Feto-Maternal Transfusion in Normal Pregnancy and During Delivery

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Abstract

Feto-maternal transfusion was studied in 2,000 pregnant Thai women. The technic used in the study was modified acid election test. The population were divided into five group, first trimester, second trimester, third trimester, during delivery and non pregnant women. Over all feto-maternal transfusion occurred in 1,055 women (65.94%). In first trimester, second trimester, third trimester and during delivery were 53.5 per cent, 63.0 per cent, 71.1 per cent and 75.7 per cent respectively. The data were significantly different from non pregnant women ($p < 0.0001$). The volume of transfusion was varied from 0 to 12.65 ml and greater in the advancing gestational age. In first trimester, second trimester, third trimester and during delivery the volume of transfusion were 0.07, 0.08, 0.13, 0.19 ml respectively.

During normal pregnancy and delivery, feto-maternal transfusion is a normal phenomena. In 1954, Chown found that the fetal red blood cells were able to pass through the intact placental barrier to the maternal intervillous space[1]. Jorgensen reviewed that two thirds of the normal pregnancy suffered from feto-maternal transfusion but they were all symptomless[1,2]. The symptomless were maybe because the volume of transfusion was very little, less than 1 ml. The hazard of transfusion will occur if the volume of transfusion is greater than 10 ml[3]. And the incidence of transfusion that was greater than 10 ml was only 5.6 per cent[4].

The feto-maternal transfusion can cause many adverse effects to the fetus such as hypovolumia, severe anemia, heart failure or even intrauterine fetal death[5]. Unexplained fetal hydrops may also be caused by massive transfusion. But this type of hydrops fetalis can be cured by intrauterine transfusion if it is detected earlier[6]. Fortunately, in Thailand, the majority of the population has Rh-blood group positive, so the adverse effects from isoimmunization are very low. The objective of this study was to find out the incidence of feto-maternal transfusion in normal Thai women in all trimesters and during delivery.

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MATERIAL AND METHOD

This research was a cross sectional descriptive study and was approved by the institute committee of human rights. The population was normal pregnant women who attended the antenatal care clinic and in the labour room, Siriraj Hospital. The control population was non-pregnant women who attended the gynaecologic out patient department. The population was classified into 5 groups, first trimester, second trimester, third trimester, during delivery and normal women. All the women had a blood test. The test was to detect the fetal erythrocytes in maternal circulation by using a modified acid elution test. The study was conducted from April, 1990 to October, 1991. The pregnant women had to have a singleton non-complicated pregnancy and with no history of blood transfusion or abortion at least 4 months prior to the study.

Sample size was calculated by the equation

$n = pqz^2 / d^2$

$p = 0.438$ (Freese and titel[14])

$q = 1-p$

$z = 1.96$ (95% significance)

$d = 0.05$ (variance 5%)

$n = 0.438\ (1-0.438)\ (1.96)^2 / (0.05)^2$

$= 378$

The sample size in each group was 400 cases and the total was 2,000 cases.

After taking the basic history and general health data, About 1-2 ml of blood was withdrawn from all the subjects mentioned above. This blood sample was put into an EDTA bottle to prevent clotting. Hematocrit and smear for modified acid elution staining was done soon after. The staining technique has been described before[7,8]. According to this technique, the fetal erythrocyte will be stained dark blue in color. The amount of fetal erythrocytes can be calculated by the following equation.

$$\text{Fetal erythrocytes in maternal circulation (ml)} = \frac{\text{Stained cells}}{\text{Unstained cells}} \times \text{adjusted maternal erythrocyte volume}$$

RESULTS

A study of feto-maternal transfusion in normal Thai pregnant women was done from 1990 to 1991 at Siriraj Hospital. The population involved in the study was divided into 5 groups as already described. Each group had no significant difference in age, weight and hematocrit (Table 1). The youngest was 14 and the oldest was 53 years old, the mean age was 25.14 years old. The weight varied from 34 to 99 kg and there was no significant difference between the groups. The hematocrit value also had no statistical difference.

Fetal blood in the maternal circulation was checked during the first trimester in 400 pregnant women and was found in 214 (53.5%) cases (Table 2). The number of pregnant women who had fetal red cells in their circulation increased with advancing trimester, 252 (63%) and 287 (71.7%) in the second and third trimester respectively. During delivery, feto-maternal transfusion was found in 302 of 400 women (75.7%). There was no fetal blood cell in the control group. The volume of blood cell in the maternal circulation was also studied (Table 3). The maximum volume of feto-maternal transfusion was 12.75 ml and was found in the second trimester. The median values of the volume of fetal blood in the maternal circulation were 0.07, 0.08, 0.13 and 0.10 ml in first, second, third trimester and during delivery respectively. The volume of transfusion increased with the advancing gestation, the highest was during delivery with statistical difference.

Table 1. General data of the population.

		Age (years)			Weight (kg)			Hct. (vol.%)		
	n	mean ± S.D.	min	max	mean ± S.D.	min	max	mean ± S.D.	min	max
1st trimester	400	25.55 ± 5.10	15	44	50.06 ± 7.42	35	76	38.04 ± 3.41	25	47
2nd trimester	400	24.67 ± 5.19	15	39	52.87 ± 8.76	34	93	35.82 ± 3.23	23	45
3rd trimester	400	24.49 ± 5.30	14	42	57.88 ± 8.35	35	99	36.69 ± 3.03	26	45
During delivery	400	23.88 ± 5.09	15	45	59.92 ± 8.22	39	87	33.76 ± 4.43	20	45
Normal women	400	27.15 ± 6.79	14	53	51.27 ± 6.19	35	83	36.68 ± 3.54	24	45

* no significant difference in all groups (ANOVA and analysis of variance)

Table 2. Rate of feto-maternal transfusion (F.M.T.) in all groups.

	n	Without F.M.T (%)		With F.M.T. (%)	
1st trimester	400	186	(46.5)	214	(53.5)
2nd trimester	400	148	(37.0)	252	(63.0)
3rd trimester	400	113	(28.3)	287	(71.7)
During delivery	400	98	(24.5)	302	(75.5)
Normal women	400	400	(100)	0	(0.0)

* $p < 0.0001$ (Chi-Square test)

Table 3. Volume of fetal blood in maternal circulation (ml) in all groups.

	n	mean ± S.D.	min.	max.	median
1st trimester	400	0.18 ± 0.46	0	4.92	0.07
2nd trimester	400	0.35 ± 1.02	0	12.75	0.08
3rd trimester	400	0.34 ± 0.64	0	4.40	0.13
During delivery	400	0.40 ± 0.70	0	6.08	0.19

* $p < 0.0001$ in all data (Kruskal-Wallis, 1-way ANOVA)

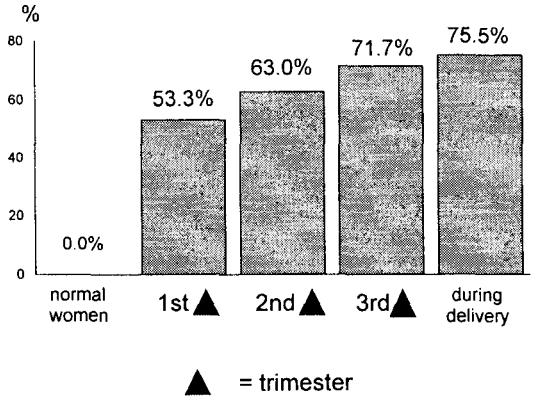

Fig. 1. Rate of feto-maternal transfusion in all groups.

DISCUSSION

Feto-maternal transfusion (F.M.T.) can be found in normal pregnancy and during delivery. The mechanism of this phenomenon is still unclear but it may be a normal physiology if the transfusion is small[9-11]. In the majority, about two thirds of the cases, the amount of transfusion is less than 0.1 ml[2]. However, in some circumstances, even a small amount of transfusion can lead to serious complications to the mother, the fetus or both. Rh-blood group incompatibility is an example. In such cases, if F.M.T. occurs in a mother who has a Rh-negative blood group and carries a fetus of Rh-positive blood, it will enhance the Rh-antibody in the mother. Though, there is almost no adverse effects during this pregnancy, serious complications will occur to the fetus in the following conception. This late adverse effect may be so severe that it can lead to fetal death. Sometimes F.M.T. can also cause immediate adverse effects especially when the volume of transfusion is a large amount. The immediate adverse effects can be either fetal anemia[12], growth retardation[3], fetal death [12,13] or maternal transfusion reaction[13].

In the study, the incidence of F.M.T. was about 65.94 per cent and this value was higher than in other studies[9,11,14]. According to the studies of Durkin[11], Freese[14] and Mclarey[9], the incidence of F.M.T. was 20 per cent, 44 per cent and 54 per cent respectively. The higher value from this study may be a false positive from the abnormal staining of beta-thalassemia or F-hemoglobin which is epidemiologically and frequently found in Asian races. However, the difference can be detected if the stained cells are studied carefully. Prior to this study, the test for these false positives was done and it was able to distinguish the fetal red cells from the others. So, there were almost no false positives in the study.

Renaer[3] classified the case to be massive feto-maternal transfusion when the volume of transfusion was greater than 10 ml and the massive feto-maternal transfusion will cause immediate problems to the fetus if the volume is over 50 ml [16,17]. In our study we found only one case that had a volume of transfusion greater than 10 ml (12.75 ml) and this was found in the second trimester. Close follow-up was done and there were no complications to either mother on the fetus.

The study showed that the rate of feto-maternal transfusion was increased as the gestational age increased and the highest was during delivery. Clayton described that in normal pregnancy, feto-maternal transfusion was increased because the placental surface area had increased,

and the increase was due to advancing gestational age[18]. The second possibility may be due to the increase of both uterine and fetal activity which caused damage to the capillaries of the placenta and leads to increase of the feto-maternal transfusion. Another reason was the cumulative effect of the fetal red cells. The fetal red cells have a life span of about 30 to 90 days, the later counting may include some of those cells which have been counted before.

In Thailand, almost all people have Rh-positive blood group so the hazard of isoimmunization from this type of blood group is very low. The other adverse effect of feto-maternal transfusion is fetal anemia. For Thais, fetal anemia is more common than Rh-isoimmunization. The severity of fetal anemia can indirectly be checked from the calculation of the fetal erythrocytes after the acid elution stain. Early detecton of symptomatic massive transfusion, intrauterine fetal transfusion can be performed and yield a good result.

This study also showed that the acid elusion test is still very helpful in detecting the fetal red cells in the maternal circulation and is quite accurate. The procedure is simple to perform and the results can be obtained quickly.

SUMMARY

In Thailand, almost all people have Rh-positive blood group so the hazard of isoimmunization from this type of blood group is very low. The other adverse effect of fetomaternal transfusion is fetal anemia. For Thais, fetal anemia is more common than Rh-isoimmunization. The severity of fetal anemia can indirectly be checked from the calculation of the fetal erythrocytes after the acid elution stain. Early detection of symptomatic massive transfusion, intrauterine fetal transfusion can be performed and yield a good result.

This study also showed that the acid elusion test is still very helpful in detecting the fetal red cells in the maternal circulation and is quite accurate. The procedure is simple to perform and the results can be obtained quickly.

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การถ่ายทอดเม็ดเลือดแดงของทารกในครรภ์ไปสู่มารดาระหว่างการตั้งครรภ์และการคลอด

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ได้ทำการศึกษาถึงภาวะ fetomaternal transfusion ในหญิงตั้งครรภ์จำนวน 2,000 ราย โดยใช้วิธีการของ modified acid elusion หญิงตั้งครรภ์ดังกล่าวแบ่งออกเป็น 5 กลุ่ม คือกลุ่มตั้งครรภ์ไตรมาสแรก ไตรมาสที่สอง ไตรมาสที่สาม ระหว่างการคลอด และในสตรีที่ไม่ตั้งครรภ์ พบว่าเกิดภาวะ fetomaternal transfusion ทั้งสิ้นเป็นจำนวน 1,055 ราย คิดเป็นร้อยละ 65.94 โดยเกิดในระหว่างไตรมาสแรก ไตรมาสที่สอง ไตรมาสที่สามและระหว่างการคลอดคิดเป็นร้อยละ 53.5, 63.0, 71.7 และ 75.5 ตามลำดับ ซึ่งแตกต่างกันอย่างชัดเจนเมื่อเปรียบเทียบกับสตรีที่ไม่ตั้งครรภ์ ($p<0.0001$) ปริมาตรเลือดทารกที่ถ่ายเทไปสู่มารดามีตั้งแต่ 0 ถึง 12.75 มล. และพบว่าปริมาตรของการถ่ายเทนั้นจะเพิ่มมากขึ้นแปรผันตามอายุครรภ์ที่มากขึ้นคือ 0.07, 0.08, 0.13 และ 0.19 มล. ในไตรมาสแรก ไตรมาสที่สอง ไตรมาสที่สาม และระหว่างการคลอดตามลำดับ

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