THE LENGTH OF THE HUMAN UMBILICAL CORD

A STATISTICAL REPORT

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Introduction and Theory

Not the least of several intriguing features of the human umbilical cord is its length. This varies considerably, but the most usual length is 20–22 in. (50–56 cm.) (Gardiner, 1922). Most textbooks (see Gibberd *et al.*, 1956) follow Gardiner in asserting that a cord nearly 14 in. (35.5 cm.) long is necessary for normal delivery. It is to be expected that a relatively long cord would often be coiled round part of the body, usually the neck. Gibberd *et al.* (1956, p. 172) claimed that this happened in about 30% of all deliveries. Furthermore, we are taught that the midwife should uncoil or cut such a cord in order to make delivery safe.

There are two points to note. First, all experienced obstetricians must have seen a normal spontaneous delivery with a cord less than 12 in. (30 cm.) long. Secondly, many of them will agree with Thomas Denman (1816) that, if the child is alive when the head is born with the cord round the neck, mother and child may be safely delivered without uncoiling or cutting the cord owing to the descent of the fundus.

In order to establish the range of cord lengths compatible with normal delivery we asked the midwives of the Cambridge Maternity Hospital, with the kind permission of the senior obstetric consultant and the matron, to measure the cord lengths of children born in the hospital from August, 1957, until January, 1958. The cords were measured with a steel rule, 2 feet (61 cm.) long when extended, within half an hour of delivery. It is the practice in this hospital to cut the cord about 3 in. (7.5 cm.) from the umbilicus, so that at least two measurements were made for each cord length.

The cord lengths varied between 7 and 48 in. (17.8 and 121.9 cm.), the mean being 21.3 in. (54.1 cm.). Spontaneous delivery of normal children occurred with any length of cord. The cord was noted to be coiled round the neck in 17% of the cases.

If normal gestation and parturition can occur with any cord length from 7 to 48 in. (17.8 to 121.9 cm.) why is the cord usually more than 20 in. (50.8 cm.) long ?

Observations on other mammals are scanty, but there is evidence that man shares with primates a relatively long cord. Starck (1957) found a chimpanzee, admittedly premature, with a cord over twice the crown–rump length of the foetus. Fox (1929) gives accounts of the births of live anthropoid apes. In an orang-outang the cord was 60 cm. (23.6 in.) long, and in a chimpanzee the cord was round the neck and was 49 cm. (19.3 in.) long.

In most mammals the umbilical cord is reasonably well adapted to the immediate post-natal requirements of mother and child. We suggest that, while the length of the cord is, within wide limits, unimportant for gestation and parturition, there may be an advantage immediately after the birth of the child in having a long cord. We submit the theory that the human cord is long in order to allow the mother to pick up her helpless newborn child and carry it away from danger without exerting harmful traction on the placenta. Further, that a cord of more than 18 in. (46 cm.) will allow the child to be put to the breast with the placenta *in utero* and that the reflex stimulation of suckling may promote an easy and bloodless third stage.

We therefore extracted from the case sheets of 223 mothers, consecutive deliveries over a period of about one month, facts about the mother and child, such as age, parity, height, weight, blood group of mother : lengths of the three stages of labour ; normal or abnormal haemorrhage ; normal or abnormal labour : sex, length, and weight of child ; maturity of child : and the cord length. In this way we hoped to discover whether there was any correlation between cord length and the various facts abstracted. For instance, it might be argued that if the third stage of labour was very short there would not be the same need for a long cord: very tall women might be expected to bear children with cords longer than the average, and so on.

Results

The cord was measured in 177 of these 223 births (79.4%). Fig. 1 shows the distribution of the 177 cord lengths. A histogram of the distribution of all cord lengths collected between August, 1957, and January, 1958, has an almost identical shape.

None of the following factors seemed to affect the length of the cord, except possibly the sex of the child.

Parity.—Mean number of previous pregnancies, between 1 and 2 ; range, 0 to 9.

Age of Mother.—Mean, 26 years ; range, 16 to 44 years.

Blood Group of Mother.—Group A, 39.5% ; group O, 39.5% ; group B, 9.0% ; group AB, 5.1% ; no result, 4.0% ; not recorded, 2.9% ; rhesus-positive, 72.3% ; rhesus-negative, 18.6% ; rhesus-negative with antibodies, 2.8% ; unknown, 6.3%.

Height of Mother.—Mean, 63 in. (160 cm.) ; range 57–71 in. (145–180 cm.).

Weight of Mother.—Mean, 136 lb. (61.7 kg.) ; range, 91–217 lb. (41.3–98.4 kg.). These weights are unreliable, as some women were several months pregnant when weighed.

Pre-eclamptic Toxaemia.—The blood-pressure, the condition of the urine, and changes of weight are tests for

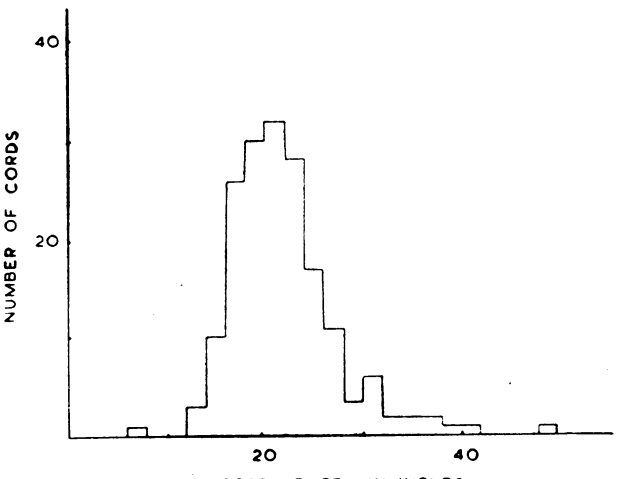

FIG. 1.—Distribution of the 177 cord lengths.

pre-eclamptic toxaemia. The findings were as follows: abnormal blood-pressure, 24.7%; abnormal condition of urine, 7.7%; abnormal changes of weight, 12.9%.

Duration of Pregnancy.—Mean, 39 weeks; range, 28 to 42 weeks. The mean cord lengths are given in Table I.

TABLE I.—*Duration of Pregnancy and Corresponding Mean Cord Length*

Duration of Pregnancy in Weeks	Number	Mean Cord Length	
		in.	cm.
28	1	17·0	43·2
32	2	22·0	55·9
34	1	19·0	48·3
35	3	17·7	44·9
36	5	18·8	47·7
37	6	23·2	58·9
38	20	23·3	59·2
39	23	21·5	54·6
40	67	21·1	53·6
41	28	20·7	52·6
42	17	22·2	56·4
Unknown	4	19·8	50·3

Presentation.—Mean cord length of breech presentations, 17.5 in. (44.5 cm.); mean cord length of vertex presentations, 21.4 in. (54.3 cm.). A breech presentation at delivery occurred in 4 cases out of 177: it appears to be associated with a shorter cord. As three of these breeches were complicated by extended legs, which made them difficult to turn, and the fourth was a very small child, we are unable to draw any conclusions from this finding.

Circumvolution of Cord.—The 13 cords which were cut during delivery had a very slightly longer mean length. The mean cord length seemed to increase slightly according to whether the position of the cord was normal, round the neck once, or round the neck twice. The findings were: Cord normal, 142 cases; cord round neck once, 24 cases; cord round neck twice, 3 cases; other abnormalities 3 cases. The mean cord length of the last three was 30.7 in. (78 cm.). Two of these abnormalities were true knots in the cord, and in the other the cord was loosely round the body.

Blood loss.—This was abnormal in 10.2%.

Sex.—Males numbered 87, with a mean cord length of 22.2 in. (56.4 cm.), and S.E. of ±0.66 in. (1.68 cm.). Females numbered 90, the mean cord length being 20.5 in. (52.1 cm.), with S.E.±0.49 in. (1.24 cm.). It seems that male children have slightly longer cords at birth than female children.

Stillbirths.—Mean cord length of live births, 21.5 in. (54.6 cm.); mean cord length of stillbirths, 17.3 in. (43.9 cm.). Mean duration of pregnancy of stillborn, 34.5 weeks; range of duration of pregnancy of stillborn, 28 to 39 weeks; mean duration of third stage of labour of stillborn, 10 minutes; mean weight of stillborn, 3.8 lb. (1,725 g.). The six stillbirths included two cases of toxaemia, one case of the cord once round the neck, and another with the cord twice round the neck. All the stillborn were females.

Abnormal Birth.—10.2% of the children were abnormal.

Weight of Child.—Mean, 7.2 lb. (3,265 g.); range, 1.5 to 10.3 lb. (680–4,670 g.).

Length of Child.—Mean, 20 in. (50.8 cm.); range, 12–22 in. (30.5–56 cm.).

Labour.—Mean duration of first stage, 10.7 hours; range of duration of first stage, 1 to 45 hours; mean duration of second stage, 42 minutes; range of duration of second stage, 0 to 3.5 hours; mean duration of third stage, 12 minutes; range of duration of third stage, 0 to 60 minutes. The mean cord lengths for the duration of the third stage of labour are given in Table II.

Our hypothesis was that the duration of the third stage of labour is related to the cord length, and this cannot be seen from the results so far obtained. To investigate this theory more closely, a multiple linear regression of cord length was done on nine factors which were thought to have the greatest bearing on the cord length, the duration of the third stage of labour coming last. These factors are listed in Table III. The mothers were classified into two groups for parity—primigravida and multigravida—as it was not thought that the number of previous pregnancies, if one or more, would affect the cord length. This form of analysis was chosen in case a relation between the cord length and the duration of the third stage of labour was concealed by one of the other factors.

TABLE II.—*Duration of the Third Stage of Labour and Corresponding Mean Cord Length*

Duration of 3rd Stage of Labour in Minutes	Number	Mean Cord Length	
		in.	cm.
<12	71	21·3	54·1
12–	67	21·1	53·6
18–	24	22·0	55·9
24+	13	19·5	49·5
Unknown	2	31·5	80·0

To take a hypothetical example of a 2-factor case: suppose a linear relationship exists between cord length and duration of the third stage of labour, but that male children have longer cords than female children. In Fig. 2A no relationship can be seen to exist between the cord length and duration of the third stage of labour. However, taking the correlations between cord length and sex and between the duration of the third stage of labour and sex into account, as in Fig. 2B, a relationship can be seen to exist. Thus, if a relation between the cord length and the duration of the third stage exists it may be concealed by one of the other factors stated in Table III.

To perform this analysis so as to ascertain whether there is such a relationship it is necessary to restrict the population still further by excluding all cases with missing records of any of the nine factors, and also all cases where mother or child were abnormal. The number remaining was 84 (37.7% of the original number); 51.1% were omitted because of missing records and the remaining 11.2% through abnormalities. The large number of abnormal cases was expected, because these are more likely to be admitted to hospital.

The distribution of cord lengths and the frequencies for the nine chosen factors are not

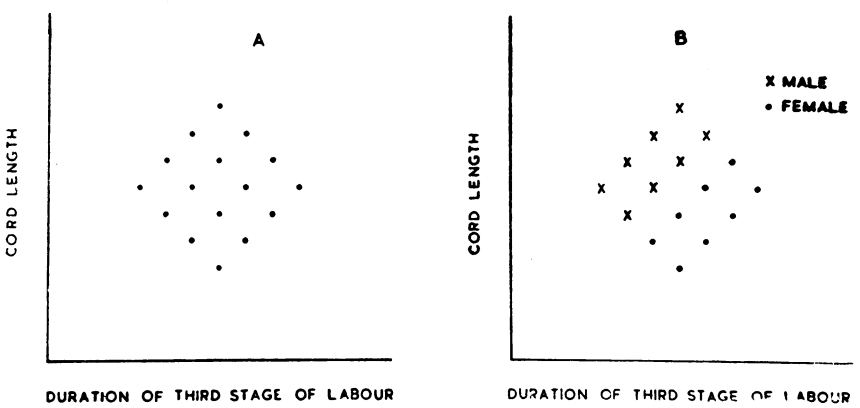

FIG. 2.—Relation between cord length and duration of third stage of labour.

significantly affected by this selection. Indeed, for some factors, notably sex, it is a better selection of the 223 cases than the original selection of 177 measured cord lengths. However, there seems to be a deficiency of mothers over the age of 35 years, and of children born before 38 weeks of pregnancy.

From Table III it can be seen that the duration of the third stage of labour does not significantly affect the length of the cord. Two of the sums of squares were significantly small. This is reasonable, since two other sums of squares were quite large, though not significantly so.

A linear regression was performed of cord length on each factor in turn, and none of the factors was found to be significant. Sex seemed to affect the cord length most, male children having slightly longer cords.

TABLE III.—*Analysis of Variance Table for Multiple Linear Regression of Cord Length*

Source	Degree of Freedom	Mean Square	P
Regression on sex	1	63·266	0·30>P>0·10
,, ,, weight of mother after above factor	1	31·025	0·30>P>0·10
Regression on height of mother after above factors	1	0·022	0·99>P>0·975
Regression on length of child after above factors	1	4·875	0·70>P>0·50
Regression on duration of pregnancy after above factors	1	4·822	0·70>P>0·50
Regression on weight of child after above factors	1	21·418	0·50>P>0·30
Regression on parity after above factors	1	6·875	0·70>P>0·50
Regression on age after above factors	1	0·013	0·99>P>0·975
Regression on duration of 3rd stage of labour after above factors	1	2·217	0·90>P>0·70
Residual	74	28·311	

Other Results

Since a linear regression of cord lengths on duration of pregnancy was not statistically significant, there is no evidence that cords grow in length after 28 weeks of pregnancy.

A linear regression of height of child on duration of pregnancy was done for each sex in order to test the hypothesis that girls stop growing after the 38th week of pregnancy while boys continue to grow. The regression was significant in both cases; thus both boys and girls continue to grow throughout the pregnancy. The slope of the regression line was slightly greater for boys than for girls, though the difference was not significant.

In 200 mothers (89.7% of the cases) the blood groups were recorded and the figures for each group were compared by means of the χ^2 test with the corresponding ABO figures for the United Kingdom (Dobson and Ikin, 1946) and Rh figures (Mollison *et al.*, 1952). χ^2 was not significant in both instances. ($0.10<P<0.25$). Thus the Cambridge data do not differ from national figures.

In 82 out of the 84 complete records, blood groups were recorded. When compared with the ABO and Rh frequencies the χ^2 test was again not significant in both cases ($0.25<P<0.50$).

Summary and Conclusions

Maternity records were collected of mother and child and of umbilical cord length at a Cambridge hospital and the data were analysed. It was found that normal gestation and delivery can occur with any length of cord between 7 and 48 in. (17.8 and 121.9 cm.).

In the sample of population examined, which is probably fairly typical of the population in this country, there is no evidence that any of the factors which were thought to be relevant are related to cord length.

Though our results are largely negative, we present this paper for two reasons. First, it demonstrates how, from a small number of easily collected data, it is possible by statistical analysis to arrive at fairly definite conclusions. Secondly, we feel that the data collected and analysed may be used for comparison with data from other populations.

It is interesting that the analysis shows that while male and female children continue to grow throughout pregnancy there is no evidence of growth in cord length after 28 weeks. This is not surprising, as the placenta begins to degenerate about this time.

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RESULTS OF TENOTOMY OF THE TENDO ACHILLIS IN INTERMITTENT CLAUDICATION

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Operations carried out solely for the relief of symptoms without rectifying in any way the underlying cause of those symptoms have never been widely practised by British surgeons. With the exception of procedures to alleviate the misery of advanced malignant disease, purely symptomatic surgery tends to be regarded as quackery, and those who practise it to be relegated to the fringe of, if not well within, the underworld of surgery. It is illogical, however, to deny a patient relief of his discomfort simply because the underlying cause is either unknown or impossible to rectify.

Intermittent claudication is an excellent example. With the exception of the very few patients suitable and fit for arterial reconstruction there is little to offer the mass of sufferers from this crippling symptom. Sympathectomy has its place as a limb-preserving procedure, but it contributes little, as a rule, to the relief of their exercise pain. An attempt was made in 1947 to relieve exercise pain confined to the gastrocnemii by division of the branches of the popliteal nerves supplying these muscles. This operation, however, proved unsatisfactory for several reasons. It was necessary to be certain that the soleus was not involved in the production of pain; isolation of the branches to the gastrocnemii was not always an easy matter; and finally it was necessary to keep the patient in bed for several days, as a result of which venous thrombosis in the paralysed