BLOOD LOSS FROM THE FOETAL CIRCULATION: A HAZARD OF LOWER SEGMENT CAESAREAN SECTION IN CASES OF PLACENTA PRAEVIA

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IN May, 1951, an infant died in this hospital at the age of 3½ hours from shock due to loss of blood from the foetal circulation, which had been damaged by the operator during delivery by lower segment Caesarean section in a case of placenta praevia. This avoidable death occurred in spite of the fact that we had encountered this complication of Caesarean section on several occasions previously, and had had to give blood transfusions to babies suffering from blood-loss due to this cause. It brought home to us our lack of the fundamental knowledge on which appropriate treatment should be based. We were unable to find any comprehensive account of the problem at that time, and although articles by Wickster (1952) and Siddall and West (1952) have drawn attention to the danger, they have not met the need for this fundamental knowledge about the prevention, recognition, and treatment of the condition. We are therefore reporting the results of a study of the whole problem, carried out by members of the obstetric and paediatric staffs of this hospital, and designed to enable us to do three things:

1. To assess the chances of placental tissue being encountered by the uterine incision when the lower segment operation is performed as a routine in cases of placenta praevia delivered by Caesarean section.

2. To decide the best technique for the delivery in such cases so as to avoid loss of blood from the foetal circulation, or reduce it to a minimum, without increasing the risk of foetal anoxia.

3. To work out a practical and rapid way of deciding if the baby has lost blood to the extent that it requires a transfusion.

Incidence of the risk

During the period covered by the investigation, from January, 1951, to March, 1953, Caesarean section was performed 45 times in cases of placenta praevia, and the lower segment operation was used as a routine. In 20 of these placental tissue was found underlying the uterine incision to an extent which involved a risk of damage to the foetal circulation: that is to say, there was a 44 per cent chance of this complication being encountered.

Technique employed in lower segment operation

Macafee (1945) detailed the technique which he used in opening up the lower segment when the placenta lay anteriorly under the uterine incision. He stressed the importance of a stab incision and in one of his diagrams illustrated the point of the scalpel passing right down through the placenta into the amniotic cavity. Macafee did acknowledge that the umbilical cord was liable to be damaged during delivery when it was attached to the anterior portion of the placenta near the incision in the lower segment. We think that damage to vessels on the foetal aspect of the placenta may cause serious

blood loss from the foetal circulation. In our hospital attention is now paid to the steps employed at this critical phase in the operation and the following technique is employed in cases of placenta praevia.

A transverse incision no longer than 1 inch is made in the lower uterine segment. If the placenta is encountered the scalpel is immediately withdrawn and the incision extended on either side by means of fingers or blunt-pointed scissors. We know that it may be difficult to get into the correct layer at this stage but with experience we have found it possible to avoid gross disruption of the placenta. We then separate the placenta from its attachment by passing a hand upwards between uterus and placenta until the sac of membranes is reached. The membranes are ruptured by the fingers and the child's face delivered into the wound as quickly as possible. Once this has been done the umbilical cord is identified speedily and clamped. The remainder of the delivery takes place slowly and deliberately. The reason for delivering the child's face before clamping the cord is to reduce the chance of the child taking a breath *in utero*. In cases where foetal vessels in the placenta have been damaged, delay in clamping the cord may result in serious blood loss from the foetal circulation and by clamping the cord quickly the time available for blood to escape from the foetal circulation is reduced.

Assessment of the baby

Our emphasis on the need to work out a method of assessing whether these babies have lost sufficient blood to require a transfusion is explained by experiences which have convinced us that care and skill on the part of the surgeon cannot completely eliminate the risk of serious blood loss during a delivery of this kind: also, what is even more important, that clinical assessment of the baby alone is quite inadequate. In every case of placenta praevia the baby has been exposed to the risk of intra-uterine anoxia, and while it may sometimes be possible to distinguish the picture of restless pallor with respiratory distress of the purely anoxic baby from that of quiet, undistressed pallor seen in the exsanguinated baby, we have found it impossible to assess the situation rapidly and reliably, on the clinical picture alone, when confronted with a baby who may be suffering from a combination of the two. Moreover, we have found that the exsanguinated baby may appear deceptively well until shortly before death. The method of assessment which we have worked out for routine use depends on obtaining evidence from two sources.

First, by recording accurately the time which elapses after the placenta has been encountered until the cord is clamped, and by examining the placenta and membranes as soon as possible for evidence of damage to the foetal circulation, we try to gauge the risk of blood loss in that particular baby. The importance of the time-interval is self-evident, for it is a measure of the period during which the baby may be losing blood. Out of 12 cases in which this observation was made accurately, the interval was more than half a minute in 7, and as long as 3 minutes in 2 cases.

The subsequent examination of the placenta and membranes, for the purpose which we have in mind, is best carried out from the foetal aspect, for then the larger tributaries of the umbilical vein can be followed throughout their course and any damage to them noted. The results of such an examination are shown in Fig. 1, where one of these tributaries is seen to have been torn across at the edge of the hole through which the baby was delivered.

We now believe that if more than half a minute has elapsed between the placenta being encountered and the cord being clamped, or if there is visible damage to the foetal circulation, or both, there is a real risk that the baby has lost sufficient blood to need a transfusion. Of course, even in such a case blood loss may have been prevented by imponderable factors such as compression of the damaged vessel by the foetal parts (Case 18 in the Table and Fig. 2). But the value of this preliminary assessment in practice is borne out by the evidence from the second source.

This consists of serial estimation of the haemoglobin level in the baby's skin-prick blood. We are aware of the discrepancy which may be found between the haemoglobin levels in skin-prick and in venous blood during the first few days of life, the former tending to be on the average *some*

15 per cent higher than the true venous level. But we discovered by chance, early in the course of this investigation, that in these babies the haemoglobin level in skin-prick blood might fall well below the accepted normal range within as little as half an hour after blood loss had occurred. We thought that this observation might be the clue we were seeking, and our subsequent experience has convinced us that it is the answer to this part of the problem. The fact that skin-prick blood can be used is a great advantage in practice because, whether they have lost blood or not, these babies are liable to be very ill at the time when the serial haemoglobin estimations need to be made.

During the course of the investigation we felt it necessary to collect our own series of observations on the haemoglobin levels in normal babies during the first 24 hours of life, because the published evidence (summarized by Smith, 1951) showed big differences between different authors' findings. As a control we made 108 estimations in 34 babies during the first 24 hours of life, with the M.R.C. grey-wedge photometer (100 per cent=14·8 g. per 100 ml.). Skin-prick blood was obtained from the babies' heels, after warming if necessary. The controls, in none of whom was there any reason to believe that blood might have been lost, resembled the babies in whom we were interested in the following respects: in all 34 the cord was clamped immediately, or at most within half a minute after delivery; 28 of them were delivered by lower segment Caesarean section, and in 11 of these the indication for the operation was placenta praevia. Of the 108 estimations, 31 were made within the first 15 minutes of life; the remainder were scattered at random throughout the rest of the first 24 hours. The number of observations made in each baby varied between 1 and 8, and depended on a variety of circumstances, one of which was that we were trying to find the lower limit of the normal range, so that we tended to make more frequent estimations in those babies with the lowest haemoglobin levels.

The range of our results was 101-164 per cent (14·9-24·3 g. per 100 ml.), and we found that in any one baby there might be a considerable fluctuation, with a rise or fall of up to 20 per cent (3·0 g. per 100 ml.) during the first 24 hours. Because of the conscious bias in their collection, the results are not suitable for determining the full extent of the normal range, nor for ordinary statistical treatment. But our colleague Dr. E. G. Knox has analyzed them with full knowledge of the method of collection. He concludes that the probability of a normal baby's skin-prick haemoglobin level falling below 100 per cent (14·8 g.) within the first 24 hours is of the order of 1 in 40.

Comparable observations were made in 13 of the 20 babies whose placentae were encountered in the uterine incision, and whose clinical progress is briefly set out in the Table. The results of these observations, during the first 24 hours of life, are graphically represented in Fig. 2. Of these 13 babies, 4 were considered unlikely to have lost a significant amount of blood, judging by the speed with which the cord was clamped, and the appearence of the placenta (Cases 14, 15, 16 and 20). In all 4 the haemoglobin level stayed within the normal range. Of the 9 babies, in whom significant blood loss was considered

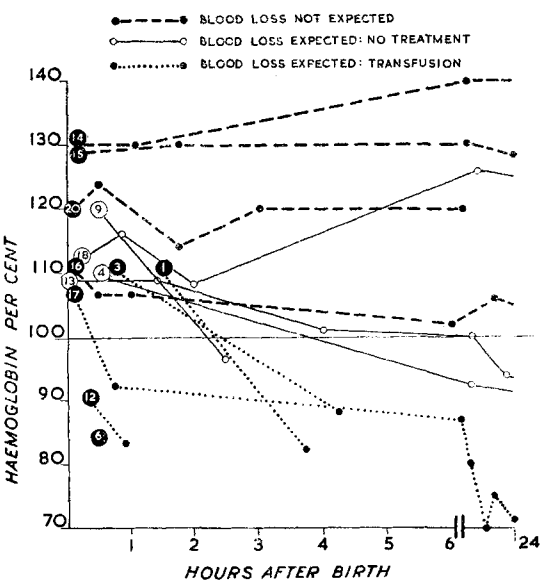

FIG. 2

Graphic representation of the haemoglobin estimations made during the first 24 hours of life in 13 of the 20 babies whose placentae were encountered by the uterine incision. Case numbers correspond with those in the Table.

likely to have occurred, 1 (Case 18) maintained haemoglobin levels within the normal range throughout the first 24 hours: 3 (Cases 4, 9 and 13) dropped to between 90 and 100 per cent (13·3 and 14·8 g. per 100 ml.), but did not require any treatment: and 5 (Cases 1, 3, 6, 12 and 17) fell to levels below 90 per cent (13·3 g. per 100 ml.) and were treated by blood transfusion. Their subsequent progress suggested that these transfusions had been necessary, and we now regard it as a fair assumption that, if haemolytic disease can be excluded, a baby whose skin-prick haemoglobin level falls to below 90 per cent (13·3 g. per 100 ml.) in the first 24 hours of life has lost blood to the extent that a transfusion should be given. If this indication arises within the first 3 hours of life, we regard the transfusion as a matter of urgency. It has been our practice to give these transfusions by polythene catheter through the umbilical vein; we run in 10 ml. of blood per pound of body weight rapidly, and then continue a slow drip until the baby's general condition is clinically satisfactory, or not improving with continued transfusion. In these very ill babies we have found it helpful to set up the transfusion in an Isolette incubator, working through the ports, so that the baby's oxygenation and temperature can be well maintained during the procedure.

A further 2 babies (Cases 10 and 11) received transfusions at the age of 30 minutes, without any indication from haemoglobin estimations. Both were considered likely to have lost blood: Case 10 was born at a time when we could not ensure adequate supervision during the next few hours, and the transfusion was regarded as a reasonable precaution; Case 11 appeared desperately ill, and responded well initially.

The following 2 brief case histories illustrate the points we want to make:

Case 6. This infant was delivered by the technique which we have recommended, but the cord had a velamentous insertion and, in rupturing the membranes with his fingers above the partially separated placenta, the operator tore across what amounted to vasa praevia, as was revealed by subsequent examination of the placenta and membranes. About 1 minute elapsed between this accident and the clamping of the cord. The baby was pale, but did not appear ill: his skin-prick haemoglobin level at 30 minutes was 84 per cent (12·4 g. per 100 ml.). An hour later he seemed rather cold and unresponsive, and it was decided that a blood transfusion was necessary; but the degree of urgency was not appreciated and time was wasted in cross-matching blood. By the time the transfusion was finally set up at the age of 3 hours the baby appeared moribund and died half an hour later. Autopsy revealed no cause of death except pallor of all organs.

Comment. This case occurred early in the series, before we had appreciated the urgent significance of such a haemoglobin level; it seems certain that the baby would have survived if the transfusion had been given within the first 2 hours of life. This case also illustrates the fact that, however much care is taken over the operation, serious damage to the foetal circulation cannot be completely eliminated as a risk in this type of delivery.

Case 12. The placenta was somewhat disrupted when being separated manually from the uterine wall, and 2½ minutes elapsed before the cord could be clamped. Subsequent examination showed that at least one major tributary of the umbilical vein had been torn across. The baby appeared to be ill and rather pale. The haemoglobin level at 20 minutes was 90 per cent (13·3 g. per 100 ml.) and by 55 minutes had fallen to 83 per cent (12·3 g. per 100 ml.). On this evidence a transfusion was rapidly set up in the incubator, and started at the age of 70 minutes. 100 ml. of blood (more than one-third of the baby's estimated blood volume) were transfused in the next 1½ hours. By the end of the transfusion the baby's condition was excellent, and it remained so thereafter. The haemoglobin level at the age of 42 hours was 112 per cent (16·6 g. per 100 ml.).

Comment. In this case the warning of the low (and rapidly falling) haemoglobin level was heeded, and the prompt action taken is regarded as having saved the baby's life.

Discussion

The numerical importance of this cause of neonatal death is difficult to assess: but it seems that the risk of it occurs about 10 times each year in this hospital. The value of the methods we have described, in terms of lives saved, cannot be tested statistically because of the small number of cases and the fact that the foetal and neonatal mortalities from placenta praevia result from a variety of causes, of which this is only one. Elimination of this cause could not be expected to show a statistically significant reduction of the mortality as a whole, especially as improvements in other directions are being attempted all the time. We do feel, however, that reliance on these methods has enabled us to approach the problem with a better understanding of the dangers involved, and to handle these dangers more confidently and promptly when

they do arise. We have also learnt something about the physiology of the newborn baby as shown by his prompt reaction to blood loss.

For many years it has been the practice of the medical staff in our hospital to perform the lower segment operation when Caesarean section is indicated in cases of placenta praevia, in the belief that this carries a lower risk for the mothers. We realize that this view is not held by all obstetricians. In a discussion of papers delivered to the Edinburgh Obstetrical Society (1947), Haultain, Lennie and Murray spoke in favour of the classical operation in cases of placenta praevia. Baird suggested that the question of upper or lower segment operation in placenta praevia was not of prime importance. Among those who prefer the lower segment operation are Macafee (1945), Marshall (1949) and Moir (1949). Those in favour of the classical operation believe that there is less risk of encountering the placental site and therefore less risk of heavy bleeding. Those who favour the lower segment section stress the smooth convalescence with less risk of complications in future pregnancies. These points refer to the mother and so far as we are aware no one has related the type of operation to the outlook for the baby, although Haultain (1947) suggested that the lower segment aproach might carry a greater risk for the child because of the possibility of the placenta being encountered. We cannot offer an opinion as to which of these operations carries the smaller risk for the baby as our experience has been limited to lower segment section in this type of case. In the lower segment operation we believe that the risk of foetal blood loss will be reduced to a minimum if the operator follows the technique which has been described in this paper.

In planning the management of the baby who has been exposed to the risk of blood loss from this cause, we have come to rely very greatly on the preliminary assessment of the magnitude of the risk in that particular case, by taking into consideration the time interval after encountering the placenta until the cord is clamped, together with the findings on subsequent examination of the placenta and membranes. If this assessment suggests that there is no risk of serious blood loss we are now content to forego the serial haemoglobin estimations. But if it suggests that a real risk exists, we consider it essential to obtain this evidence. We repeat the estimations more frequently if the haemoglobin level falls below 100 per cent (14·8 g. per 100 ml.), and give a blood transfusion if it falls below 90 per cent (13·3 g. per 100 ml.) within the first 24 hours of life.

We are well aware that the evidence on which this course of action is based falls short of what is desirable, and we regret having missed opportunities for obtaining relevant evidence in Cases 2, 5, 7, 8 and 11, especially as increasing skill in the delivery of these cases seems likely to reduce the supply of affected babies for further study. There are also theoretical objections to our interpretation of the fall in skin-prick haemoglobin levels as being evidence of rapid haemodilution in response to, and compensating for, rapid reduction in the baby's blood volume by blood loss. But there was nothing to suggest a haemolytic process in any of our cases: only 1 mother was Rhesus-negative, and the Coombs test on the baby's blood was negative (Case 17). The possibility that shock due to anoxia may produce peripheral vascular changes resulting in a fall in skin-prick haemoglobin levels receives no support from the fact that of the 11 control babies delivered by Caesarean section on account of placenta praevia several were very ill and 2 died, but none showed a comparable fall in haemoglobin level. It also seems possible that a baby whose initial haemoglobin level was high might experience a severe haemodilution without the level falling below 100 per cent (14·8 g. per 100 ml.). We have not encountered such a case in practice, but would regard with suspicion a fall of more than about 20 per cent (3·0 g. per 100 ml.) in the first few hours of life.

Our observations are consistent with those made in adults following blood loss resulting from venesection (Ebert, Stead and Gibson, 1941; Wallace and Sharpey-Schafer, 1941) or from limb wounds (Grant and Reeve, 1951), but it is our strong impression that haemodilution occurs more rapidly in these newborn babies. Several relevant observations in the newborn have been published since the start of our investigation. Busby and Neal (1951) reported a single case in which there was bleeding from a

TABLE

Details of 20 cases in which the Placenta was encountered during Lower Segment Caesarean section for Placenta Praevia

Case No.	Birth Weight	Damage to Foetal Circulation	Time until Cord Clamped	Lowest Haemoglobin Level	Transfusion	Comment
	lb. oz.			Per cent	ml.	
1	5 2½	Moderate	Long	82 at 3¾ hr.	80 at 4½ hr.	Died at 11 hours. Autopsy showed massive bilateral suprarenal haemorrhage, with haematomata of liver and kidneys
2	6 7	Moderate	Not known	—	—	Satisfactory progress
3	7 5	Moderate	Not known	88 at 4¼ hr.	75 at 7 hr.	Hb. 97 per cent at 25 hr. Satisfactory progress
4	6 4	Doubtful	1½ min.	91 at 49 hr.	—	Satisfactory progress
5	8 2	None	Doubtful	—	—	Satisfactory progress
6	4 14½	Severe	1 min.	84 at 30 min.	60 at 3 hr.	Died at 3½ hours. Autopsy showed pallor of all organs
7	5 2½	None	Short	—	—	Satisfactory progress
8	over 5 lb.	None	1 min.	—	—	Died at 26 hours. Autopsy showed atelectasis with extensive hyaline membranes in lungs
9	6 9	Moderate	Short	97 at 2½ hr.	—	Satisfactory progress
10	7 3	Moderate	3 min.	106 at 20 min.	70 at 30 min.	Transfusion given because adequate medical supervision could not be guaranteed. Hb. 120 per cent at 8 hours. Survived
11	3 11½	Moderate	3 min.	—	50 at 30 min.	Transfusion given because of placental findings and extreme pallor. Baby improved but died at 31 hours. Autopsy showed atelectasis with extensive hyaline membranes in lungs
12	6 15	Moderate	2½ min.	83 at 55 min.	100 at 70 min.	Hb. 112 per cent at 42 hours. Satisfactory progress
13	3 4	Moderate	½ min.	94 at 23 hr.	—	Hb. 97 per cent at 6 days, 60 per cent at 2 months: treated with iron. Satisfactory progress
14	4 15	None	½ min.	130 at 65 min.	—	Satisfactory progress
15	5 0	None	Short	107 at 38 hr.	—	Satisfactory progress
16	5 13	None	½ min.	102 at 6 hr.	—	Hb. 97 per cent at 43 hours. Satisfactory progress
17	8 0	Moderate	2 min.	58 at 33 hr.	80 at 39 hr.	Hb. 90 per cent at 57 hours: signs of circulatory overloading. Died at 19 days. Autopsy showed infantile type of coarctation of aorta
18	3 12	Slight	1¼ min.	108 at 2 hr.	—	Hb. 60 per cent at 45 days. Satisfactory progress
19	6 3	None	Doubtful	128 at 25 min.	—	Satisfactory progress
20	6 6	None	½ min.	114 at 1¾ hr.	—	Satisfactory progress

tributary of the umbilical vein during vaginal delivery, and the haemoglobin concentration in the baby's venous blood a short while later was 11·0 g. per 100 ml. Siddall and West (1952) reported 7 babies with abnormally low haemoglobin concentrations during the first day of life, in 6 of whom the presumed cause was blood loss resulting from incision of the placenta during Caesarean section. Wickster (1952) recommended repeated haemoglobin estimations in babies whose obstetric history suggests that blood may have been lost from the foetal circulation, but does not bring forward any direct evidence of their usefulness. We believe that the facts graphically represented in Fig. 2, and illustrated by the histories of Cases 6 and 12, support the adoption of the method as a routine procedure in the practical management of these cases.

Summary

1. In 45 consecutive cases of placenta praevia delivered by lower segment Caesarean section, the placenta was encountered in the uterine incision on 20 occasions. There is a risk of damage to the foetal circulation, with resultant blood loss of sufficient severity for a transfusion to be required, in all such cases.

2. By careful attention to the technique of delivery this risk can be reduced to a minimum. Details are described of an operative technique in which emphasis is placed on avoidance of damage to the placenta, and on rapid clamping of the cord after any risk of such damage.

3. In the management of the baby rapid assessment of the degree of blood loss is essential. One baby died at the age of 3½ hours because of delay in setting up a blood transfusion.

4. Clinical assessment of the baby alone has been found inadequate in these cases. We now assume that if more than half a minute has elapsed between encountering the placenta and clamping the cord, or if there is visible damage to the vessels when the placenta is examined from its foetal aspect there is a risk of serious blood loss in that baby. In such a case we have found serial estimation of the baby's skin-prick haemoglobin level a useful guide to the urgency of the situation. Observations in 13 of the 20 babies whose placentae were encountered, and in 34 control babies, have led us to believe that if the level falls below 100 per cent (14·8 g. per 100 ml.) within the first 24 hours of life, the baby has probably lost blood and requires to be watched with extra care: and that if it falls below 90 per cent (13·3 g. per 100 ml.) the baby requires a blood transfusion. If the fall occurs within the first 3 hours of life we regard the matter as one of urgency.

We wish to thank our colleagues on the obstetric staff who have allowed us to include in this report cases delivered by them, and Dr. L. M. Bruce and Dr. L. B. Strang, who made many of the observations on the babies; also Dr. E. G. Knox for his help with the statistical analysis of the control observations, and the Department of Photography, King's College, for Figs. 1 and 2.

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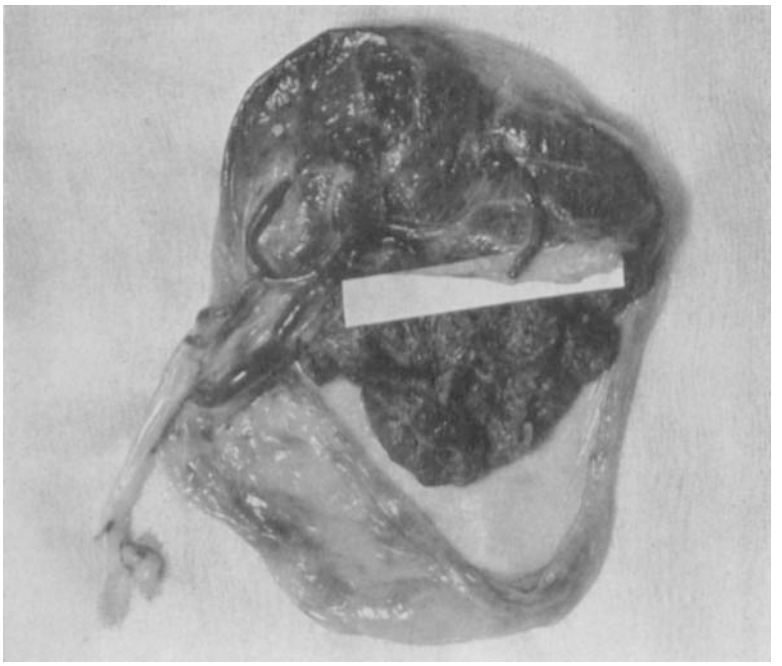

FIG. 1

The placenta in Case 13, from the foetal aspect, with the bag of membranes turned inside out. The strip of white cardboard forms a background for the tributary of the umbilical vein which was torn across at the edge of the hole through which the baby was delivered.