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Introduction

Over the last three decades, there is a steady rise in cesarean sections globally [1]. This has mainly happened due to expanding indications for primary cesarean section. We now perform elective CS in almost all breech pregnancies; preterm labor; various pregnancy situations such as associated medical problems, e.g., diabetes, hypertension, and immune problems; IVF pregnancies; advanced age pregnancies; and morbidly obese mothers. These higher rates of primary cesarean sections have led to very high repeat cesarean section rates! In almost all recent surveys for indications for CS, “previous cesarean section” has become the number one indication, contributing to almost 40–50 % of CS. The US data also shows a rise from 21 % to 32 % in 15 years [2]. These factors like previous cesarean section,

morbidly obese woman, and preterm elective cesarean section have brought in their wake peculiar situations for the delivery of the baby during CS. We have tried to discuss various difficulties encountered in delivering the baby during CS and various means to minimize trauma to the baby as well as to the mother. We have also outlined current concepts and have enlisted suggestions to ease the delivery of the baby with the evidence base. Difficult fetal extraction occurs in approximately one in ten cesarean deliveries, more commonly seen with preterm, elective, and late intrapartum cesarean sections.

In a small survey conducted in our hospital (Smt. SCL Hospital, NHL Mun. Medical college 2003–2004), we found the frequency of indications as previous CS 28.0 %, fetal distress 25.3 %, breech 10.7 %, and CPD 10.7 %.

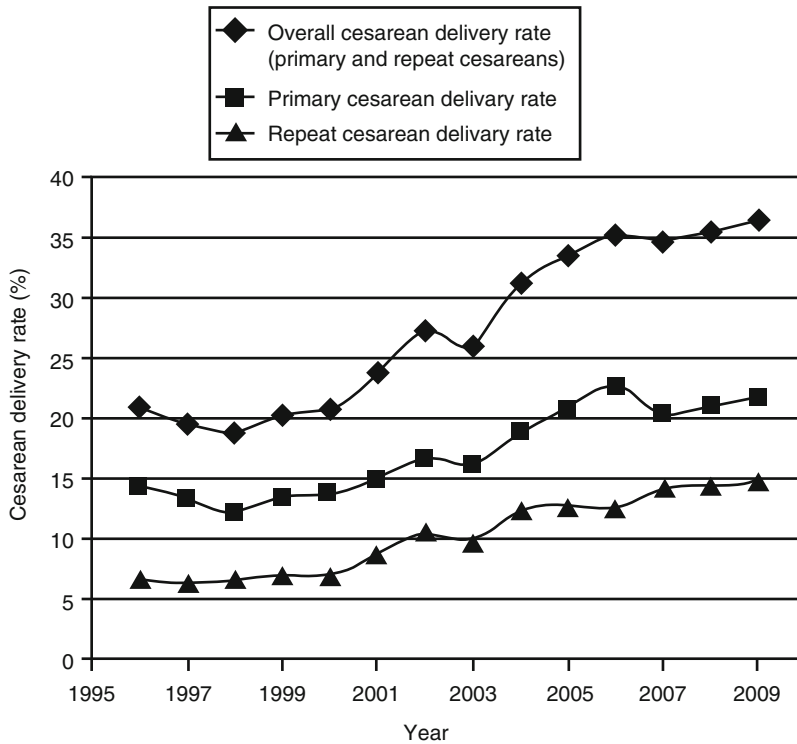
The various difficulties encountered during delivery of the baby can be listed as following:

1. Abdominal wall issues like previous scars, adhesions, and physical disability in the mother.
2. Problems of access to the lower segment like adhesions due to previous surgery, tumors like fibroid in the lower segment, or cancer of the cervix where trauma to the cervix may upstage the cancer. Uterine malformation, torsion of the uterus, and pre-labor CS where the formation of lower segment is incomplete also contribute to the difficulties.

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3. A mal-positioned baby, fetus with high floating head or deeply engaged head may also pose problems in smooth delivery. Placenta previa, especially those located anteriorly, would make the delivery of the baby extremely testing!

segment easily. One may employ the incision according to the need of individual case.

- Adhesions: Adhesions due to previous surgeries in the abdomen, due to endometriosis, or due to extensive pelvic inflammatory disease would cause problems to reach the lower uterine segment.

Abdominal Wall

- Scars over the abdomen: Scars of previous cesarean section/sections or scars of laparotomy may lead to extensive adhesions which can pose problem while entering the abdominal cavity. Inflexible scar tissues may need a slightly bigger incision. Once an adequate sized scar is made, the delivery of the baby is not affected much.
- In general a vertical scar gives easy access to the upper parts of the uterus, but may make access to the extreme lower part of the uterus difficult, especially in an obese woman. A transverse scar gives an easy access to the lower segment, but may not allow access to the upper

Obesity Recent fact sheet published by WHO has shown alarming trends for global obesity. In 2014, more than 600 million adults, 18 years and older, were obese. In 2014 about 13 % of the world's adult population - 15 % of all women were obese & 40 % of all women were overweight. The worldwide prevalence of obesity more than doubled between 1980 and 2014 [3].

Operative and postoperative complications among obese pregnant women include increased rates of excessive blood loss, operative time greater than 2 h, wound breakdown, infection, and endometritis. Sleep apnea occurring in this group of women may further complicate anesthetic management and postoperative care [4].

For obese women who require cesarean delivery, consideration should be given to using a higher dose of preoperative antibiotics for surgical prophylaxis than a normal-weight woman. Attempts to decrease the incidence of wound breakdowns and infections that have been studied include closure of the subcutaneous layers and the placement of subcutaneous drains. Although suture closure of the subcutaneous layer after cesarean delivery in obese patients may lead to a significant reduction in the incidence of postoperative wound disruption, postoperative placement of subcutaneous draining systems has not shown to be of consistent value in reducing postoperative morbidity. Prophylaxis against venous thromboembolism is vital in obese women due to higher risk, and the use of pneumatic compression, elastic bandages, and medical prophylaxis with unfractionated heparin or low molecular weight (LMW) heparin is indicated. An emergency cesarean delivery should not be delayed to start the medical prophylaxis, but mechanical measures may be employed. Postpartum medical prophylaxis is recommended for patients who are at high risk of venous thromboembolism. As there is higher chance of emergency cesarean delivery and more complications, some resource planning like additional blood products, a large operating table, and extra personnel in the delivery is advisable. The type and placement of skin incision will also vary from routine low transverse incision,

and at times one may need to consider placing the incision above the panniculus.

The massively obese group was observed to be at significantly increased risk for delayed delivery and long operative time (emergency cesarean section 32.6 % vs. 9.3 %, prolonged delivery interval 25.6 % vs. 4.6 %, and total operative time 48.8 % vs. 9.3 %, blood loss >1,000 ml 34.9 % vs. 9.3 %, multiple epidural placement failures 14.0 % vs. 0 %, postoperative endometritis 32.6 % vs. 4.9 %, and prolonged hospitalization 34.9 % vs. 2.3 %) [5].

Incision over the abdominal wall beneath the panniculus is avoided so as to prevent wound infection postoperatively. Instead, a supraumbilical approach would give entry to the uterus easily, but cosmetically, it may not look good. The other approach is by lifting the panniculus by a Montgomery strap and putting an incision just above the pubic symphysis, which is cosmetically sound, but it makes access to the uterus difficult [6, 7] (Fig. 34.1).

Conventional wisdom dictated a low transverse incision after pulling up the panniculus by various means and performing the CS and to employ a vertical incision if this was not possible. Both of these had a higher morbidity attached; the low transverse may not be adequate enough for intra-abdominal maneuvers for the delivery of the fetus. It also has a higher chance of post-op infection (due to overlying panniculus reducing aeration

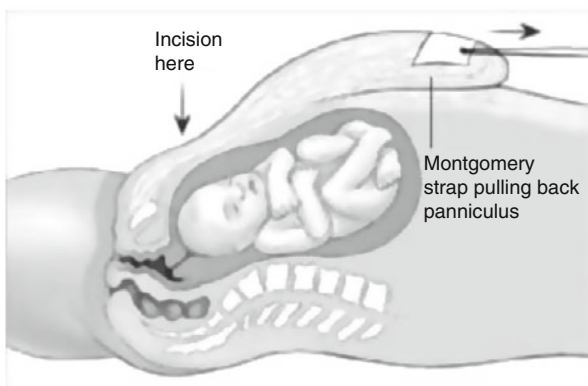


Fig. 34.1 Panniculus

and less drying and irritation due to rubbing). The vertical incision has difficulty in accessing the lower uterine segment, higher rate of disruption, and hernia risk. Current experience has shown that a high transverse incision above the panniculus, after pulling it down as shown in the figure, may be the most appropriate in obese women. When the lower segment has not formed, preterm elective CS, a deliberate transverse incision just below or above the umbilicus, and a fundal delivery of the baby would be the most appropriate. A lower incision and delivery through the lower segment is far more traumatic and risky in comparison to the marginally higher risk (2–3 %) of subsequent rupture. Several recent studies have concluded that if the lower segment seems inaccessible due to large panniculus, it is better to opt for a high transverse incision with fundal delivery for better perinatal outcomes [8–10].

Lower Uterine Segment

- *Adhesions:* Adhesions covering the lower uterine segments, omental flaps extending over the fundus of the uterus, and the urinary bladder adhering high up to the upper uterine segment would cause difficulty in putting an incision over the lower uterine segment. A clear delineation of tissue planes is important for a safe delivery. In some cases where very low transverse incision was employed in a previous CS (Pfannenstiel), at times one may find direct contiguous adhesions between the uterus and the abdominal wall. Such adhesions require sharp dissection and may at times damage the bladder.
- *Tumors in the lower segment (fibroid, Carcinoma cervix, etc.):* Tumors/fibroid in the wall of the lower uterine segment along with its increased vascularity would prevent an easy entry through it. An incision just above the tumor may work well in accessing the uterine cavity and also for post delivery myomectomy if deemed fit. In a pregnancy with carcinoma of the cervix, one needs to be very gentle in handling lower parts of the uterus to avoid dissemination of the carcinoma as well as to avert significant bleeding in case of direct trauma. A fundal delivery may be the most appropriate route since this woman would never become pregnant again!
- *Torsion:* Generally there is dextrorotation of the uterus. Excessive rotation may lead to torsion of the uterus bringing the uterine vessels anteriorly, as shown in the figure. If an incision is placed without correcting the torsion, inadvertent damage to the uterine vessels may occur. A proper orientation and correction of the torsion are very vital in this rather rare phenomenon (Fig. 34.2).
- *Anterior placenta previa:* An anteriorly placed placenta overlying the lower uterine segment can be a major dilemma. An incision through the placenta is to be avoided, as it leads to fetal blood loss. The fetoplacental unit has a blood volume of just 450 ml, and a minor blood loss of 50 ml may be significant for the fetal health. The aim while dealing with placenta previa should be to cause minimum separation of the

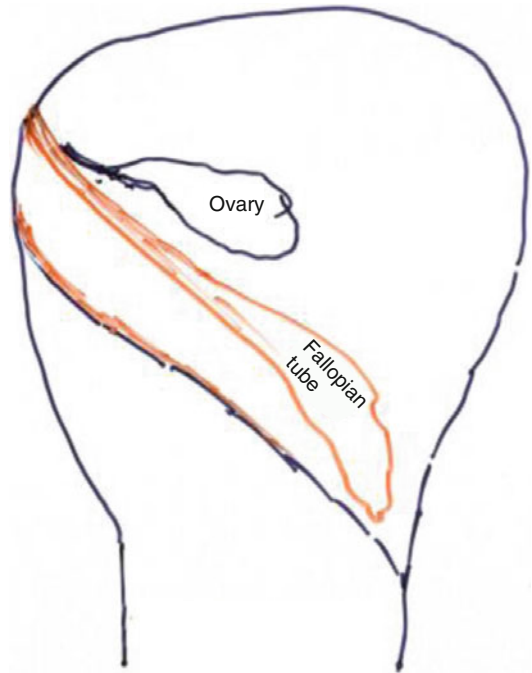


Fig. 34.2 Torsion

placenta to reach the membranes. Separation of the placenta leads to stoppage of oxygen supply to the fetus, leading to fetal asphyxia. Hence one should either dissect the placenta upwards or downwards, whichever side the placental edge is closer, reach the membranes, and rupture them. A preoperative USG mapping of the placenta is very important to help decide the direction of placental dissection. Generally speaking, if the placenta is covering the internal os, membranes are to be ruptured superiorly (toward upper segment) after putting an incision over the lower uterine segment. If the placenta is in the lower segment, but short of the internal os, the rupture of membranes is performed going down toward the cervix after incision. This has to be a very gentle handling as the lower segment is thin and decidualization makes it prone to tear (Fig. 34.3).

- *Transverse lie*: There will be narrow lower uterine segment in the absence of a presenting

part in it. Hence, the incision over this narrow uterine segment would be found inadequate to bring the baby out. An upward extension at the lateral margin of the incision on one side in the form of a “J,” or lateral upward extensions on both sides of incision (like flap valve) in the form of a “U” should be made to get adequate opening and to facilitate safe delivery of the fetus. A midline vertical extension of the transverse incision (inverted “T” shape) is tantamount to a faulty judgment and will result in a weak scar and should be avoided (Fig. 34.4).

- *Poliol/pelvic trauma*: Polio or accidental pelvic trauma would disrupt the normal pelvic anatomy making it difficult to have access to the baby. One needs to improvise according to the alterations in the pelvis and get safe access to the baby, and no “rule of thumb” plan can be proposed.

Difficulties Encountered in Case of Deeply Engaged Head

- *ERR sequence*: Outlined by Andrew Chao [11], ERR sequence is an interesting maneuver for a safe delivery of the engaged head. Although this looks quite complex and a bit too intricate, it is well worth a mention here (Fig. 34.5).

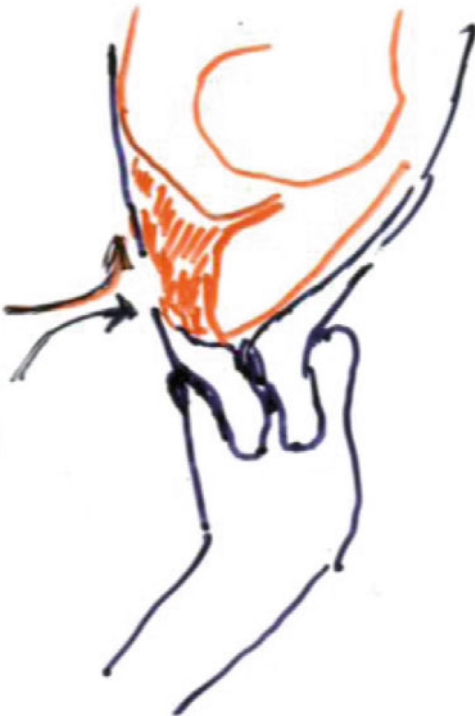


Fig. 34.3 Anterior placenta previa

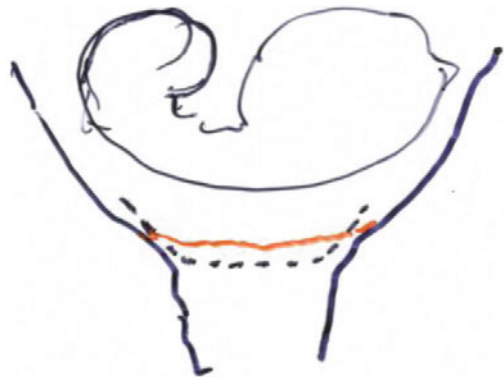


Fig. 34.4 Transverse lie

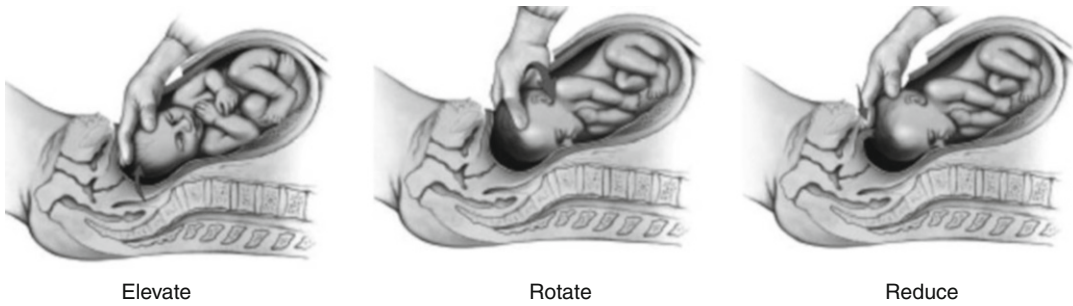


Fig. 34.5 ERR sequence

1. Elevate: Lock the fingers into a quarter-circle around the vertex. Apply traction out of the pelvis with the hand and the entire extended arm.
2. Rotate: Grasp the fetal head between the thumb and fingers and rotate it so the occiput faces the incision.
3. Reduce: Push the lower edge of the uterine incision down until it is posterior to the fetal head.

Too long trial Long trial of labor and failure of vaginal delivery would end up in a deeply engaged head, especially in deep transverse arrest. Baby delivery at cesarean in this situation has difficulty in passing fingers below the head to disimpact and forward pull for delivery. Here a forcible pushing of fingers and hand below the head may be very traumatic with lateral scar extensions and vertical tears toward the bladder. The following options may be employed to deal with this situation:

Push the head up from the vagina In this an assistant remains at the vaginal end between two legs. A Whitmore position is employed to increase the inlet dimensions to facilitate disengagement of a jammed head. As shown in the figure, Whitmore position leads to pressure on the acetabula and opening of the pelvic inlet. This is a modified lithotomy position where thighs are moderately abducted and flexed to approximately 135° relative to the trunk [12] (Fig. 34.6). The moderately abducted thighs would press the bilateral acetabula which results

in more opening up of the pelvic cavity which can allow the push from below for delivering deeply engaged head. The vaginal hand pushes the head up out of the pelvis which can then be flexed and delivered by the abdominal hand (Fig. 34.7).

Intravenous nitroglycerin IV nitroglycerin bolus has been tried successfully to relax the uterus temporarily. Once the uterine muscle relaxes a little bit, one may be able to glide fingers below the head and dislodge it for a smooth delivery. An IV bolus of nitroglycerin (0.25–0.5 mg) will relax the uterus for approximately 20 s, long enough to pass fingers below the head. The anesthesiologist needs to be taken in to confidence as a short but steep dip in blood pressure is anticipated. Nitroglycerin does decrease the blood supply to the uterus, but the bolus dose has a transient effect which doesn't cause any fetal hypoxia. Intraoperative nitroglycerin application during cesarean section has no unfavorable effect on the condition of newborns <32 weeks or between 500 and 1,500 g. The incidence of intraoperative maternal blood loss >1,000 ml was not increased. Differences in the interval between nitroglycerin application and cutting of the umbilical cord have no clinically relevant effects on Apgar scores or arterial umbilical pH [13, 14].

Pull from above Patwardhan described two maneuvers for different situations [15] (Fig. 34.8):

1. *Back anterior*: If the back is anterior and the head is deeply engaged, one needs to deliver

Fig. 34.6 Modified lithotomy position

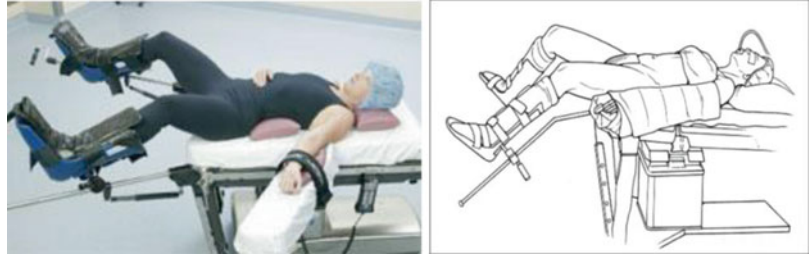


Fig. 34.7 Push from below



Fig. 34.8 Pull from above

one hand and the shoulder out of incision, to be followed by the second hand and the shoulder. Thereafter, the further pull in the groove of the abdomen will double up the child, and gradually the lower back, buttocks, and the legs will be delivered. Subsequent pull on the baby will bring out the head at last.

2. *Back posterior (reverse breech delivery/foot extraction method)*: If the back is posterior and the head is deeply engaged, the feet are in the front. Passing the hand up from the abdomen and pulling down the feet is easy, followed by the buttocks, and the head is delivered at the end.

Back lateral In almost a similar way, the operator's hand is passed to the opposite side, and the

foot is grasped and pulled down and out. The buttocks, trunk, and the head will follow.

Pull vs. Push In general it has been found that a push from the vagina is more traumatic to the baby as well as to the genital tract [16–20]. A pull from above, by pulling at the foot (reverse breech extraction), is safer for both the newborn and the mother. Several studies have confirmed this.

Short Simpson's Forceps

Vectis Mechanical disengagement of the fetal head has been tried since ages (Fig. 34.9). A thin metal blade of an instrument occupies much lesser space than fingers. A "spoon-shaped device," also called a "Vectis," works

quite well. The blade is passed between the lower segment and the fetal head till the device handle touches the symphysis pubis. Further sliding leads to fulcrum effect at the symphysis and lifts the fetal head up and anteriorly. Simultaneous fundal pressure will lead to delivery of the head. To facilitate easy insertion, a device with a hinge is also available. Vectis with a flat blade avoids tissue locking into the fenestrum. Murless head extractor is also an innovative design of a Vectis [21] (Fig. 34.10). In the absence of a special device, a single short straight blade of Simpson's forceps can also be used effectively.

Head disengaging device In a bid to disengage a deeply impacted fetal head from the vagina, a new device has been developed and tried in the UK. Known as "Fetal Disimpacting System," the device is used vaginally. The deflated device is folded and placed just above the pelvic floor. It is then distended by injecting into it 100 ml saline (range 60–120 ml). A study showed mean

elevation of 3 cm with this [22] (Figs. 34.11 and 34.12).

A simple but innovative device (Snorkel) to disengage a deeply engaged head is worth a try (Figs. 34.13 and 34.14). This simple disposable device has a flat pad with multiple holes, which is attached to a tube to blow air into it. The flat pad is inserted vaginally, and is guided posteriorly, between the head and the genital tract. Once in place air is blown into the tube, creating an air pocket below the head, allowing easy passage of fingers below the head during CS [23].

The problem of dealing with deeply engaged head or a CS during stage II of labor can be very taxing. In a recent survey among resident doctors in the UK, it was confirmed that a majority of them were not confident of dealing with this situation. The sentinel audit report published by the RCOG recommended a consultant's presence whenever cesarean section is performed at full dilatation. It also goes on to say "Proper training of resident doctors should be done for delivery of deeply engaged head," underlining the need for special emphasis on this skill development in residency training program [24].



Fig. 34.9 Vectis



Fig. 34.10 Murless head extractor

Floating head Difficulties encountered in case of floating head can be due to an elective pre-labor CS, too large head, preterm fetus, hydramnios, placenta previa, etc.

To ease up the head delivery, the first option is to induce uterine contractions to facilitate descent and expulsion. One should rupture the membranes and let the liquor drain out. The reduction in the volume inside the cavity will bring about uterine contraction. A simultaneous oxytocin infusion will help augment these contractions. A predelivery infusion of dilute oxytocin may achieve the same results, but care must be taken to avoid uterine hyperstimulation and resultant fetal compromise. Since the head is difficult to grasp and pull with a gloved hand, either pulling devices like vacuum extractor or obstetrical forceps may be employed, or the foot

Fig. 34.11 Head disengaging device 1a

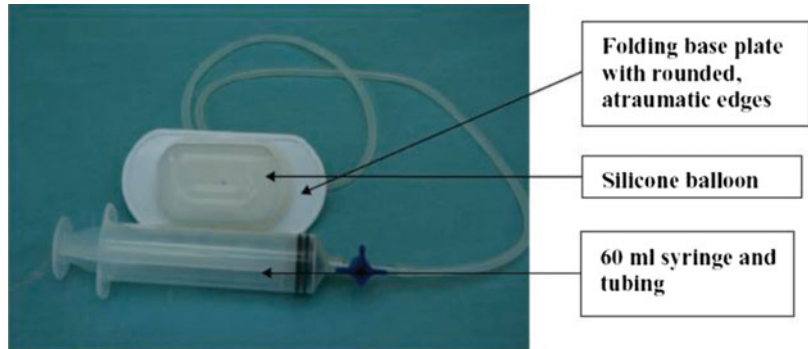


Fig. 34.12 Head disengaging device 1b

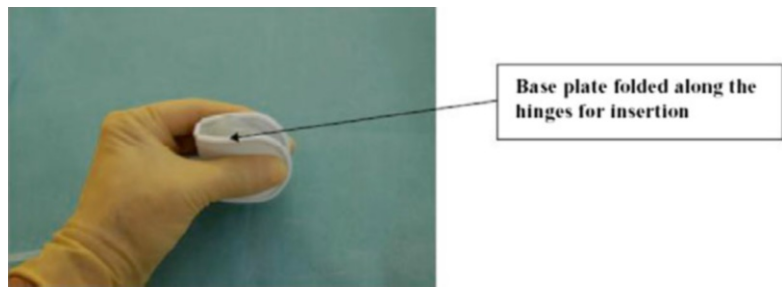


Fig. 34.13 Snorkel 1a

extraction by reverse breech delivery may be employed. In case of foot extraction, one may need to act swiftly, and should not let much drainage of liquor, to allow the fetal somersault during the delivery!

Forceps/vacuum Both forceps and vacuum have been tried for delivery of a floating head.

Forceps: Short Simpson’s forceps without a pelvic curve is the best suited instrument for head delivery (Figs. 34.15 and 34.16). Generally the head will be in one of the transverse positions. Hence there will be a posterior and an anterior application. The anterior application can be

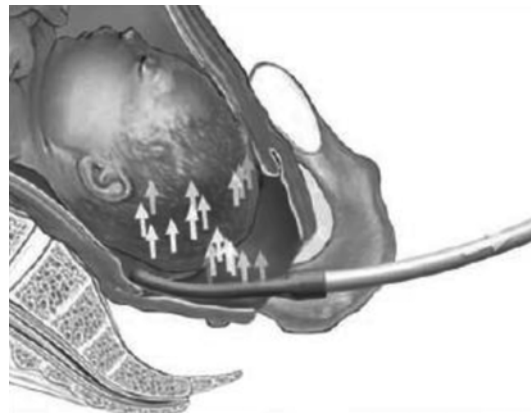


Fig. 34.14 Snorkel 1b

difficult at times. The Barton’s forceps with a hinged anterior blade is being proposed as a great tool to avoid this difficulty of application! The shank angling is also beneficial in easy application than straight shanks of a Simpson’s forceps.

After application, one should rotate the face anteriorly (occiput posterior) in a bid to reduce the transverse dimension of the head, and then pull out in a rotational arc toward the chest of the mother. Some colleagues rotate the face first to

the anterior by inserting a finger in the mouth of the baby holding firm, and using a direct lateral application of the forceps blades on each side of the head! A direct pull out in transverse is also quite reasonable as in routine CS the head is delivered in a transverse position.

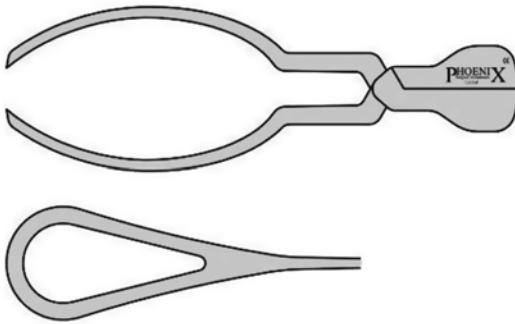


Fig. 34.15 Forceps



Fig. 34.16 Forceps

Barton's forceps An effective aid in cesarean deliveries. The unique qualities of this classic medical instrument make it an effective, ergonomic option for cesarean deliveries involving a high transverse position of the fetal head [25] (Fig. 34.17).

Vacuum Vacuum delivery of the floating head seems very plausible (Figs. 34.18 and 34.19). But the correct application is very vital. Otherwise it may harm the fetus rather than facilitate the delivery. A correct application would be on the flexion point, the point at which the mento-vertical diameter crosses the sagittal suture, promoting flexion of the fetal neck. This will result in lesser traction force required to deliver the baby. A misplaced cup is the cause of majority of the complications. As most of the vacuum cups are designed for vaginal use have the pulling direction perpendicular to the device, their use during CS where the traction angle is almost a tangent, is ineffective. This leads to situations where the cup either slides over the scalp or it comes off due to the angle of the pull. To help an easy and optimally directed pull, special vacuum cups for CS are now designed. The Omni C is one such cup. The figure itself is self explanatory! While applying the vacuum cup to



Fig. 34.17 Barton's Forceps

Fig. 34.18 Compare vacuum cup design for vaginal delivery and CS application

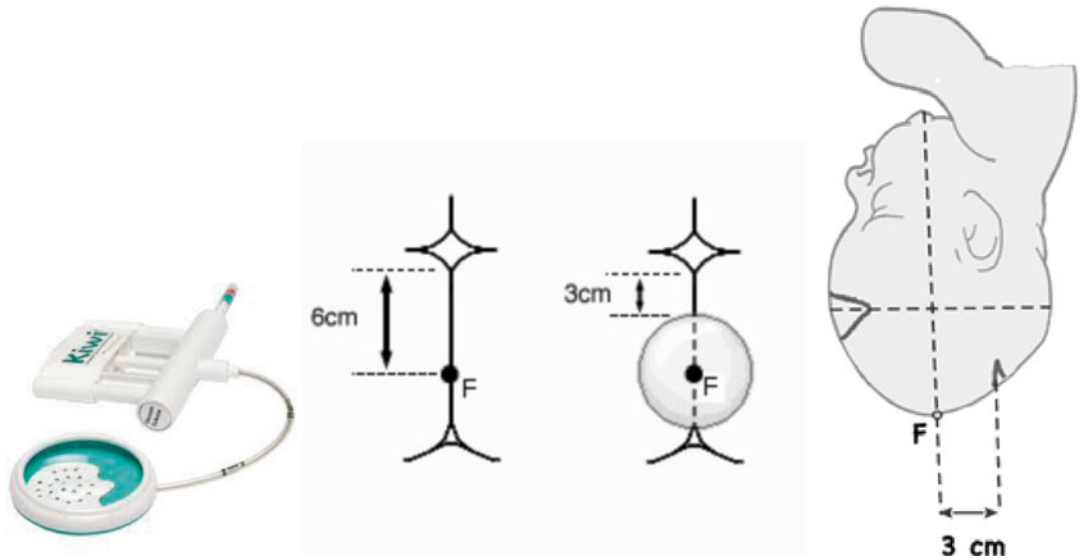
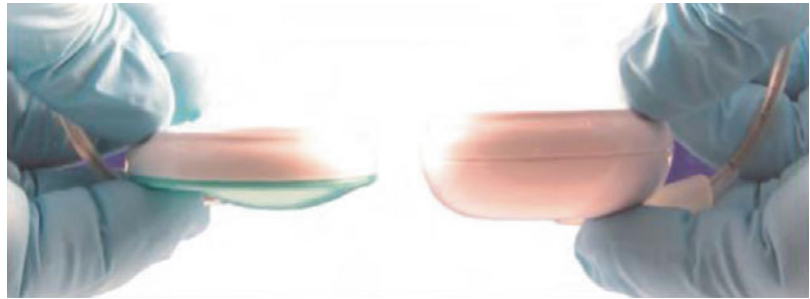


Fig. 34.19 Vacuum cup and flexion point

the scalp of the fetus, a tedious interphase of liquor may test the patience of the operator [26] (Fig. 34.20).

Kiwi Omni C cup is a type of rigid “posterior cup” indicated for cesarean section.

Malpresentations

Transverse lie (1:300 deliveries): There can be a curve of the fetal spine oriented upward (dorso-superior) in which fetal small parts present at the cervix, or the curve of the fetal spine can be oriented downward (dorso-inferior) in which fetal shoulder presents at the cervix. In dorso-superior the delivery is easy as the feet are lying in the vicinity of the cervix. A direct pull on one of the



Fig. 34.20 Kiwi Omni C cup

feet and gradual delivery will be easy. But the more difficult situation is dorso-inferior. Here if the surgeon is sure of the lie of the fetus, he

should push the head of the fetus up toward the fundus before putting an incision on the uterus. With an assistant pushing the head up, the buttocks will come closer to the cervix and will help gripping one of the feet or insert a finger in the groove of the breech. Otherwise, the foot principle (reverse breech extraction) is the best option. Sometimes, if the lower segment is too narrow, a lower segment vertical incision on the uterus may be an option.

Breech presentation is one of the easiest presentations to deliver at cesarean section, even easier than a cephalic presentation. One can always track the foot from the buttocks and pull it out and thereby conduct delivery. Breech complicated with 1 ft in the vagina of locked twin would need extra caution so as to avoid any fetal trauma/maternal tears.

Malformed uterus Malformed uterus generally leads to nonvertex presentations. So, very close deliberate examination to confirm not only fetal lie but position of the back and feet becomes vital in conducting delivery. A general rule of thumb of following foot and delivering the baby would be least traumatic to baby as well as to the uterus.

Twins/multiple pregnancy Clear detailed examination to know the lie and position of the first fetus and possibility of locking of the second fetus is to be anticipated. “First breech and second vertex” twins are the most high risk for locking, and this should be anticipated in this combination [27]. Generally, in case of the sec-

ond fetus, rupture of membranes followed by foot extraction is a preferred mode of delivery because of the time lapsed already in the delivery of the first fetus. The second fetus is always at disadvantage because after the delivery of the first fetus, uterine contractions lead to reduction in placental perfusion and any delay would aggravate compromise in fetal oxygenation, so a prompt delivery of the second fetus is always planned. An oxytocin infusion is started soon after the delivery of the first baby to help quicker delivery as well as to reduce the chance of PPH.

Overstretched Lower Segment (Bandl's Ring)

This rather rare and curious condition can create problems in the delivery of the baby during CS (Fig. 34.21). Due to extended labor and prolonged drainage of liquor amnii, the upper segment of the uterus retracts and thickens, leading to overstretching of the lower segment. This differential thickness is pronounced at the junction known as Bandl's ring. This narrowing leads to holding of fetal parts above it at the time of delivery. A forcible delivery through this ring may produce trauma to the uterus. It is vital that either the ring is reduced by giving uterine relaxants like nitroglycerin, or the ring is deliberately cut at its anterior part for a safe delivery. Hence a lower segment vertical incision on the uterus extending and cutting through the ring is the most appropriate method of delivery during CS.

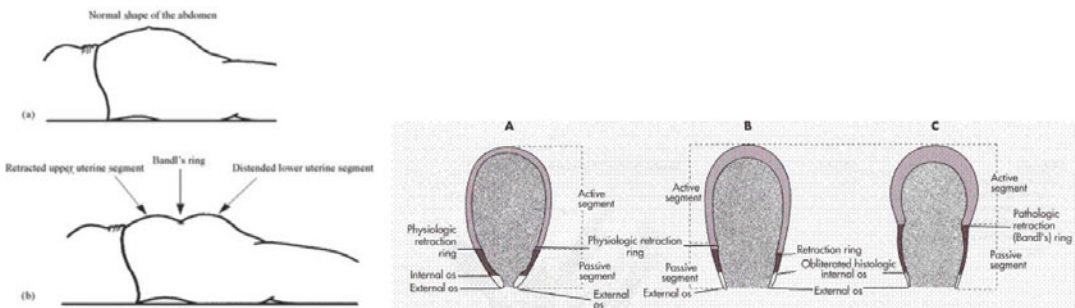


Fig. 34.21 Bandl's Ring

Conclusion/Summary

The rates of cesarean sections are on the rise. The delivery of the fetus at Cesarean section can be testing, and in approximately 10% of cesarean sections, the operator encounters difficulty in the delivery of the fetus. The rising rates of primary cesarean sections have contributed to a large number of repeat cesarean section. These repeat C sections, along with preterm, elective & late intra-partum C sections lead to higher possibility of difficult fetal extraction

- Access to abdominal cavity has to be planned ahead in consultation with the patient.
- An inaccessible lower segment is not an end of the world situation. Upper segment C section can be a valid option & should be seriously considered, if serious harm is anticipated in accessing the lower segment.
- Floating head should be allowed to descend by letting the liquor drain and let the uterus contract by using oxytocin. A delivery by pulling at & delivery of the foot first, or use of vacuum/forceps will help.
- Deeply engaged head: A semi-lithotomy position, reverse breech extraction, use of I/V nitroglycerine, and use of disengaging devices are safer options.
- Obese women: A horizontal incision above the panniculus, at times going supra-umbilical will facilitate the smooth delivery. A fundal delivery of the baby may be considered.
- In cases of anterior placenta previa a detailed mapping of its margins will help decide the side where the membranes may be accessed with minimal separation of placenta & avoid incising the placenta.
- An emphasis on training the resident doctors for intra-partum C sections will increase their confidence and efficiency.

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