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# "En Caul" Cesarean Delivery for Extremely Premature Fetuses: Surgical Technique and Anesthetic Options

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## Abstract

The risks and technical difficulties at the cesarean delivery for extremely premature infant under 1,000g are as follows: (1) a premature infant is very weak for pressure of uterine wall or human hands, (2) skin of infant is really premature and weak, (3) uterine wall is thick and difficult to incise at lower segment of uterus, (4) classical vertical incision or reverse T-shape incision are at risk for future uterine rupture, and (5) at the timing of rupture of membrane, uterine wall may contract drastically and the infant is trapped the uterine wall, so called "hug-me-tight-uterus".

To resolve the problems, we use the technique of "En Caul" cesarean delivery with nitroglycerin. Intravenous injection of nitroglycerin just before uterine incision made the rapid and sufficient relaxation of uterine muscle. After getting adequate uterine relaxation, U- or J-shaped incision is made to lower segment of the uterus; however, we never incise the membrane before the infant was delivered. The baby is delivered with wrapped amniotic fluid and the membrane, which protect the infant against the pressure of uterine wall or surgeon's hands. The infant is gently handled to neonatologist by "En Caul" with the placenta. Neonatologist can make the membrane ruptured and resuscitation. Own blood transfusion can be made through the umbilical cord and placenta, if the infant was anemic or hypovolemic.

**Keywords**

- extremely premature infant
- cesarean delivery
- en caul
- unruptured amniotic membrane

## Surgical Strategy of Cesarean Delivery for Extremely Premature Fetuses

There are numerous risks and technical difficulties of cesarean delivery for extremely premature fetuses, especially those under 1,000 g. Premature fetuses are quite fragile and weak and can be harmed by the pressure of the uterine wall or that of human hands, and the tissues of premature fetuses, such as the skin, bones, and brain, are easily damaged, especially by the stress due to pressure. In addition, the uterine wall is thick and difficult to incise at the lower segment of the uterus, and classical vertical incisions or reverse **T**-shape incisions put patients at risk for future uterine rupture. At the time of rupture of the membrane, the uterine wall may also contract drastically, causing the fetus to be trapped by the uterine wall (known as the "hug-me-tight-uterus"; ►**Fig. 1**).

To resolve these problems, the technique of "en caul" cesarean delivery is recommended to reduce fetal stress and trauma during delivery (►**Fig. 2**). To improve chances of success for "en caul" cesarean deliveries, the following techniques are used:

- Anesthesia and tocolytic agents: combined spinal and epidural anesthesia with intravenous (IV) injection of nitroglycerin for achieving rapid and sufficient relaxation of uterine muscle (rapid tocolysis).

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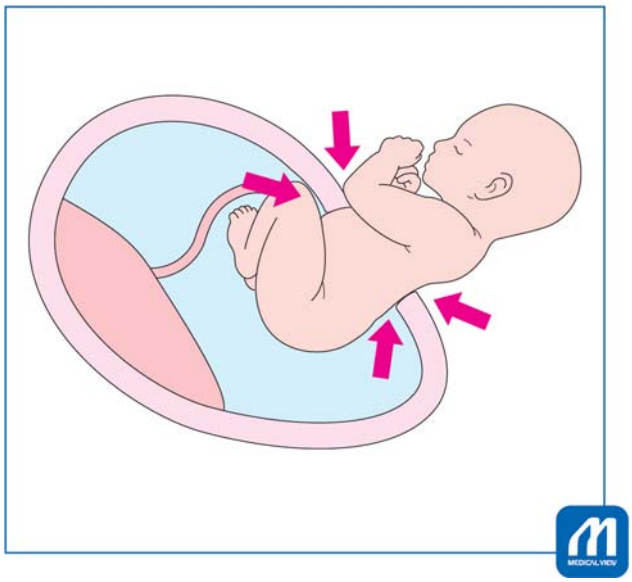

**Fig. 1** Fetus and uterine wall during cesarean delivery. After rupture of the membrane, the uterine wall can rapidly contract, and the fetus may be easily trapped in the uterus and become difficult to deliver (known as a "hug-me-tight-uterus"). Unless the surgeon performs a quick maneuver, entrapment problems can occur causing a further delay in delivery and compression trouble to the fetus. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).[7]

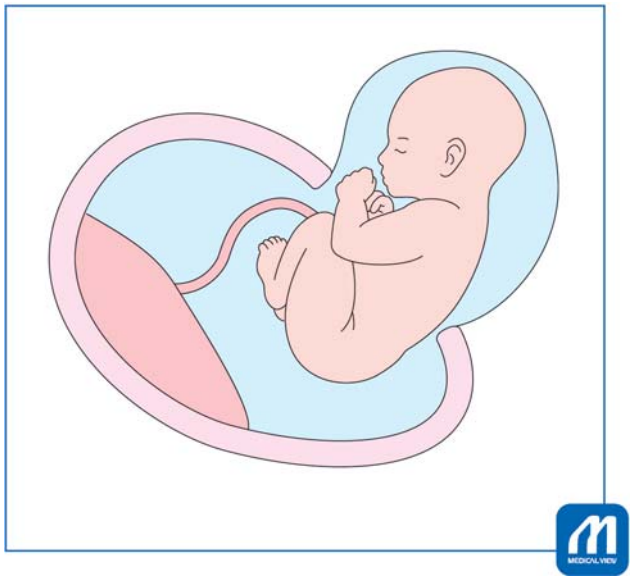

**Fig. 2** Fetus and uterine wall during "en caul" cesarean delivery. To avoid the pressure trauma from the uterine wall, unruptured-membrane uterine incisions should be used. The fetus is then delivered with the wrapped amniotic fluid and the membrane that protects the fetus against the pressure of uterine wall and/or the surgeon's hands ("en caul" cesarean delivery technique). (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

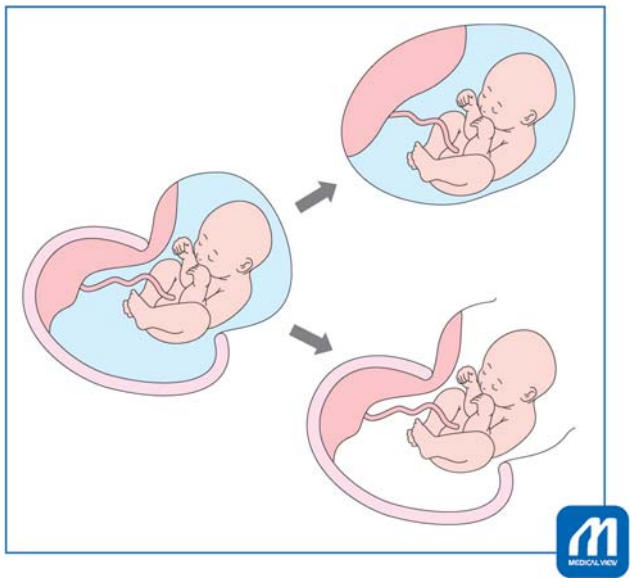

**Fig. 3** Total and partial "en caul" cesarean delivery. Total "en caul" cesarean delivery: the fetus is totally covered in the amniotic membrane with the placenta, and is handed over to the neonatologist. Partial "en caul" cesarean delivery: almost the entire fetus is delivered through the uterus with the wrapped amniotic membrane, and the membrane is ruptured during delivery by the obstetrician. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

- Uterine incision: **U**- or **J**-shaped incisions are made to the lower segment of the uterus; a classical vertical incision should be used for a very narrow uterine isthmus (lower segment); however, the membrane should never be incised before the delivery of the fetus.
- Method of atraumatic delivery ("en caul" cesarean delivery): the fetus is delivered while encased in amniotic fluid, as well as the membrane ("en caul"), which protects the fetus against the pressure of the uterine wall or the surgeon's hands.
- Subsequent neonatal care: the fetus is gently handed to neonatologists with the whole gestational sac including the placenta ("en caul"), following which the membrane is intentionally ruptured by a neonatologist. Own blood transfusion can be made through the umbilical cord and placenta if the neonate is anemic or hypovolemic during resuscitation.

## Indication and Contraindication for "En Caul" Cesarean Delivery

### Total and Partial "En Caul" Cesarean Delivery

Total "en caul" cesarean delivery[1–5] (►**Fig. 3**): the fetus is totally covered in the chorionic and amniotic membranes with the placenta when handed over to neonatologists.

Partial "en caul" cesarean delivery: almost the entire fetus is delivered through the uterus with the wrapped amniotic

membrane, and the membrane is ruptured during delivery by an obstetrician.

### Indication

Total "en caul" cesarean delivery is recommended for fetuses with an estimated fetal body weight (EFBW) under 1,000 g. Partial "en caul" cesarean delivery is recommended for those with an EFBW under 1,500 g.

Twin pregnancies and fetuses with premature rupture of the membrane are also indicated for "en caul" cesarean delivery; however, there are technical difficulties in each of these cases.

### Contraindication

It is same as the conventional cesarean delivery.

### Preoperative Evaluation

Ultrasound imaging of the placenta location and fetal position (cephalic or breech, vertical or nonvertical, and fetal trunk position) should be used for intrauterine safety maneuvering during delivery.

## Surgical Steps

1. Select adequate anesthesia and uterine relaxation
   (a) Combined spinal and epidural anesthesia.
   (b) IV injection of nitroglycerin just before uterine incision.[6]
   ↓
2. Laparotomy
   (a) Low abdominal vertical incision.
   (b) Low abdominal transverse (Pfannenstiel or Maylard) incision.
   ↓
3. Uterine incision
   (a) **U**- or **J**-shape incision.
   (b) Reverse T incision.
   (c) Classical vertical incision.
   ↓
4. "En caul" delivery
   (a) Additional IV injection of nitroglycerin for uterine relaxation, if needed.
   (b) Manually separate uterine wall and amniotic membrane.
   (c) Deliver fetus gently with uterine contraction.
   (d) Rupture the membrane and perform resuscitation.
   (e) Own blood transfusion through umbilical cord and placenta, if necessary.
   ↓
5. Repair the uterine wall and abdominal closure
   (a) As usual.

## In-Depth Explanation

### Select Adequate Anesthesia and Uterine Relaxation

Adequate uterine muscle relaxation will be needed for atraumatic delivery of extremely premature fetuses. If uterine relaxation is insufficient with spinal and/or epidural anesthesia, IV injection of nitroglycerin is recommended.

Nitroglycerin is quite useful and easily administered for uterine relaxation during anesthesia,[6] due to the very short time required for it to take effect (usually within 60 seconds) and the rapid decrease and disappearance of its effects (usually within 5 minutes).

First, 100 µg nitroglycerin IV is administered, followed by an additional bolus of 100 µg nitroglycerine until adequate effectiveness of uterine relaxation is achieved. Usually, 200 to 500 µg nitroglycerine will be needed.

The nitroglycerin bolus IV can decrease blood pressure as a side effect, therefore adequate fluid replacement with crystalloid or colloid fluid before using nitroglycerin should be performed, or alternatively, the use of ephedrine IV if necessary.

### Laparotomy

As usual with cesarean delivery, either transverse or vertical incisions can be selected; however, difficult cesarean deliveries should be avoided, where there is a uterine trapped fetus or pressure stress applied to a premature fetus, by using a smaller skin incision if possible.

### Uterine Incision

Incising the lower segment of the premature uterus is difficult as the uterine isthmus is poorly formed and thick in mothers with extremely premature fetuses; therefore, atraumatic cesarean delivery will be difficult with the usual uterine low transverse incision. Classical vertical incisions, along with reverse **T**- and **L**-shaped incisions, are rather safer in comparison and less traumatic for the fetuses as they are oversized; however, the risk of future uterine rupture will be increased in these cases (►**Fig. 4**).

**U**- or **J**-shaped uterine incisions are ideal for premature fetuses, because it is easy to obtain the adequate size of incision, as well as to extend the incision safely with scissors (►**Figs. 5** and **6**).

Technical tips for uterine incisions for "en caul" or nonruptured membrane cesarean delivery are as follows:

- First make a shallow and wide **U**-shaped uterine incision, followed by a deeper and narrower incision step by step, with the final incision stopping just before the chorionic membrane (►**Fig. 7**).
- Insert the index and middle fingers into the gap between the uterine wall and chorionic membrane, then give the uterine incision a **U**-shape with scissors under the guide of the fingers to avoid membrane and vascular injuries, and extend the incision toward the round ligament if necessary (►**Fig. 6**).

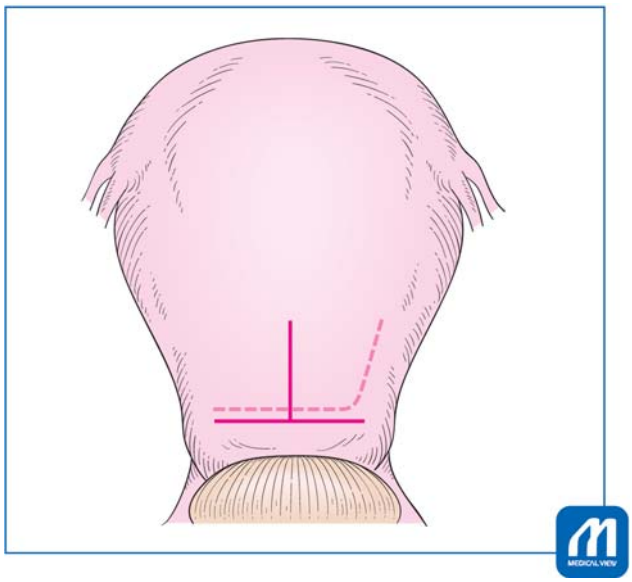

**Fig. 4** Reverse **T**- and **L**-shaped uterine wall incision. When fetus is trapped in the uterus, or is difficult to deliver with a normal lower uterine transverse incision, the uterine incision will be extended as a reverse **T**- or **L**-shaped incision for a less traumatic fetal delivery. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

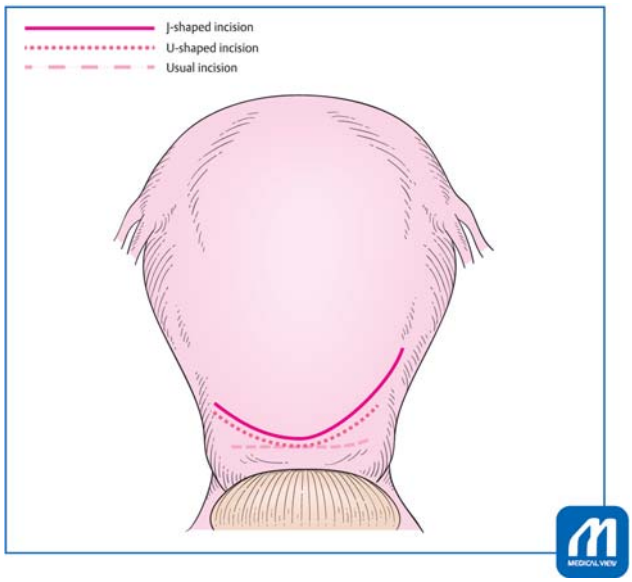


**Fig. 5** **J**- or **U**-shaped uterine wall incision. When the fetus is trapped in the uterus or is difficult to deliver with the normal lower uterine transverse incision, the uterine incision will be extended as reverse J or U-shaped incision for less traumatic fetal delivery. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

## "En Caul" Delivery

As premature fetuses are quite fragile, "en caul" delivery should be performed gently to avoid rupture of membrane. When an adequate uterine incision and relaxation of uterine tone can be achieved, the physician's dominant hand will insert between the uterine wall and chorionic

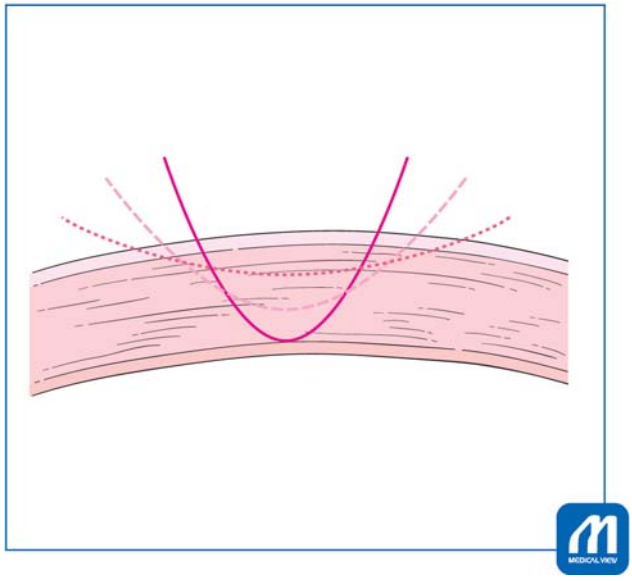

**Fig. 6** Technique for extending uterine incision with scissors. To avoid membrane and vascular injuries, the surgeon inserts the index and middle fingers into the gap between the uterine wall and chorionic membrane, and makes the uterine incision **U**-shaped with scissors under guide of the fingers, extending the incision toward the round ligament (**J**-shape) with sufficient length, if necessary. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

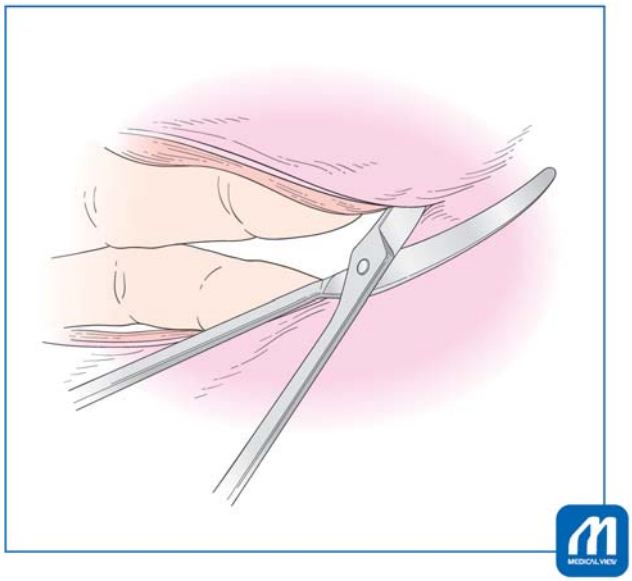

**Fig. 7** Technical tips of uterine wall incision for "en caul" or non-ruptured membrane cesarean delivery. A shallow and wide **U**-shaped uterine incision is made first, followed by a deeper and narrower incision step by step, until finally the incision should stop just before the chorionic membrane. (Reproduced with permission from Murakoshi T. In: Hiramatsu Y, Konishi I, Sakuragi N, Takeda S, eds. Mastering the Essential Surgical Procedures OGS NOW, No.3. Cesarean section. (Japanese). Tokyo: Medical View; 2010: 64–71. Copyright © Medical View).

**Fig. 8** Technique of total “en caul” cesarean delivery. Scissors are used to extend the uterine incision to a sufficient length as a **U**- or **J**-shape, following which the obstetrician’s fingers are inserted into the space between the decidua and the chorionic membrane. After the amniotic sac and the placenta are free from the uterus, the gestational sac bulges out of the uterus with the fetus contained within it. The sac can then be lifted out in an intact state with the placenta (“en caul” cesarean delivery). The **J**-shaped uterine wound was not so long, and was repaired in the usual manner.

membrane, and separate the membrane and placenta from uterine wall widely, with care to avoid placental destruction and rupture of the membrane. Following this, the fetal prominent part (head or buttocks) will lead out of the uterus with the guide of the physician’s hand. An important note is to never tract the fetus, as he or she can be naturally delivered with uterine contraction and uterine pushing (►**Fig. 8**).

After half of the fetus is delivered, the physician will hold the “en caul” baby with the wrapped amniotic fluid and the membrane, which protect the fetus against the pressure of the uterine wall and/or the surgeon’s hands, and support to delivery gently. The placenta will usually separate from the uterus spontaneously; however, manual separation of the placenta will be sometimes needed.

### Repair the Uterine Wall and Abdominal Closure

After delivery of the fetus and placenta, the uterine wall and abdomen are repaired and closed as per the usual manner.

## Tips and Warnings

1. In the case of premature cesarean delivery, maternal anxiety might be higher than with a usual-term cesarean delivery; therefore, it is preferred to use spinal or epidural anesthesia with nitroglycerin as the mother can then contact her baby as soon as its condition is settled in the operating room. The obstetrician should take care of maternal anxiety during the procedure, and should try to relieve her uneasiness.
2. After the "en caul" delivery, the baby will be handed over to the neonatologist team, following which the membrane will be ruptured and resuscitation will start at the infant warmer. The time between placental separation and the start of resuscitation is 30 seconds on average, and in our data, there were no effects of umbilical arterial gas analysis.

Conflict of Interest
None declared.

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