

A CASE OF TIGHT KNOT OF THE UMBILICAL CORD  
AND CONSEQUENT ANTEPARTUM DEATH  
OF THE FETUS.\*

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BY  
ROBERT T. FRANK, A.M., M.D.,  
New York.

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(With four illustrations.)

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AMONG the possible accidents imperiling the life of the fetus before labor, true knots of the cord, sufficiently tight to interrupt the fetal circulation, are of most infrequent occurrence. Some of the older writers, such as Carl Braun, are unwilling to ascribe any harmful effects to knots, whereas v. Hecker, who saw no injury result to the fetus in 83 cases of true knots, does not categorically deny the possibility of dangerous consequences. The new edition of v. Winckel's Handbuch, however, cites fatal cases from the literature, although the author personally has never seen a case in which the cause of death was due to this accident.

From the above it can be noted that true knots, sufficiently tight to cause fetal death, must be very uncommon, and that, therefore, any such case well merits being put on record. The following is the history of a case which recently occurred in my practice.

Mrs. R. B., 31 years of age, married ten years, began to menstruate at 15 years, four-weekly regularly, profuse. Since the birth of her child nine and one-fourth years ago, menstruation appears every three to three and one-half weeks, and is very profuse. She was curetted six and one-half and one and three-fourths years ago, with only temporary relief of the menorrhagia.

The first confinement lasted thirty-six hours because of early rupture of the membranes and inefficient pains. She was delivered of a healthy child by the aid of low forceps. A resulting cervical and perineal tear was repaired three years later.

The patient first consulted me on October 6, 1906. The first day of the last period had occurred on June 12th of the same year; she was therefore due about March 19, 1907, according to calculation, although she herself did not expect labor to take place before the very end of March. The patient was found to be very anemic, as the result of her prolonged menorrhagia. She was otherwise well, except that the minor discomforts of the early months of pregnancy (nausea, constipation, and frequent urina-

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tion) were somewhat pronounced. Physical examination showed a normal uterus, corresponding to the third month of gestation, slight leucorrhœa, and a normal urine. The pelvic measurements were normal, and the sacral angle could not be reached by internal examination.

The pregnancy progressed normally, except for a purely subjective dyspnea, due to globus hystericus, most annoying at night. During the sixth month the patient fell upon her abdomen, while walking in a slippery street, but sustained no injury, excepting several bruises about the body and knees. Life was first felt during the middle of the sixth month, and regularly thereafter.

At the regular monthly visits examination showed a somewhat increased quantity of amniotic fluid, not at any time, however, sufficient to merit the name of a true hydramnios. From the seventh month on the fetus was found to show a cephalic presentation, and the heart sounds were always heard in the left lower quadrant.

The labor did not set in until the early morning of April 1st. The last time that fetal movements were felt was early on the preceding day, when they abruptly ceased without apparent cause.

Within one-half hour after the onset of weak pains the membranes ruptured, and a considerable quantity of deeply stained but odorless liquor amnii escaped. Vaginal examination showed a long conical cervix, barely admitting the tip of one finger, within the internal os. The position was O.A., the head resting against the pelvic brim without, however, being engaged. *Neither at this time nor throughout the course of the labor were fetal heart sounds heard*, although careful and frequently repeated examinations were made. For the next twenty hours the pains appeared at intervals of 15 to 30 minutes, but always weak, the cervix then admitting two fingers and proving somewhat softer and shorter. As intervention in the interest of the child, whose death was strongly suspected, seemed hardly justified, and as dilatation of the cervix, followed by high forceps, was a serious undertaking in an anemic patient with cervical cicatrices, a purely expectant treatment was advisable. Dr. Brettauer, who was called into consultation, concurred in the opinion of noninterference, and expressed it as his view that the child had not as yet been subjected to serious pressure, and therefore, if alive, would not be jeopardized, as the head had not engaged. On the other hand, if the child were dead, as seemed likely, the mother would be uselessly endangered by dilatation followed either by high forceps or craniotomy. Sleep and rest were induced by means of morphine, and after awakening quinine was given. The pains during the next twelve hours, although frequent, were at no time either strong or propulsive. Dilatation had now progressed, and the cervix was reduced to a thin rim of about one inch in width.



Examination, under anesthesia, showed the head in the position O.A., just fixed in the pelvic inlet, but above the symphysis, with very little evidence of moulding and no caput succedanium. The application of the forceps proved easy, and delivery was effected in the course of twenty minutes, without undue effort. After the delivery of the head a loop of the cord was found loosely coiled about the child's neck and was stripped over the head without the slightest difficulty. There was no pulsation in the cord. The liquor amnii that followed the expulsion of the fetus was deeply stained and contained much meconium.

The child was born dead, but normal in every respect, of full size, and well developed. Its lips were a deep blue-black, the skin was beginning to show signs of maceration, the cornea glazed and opaque. The fetal head bore no forceps marks, or other evidence of injury or pressure. An autopsy was not allowed.

The placenta was expressed by the Credé method twenty-five minutes after the birth of the child. It weighed 22½ ounces, and appeared normal. The cord was centrally implanted, 90 cm. in length, of average thickness, and with the usual amount of Wharton's jelly. Thirty cm. from the placenta was a single, simple knot (Fig. I), very tightly drawn, showing deep indentations of Wharton's jelly, where the pressure of the loop had displaced this soft substance. Above the knot, *i.e.* toward the placenta, the umbilical vessels were greatly dilated (see cross section of cord, Fig. I); below the knot, although a heavy forceps had been applied before removing the fetus, so that no blood could escape, the vessels were empty, contracted, and almost invisible.

AUTHOR'S NAME AND DATE	Age of Mother	Previous Pregnancies	Month of Gestation	Nature of the Labor	Condition of Child at Birth	Situation of Knot
(1) Hannay, 1841.....	28	11	?	Normal.....	Slightly mac'rat'd.	Middle of cord.....
(2) Grieve, 1842.....	?	?	Term.	Normal.....	Macerated.....	Middle.....
(3) Woets, 1842.....	?	V	?	Forceps.....	Badly mac'ated	?
(4) Agouard Sen., 1842	?	?	7th	Induced, breech	Macerated.....	?
(5) Piogey, 1852.....	?	O	Term.	Normal.....	Freshly dead...	Middle.....
(6) Belluzi, 1860.....	?	Multi.	9th	Normal.....	Macerated.....	45 cm. from placenta
(7) Billi, 1857.....	24	I	8th	Breech, Normal	Macerated.....	34 cm. from placenta
(8) Billi, Case II.....	38	O	9th	Normal.....	Macerated.....	Middle.....
(9) Mastin, 1866.....	19	O	9½	Normal.....	Macerated.....	?
(10) Gery, 1876.....	32	I	7½	Normal.....	Macerated.....	½ dist. from placenta
(11) Bernard, 1891.....	?	?	7th	?	Macerated.....	Middle.....
(12) Weston, 1893.....	?	?	?	?	Macerated.....	?
(13) Veit, 1803.....	?	?	Term.	?	Macerated.....	?
(14) Bonnaire and Schwab, 1005.....	10	O	7-8th	Normal.....	Mac'd hydrocephalic	?

From the history, and from the description of the specimen, it will be seen that a perfectly normal, full-term child was destroyed

in utero, by the tightening of a true knot, before labor had set in.

In studying the literature I have been able to find fourteen cases in which the death of the child was due to the same cause (see Chart —).

Passot<sup>15</sup>, in addition, reports a case, in which fetal movements ceased twenty-four hours before labor, an otherwise normal, dead child, showing the beginning signs of maceration, being born. The cord was 110 cm. long, and contained *two simple, tight knots*, one at each distal and proximal third of the cord.

Canivet<sup>16</sup> delivered a pair of twins, of which one was alive and well, the other, of an equal degree of development, was dead because of a single tight knot in the funis. Its cord was 95 cm. long, and wound three times about the neck. In this case the twins were contained in separate amniotic cavities.

Weston's case (videante) was one of monamniotic twins, one cord forming a knot, through the loop of which the other cord had passed (see Fig. II). Both children had been dead about two to three weeks, the sole cause of death appearing to be the very tight knot, which effectually blocked both fetal circulations.

Newman<sup>17</sup> reported a case in which the mechanism is identical with that described by Weston, except that in this instance the knot was tightened by the midwife, and not by natural agencies. The first child, in whose cord the knot was situated, was born alive. The midwife then kept a strong and continuous tension upon this cord to prevent it from "going up again," thus effectually cutting off the circulation of the second child, whose

Variety of Knot	Description of the Cord	Length of Cord	Number of Loops About Neck or Body	Fetal Movements Last Noted	Liquor Amnii	Cause Assigned; Other Findings
Simple..	Congestion <i>below</i> knot.	?	Neck, 1.	3 days...	Normal..	Sudden rising, followed by violent fetal movement.
Simple..	Shriveled and soft.....	?	?	3 weeks...	?	No movements since sl. labor pains 3 weeks ante.
Simple..	?	35 cm.	.....	?	?	Knot very tight, head of fetus pulled off.
Simple..	Reduced to mere str'nd	?	.....	1 month..	Foul....	Case is doubtful.
Simple..	Congested above knot.	?	.....	?	?	Sudden rising, but fetal heart afterward heard.
Simple.	?	67 cm.	Neck, 1.	4 weeks...	?	No details.
Simple..	?	90 cm.	Body, 2	4 days...	F'l & d'k	Injection failed.
Simple..	?	65 cm.	Neck, 2.	4 weeks...	F'l & d'k	4 weeks in hospital, no heart sounds heard.
Simple..	?	Long..	.....	?	?	Always excessive movements.
Simple..	Dry, thick, hard.....	?	.....	?	?	?
Simple..	Congested above knot.	?	.....	6-8 days..	?	?
Simple..	?	?	.....	2-3 weeks.	?	After stooping, commotion; then no movements.
Simple..	Congested above knot.	?	Neck, 1.	14 days...	?	?
Simple..	Congested above knot.	77 cm.	.....	?	Much....	No heart sounds.

cord passed through the knot. In due time the second child was born dead and asphyctic.



Bartscher<sup>18</sup> has described a case in which the death of the child was due to two tightly drawn loops of the cord, which passed about the neck of the fetus, and were reinforced by a knot (Fig. III), the cord thus not only compressing the neck to the detriment of the carotid circulation, but also, where the knot was located, cutting off the umbilical circulation.

A few of the cases quoted by others—namely those of Smellie<sup>19</sup>, Comein<sup>20</sup>, and Stein<sup>21</sup>, will not bear strict investigation,



FIG. I.—*Author's case.* Tight knot of cord. Note congestion above knot. The cross section at the placental site shows increased size of blood-vessels. Deep indentation of Wharton's Jelly.

as the knot apparently did not occasion death. Guéniot, Lee, Ferrari (according to Müller's *Handbuch der Geburtshilfe*), and A. Martin (according to Veit, *vide ante*) are said to have reported cases, but I have been unable to find the articles referred to.

#### OF KNOTS IN GENERAL.

*Varieties.*—The best and most complete discussion of knots of the cord will be found in Chantreuil<sup>22</sup>, published in 1875.

This author divided knots into simple (Fig. IV), figure of eight (Fig. V), and complicated, in which the most bizarre and varied interlacings are met with in mon-amniotic twin pregnancies.

*Situation.*—Knots may be found in any part of the cord, though they are most common near the middle. Chantreuil quotes a



FIG. II.—*Illustrating mechanism of Weston's case. Monamniotic twins. The cord of one fetus passed through a knot in the cord of the second fetus.*

case in which the knot was so close to the umbilicus that before the cord could be tied the knot had to be pushed away; Kolschütter (from Chantreuil) met with the opposite condition, the knot almost touching the placenta in this instance. According to Hyrtl<sup>28</sup> an approximate computation of the time of occurrence of the knot formation can be determined from its situation

—if found within a shorter distance of the umbilicus than the distance between the navel and the presenting part of the fetus, the knotting must have taken place in the earlier months, when the fetus was of smaller size. This rule will not bear strict application, as we are dealing with a soft, slippery, and flexible structure, upon which a loose knot can readily slip upward or downward.



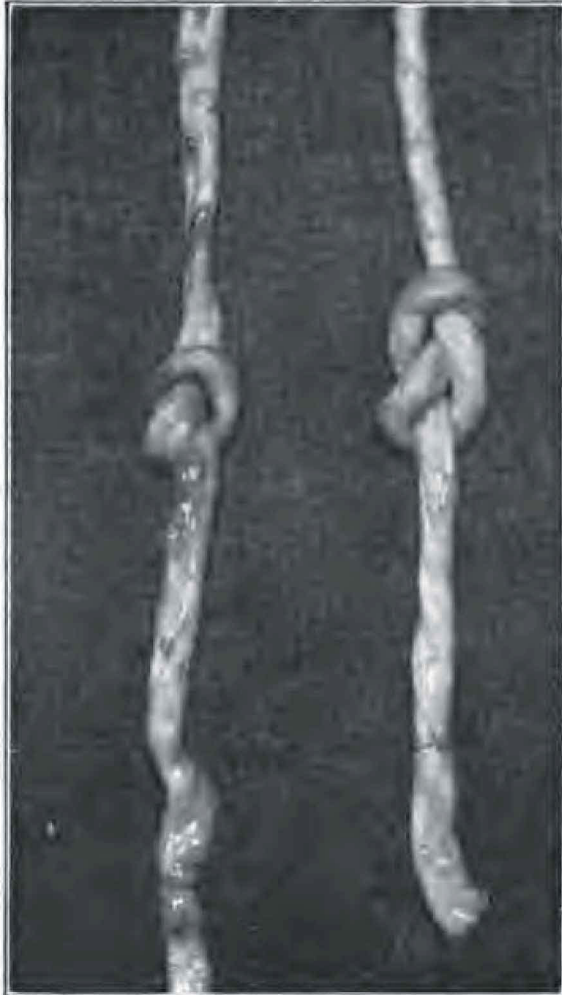
FIG. III.—*Illustrating mechanism in Bartscher's case.* The cord passed twice about the neck of the fetus and then formed a knot.

*Mechanism.*—Loop formation of the cord causes the knot, the presenting part of the fetus descending through the open loop. If the fetus first revolves about its cord, before entering the loop, a figure of eight knot results. It is probable that the loop, in most of the cases, exists at term, and that the presenting part first



"threads itself" during labor. Such recent knots, according to Chantreuil, are differentiated from older ones, by the fact that upon untying the knot, the cord shows no indentations, and at once resumes its normal shape.

*Frequency.*—Statistics show that knots occur frequently, v. Winckel<sup>24</sup> finding them in 0.4-0.5% of all births; Chantreuil in 1%.



FIGS. IV., V.—Simple and figure of eight knots of the cord not tightly drawn.

*Tight Knots.*—For the sake of simplicity, in this paper, only such knots as entirely interrupt the fetal circulation will be designated as tight knots. Their occurrence is of the utmost rarity, as can be gathered from the statistics of Chantreuil, Elsaesser<sup>25</sup>, and v. Hecker,<sup>26</sup> which comprise 31,590 births with 115 cases



of knots, not a single instance of injury resulting to the child therefrom. Many other authors of wide experience, at large maternities, have never seen this accident.

*The Causation of Tight Knots.*—The actual cause which might explain why in most cases the knot remains loose, has never been satisfactorily demonstrated. It should really be a matter of surprise that knots do not more often produce serious consequences, for the experimental work of Lefour and Oui<sup>27</sup> shows that the slight force of 25-90 gms. suffices to tighten a knot of the cord sufficiently to cut off an artificial circulation, corresponding to that of the fetus. Usually the length of the cord is in excess of the actual requirements, but loose knots have also been encountered in excessively short cords. From some of the collected cases it would appear that a sudden movement on the part of the mother, as arising from the stooping to the erect posture, has been followed by tumultuous fetal movements, at once succeeded by their complete cessation; in one case slight uterine contractions three weeks before labor had as a sequel these same symptoms. Whether the fetus alone, either through excessive movements or through abnormal positions, can produce the strangulation, is a matter of conjecture. In a number of the cases referred to the cord was materially shortened by one or more loops, which ran about the neck or body of the child, and probably served to aid the unknown mechanism to bring on the disaster.

Details in many of the fatal cases are wanting, but on the whole the accident occurred more often in primipara than in multipara, although the roomier uterus in the latter might appear to favor the occurrence. The labors were almost all spontaneous, and vertex presentations were in the majority. In my own case and in one other forceps were applied; in three cases, one of them a twin, the breech presented. Some of the labors took place before term, about an equal number in the seventh and ninth month. With but two exceptions the children showed well-marked evidences of maceration, death apparently having taken place from one to thirty days before labor.

The knots were found in the middle of the cord in most of the cases; in two they were nearer to the placenta than to the fetus, and in only one nearer to the navel than to the placenta. The general appearance of the cord is recorded as "reduced to a mere strand," by one observer, and as "hard, dry and thick," by another. Where details are given, the vessels of the cord between

the placenta and the knot are described as markedly congested, whereas in the lower segment they are contracted and empty. This might be explained by the fact that the fetal heart succeeds in pumping the blood past the obstruction, but that the weaker return current is interfered with until the fetus has, so to speak, emptied its blood into the placenta. The length of the cord in these cases shows nothing special, varying from 35 cm. in the case of Woets to 90 cm. in my own case, and reaching 110 cm. in Passot's case, in which there were two knots.

The liquor amnii, as would be expected, from the asphyxiation of the fetus, was found dark, due to discharge of meconium, and where maceration was advanced, foul in its odor.

The characteristics of these fatal knots would appear to consist in their extreme tightness with consequent deep indentation of Wharton's jelly; the congestion of the vessels extending from the placenta to the knot; and, as tested in a few instances, the impermeability of the vessels to attempts at injection.

Fortunately the occurrence of this accident is extremely uncommon, for we are unable to foresee it, powerless to adopt prophylactic measures, and without means of treating it, if the strangulation takes place before the complete expulsion of the child.

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6 EAST EIGHTY-FIRST STREET.