

# EXTREMELY PRETERM CESAREAN DELIVERY “EN CAUL”

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## SUMMARY

**Objective:** Intact amniotic membranes may serve to protect the extremely fragile preterm infant from some of the mechanical forces caused by strong uterine contraction. This article introduces the technique of “en caul” cesarean delivery and reviews the experience of the National Taiwan University Hospital.

**Materials and Methods:** This is a prospective study carried out to perform the “en caul” cesarean delivery for early preterm labors between October 2007 and December 2008. Cases were included if the estimated birth weight was below 1,500 g or gestational age was  $\leq 32$  weeks.

**Results:** Twenty women including four twin pregnancies were included, and 23 neonates were born with intact membranes. Preterm labor was indicated in 16 cases, and nine of the cases were due to severe hypertensive disorders during pregnancy. Except in the case of placenta accreta, all underwent lower transverse uterine incision without wound extension. One fetus died after 3 days due to sepsis and the mortality rate was 4.3%. A total of 15 babies had an Apgar score at 5 minutes of more than seven. The value of first arterial pH was  $7.278 \pm 0.117$  and hemoglobin was  $16.1 \pm 2.1$  g/dL. The corrected post-menstrual age at discharge was  $277.75 \pm 38.56$  days.

**Conclusion:** Cesarean delivery en caul is an effective and easy technique for extremely preterm fetuses to protect them from pressure trauma and also results in less uterine injury. [*Taiwan J Obstet Gynecol* 2010;49(3):254-259]

**Key Words:** cesarean, en caul, membranes, preeclampsia, preterm labor

## Introduction

The intensive care of preterm babes has improved greatly over the last few decades; however, preterm birth is still the leading cause of neonatal mortality and subsequent short- and long-term morbidity [1]. The small fetus is vulnerable to delivery trauma. In general, the more immature the fetus is, the greater the risk of labor. Meis et al showed that 28% of preterm singleton births were indicated. About half of the preterm labors were due to preeclampsia and 25% due to fetal growth restriction, placenta abruption, or fetal death [2,3]. Although the most appropriate delivery mode of preterm fetuses is still controversial, cesarean birth is usually

recommended for preterm babies of high risk, low birth body weight labors such as preeclampsia, fetal distress, placenta previa with antepartum hemorrhage, placenta abruption, or malpresentation.

However, obstetricians may encounter difficult cesarean births due to an undeveloped lower uterine segment or an inadequate incision for those with a birth weight below 1,500 g or gestational age  $\leq 32$  weeks. It is common for extremely preterm infants to experience birth trauma at cesarean delivery after rupture of membranes, especially when the fetus is malpresented and the uterus contracts strongly. If the membranes are ruptured at the time of delivery, the preterm fetus will be trapped instantly by a so-called “hug-me-tight uterus”. However, the fetus may be protected by surrounding amniotic fluid from pressure trauma if delivered with the intact membranes.

According to Dorland’s medical dictionary, in the field of obstetrics, the caul refers to the amniotic membrane. To be born in a caul (en caul) means to be born with the head covered by the amnion (or be born



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within an intact unruptured amnion). This occurrence is rare but occasionally happens in normal spontaneous births. The benefits of en caul delivery for very premature infants was first introduced in the literature in 1983 and 1984 [4,5]. The potential benefits such as avoidance of bruising injuries are obvious but few subsequent publications have discussed the technique. We introduce the technique and the experience of the National Taiwan University Hospital in this article.

## Materials and Methods

This study was conducted in the Obstetrics section of the Department of Obstetrics and Gynecology at the National Taiwan University Hospital. We performed en caul cesarean delivery for early preterm labors between October 2007 and December 2008. Cases were included if the estimated birth weight was below 1,500 g, gestational age was  $\leq 32$  weeks, and infants were delivered by cesarean section with intact membranes. The information including the indication for cesarean delivery, gestation age at birth, presentation of fetus, birth body weight, Apgar score, the level of first neonatal hemoglobin and arterial pH, the infant's subsequent stay in the neonatal intensive care unit (NICU), and their corrected post-menstrual age (days) at discharge, were recorded. Dating of pregnancies and infant corrected post-menstrual age (days) were based on the last menstrual period or the adjusted expected date of delivery by the first trimester ultrasound scan if the discrepancy was more than 7 days. The Apgar score was recorded at 1 minute and 5 minutes after delivery. The neonatal hemoglobin and arterial pH were obtained in the NICU after initial resuscitation.

### Surgical methods

We made a phannestiel or vertical skin incision and opened the abdominal wall, layer by layer, to expose the uterus. A transverse lower segment uterine incision was made without incising the membranes. It is very important to make the uterine incision large enough to allow delivery of the whole sac without tearing into the uterine arteries and veins. The operator's fingers pass between the membranes and uterine wall to separate the placenta gently. An assistant helps by pulling the angle of the uterine incision wound, the rectus abdominis muscle and skin wound, to make the opening as large as possible. With fundal pressure the whole sac including the placenta is delivered intact (Figure). The sac was ruptured artificially after delivery. We removed the baby, clamped the umbilical cord, and transferred the preterm fetus to a neonatologist for further resuscitation.

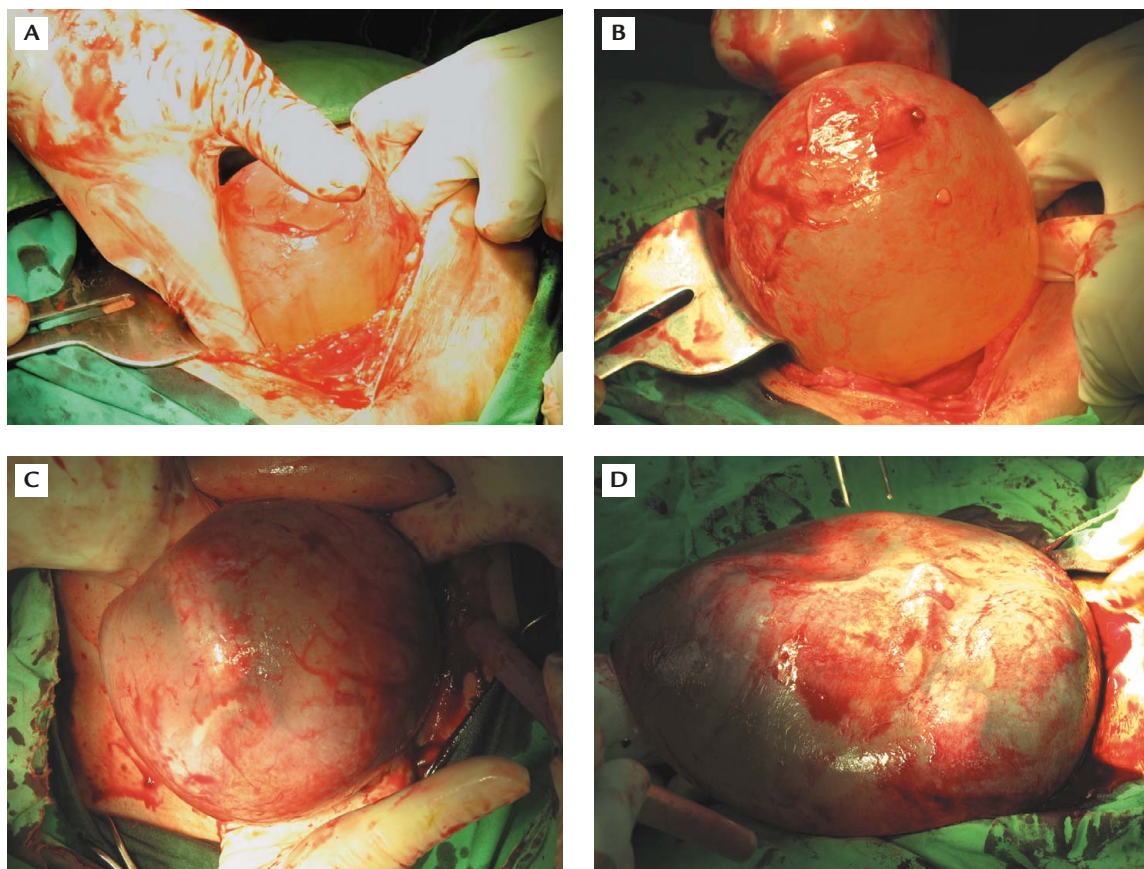
The membranes may rupture before the fetus is fully delivered, but usually it is easy to achieve atraumatic delivery en caul. The plane of separation of the placenta is deep to the basal plate and although maternal vessels are divided during separation, the fetal circulation would not normally be breached.

## Results

Twenty pregnant women including four twin pregnancies were recruited, and twelve of them were transferred from other clinics or hospital. Nineteen of them were delivered *via* a lower transverse uterine incision without uterine wound extension. One case received classical uterine incision to avoid placenta damage due to placenta previa and accreta, and then she underwent hysterectomy after the fetus was delivered. The babies were all delivered without artificial rupture of membranes. Three of them had membranes that spontaneously ruptured during the procedure after the main part of the fetus was delivered outside of the uterus and they also achieved an atraumatic delivery. All of the neonates had no bruising or fractures after delivery.

In one twin pregnancy at 24<sup>+6</sup> gestational weeks when admitted, twin A had preterm premature rupture of membranes and he was entrapped in the cervix, while twin B lay transverse with intact membranes. They were delivered by emergency cesarean but twin A was only 240 g and died immediately after birth. Twin B was 568 g but also died after 3 days due to sepsis caused by *Enterobacter cloacae* infection. The other 22 babies survived. One baby (Case 11) had multiple congenital anomalies, including hemivertebra, and complex congenital heart disease. Excluding the fetus that died immediately, 23 babies were evaluated. Twelve babies were boys and 11 were girls, and the mortality rate was 1/23 (4.3%). Detailed information regarding these fetuses is shown in the Table.

The gestational age at delivery was  $28^{+0} \pm 4^{+5}$  weeks. The birth body weight was  $1,073 \pm 300$  g. Sixteen of 20 mothers (80%) experienced preterm births including nine with hypertensive disorders during pregnancy such as severe preeclampsia and hemolysis, elevated liver enzyme, and low platelet count (HELLP) syndrome. Two cases experienced placenta abruptio, another two exhibited placenta previa with massive antepartum hemorrhage, two others experienced fetal distress and one experienced maternal pulmonary hypertension. Breech presentation occurred with 10 fetuses, one was transverse lie, and the other 12 were vertex presentations. Except for the fetus with placenta previa and accreta, most babies of the indicated preterm births were growth restricted



**Figure.** (A) The operator's hand passes between the membranes and uterine wall to separate the placenta gently. (B, C) The opening is enlarged as much as possible. With fundal pressure the whole sac is delivered intact. (D) The fetus with transverse lie was delivered in the intact sac without trauma.

with low birth body weight. Five babies had birth body weight less than 3 percentile of their gestational age. The 5-minute Apgar score had prognostic significance for neonatal survival. Fifteen of 23 (65.2%) babies had an Apgar score greater than seven at 5 minutes.

The value of first arterial pH was  $7.278 \pm 0.117$  and only one case had profound metabolic acidemia ( $\text{pH} < 7$ ). The neonatal hemoglobin level was  $16.1 \pm 2.1$  g/dL. Hospital stay was related to the birth gestational age. Excluding two babies who were born in December 2008 and remained in the hospital when this report delivered, the corrected post-menstrual age of survivors after discharge was  $277.75 \pm 38.56$  days, which was close to term age. The baby who had multiple anomalies including hemivertebra and congenital heart disease stayed in our hospital for 183 days (post-menstrual age was 386 days) and then transferred to a local hospital for further care.

## Discussion

The first fetus born in a complete caul was reported in 1975. The infant survived 25 minutes of extrauterine

life inside the intact sac of membrane and no ill effects were demonstrated after a follow-up of 3 years [6], so the oxygen stored in the placenta can maintain the fetus for a short period. The en caul delivery for early premature infants was discussed in the literature in 1983 and 1984 [4,5]. The potential risks of preterm labor include malpresentation, prolapsed umbilical cord, cervical entrapment of the head of the breech fetus, and severe bruising of the presenting part. Breech presentation is noted more frequently at early gestational ages (21%) such as 25–26 weeks gestation, compared with 3–4% at term [7]. The earlier the preterm labor, the more likely the breech fetus will have non-frank presentation. With a preterm fetus, the disproportion of fetal head and buttock may increase the risk of prolapsed cord and after-coming head if the cervix is not sufficiently effaced and dilated adequately. It was hypothesized that cesarean delivery to obviate trauma from vaginal labor might prevent neonatal intracranial hemorrhage, but this has not been validated by subsequent studies [8,9]. The benefit of cesarean delivery in spontaneous preterm breech fetuses is controversial [8–12]. Nevertheless, in most institutions virtually all preterm breech infants are delivered by cesarean delivery. In 2002, 87%

**Table.** Antenatal and neonatal data of infants delivered by cesarean delivery "en caul"

Case	Delivery gestation (wk)	BBW (g)	BBW (%)	Sex	Apgar score (5 min)	Presentation	Cesarean delivery indication	Arterial pH	Hb (g/dL)	Age at discharge (d)	Corrected PMA at discharge (d)
1	23 <sup>+6</sup>	730	75	M	7	Breech	Twin, malpresentation	7.182	14.7	209	376
2	23 <sup>+6</sup>	600	25	M	1	Breech	Twin, malpresentation	6.883	12.8	147	314
3*	24 <sup>+6</sup>	568	10-25	M	6	Transverse	Twin, malpresentation	7.357	15.9	3	-
4	27 <sup>+1</sup>	866	10-25	F	6	Breech	Placenta previa with APH	7.320	14.3	81	271
5	27 <sup>+2</sup>	906	10-25	M	6	Vertex	Preeclampsia	7.320	14.5	91	280
6	28 <sup>+0</sup>	1,328	75-90	M	8	Vertex	Placenta previa and accreta with APH	7.301	15.2	NA <sup>†</sup>	NA <sup>†</sup>
7	28 <sup>+1</sup>	922	<10	M	8	Vertex	Eclampsia, HELLP	7.367	15.2	55	251
8	28 <sup>+2</sup>	686	<3	F	9	Breech	Preeclampsia, previous cesarean delivery	7.365	12.4	72	270
9	28 <sup>+3</sup>	956	<10	F	7	Vertex	Placenta abruptio with fetal distress	7.296	17.4	71	267
10	28 <sup>+5</sup>	758	<3	F	9	Vertex	Preeclampsia, AEDV, previous cesarean delivery	7.362	16.6	78	274
11	29 <sup>+2</sup>	1,260	25-50	M	4	Breech	Breech, previous cesarean delivery	7.492	14.7	183 <sup>‡</sup>	386 <sup>‡</sup>
12	30 <sup>+2</sup>	802	<3	M	4	Breech	Placenta abruptio with APH	7.197	19.8	71	281
13	30 <sup>+4</sup>	1,222	10-25	F	4	Vertex	Preeclampsia, HELLP, twin	7.179	18.5	47	261
14	30 <sup>+4</sup>	1,460	25-50	M	2	Breech	Preeclampsia, HELLP, twin	7.297	17.2	52	266
15	30 <sup>+4</sup>	1,158	<10	F	8	Breech	Preeclampsia, previous cesarean delivery	7.000	16.2	41	255
16	30 <sup>+6</sup>	1,698	50	M	7	Vertex	Fetal distress, chorioamnionitis	7.290	15.0	24	240
17	30 <sup>+6</sup>	1,316	10-25	M	8	Vertex	Preeclampsia, previous cesarean delivery	7.205	19.1	40	246
18	31 <sup>+2</sup>	1,314	10-25	F	9	Vertex	Twin, malpresentation	7.345	13.4	45	264
19	31 <sup>+2</sup>	1,322	10-25	F	9	Breech	Twin, malpresentation	7.165	16.6	49	268
20	31 <sup>+6</sup>	1,041	<3	F	9	Vertex	Fetal growth restriction, AEDV	7.314	18.7	NA <sup>†</sup>	NA <sup>†</sup>
21	32 <sup>+1</sup>	1,326	<10	M	8	Vertex	Maternal VSD with pulmonary hypertension	7.229	18.9	34	258
22	32 <sup>+5</sup>	1,276	<10	F	9	Vertex	Preeclampsia	7.345	18.6	31	255
23	32 <sup>+5</sup>	1,166	<3	F	9	Breech	Preeclampsia, breech	7.215	14.9	43	272

\*Died at 3 days of age due to sepsis with *Enterobacter cloacae* infection; <sup>†</sup>not applicable because they were not discharged at the time this article was prepared; <sup>‡</sup>multiple congenital anomalies and was transferred to a local hospital for further care. AEDV = absent end diastolic velocity of umbilical artery; APH = antepartum hemorrhage; BBW = birth body weight; Hb = hemoglobin; HELLP = hemolysis, elevated liver enzyme, low platelet count; NA = not applicable; PMA = post-menstrual age; VSD = ventricular septal defect.

of breech fetuses in the USA were delivered by cesarean [13]. They appear less likely to have traumatic and asphyxial injuries when delivered by cesarean delivery.

Preterm infants, and especially very early preterm infants, are more vulnerable to trauma during delivery than fetuses at term. They are far more likely to suffer soft tissue damage, neurological injury, and traumatic intracranial hemorrhage than term infants. For this reason, special care should be taken not to traumatize these infants, especially during cesarean delivery. In these cases, obstetricians often encounter the critical situation of strong uterine contraction and change of fetal presentation, especially transverse lie, after rupture of membranes. Additionally, cesarean births for those with a birth weight below 1,500 g or gestational age  $\leq 32$  weeks were more difficult due to an undeveloped lower uterine segment and inadequate incision. Due to the above reasons, extension of the uterine wound is often necessary.

Women who underwent a classical or T-shaped uterine incision have a higher risk (4–9%) of uterine rupture during a subsequent pregnancy than those subjected to transverse lower uterine incision (0.2–1.5%) [14]. For most cesarean deliveries, the transverse incision has the advantages that it is easier to repair and theoretically reduces maternal blood loss; is located at a site least likely to rupture during subsequent pregnancy; and does not prompt adherence of bowel or omentum to the incisional line. The en caul method is an easier technique for achieving transverse uterine incision without the need of wound extension. In our cases, all deliveries except the case of placenta accreta were performed successfully with transverse lower uterine wound incision. Some of these preterm deliveries were emergencies and an easy technique for a first-line doctor is critical.

The main potential danger of the procedure is that if the fetal vessels are breached during separation of the placenta, the fetus may exsanguinate. A case study of preterm delivery by cesarean “en caul” mentioned the danger of causing fetal blood loss and the need for transfusion [15]. However, only three of 24 babies’ hemoglobin levels were less than 15 g/dL, with 11 babies needing fetal transfusion [15]. The babies seemed to have no anemia initially. The reasons for transfusion may be due to the frequent blood examinations that are required and because of the small blood volume of low body weight preterm babies. Our cases have similar hemoglobin level distribution (4 cases  $< 14.5$  g/dL, 13 cases between 14.5–18 g/dL, and 6 cases  $> 18$  g/dL) with average hemoglobin levels at 16.1 g/dL. The plane of separation of the placenta is deep to the basal plate, and although maternal vessels are divided during separation, the fetal circulation would not be damaged.

If there was fear of fetal blood loss during separation, some cord blood could be squeezed to the fetus before cord clamping. In some cases like the placenta accreta, we could deliver the sac with the placenta *in situ*. As long as the main part of the fetus was delivered outside the uterus with amniotic fluid protection, the atraumatic goal was usually achieved.

Extremely preterm vaginal breech delivery en caul was also discussed in the literature [16]. With simple spontaneous preterm labor, vaginal en caul delivery had the benefit of completing a steroid course, higher cord pH, and higher 5-minute Apgar score. The retrospective cohort study compared vaginal delivery with or without intact membranes of extreme preterm delivery ( $24^{+0}$  to  $26^{+6}$  gestational weeks) and showed that the en caul method of delivery was associated with significantly higher arterial cord pH values [17].

Intrapartum acidemia may intensify some of the neonatal complications such as severe respiratory distress [18]. Five of the 23 babies had initial arterial pH less than 7.2 and only one less than 7.0. Unfortunately, we collected the blood data after the neonate was admitted to the NICU, so the timing of blood sampling was not consistent. In previous en caul vaginal delivery studies, the en caul method was thought to have higher cord pH than those with membranes ruptured [16,17]. We need more data and controlled trials to compare the results of these two groups. Long-term outcomes should be followed and compared in the future.

In conclusion, an apparently healthy and viable preterm fetus with the mother in either active labor or in whom delivery is present with severe fetal growth restriction, severe preeclampsia, placenta abruption, or massive antepartum hemorrhage, cesarean birth is still recommended. Although there are no randomized trials to confirm this, there appears to be less labor and delivery trauma when preterm labor is conducted with intact membranes. For this reason, especially for early preterm deliveries, artificial rupture of membranes should be performed only for a clear indication. The cesarean delivery en caul method is an easy technique to perform, especially for junior doctors and residents who have less experience in dealing with extremely preterm fetuses.

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