Cesarean delivery “en caul” in Japan: Results of a national survey of maternal and perinatal centers in Japan

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Aim: “En caul” cesarean section can prevent mechanical damage to preterm babies upon cesarean delivery, by intentionally not rupturing the fetal membranes. This survey investigates its prevalence, indications, and advantages and disadvantages in Japan.

Methods: Questionnaires were posted to all registered Level 2 and Level 3 maternal and perinatal centers (where most premature babies are delivered) in Japan (n=327). Percentages of centers are presented as survey results.

Results: Response rate was 53.2%. En caul cesarean section was employed in 43.2% and 81.6% of Level 2 and 3 centers, respectively. Gestational age considered for en caul cesarean section was less than 31 weeks in 75.9% of centers. Low transverse and vertical uterine incisions were made at 64% and 29% of centers, respectively. En caul cesarean section was considered useful by 87% of centers. However, nearly one-third of the respondents noted that this procedure presents some technical difficulties if membranes happen to rupture accidentally before the delivery of the fetus is complete.

Conclusions: En caul cesarean section is a routine cesarean delivery technique used for preterm babies born at Level 3 maternal and perinatal centers in Japan. However, certain technical and educational aspects should be considered to achieve better outcomes.

Introduction

With marked advancements made in maternal, fetal, and neonatal medicine, the prognosis of premature infants born in Japan has improved dramatically and is considered among the best in the world. Perinatal medical services strongly influence these prognoses and are provided primarily at the municipal district level. Japan is divided into nine regions comprising 47 prefectures, each of which has at least one Level 3 institute, i.e., a tertiary perinatal center with maternal and neonatal intensive care units to handle highest risk pregnancies. Each region has several Level 2 perinatal centers with neonatal intensive care units associated with the Level 3 perinatal center in the same region; these cover relatively high-risk pregnancies. Several factors affect the prognoses of premature infants, including antenatal maternal care, delivery room management, postnatal respiratory care, nutrition, infection, and retinopathy care.

Regardless of the indications for cesarean delivery of premature infants, the overall prognosis of infants is better for those born by cesarean than by vaginal delivery. Nonetheless, cesarean delivery is not always safe, with an incidence of fetal injury during cesarean delivery of 1.1%. More than half of the injuries involve skin lacerations, while others include cephalohematoma, clavicle fracture, facial nerve palsy, brachial plexus injury, intracranial hemorrhage, and long-bone fracture. Therefore, less traumatic cesarean delivery techniques for premature infants have been sought.

In 1990, Pearson introduced “en caul” cesarean section (ECC), in which the fetal membranes are intentionally left intact until the whole sac has been delivered, to avoid neonatal injuries during the procedure. Eight years later, Abouzeid and Thornton reported an ECC case series based on a postal survey of 78 consultants in the
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Yorkshire region in the United Kingdom,\(^5\) We reported on the introduction of the ECC technique in Japan in 1993,\(^6\) leading to its widespread use throughout Japan since then.

In this study, we investigated the extent to which this technique is applied and the problems encountered in its implementation. To this end, we performed a nationwide postal survey targeting maternal and perinatal centers in Japan.

**Materials and methods**

In 2010, questionnaires were posted to all registered Level 2 and Level 3 maternal and perinatal centers in Japan \((n = 327)\). The survey queried whether or not ECC is employed, and if so, the indications to perform ECC, gestational age, fetal growth, and fetal presentation. The number of ECC cases during the year 2010 was also asked, along with primary indications for ECC. Free space for additional comments was also included in the questionnaire.

| Number of centers and targeted and response rates | Level 3 | Level 2 | Total |
|-----------------------------------------------|---------|---------|-------|
| Number of perinatal centers                   | 84      | 243     | 327   |
| Response (%)                                  | 49 (58.3) | 125 (51.4) | 174 (53.2) |

| “En caul” employed (%) | Level 3 | Level 2 | Total |
|-----------------------|---------|---------|-------|
| 40 (81.6)             | 54 (43.2) | 94 (54.0) |

**Results**

The overall response rate was 53.2%; response rates were 51.4% for Level 2 and 58.3% for Level 3 centers.

**Table 1.** Number of registered Level 2 and 3 maternal and perinatal centers in Japan

**Table 2.** Rate of implementation of en caul cesarean section

Among the 94 institutions that responded, 19 did not answer this question, 20 answered that they did not consider gestational age, 9 answered that they consider gestational age but did not define a specific cutoff with regard to gestational week.

![Figure 1. Indication for en caul cesarean section by gestational age and cumulative number of institutions](image-url)
ECC was employed in 43.2% of Level 2 and 81.6% of Level 3 perinatal centers in Japan (Table 2). With regard to indications for ECC, 58 institutions (62%) responded that they considered gestational age an indication for ECC. When ECC was employed according to gestational age, some institutions employed the procedure only for a very young gestational age, whereas others simply employed ECC for any preterm cesarean delivery (Figure 1). Indication for ECC in terms of gestational weeks was considered in nearly half of the institutions; specifically, ECC was considered for those younger than 28 gestational weeks with an estimated birth weight under 1,000 grams (Figures 1 and 2).

With regard to the mode of ECC, 29 institutions employ complete ECC (25.5%), 19 institutions employ incomplete ECC (20.2%), and the remaining 30 institutions employ both types of ECC (31.9%) (Figure 2).

The choice of uterine incision (lower segment incision, or classical or vertical incision) is shown in Figure 3. Moreover, 75 institutions (64%) use a lower segment incision, 34 institutions (29%) use the classical vertical incision, and 8 institutions did not respond to this question (Figure 3).

With regard to the application of rapid tocolysis upon ECC, 46 institutions (48.6%) employ nitrate and 7 institutions (7.4%) employ inhalational agents (not specified), while no institutions employed ritodrine hydrochloride. Twenty institutions (21.3%) do not employ tocolysis (Table 3).

Other comments left in the survey about ECC were as follows. Seventy institutions (74.5%) noted that ECC is beneficial for neonate protection, 33 institutions wrote that it is beneficial for the surgeons, and 2 institutions (2.1%) responded that they performed ECC upon request from the neonatologists (Table 4). With regard to the disadvantages of ECC, 29 institutions (30.9%) answered...
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### Table 4. Additional survey comments on the advantages of en caul cesarean section

|                | Minimized stress | Prevents damage | Skin damage          |
|----------------|------------------|-----------------|----------------------|
| For neonates   | 22 (23.4%)       | 35 (37.2%)      | Mechanical damage to the brain |
| 70 (74.5%)     |                  |                 | Cerebral hemorrhage  |
|                |                   |                 | Birth asphyxia       |
|                |                   |                 | Better Apgar score   |
|                | Prevents the “hug me tight” phenomenon | 13 (13.8%) |
| For surgeons   | 33 (35.1%)       | 33 (35.1%)      | Requires more careful uterine incision (4) |
| 33 (35.1%)     |                   |                 | Expulsion of the bag (4) |
| At neonatologist’s request | 2 (2.1%) |                   |                       |

The “hug me tight” phenomenon is a colloquial term that means to “hold someone you love tightly”. In this case, the uterus might hold the baby tightly enough to prevent delivery, despite strong uterine contractions after the rupture of the membranes.

### Table 5. Free descriptive comments on the disadvantages of en caul cesarean section

|                          | Takes longer 8 (8.5%) | Technically difficult 14 (14.9%) | Adverse effects on the neonates 6 (6.4%) | Other  |
|--------------------------|-----------------------|----------------------------------|-----------------------------------------|--------|
|                          | Requires more careful uterine incision (4) | Incidental membrane rupture (5) | Hypothermia when membranes rupture on infant warmer (2) | No evidence (1) |
|                          | Expulsion of the bag (4) | Not applicable in PROM (2) | Hypoxia due to iatrogenic abruptio placentae (3) |        |
|                          | Difficult to teach (3) | More bleeding (when nitrate is used) (3) |                               |        |
|                          | Incidental membrane rupture (5) | Difficult to estimate blood loss (1) |                               |        |

Figure 4. Mode of uterine incision in en caul cesarean section

|                  | No answer 8 (7%) | Classical 34 (29%) | Low segment transverse 75 (64%) |
|------------------|------------------|--------------------|---------------------------------|

that it had some disadvantages. Their comments are shown in Table 5; the disadvantages were that it “takes longer time” (8 institutions), is “technically difficult” (14 institutions), has “adverse effects on the neonates” (6 institutions), and has “no evidence” (1 institution).

### Discussion

ECC was first introduced to Japan in 1993; by 2010, more than 80% of Level 3 and nearly half of Level 2 maternal and perinatal centers were employing this technique. Although its contribution to the incredibly low perinatal mortality and morbidity rates of low-birth weight infants in Japan is difficult to demonstrate, the ECC technique is now widely used in maternal and perinatal centers all over Japan and has become common practice in cesarean deliveries of low-birth-weight infants. While indications for ECC varied among the institutions, most employed ECC for very premature cesarean deliveries.

Lin et al. conducted a prospective study of ECC from 2007 to 2008, investigating 24 cases for which either the estimated birth weight was < 1,500 g or gestational age was ≤ 32 weeks.7 They noted that only 3 of 24 infants had hemoglobin levels < 15 g/dl; reasons for the anemia were unrelated to ECC and were likely due to the frequent blood sampling in the neonates. In contrast, the retrospective study of 211 ECC cases conducted by Jin et al. compared these to 836 cases of conventional lower segment cesarean section as the control. This comparison revealed a success rate of 66.8% for ECC (141/211), with a significantly higher 5-minute Apgar score in the subgroup of ECC cases for whom gestational age was < 32 weeks.8 With respect to anemia, 4 of 121 cases had severe anemia. Thus, neonatal anemia appears
to be a possible adverse effect of ECC. Notably, Lin et al.’s series targeted cases of complete ECC, in which the placenta is completely separated and delivered without rupturing the fetal membranes.7) In contrast, the cases in the study by Jin et al. employed partial ECC, i.e., the placenta was not yet separated at the time of delivery.9) Murakoshi advocated autotransfusion from the placenta before rupturing the membranes on the infant warmer, while holding the placenta at a higher position than the infant.9) Our findings are consistent with these reports with respect to the gestational age and the birth weights for the indication of ECC.

Rapid tocolysis during ECC appears to be useful for relaxing the uterus at the moment of delivery of the fetus, with or without rupturing the membranes, and helps to avoid mechanical stress to the infant. Our survey did not reveal the most suitable tocolytic agent specifically for ECC. It would be desirable to propose selection criteria for uterine incision, i.e., vertical or transverse, and whether or not rapid tocolysis should be employed. Addressing these questions is difficult given the retrospective nature of this study. However, rates of the low transverse incision and of the employment of rapid tocolysis are quite close; we speculate that employment of rapid tocolysis may benefit from the use of a transverse uterine incision at earlier weeks of gestation. With regard to the choice to employ complete or incomplete ECC, the questionnaire did not address the intentionality of the doctors to perform complete or incomplete ECC. Some doctors may perform incomplete ECC to prevent artificial placental abruption with complete ECC. In some cases, the procedure may conclude with an incomplete ECC if the membranes rupture during the course of the complete ECC. In our experience, we have found that once the majority of fetal body parts are delivered, it works best to rupture the membranes in order to proceed with the rapid neonatal resuscitation. We would describe a successful ECC as one in which the membranes are peeled gently away from the uterine wall by the surgeon’s palm before fundal pressure is applied to expel the fetus.

In conclusion, ECC has become a routine technique used in cesarean deliveries of preterm babies born in Japan at Level 3 maternal and perinatal centers, where the majority of premature babies are delivered. Some technical and educational issues remain with this technique, and further investigation is needed to achieve better outcomes with ECC.

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Conflicts of Interest

There are no conflicts of interest to disclose.

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