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EFFECT OF PLACENTAL TRANSFUSION ON THE
CLINICAL CONDITION OF THE NEWBORN

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A neonate's circulatory and respiratory mechanisms have to undergo tremendous changes to enable it to start an existence independent of the mother and the placenta. These changes have a profound importance on the clinical condition of the newborn infant. At birth, an infant may lose or gain blood from the placenta equivalent to 25% or more of its blood volume depending on whether the umbilical cord is clamped early or late. The benefit or otherwise of this placental transfusion to the newborn infant is still a controversial issue. The majority of obstetricians are of the opinion that the placental transfusion benefits the infant by filling

its expanding pulmonary vascular bed, by initiating or aiding the initial lung expansion, by prevention of haematogenic shock and by increasing the haemoglobin and haematocrit levels and the iron stores of the body. The possible harmful effects of this rapid and relatively large transfusion reported so far are that it might overload the infant's circulation and encourage haemorrhage and the formation of pulmonary oedema. Its effect on the incidence of neonatal jaundice is also equivocal.

Several excellent studies have previously appeared on the effect of early and delayed clamping of the umbilical cord on the haematological status, respiratory status (including incidence of respiratory distress syndrome), neonatal jaundice and mortality rate of the newborn infant. In the present study, the effects of placental transfusion on the clinical

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condition of the newborn infant have been studied, using in addition to the above parameters, the Apgar method of scoring, to ascertain the general condition of the newborn. Except for the report of Taylor *et al.* (1963), this method of scoring does not appear to have been previously used in such studies.

Material and Methods:

The cases included in this study were selected from admissions to the obstetrical wards of the State Zenana Hospital, Jaipur, between February and March 1968. The total number of cases selected and studied was 150.

1. *Selection of women for study*

Every precaution was taken to see that the mothers whose infants were included in the study belonged to the average age group, parity, duration of pregnancy and general health, so that these could not by themselves have affected the clinical condition of the newborn infants. The average age of the mothers was 25 years, with a range between 16 to 40 years. No woman had haemoglobin level of more than 13 gm.%. Nearly 85% of women had haemoglobin level between 8 to 11 gms.%, and total erythrocyte counts between 2.5 to 4.0 millions per c.mm. of blood.

Routine clinical and laboratory investigations were done in every case to exclude women with gross anaemia, hypertension, diabetes, toxæmia of pregnancy and other complications from the study.

2. *Progress of labour*

Prolonged labour by itself affects the clinical condition of the newborn

infant and so cases with prolonged labour, forceps deliveries, or presentations other than vertex were not included in the study.

3. *Selection of infants*

One hundred and fifty normally delivered infants were selected for the study, with 75 infants in the early clamped group and 75 in the late clamped one. The former group is henceforth called group A and the latter, group B. The infants were put in one group or the other at random and both the groups were studied simultaneously and not in consecutive periods.

Most of the infants weighed from 1775 gms. to 3625 gms. at birth. Only 6 infants (8.0% in the whole study) weighed less than 1775 gms. at birth.

4. *Clamping of the cord*

In group A, the umbilical cord was tied within 5 seconds of complete expulsion of the infant from the birth canal and throughout the procedure the infant was kept at the same level as the mother's perineum.

In group B, the delivery was conducted in the usual way except that the perineum of the mother was kept as near the edge of the table as possible. Immediately after expulsion the infant was wrapped in a sterile towel (previously weighed) and placed on the weighing machine, kept about 2 to 4 inches below the mother's perineum. The weight was recorded immediately. The umbilical cord was tied after complete cessation of pulsations and again the weight of the infant was noted, the difference denoting the gain in blood volume due to placental transfusion.

Stripping of the cord was not utilized in either group.

5. Assessment of general condition of the newborn infant

i. General response:

This was judged by the scoring method described by Apgar. Infants with Apgar score between 7 to 10 were classified as satisfactory response, between 3 to 6 as unsatisfactory response and with scores between 0 to 2 as poor response. The scoring was done one minute after the complete birth of the infant.

ii. Respiratory status:

This was judged by the time taken for establishment of spontaneous respiration and by counting the respiratory rate at 1, 2, 4, 8 and 24 hours after birth. Presence or absence of respiratory distress, such as dyspnoea and thoracic retractions, were looked for. Ventilatory efficiency was assessed by absence of cyanosis. Any sign of complications such as atelectasis, collapse, consolidation or pulmonary oedema was noted.

iii. Haematological status:

Haemoglobin estimation was done by the acid haematin method of Sahli with Helig's modification, on the second day of birth (24 to 36 hours after birth).

Total red cell count was done with Neubauer counting chamber. Capillary blood samples were used for both the examinations.

iv. Jaundice:

Only clinical assessment was done for evidence of jaundice and no laboratory investigations were done.

v. Complications:

Babies were closely watched and complications like attacks of cyanosis, diarrhoea, convulsions, undue irritability, excessive vomiting, distension of abdomen, inability to suckle, abnormalities of heart sounds and bleeding tendency were looked for and noted.

vi. Mortality:

In cases of death, the cause of death was assessed on clinical grounds only, as postmortem examinations could not be carried out.

Observations:

1. Placental transfusion (gain in weight in the delayed clamped group)

Average gain in weight by infants in this group was 45.3 gms. Taking 1 gm. of weight gain as equivalent to 1 ml. of placental transfusion (Duckman *et al.* 1953), the average volume of placental transfusion was thus about 45 ml. The maximum amount of weight gain was 85.0 gms. equivalent to 85.0 ml. of placental transfusion. Three infants (4%) did not show any gain in weight.

Infants with birth weights between 1500 to 2725 gms. gained between 41.9 to 43.9 ml. of blood. Infants with birth weights between 2726 to 3625 gms. gained between 46.2 to 56.7 ml. of blood.

2. General response: (Apgar score)

Eighty-four per cent of group A and 93.3% of group B infants showed a satisfactory general response; 16.0% and 6.7% of infants in the respective groups showed unsatisfactory

general response. No infant in either group showed poor response.

3. Respiratory status

Onset of spontaneous respiration was evident within 15 seconds of birth in 55.3% of the group A and in 74.7% of the group B infants.

30.7% of group A and 17.3% of group B infants established spontaneous respiration in 15 to 30 seconds after birth.

24.0% of group A and 8.0% of group B infants required more than

30 seconds before spontaneous respirations were established. Table I.

4. Haematological status

Mean haemoglobin levels in group A and group B were 12.7 mg.% and 14.7 gm.% respectively, a difference of 2.0 gms. (Table II).

5. Erythrocyte count

Mean erythrocyte count levels in group A and group B were 4.16 millions per c.mm. and 4.63 millions per c.mm. respectively—a difference of 0.47 millions per c.mm. (Table III).

TABLE I
Respiratory Status

Respiratory Status		Early clamping (Group A) %	Delayed clamping (Group B) %
Dyspnoea	Absent	84.0	98.1
	Present	16.0	1.3
Thoracic retraction	Absent	93.3	98.7
	Present	6.7	1.3
Cyanosis	Absent	74.7	78.7
	Present	25.3	21.3
Auscultatory findings	Normal	84.0	93.3
	Abnormal	16.0	6.7

Table showing comparison between respiratory status of the early and the delayed clamping group.

TABLE II
Haemoglobin level

Haemoglobin level in gms. %	Early clamping (Group A) %	Delayed clamping (Group B) %
Less than 13	54.7	10.6
13—15	44.0	49.2
15—17	1.3	39.8
More than 17

Table showing difference between haemoglobin % in the early and the delayed clamping group.

TABLE III
Erythrocyte count

Erythrocyte count in millions per cmm.	Early clamping (Group A) %	Delayed clamping (Group B) %
Below 3.5	2.7	..
3.5—5	94.6	80.0
5—6	2.7	20.0
Above 6

Table showing difference between total erythrocyte counts in the early and the delayed clamping group

6. Neonatal jaundice

Physiological jaundice of significant severity was seen in 22.7% of the early clamped and 16.0% of the delayed clamped groups of infants.

7. Neonatal mortality

No neonatal deaths occurred in group B infants. Group A showed 6.7% neonatal mortality rate. Four infants died with a clinical picture of respiratory distress syndrome and 1 infant died of prematurity.

Discussion and Comments

'When to ligate the umbilical cord' is a problem which has faced obstetricians for a long time. A lot of work has been done on the problem since *Erasmus Darwin*, in 1801, suggested that the loss or gain of the considerable volume of blood on the placental side of circulation might prove to be of immense physiological importance for the newborn infant, but still the question is far from settled. Whether the cord is clamped late or early decides whether the infant is going to receive or not the placental transfusion.

1. Placental transfusion

Placental transfusion is the amount of blood retained in the placenta as a result of early ligation of the cord and which would otherwise have flowed to the foetal circulation. This volume does not necessarily correspond to the total placental blood volume, as not all the blood is retrievable (Smith).

Placental transfusion can be measured by the amount withdrawn after immediate ligation of umbilical cord

or by recording the gain in weight of newborn just after birth.

Several factors affect the amount of blood which can be transferred from the placenta to the infant and are considered below.

i. Time of ligation:

"Early" and "delayed" are only comparative terms and give only a vague idea exactly how soon or late after birth the cord should be ligated. Usually, a cord clamped within 10 seconds of birth is considered to be early clamped (De Marsh; and Whipple *et al.*). Delayed clamping is more difficult to define. Bernstine and Ludmir advocated a delay of one hour. Montgomery advocates waiting for 15 to 20 minutes after the stoppage of cord pulsations, and Lanzkowsky advocates waiting till signs of placental separation are evident, while Taylor *et al.* consider that if a cord is clamped after 3 minutes it is 'delayed clamping'.

ii. Gravity:

Once the cord has stopped pulsating, gravity determines whether blood flows from the placenta to the foetus or vice versa (Landau, *et al.*, Duckman *etl al*). Gunter showed that though the flow of blood was mostly towards the baby, rapid loss from the baby to the placenta also took place sometimes, equalling or even exceeding the gain, if the level of the baby was above the level of the placenta.

iii. Uterine contractions:

Uterine contractions greatly increase the flow of blood from the placenta to the infant, specially after the

cord pulsations have stopped (De Marsh *et al.*; Smith; Reynolds; and Barcia).

iv. *Stripping of the cord:*

Stripping or milking of the umbilical cord before ligation is held to be beneficial in increasing the amount of placental transfusion (De Marsh *et al.*; Whipple *et al.*; Lanzkowsky). Sudden overloading of circulation due to stripping may have an undesirable effect.

In the present study the average volume of placental transfusion was found to be 45.0 ml. This is lower than the usually reported value of 60 to 100 ml. The lower figure might be because no stripping was employed.

2. *Birth weight and placental transfusion*

In premature infants the ratio of placental blood volume to the foetal blood volume is higher as compared to that in full-term infants. It has, therefore, been presumed that premature infants gain relatively larger quantities of blood on delayed clamping of the cord. Results in the present study do not support this contention, as infants in 2775 to 3625 gms. range gained on an average more blood as compared to those in 1500 to 2775 gms. range.

3. *Blood volume of newborn infant*

Smith compiled the available data from the literature and found the average value to be 85 ml./kg. body weight in term and 108 ml./kg. body weight in premature infants.

Placental transfusion is thus equi-

valent to 20 to 25% of infant's total blood volume at birth. In case of premature infants this proportion is still greater. It can be appreciated that placental transfusion has a profound effect on the circulatory changes immediately after birth. Opinions differ whether it aids the circulatory adjustments or it adds to the problems. According to Reynolds, the pulmonary vascular capacity increases on aeration of the lungs and this calls for more blood to fill the system, which ought to come from the placenta. Smith, however, is of the opinion that even if vessels of the pulmonary vascular tree were completely empty before, they could accept only 10% of the total blood volume at birth and could provide only an insignificant additional receptacle for blood compared to that abandoned with the cord and the placenta. Stevenson and Erhard also think that the lungs of the infant increase the reservoir by 5% and he loses four to five times as much blood space when the cord is clamped and so a placental loss of 25% of his blood volume may relieve him of plethora of blood.

4. *General response of the newborn*

In the present study it was noted that infants with delayed ligation of the cord had generally better Apgar scores as compared to infants with early ligation.

Only Taylor *et al.* have reported the effect of early and delayed clamping on the general response of the newborn infant as scored by Apgar method. These authors found increased incidence of lower Apgar score in infants with delayed clamp-

ing of the cord and so concluded that delayed clamping did not appear to help the infant. Previously, De Marsh *et al.* have reported that early or delayed clamping of the cord had no effect on the infant's general condition and weight gain. Similar observations have been made by Colozzi. Duckman *et al.*, however, reported that late clamped infants exhibit more activity and enjoy better general health.

5. *Haematological status*

Delayed ligation of the cord is believed to result in better haematological status in the immediate neonatal period. Several studies on the subject support the belief, and results to this effect have been reported by Borner, Duckman *et al.*, Whipple *et al.*, Montgomery, Bernstine and Ludmir, and Lanzkowsky. In the present study too, infants with delayed ligation of the cord had an average 2.0 mgs. more haemoglobin per 100 ml. of blood and 0.47 millions more erythrocytes per c.mm. of blood, as compared to early clamped group.

6. *Effects of placental transfusion on the respiratory physiology*

Prior to birth, all foetal gas exchange is through the placenta. After delivery, the lungs must expand and, within a few minutes at the most, must be able to provide adequate gas exchange for metabolic needs. The striking alveolar changes with the initial expansion are accompanied by equally important changes in the pulmonary vasculature. According to Jaykka, pulmonary blood flow must increase synchronously with inflation of lungs if the lungs are to function

satisfactorily. The amount of blood in the lungs probably doubles over the period of delivery (Everett and Simmons), and thereafter comprises a fifth of the total blood volume (Lagerloof *et al.*). Placental transfusion may be important in providing for this increased pulmonary blood volume.

7. *Respiratory distress syndrome and placental transfusion*

Exact cause of this condition is unknown but probably the syndrome is set up long before delivery and it is basically a manifestation of disturbance in the chemistry of pulmonary epithelium, which in turn is the result of maternal disorder. Placental transfusion might probably influence the ability of the child to overcome the inherent disability, but is not the primary cause of the syndrome (Crawford; Barrie).

Engel demonstrated a considerable drop in death rate due to pulmonary complications after instituting the practice of delayed clamping of the cord. Landau has reported a marked drop in the death rate due to pulmonary distress syndrome in caesarean babies after instituting delayed ligation of the cord. Taylor *et al.* found the incidence of respiratory distress syndrome and pulmonary haemorrhages to be higher in late clamped group of premature infants. Buckles and Usher found infants with delayed clamping to have a higher incidence of chest retraction, diminished air entry, râles, hyperactive second sound, hepatomegaly, cyanosis, and plethora.

In the present study, a significantly larger number of infants were found

to have enjoyed better respiratory status as a result of delayed clamping of the cord. Respiratory distress syndrome was more common, and, when it occurred, of a more severe degree in the early clamped group of premature infants. All the five infants dying of the syndrome belonged to the early clamped group.

8. *Effect on incidence of neonatal jaundice*

In the present study physiological jaundice was present in 22.7% of the early clamped group and in 16.0% of the delayed clamped group of infants. It is thus apparent that placental transfusion did not lead to an increased incidence of neonatal jaundice.

9. *Neonatal mortality rate*

A significant difference in the neonatal mortality rate was noticed in the two groups of infants. Mortality rate was 6.7% in the early clamped group, while there were no neonatal deaths in the delayed clamped group.

Engel noted that the neonatal mortality rate in premature infants with early ligation of the cord was twice as high as in the infants with delayed ligation of the cord. Landau *et al.* reported a marked fall in mortality rate in caesarean babies when delayed ligation of the cord was started. Bound *et al.* reported a lower mortality rate in late clamped group of infants. Taylor *et al.*, however, found no difference in the mortality rate in early and delayed clamped full term infants.

Conclusions:

1. Delayed ligation of the cord, that is ligation after the pulsations

have stopped, when assisted by gravity, results in the infant gaining on an average 45 ml. of blood as placental transfusion.

2. Delayed ligation of the umbilical cord results in better general response, better respiratory status, lower incidence of respiratory distress syndrome and better haematological status. It does not increase the incidence of neonatal jaundice.

3. No harmful effects of delayed ligation of the umbilical cord are seen in full term infants.

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