membrane, however, 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 chorioamnion. 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 reflection.

Nutrition.

In the tissues whose function
Carpenter, Principles of Comparative Physiology, 1852. p. 352, et seq.
is simply physical, the processes of nutrition are but little active, and consequently they need only a small supply of blood. Accordingly, the common fibrous tissue of the body is one of the least vascular of structures, and the vessels that ramify in it are destined for the supply of the fat cells and other structures. The observation is still more strikingly exemplified in the fibrous tissue of that funus; for, excepting the permeating blood vessels, no capillary or trace of nutritive vessel can here be seen. We can scarcely suppose that nourishment is supplied to it through the thick walls of the arteries and veins, although the fluid traversing may possibly serve to support their coats. The liquor amni, besides that it is in all probability a fat secretion, is possessed of solid constituents in far too minute a proportion to induce us to suppose that nutritive material is embibed from it through the serous-like surface, although the existence
Anatomical and Pathological Observations, pp. 62, 63.
of villi or papillae on the cord of many of the lower animals would seem to indicate such a process. We must look, therefore, for the source of its nourishment to the fetal 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, and deposited around the capillaries, as shown by W. Goodall. 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.
Dissertatio inauguralis de Radio veris Funiculi Umbilicalis.

Adversariuvm Anatomico-medico-chirurgicorum
Deca II. Obs. 5, p. 39.

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 5 mm. It is subject to much variation, however, in accordance with the enlargements and tortuosities of the vessels, and still more with the measure in quantity of the Whartonian gelatin. De Buysser states, in the authority of Osiander, that it is thicker during the 7th and 8th months than before or afterwards. Hoboken, in the curious work already referred to, describes figure a cord no thicker than a swan's quill. Ruyssch states that he had a preparation of a fetus whose navelstring was slender like a filament; most probably the patient had aborted at an early period of pregnancy. Madame Bobin relates that she has seen a fetus 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.
Perfect also gives a case in which the cord "appeared twisted like a jack-in-the-box, it almost as hard: the circumference of it did not exceed two-thirds of an inch." The greatest thickness of the cord, however, compatible with the full nutrition of the embryo must be much short of this: it, accordingly, we find such extreme twisting and tenuity to be commonly associated as in all these cases with abortions. I have twice seen cords of this description, and in both instances they were attached to fetuses born one toward the close of the third month, the other between the third and fourth month of gestation. But we have sufficient 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 mentions another case where the funis was found to be 2 inches in circumference.
1. Umburfey, p. 144
2. Ut supra, p. 34
3. Observations sur la Griffe et l'Accouchement
   obs. 460
Dr. Burton takes notice of one which was twice as thick as his thumb. Minberg records a case where the cord was 2.5 inches in diameter at one part, and 6 inches in circumference. Mauricius relates the case of a large female child whose navel string 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 alternate cords, which are for the most part of unusual extent in proportion to the length of the infant. According to Maggret, 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 Heckel, Jacquemier, and others to hark in general a greater
Obs. 641. Observations 578 & 672 have also references to shortness of cords & its risks.

Opera medic-chirurgica Cent. II, obs. 2.

p. 138


Tab. XXII ff. I. V Tab. XIV.

Vide Baudelocque: Midwifery, Vol. I. p. 293
98. a note to Hunter on the Baird uterus p. 298.

p. 285.
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 has recorded a case where the umbilicus was six inches long. "Hildanus" has a notice of one which was four inches and a half. Hald. Brown has seen a cord at the full time only three inches long. Rigby records one of two inches in length. An Ustich 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'Heriter has seen it fifty seven inches in length. Mauriceau, sixty-one; Barus, sixty-five; Rigby, sixty-eight. V in the Edinburgh Monthly Journal of Medical Science for May 1830, "there is a notice of a cord which measured 67 34 Schleswig inches, it was believed by Dr. Stoppelbauer, in whose profession it was, to be the largest on record. The only statistics bearing on the ordinary
\[ \frac{15}{66} \times 700 = \frac{21}{6} \]

imw correctly 21 \( \frac{2}{3} \)
length of the cord are those of Dr. Churchill who has given a table of the length of 500 cases, from which he found that "the most frequent length was eighteen inches, the next twenty-four, the next is that twenty inches."

From the records of the Royal Maternity Hospital of this city, I have made out the following table of 400 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.

<table>
<thead>
<tr>
<th>Length</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>14½</td>
<td>1</td>
</tr>
<tr>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>15½</td>
<td>3</td>
</tr>
<tr>
<td>16</td>
<td>21</td>
</tr>
<tr>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>18</td>
<td>56</td>
</tr>
</tbody>
</table>
The cord was 18½ inches long in 1 instance = 18½ inches.

<table>
<thead>
<tr>
<th></th>
<th>19</th>
<th></th>
<th>37</th>
<th></th>
<th>103</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td></td>
<td>70</td>
<td></td>
<td>1400</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td></td>
<td>81</td>
<td></td>
<td>1701</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td></td>
<td>41</td>
<td></td>
<td>902</td>
</tr>
<tr>
<td></td>
<td>22½</td>
<td></td>
<td>3</td>
<td></td>
<td>067½</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td></td>
<td>49</td>
<td></td>
<td>1081</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td></td>
<td>49</td>
<td></td>
<td>1896</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td></td>
<td>11</td>
<td></td>
<td>275</td>
</tr>
<tr>
<td></td>
<td>25½</td>
<td></td>
<td>1</td>
<td></td>
<td>25½</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td></td>
<td>19</td>
<td></td>
<td>494</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td></td>
<td>45</td>
<td></td>
<td>1215</td>
</tr>
<tr>
<td></td>
<td>28</td>
<td></td>
<td>9</td>
<td></td>
<td>252</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td></td>
<td>11</td>
<td></td>
<td>319</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td></td>
<td>15</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td></td>
<td>3</td>
<td></td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>32</td>
<td></td>
<td>10</td>
<td></td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td></td>
<td>10</td>
<td></td>
<td>330</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td></td>
<td>2</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td></td>
<td>2</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td></td>
<td>6</td>
<td></td>
<td>216</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td></td>
<td>2</td>
<td></td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>3½</td>
<td></td>
<td>1</td>
<td></td>
<td>37½</td>
</tr>
<tr>
<td></td>
<td>40</td>
<td></td>
<td>2</td>
<td></td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td></td>
<td>1</td>
<td></td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td></td>
<td>1</td>
<td></td>
<td>44</td>
</tr>
</tbody>
</table>

The total length of the cords in the 700 cases was 15166 inches.
W. de 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 following table:

| No of Cords | Females | | | Males | | |
|-------------|---------|---|---|-------|---|
| | Total Length | Average Length | | Total Length | Average Length |
| 30 | 672 inches | 23⅔ inches | | 672 inches | 21⅔ inches |
| 25 | 572 " | 20½ " | | 499 " | 20 " |
| 25 | 562 " | 20 " | | 495 " | 20 " |
| 40 | 885 " | 22 " | | 906 " | 22½ " |
| 40 | 949 " | 23½ " | | 922 " | 23 " |
| 40 | 869½ " | 20½ " | | 905 " | 22½ " |
| 200 | 4329½ " | 21½ " | | 4379 " | 21½ " |

This table shows 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 two inches, while the average length of the boys' cords exceeded that of the girls' by fully two inches: and 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 navellstring.

With the view of determining whether there subsisted any fixed relation between the lengths of the fiteen & its females, 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 & female was 1862 inches, giving an average of 18 ½ inches to each, while the sum of the
total length of their cords was 20.15 miles, or 20 miles 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 1 2 or 3 inches. But while the great majority of cords have the proportion to the children of 20-21 inches to 18 or 18 to 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 fetus, at other times much shorter, or, as was found in 6 cases of the 100, the fetus and funis may be of equal lengths.