

On the Formation of Knots on the Umbilical Cord. Read before the Obstetrical Society of Boston, May 4, 1861. By WILLIAM READ, M. D., formerly Physician to the Boston Lying-in Hospital. (With eight wood-cuts.)

OBSTETRIC writers, with very few exceptions, have attributed the formation of the knots which are occasionally found on the umbilical cord, at birth, to a change in position of the foetus while in the uterus. This may take place either from its own movements, or from some movement communicated to it by the mother. In this way, passing through a loop of the cord, it forms the knot, which may be tightened by the further gyrations of the foetus, or remain loose till delivery. Practically the subject is of no importance. The very nature of the complication effectually prevents any measures to protect the foetus from the dangers which may arise if the knot should tighten. But while granting all this, and admitting that nothing we can do will prevent their occurrence, it may be well to examine into the evidence upon which the general belief, as to their formation, is based; to determine whether it rests upon good foundation, or is one of those fallacies, so many of which, like the rubbish which disfigures the proportions of many a stately fabric, are to be found in the writings of obstetric authors, and which have been handed down from one generation to another, and passed current because they have never been questioned.

Smellie¹ states the fact of their occurrence, without attempting any explanation of their formation. Dr. R. Lee² says: "True knots are sometimes made by the foetus upon its own umbilical cord, and it thereby unconsciously,

¹ The description of the heart and arteries, which is here given, is nearly, if not precisely, according to the views entertained by Dr. Bennett Dowler, of New Orleans, who has made such extensive researches into the anatomy and physiology of the alligator. These views, however, have never been fully published by him, but were verbally communicated to the writer.

² Coll. 19, No. 2, case 3.

if I may so express it, commits suicide by compressing the vessels. I have seen two instances of this, and in both the knots must have been tied before the labours commenced." Rigby¹ states that "the manner in which these knots are formed may be easily imagined, when by chance the cord lies in the form of a ring, and the fœtus happens to float through it, a noose is made, which, when drawn tight, by accident, forms a knot." Churchill² says of the funis: "Occasionally, owing to the movements of the child at an early period, it may be coiled round its neck, tied in knots, or escape below the head, so as to prolapse during labour." Montgomery³ entertains the general belief of their formation while the fœtus is yet in utero. Prof. Miller⁴ remarks that the coiling of the funis about the neck "affords the key to an explanation of these knots, at least when they are single. They are tied by the fœtus slipping through the circle about its neck." Levret⁵ merely mentions the fact of their occurrence, and states that, when they do occur, "the infant ordinarily perishes before birth, or is born very much emaciated." Baudelocque⁶ says: "They sometimes form themselves during pregnancy, and at an early date, but there are also cases where the cord does not knot itself, until the instant when the child issues from the womb of the mother." Mauriceau⁷ mentions having delivered eight children with knots upon the funis of each, which he says were formed during the intra-uterine life of the child. Velpeau⁸ remarks: "On some occasions they are real knots, either simple or complex; more frequently, however, they are doublings, vascular nooses, whether of arteries or of the veins; the former are met with particularly where the cord is very long, are owing to the movements of the fœtus, are effected in the same way as the twisting of the cord about the neck, limbs, or other parts of the child, frequently met with in parturition, and, it may be said, are but the definite result of this last mentioned disposition." Blundell⁹ says: "To Dr. Hunter I may refer you for a very plausible explanation of the formation of these knots when single, for he has suggested that the umbilical cord, at birth, may, perhaps, form a coil round the margin of the os uteri within, and that the fœtus, in passing the orifice of the uterus, may at the same time pass through the loop, carrying the umbilical extremity of the cord along with it, so as to form a knot at the very moment when the body passes into the world. And this explanation enables us to understand well enough how a single knot may be formed; but then how is it that two or three knots are produced? how that a knot may be found on the cord in the earlier months, though the fœtus has never left the cavity of the uterus?" Prof. Meigs¹⁰ explains

¹ Mid., Chap. III.² Mid., Am. ed., p. 181.³ Signs and Symptoms of Pregnancy, Am. ed., p. 541 et seq.⁴ Obstet., p. 151.⁵ Art. des Accouch., p. 305.⁶ Art. des Accouch., p. 518.⁷ Obs., p. 133.⁸ Transl., by Meigs, 4th Am. ed., p. 202.⁹ Ed. by Castle, p. 108.¹⁰ Obstet., 2d ed., p. 218.

their formation, by supposing that "if in its gyrations within the womb, the child should enter a coil of the navel-string, and, passing through it, should thus make a knot on the cord—that knot happening to be strongly drawn, might cause its death by hindering the complete return of the blood of the placenta." Cazeaux¹ says: "When the cord is very long, it very often shows one or more knots. Some of these are formed during pregnancy, and often at a very early date; but others are never formed except at the moment of delivery. They never can be drawn tight enough (during pregnancy) to compromise the life of the child, to whose movements they are certainly owing. But we can understand how the cord, shortened by its circulations about the trunk or the neck, may find itself stretched with great force. The knots will then be drawn tight enough to interrupt the circulation entirely. If the labour is prolonged, the death of the child will be the result." Ramsbotham² says: "Sometimes the funis itself is found in labour to be twisted into a loose knot; but this appears to me to be produced rather by the movements of the foetus in utero, than to exist as an original conformation." Davis³ says: "We occasionally find a knot on the string, which in all probability, and in the greater number of cases, is found at the time of labour. It may, however, happen at any other time, in cases where there might be an excessive quantity of liquor amnii, as, for example, we find mentioned in Smellie's cases. Most frequently, however, this knotting takes place during labour; and it is very easy to conceive how this may happen. Let the cord be supposed to be lying in a coil round the orifice or neck of the womb; the head of the child having to pass in that direction, will find its way through it, and must necessarily draw it into a knot." Hunter⁴ says: "If I have not been deceived, I have seen it twice." Rokitsky⁵ says: "The true knots of the umbilical cord, that occur in rare cases, are of importance, as they may occasion obstacles to, or a cessation of, the circulation in consequence of the traction exerted upon them during parturition." The inference from this is, that he believed them to be formed during the intra-uterine life of the foetus, or *before* the time of parturition.

They may be single, or double, or more than one on the same cord.

Usually when they occur, the cord is found free from any convolutions about the body of the child, but, in rare cases, where the cord is extraordinarily long, both these conditions have been noticed: Baudelocque⁶ mentions a case where he found a triple knot on the cord, which was thirty-six or thirty-seven inches long, and moreover twice round the neck of the child. The position of the knot he estimated at about a foot from the umbilicus.

¹ Accouch., 5th ed., Paris, 1856, p. 205.

² Process of Part., Am. ed., p. 82.

³ Prin. and Pract. of Obstet. Med., p. 833.

⁴ Anat. Descript. of the Gravid Uterus.

⁵ Vol. ii. p. 350, Pub. of Sydenham Soc.

⁶ Loc. sup. cit., § 521.

He also states that it was drawn as tight as any other knot could have been in like circumstances. The child was, however, born alive. Smellie (*loc. cit.*) mentions a case where the funis was "nine hand-breadths long, had a loose knot on it, and was twisted round the neck of the child, which was dead." Dr. Lee¹ instances a case where the knot was "ten inches from the umbilicus, and the cord also surrounded the neck of the child once." In this case the cord was much compressed where the knot was tied. Another is quoted by the same author, in which the cord was "atrophied between the knot and the umbilicus." "I have no doubt," says Dr. Lee, "these were both formed early in pregnancy." In both these cases, the context warrants the opinion that the children were dead. Dr. Coale² reports a case where there were two knots on the cord, about five inches apart, one of which was double, and the other single—the latter being nearest the placenta. Prof. D. H. Storer³ mentions a case, quoted from a foreign journal, in which the "patient, seven or eight months advanced in pregnancy, being under a bed for some purpose, was suddenly surprised in that position, and hastily backing out, immediately had the symptoms of a dead child, of which she was delivered ten days after. A knot was found in the cord, so tightly drawn as to fully account for the death of the child by impeding the circulation." Dr. Zollickoffer⁴ reports two cases, in both of which there was a knot on the funis, which was coiled about the neck and chest.

Knots may occur when the cord is comparatively short.

In a case of my own—Mrs. S., third pregnancy, April 24, 1860—I found a single knot on the cord, about midway its length. The child, a full-sized boy, was perfectly healthy and vigorous. The cord was twisted in both directions very strongly. To the right—the exceptional way—from the umbilicus to the knot; and to the left—the ordinary and most frequent direction—from that point to the placenta. The entire length of the cord was a little short of twenty-eight inches; exceeding the child's length by about six inches only. In another case, three weeks later than the preceding (May 13), the cord was thirty-three inches long, and the knot, which was first noticed lying loosely encircling the left ankle, tied back towards the umbilicus, so that when it was drawn tight by the tension brought on it in withdrawing the child from the mother, it was situated so near the umbilicus as to make it impossible to apply the ligature without untying it. This was also a simple knot. In another case still (Oct. 5, same year), the cord was fifty-four inches long, very firmly twisted, and as large as the forefinger, with a single knot, about the middle. The child was vigorous, weighed thirteen pounds, and its condition forbade the supposition of any diminution of nourishment by constriction of the cord.

By some writers much importance has been given to the complicity of

¹ Mid., p. 124.

² Ibid.

³ Records Bost. Soc. Med. Imp., vol. iii. p. 190.

⁴ Am. Journ. Med. Sci., July, 1841, p. 109.

the knots described. Montgomery,¹ in alluding to this point, says: "The formation of the single knot, as it is generally called, is not difficult to conceive; but there is one of a very curious kind, of which I have seen but two instances, and it is so complicated, and requires for its formation so much dexterity and management to imitate it, that I feel at a loss to understand how it could have been formed in utero." The knot referred to, is what is usually called the figure of 8 knot, and is the same as that to be seen in the specimen presented by Dr. Coale to the museum of the Medical College in this city. The knot figured by Baudelocque is still more complicated; a knot in this case having been tied on a knot. Dr. Lee, in commenting on this knot (*loc. cit.*), remarks: "Baudelocque gives a figure of a double knot on the cord. These appear to consist of two knots formed at different times. The foetus must have passed twice through a large loop of the cord." By this opinion, adding his testimony to the impossibility of such a knot being tied at any other time, or in any other way.

Fig. 1.

P



Fig. 2.

P



BAUDELLOCQUE'S KNOT.—Fig. 1 represents the knot in its first stage of formation; P, placental end. Fig. 2, the knot as found at birth; P, placental end.

Equal in complexity with this knot figured by Baudelocque, is a knot noticed by Dr. George H. Lyman, of this city, a figure of which is here

¹ Signs and Symptoms of Preg., *loc. cit.* 

given. In this case the cord was thirty inches long, and was round the neck and one of the arms of the child. The knot it will be seen is double; a knot being tied upon a knot, as one would tie a string twice in the same place.

Fig. 3.



Fig. 4.



Fig. 5.



DR. LYMAN'S KNOT.—Fig. 3. Knot in the stage of formation; P, placental end. Fig. 4. Intermediate form. Fig. 5. Knot as it was found tied at birth.

The funis of one child, in twin cases, is sometimes found tied in a knot round that of the other.

Mr. William Newman reports a very interesting case of this kind in the *Edinburgh Monthly*.¹ In this case the children were contained in one bag of membranes, and were born at an interval of two and a half hours. The first was born alive, the second dead. "About midway between the umbilicus and the placental attachment of the funis, the cord of the first child, which was readily distinguishable by the ligature placed upon it, was tied in a single knot, and passing through the noose so formed, was the cord of the second child, which, on account of the tightness of the knot, was completely strangled. With the exception of some flattening at this point, the cords presented a perfectly healthy appearance. The children were equally mature and well nourished, so that the circulation through the cords could not have been obstructed for any length of time before death. It has already been stated that the nurse, before my arrival, had

¹ July, 1858, p. 8.

exercised some force upon the cord of the first child, by drawing it downwards, from which I conclude that the constriction probably took place at that period." The length of these cords was about twenty-four inches each.

The appearance of this knot on the cord is represented in Fig. 6, *A* being the cord of the first child, *B* of the second.

Fig. 6.



The knot figured by Mr. Newman who offers two solutions of its mechanism, makes no exception to the rule of formation proposed in this paper. "By the first, it may be supposed that at an early period of pregnancy the cord *A* must have been twisted into a single loop; through this loop the fœtus of cord *A* must have passed, and in place of going through it in part only (as when the cord encircles the neck in ordinary cases), it must have passed completely through; the noose still remaining so far loose as to permit the second fœtus with its cord *B* to drop through it.

"The second view may be that cord *A* may have made a single twist around cord *B*, the subsequent noosing of cord *A* being due to the formation of a knot upon it after it had already encircled cord *B*."¹

The latter of these two explanations is incontestably the true one. The rotation of one child round the other, in a single sac of the membranes, without the necessity of any extraordinary movements, will bring its funis in such a relation to the other that all the conditions requisite for the formation of the knot will be then present, needing only the passage of the child through the loop thus formed, to complete and tie the knot at delivery. Complicated as the fact of the knot being tied round the funis of the other child, *apparently*, makes the case, in reality it is no more complex or incomprehensible, nor does it require any other conditions for its formation than are necessitated to tie a single knot alone.

As to the knot reported by Stein, which is quoted by Mr. Newman* and called a "real knot," no figure is given. The impossibility of imitating, on a cord, such a knot, without so much manipulation as seems to be forbidden by the circumscribed capacity of the uterus in such a case, induces

¹ Loc. cit.

* Mr. Newman, in addition to his own case, quotes a case from Siebold's *Lucina*, 1806, vol. iii. part 1, No. 144, p. 313, also of twins, "which had only reached the seventh month, and were putrid: they were inclosed in a common bag of membranes and had one placenta. Close to the placenta the two cords were tied together in a real knot, and the one was afterwards twisted round the other several times."

a doubt whether the knot was so "real" as is reported. A half knot can be tied with the utmost ease—more easily even than when there is but a single cord—but a complete knot, in which both parts are perfect, as may easily be proved by experiment, is a difficult operation to succeed in.

The condition of the cord at the place of the knot, has been brought forward by some writers to prove the date of their formation, whether at delivery or earlier in the pregnancy.

Dr. Priestly¹ says that, "early in pregnancy, when the foetus is small, and the liquor amnii is proportionately large, knots may be formed on the cord. Later in pregnancy also, or at delivery, they may also be formed, if the cord is very long. The difference between those formed early, and at birth, is, that the former cannot be untied and straightened out, while the latter can." (See also Dr. Lee's cases, quoted *ante*.)

The data thus presented are sufficient to show that it is the common belief of the profession that knots on the cord may be formed during the intra-uterine life of the child, as well as at the time of delivery. The evidence upon which this opinion is based may be divided into two kinds: 1st, that derived from the state or condition of the foetus, and the cord at the place of the knot: 2d, the complexity of the knot itself, and the supposed difficulty of its being tied at the time of delivery, when the child passes through the organs of the mother.

And 1st: As to the evidence derived from the condition of the foetus at birth:—

In regard to this part of the evidence, many writers, without questioning its validity, have assumed that in all those cases where the child has been stillborn, with a knot on the cord, its death was the result of such obstruction.

But, in reality, this is no proof at all, for the same condition of the foetus—i. e., stillborn—is observed very much more frequently when there are no knots on the cord. The final decision, therefore, whether the death was a coincidence only, or the actual result of the knot, must be determined on other grounds.

For still stronger reasons, if the condition of the foetus at birth, whether alive or dead, when a knot is found on the cord, cannot be brought in evidence that the death resulted from the constriction of the cord by the latter, it cannot be offered in proof as to the *time when the knot was tied*; for in the first place, children are born alive with knots tightly drawn on the cord, and in the second place, children are born putrid, with the skin peeling off, and in all respects like what Smellie (see *ante*) reports, in many instances where there is no obstruction to the circulation of the blood through the cord, in consequence of a knot having formed on it. Now, when similar results occur under different conditions, or different results under similar conditions, it is a fair inference that they cannot stand to each other in the

¹ Med. Times and Gaz., Feb. 26, 1859; also, Lect. on the Gravid Uterus, p. 75, Lond. 1860.

relation of effect and cause. That is to say, if children are found both alive and dead, under exactly the same circumstances, so far as the knot is concerned, the question as to the effect of the previous formation of the knot in causing the death must be settled upon the probabilities of the case, upon the validity of the proof whether a knot can be thus tied in utero, and vice versa; unless it can be reasonably inferred that the death resulted from the knot on the cord, no proof can be deduced from its occurrence, that it was tied while the child was alive.

And here, perhaps, is the turning point of the whole matter; for, if by any reasonable proof it shall be decided that knots can be tied in utero, the death, when they are found, may fairly be attributed to them with just as much reason, as in their absence to any other cause.

We come next to the evidence derived from the condition of the cord at the knot, whether compressed or otherwise, or so firmly fixed in the shape of the knot that it cannot be made to return to its former state before the knot was tied.

In regard to this point Dr. Priestly (see *ante*) asserts that "the difference between those (*i. e.*, knots) formed early and at birth is, that the former cannot be untied and straightened out, while the latter can."

If we take a fresh cord, before it becomes cold and has lost what little vitality it possessed, and tie a knot in it as tight as may be, and leave it in this condition till it becomes thoroughly dead, till it is in the same state that the body is in when it has become stiff with cadaveric rigidity, and which, in so small a body as the funis, is reached in a very short space of time, not exceeding a few minutes, we shall find when we untie the knot, that it no longer returns to its former round, pulpy, and ordinary form; it is thin, ribbon like, and condensed, and has a strong tendency to retain the curved and curled shape which it held when in the knot. In other words, it is in precisely the same state, which Dr. Priestly considers to be a proof that the knot had been tied for an indefinitely long time. The same result is obtained by tying a ligature round the cord, or subjecting it to any force which will compress it while still alive, and which is not removed till the fluids within its substance have become cold and coagulated by the loss of its vitality. The condition of the cord at the knot cannot, therefore, be quoted in evidence as to the time when the knots were tied.

And, moreover, it needs but a moment's reflection or consideration to satisfy any one that if sufficient tension should be made on the cord in utero to draw the knot tight and compress the vessels so as to produce the condition mentioned by Dr. Priestly, it would of necessity stop the foetal circulation, and the child would die. But, as before remarked, the children are not always dead, and therefore the knots could not have been drawn tight before birth. The only exception to this tightening of the knot which could occur, would be in those cases where the cord is so long as not to be put on the strain, after the body of the child had passed through the

bight which forms the knot. But the shortness of the cord in many of the instances reported, negatives this supposition; and in those cases where the cord is so long as to be coiled round the neck once, twice, or even oftener, such as the cases reported by Dr. Zollickoffer, Dr. Lee, and Baudelocque (see *ante*), the fact that at the first turn of the child's body the knot would be drawn tight, and in consequence the child become at once asphyxiated and die, render the conclusions drawn from such premises unworthy of credence; since in those very cases the coiling of the funis went on after the first strain on the cord, to the extent of a second entire coil about the neck in the one case, and about the neck or chest in the other, and yet both children were born alive.

Dr. Lee (see *ante*) remarks that the knot in one of the cases he reports, must have been tied a long time before delivery, for the cord was atrophied between the knot and the umbilicus. But if the knot was drawn so tightly as to obstruct the circulation, the child could not have lived long enough in utero, after the knot was tied, to have given time for any such state of the cord to have become evident, or any such condition of the child to have developed itself as would have resulted from a lack of nourishment for a period of time.

Following out the division of the argument, we come next to consider the nature of the proofs derived from the complexity of the knots, as bearing upon the question of the possibility of their being tied at any other time and in any other way than by the child while in utero.

The intricate nature of some of the knots which have been recorded and figured (*e. g.*, that of Baudelocque, quoted by Montgomery and Lee (*ante*), a copy of which has been already given in this article, and the figure of 8 knots, so called, also mentioned by Montgomery (see *ante*) and reported by Dr. Wm. E. Coale of this city), seem to have inspired the greatest reverence in writers, who have held them up as being among the incomprehensible things of midwifery, the result of an inscrutable cause.

But before we proceed further in discussing this part of our subject, it will be well to consider another question as a preliminary step to its more perfect solution. That is to say, What are the probabilities, taking into consideration the condition of the fœtus in utero, that it can pass through a loop of the cord and form the knot during its intra-uterine life?

What are the facts? To tie the knot, two conditions are essential: 1st, that there be a loop; 2d, that the child should pass through it. But so long as the fœtus remains suspended by the cord, or until the time when the cord has acquired a length sufficient to allow the child to rest on the walls of the uterus, a loop can by no possibility be formed; and after this time, in order to form the knot, the fœtus must pass entirely through the bight of the loop, and clear it on the other side. Now, although the fœtus in utero may revolve on its axis, and extend itself by kicking and straightening out its limbs, is it supposable, is it within the bounds of

probability, that there is room enough in the uterus for the acrobatic display necessary to tie a knot, or form it even, on the cord?

In the case quoted by Prof. Storer, which is the only one on record in which any such connection between cause and effect, as at first glance seems to be there apparent, has been proposed, a second thought will show that the conclusion is scarcely warranted by the premises. If we take into consideration the conditions—patient seven or eight months pregnant, the child of course proportionately filling the cavity of the uterus—it seems almost beyond the bounds of possibility that a loop on the cord of sufficient size (five inches at least in diameter, fifteen inches in circumference) to allow the child to go clear through, could have been formed there; or that room enough for the foetus to go through it, and turn and draw the knot tight, could have been afforded within the abdomen of an ordinary sized woman.

And again, if all this could take place, there are other reasons which add to its difficulty. If loops should form on the cord, they would, from the weight of the cord itself, naturally fall to the lowest part of the uterus, wherever, for the time being, that might be, and we can hardly conceive of any other arrangement. They might slip about, and slide from side to side, but the structure of the cord does not possess sufficient firmness to keep it upright in the form of an open loop, even were there room for it in the uterus.

If it be objected to this view of the question, that in the earlier periods of pregnancy, before the foetus acquires bulk enough to largely encroach on the intra-uterine space, all the movements necessary for the formation of a knot can be easily made, it may be answered that before the tenth or twelfth week, by which time the foetus has gained nearly one-third of its final size, and has by this very growth rendered any free movements in utero, except that of rotation, difficult, there is no twist in the funis; and until this takes place, it will not form loops from which knots can be tied, but only flexures. This view is corroborated by all the specimens of knotted cords that have been inspected, which show that the twist in every one of them is strong and decided, and has apparently thrown the cord into the kinks which form the foundation structure of the knots.

But it may be said that cases are reported on unquestionable authority, in which at the birth of the child the cord has been found tied in the groove of a limb almost separated or amputated in utero, and which must have been the effect of the stricture from the knot long before tied. Montgomery, in his essay upon "the Spontaneous Amputation of Fœtal Limbs in Utero," appended to his great work on the Signs and Symptoms of Pregnancy, discusses this subject at length, and has collected together a great number of cases bearing on this point. Though hardly firm in his convictions, he inclines to the belief that the pressure of the cord acting in this way, is one of the causes of the amputation. In Case No. 37, quoted from Siebold's Journal (Bd. xvii. st. 2, 1838), Montgomery reports that

Dr. Schwabe found "the umbilical cord wound round the right leg a little above the ankle, where it *formed a knot*, by which the development of the parts was completely prevented, and the foot nearly separated from the leg."

It is not worth while to question the fact here noted—that when the child was born the cord was found knotted in the groove of the limb—even if the authority was not unquestionable; but by what kind of proof can we connect the two together as cause and effect? Can we suppose that a degree of constriction sufficient to have caused the amputation, could have been exerted on the limb by the cord, and in the form of a knot also, with one part crossed over the other, adding compression to extension, without interfering so much with the circulation in the cord as to kill the child? As regards the ability to keep up the circulation under direct tension of the vessels, the difference between a simple coil and a knot is very great indeed, and it is much more probable that the knot was caught and retained where it was found at birth, after it had been tied by the child during its egress from the uterus passing through a loop, than that it had been previously formed on the limb in utero, and by its constantly exerted pressure caused absorption of the integuments beneath it. And in this connection it is worthy of notice, that in the great majority of the cases reported, the lesion attributed to the pressure of the cord is not the only one found. Various deformities, often uniting in the same case, show that the tendency is to abnormal growth or arrest of development, either of which would produce the results attributed to the pressure of the cord.

But if the pressure of the cord exerted on a limb produces such evident effect, why should it not always bring about the same result? Why should not the same amount of pressure, in every case, produce absorption of the integuments at the place where the pressure is made? Why is it that no instance of amputation of the head, or signs of decapitation, have ever been noticed in cases—and they are by no means rare—where the cord is once, twice, or even oftener round the neck? Or, at least, if the neck, for wise and good reasons, should escape, why does not the cord leave some depression, or mark of its contact, along the course it took across the clavicle, up one side of the neck and down the other? Certainly the integuments of the fœtus are alike throughout, and why a result will follow certain causes in the one case, and not in the other, it is impossible to understand.

It appears strange that no attempt should have been made, by actual experiment, to imitate these knots. But such, so far as any record exists, is really the fact. No one has thought that, by very simple and easy manipulations, the most complex and reduplicated knots could be imitated at pleasure, and in the very way also in which they are probably tied—by the child at delivery, and at no other time, slipping through a bight (to use a nautical phrase) of the cord lying round the os uteri.

Prof. Miller (see *ante*) very summarily explains the whole matter, by supposing that the child, after the cord has coiled round its body, slips through, and thus ties the simpler kinds—for the complex knots he has the same reverence that inspires all the rest. But this is not so. It is impossible to tie a knot, so long as the cord remains simply *coiled* about the body or neck of the child. Suppose this to be the case—the child slips through, and the cord comes straight without any complication, in every attempt. But let a loop be formed in the cord, *i. e.*, let one part of the funis be crossed on the other, and the same passage of the child through it ties the knot, invariably and at once, differing in complexity just in proportion as we increase the number of turns on itself in the loop.

To make my meaning more clear, take a string, one end of which is fixed to some object, representing the placenta, and the other free, but which shall represent the umbilical end of the cord. If now we take up a loop of this string, and turn it once on itself, so as to bring its two parts across each other, and pass the umbilical end of the string through the bight thus formed, we form and tie the single knot, as represented in Fig. 7.

If we twist the loop once more, that is, twice on itself, and proceed as before, we get the double, square, or figure-of-8 knot, so called, which we have here. (See Fig. 8.)

Fig. 7.



Fig. 8.



Fig. 7. SINGLE KNOT.—P. Placental end of funis. U Umbilical or foetal end of funis.

Fig. 8. DOUBLE OR FIGURE-OF-8 KNOT.—P. Placental end of funis U Umbilical or foetal end of funis.

If we take two loops, each with a single turn and as near to each other as may be, and pass the free end of the string through them, we have formed the combination which, when drawn tight, exactly imitates Dr. Lyman's knot. (See *ante*, for illustration of this.) If one of the loops has a double turn on itself and the other but one, we get the knot figured by Baudelocque, and already drawn and explained. In this way one, two, three knots, or more, provided the length of the cord suffices, may be tied upon the same cord, and at various distances from each other, if instead of tying them together in one complex knot, each one as fast as it is tied is allowed to come through the other loops and tie in reversed order, the lowest loop on the cord forming the last and uppermost knot when they are finished.

If the argument thus set forth is sound, and a case does not occur in which while yet in utero a knot is found tied upon the umbilical cord, and of which, so far as any records at hand have been consulted, no instance has been found, the opinion held by many members of the profession as to the mode in which they are produced is erroneous, and the only way they can be tied, and the time when they can be formed, must be by the passage of the child through a loop of the umbilical cord lying around the os uteri when it is ushered into the world.