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Advantages of Vaginal Delivery

CATALIN S. BUHIMSCHI, MD and IRINA A. BUHIMSCHI, MD
Department of Obstetrics, Gynecology and Reproductive Sciences, Yale University School of Medicine, New Haven, Connecticut

Despite an impressive amount of effort and extensive research, our knowledge of parturition remains limited. Scientists have exhaustively investigated "the timing of birth"; yet, we still have a limited understanding of the biologic mechanisms that control the events initiating delivery, and consequently, we lack tools to prevent these mechanisms from acting inappropriately. A multitude of factors and structures are involved; the uterus, the cervix, the placenta, and the fetus must all act in concert to ensure a successful delivery. We know that achievement of "perfect" myometrial contractile force to produce cervical dilatation is not the sole factor. Successful delivery also depends on pelvic shape and size as well as fetal size.

Birth is perhaps the most exciting and risky journey taken over a lifetime.[1] For many years, labor was simplistically regarded as the physiological process of expelling the fetus from the "womb" at or near term. Today, terms such as "labor" and "successful vaginal delivery" have a different meaning for many who have concentrated their attention on maternal and fetal short- or long-term outcomes of a successful or unsuccessful vaginal birth, but also for the ones who have witnessed the evolution of obstetric "fashion." Rational arguments have imposed a clear distinction between "facts" and "convenience."[2] Practice changes as knowledge progresses.

Correspondence: Catalin S. Buhimschi, MD, Yale University School of Medicine, Department of Obstetrics, Gynecology and Reproductive Sciences, 333 Cedar Street, New Haven CT 06510. E-mail: catalin.buhimschi@yale.edu

One of the changes witnessed in the last decades is a steadily increasing focus on the fetus. Thus, it is not surprising to see that the overall rate of labor induction has doubled as part of our efforts to "save life."[3] Although there is compelling evidence to suggest elective induction of labor significantly increases the risk of cesarean delivery (CD),[4] the concept of elective primary cesarean section is not anymore a "myth."[5]

Powerful debate is taking place in obstetrics regarding the benefit of cesarean over vaginal delivery. Several lessons can be learned from this controversy, and skepticism must be countered only by solid lines of evidence. The purpose of this review is to provide the reader with a summary of our current understanding of the advantages of vaginal delivery.

Cesarean Section—A National Policy

During the 1970s and 1980s, the rates of CD increased progressively throughout the world, although in some countries more than others. Still, what 20 years ago was appreciated to be an "American problem"

is becoming now an international crisis. The CD rate in Norway increased from 2% in 1968 to 12.6% in 1990 and reached 13.4% in 2000.[6] In Europe and the United Kingdom, the increase was also dramatic, doubling from 11% of all deliveries in the 1990s to over 22% in 2001.[7,8] Puerto Rico has a rate of 31%, whereas Brazil has reached an all-time record of 35%.[9] CD is the most frequent major surgical procedure performed in the United States.[10] The increase in both emergent and elective CD generated considerable debate regarding possible contributing factors such as level of medical training, defensive medical practice, increased maternal age at the time of first pregnancy, and most recently, the "celebrity" factor related to the issue of CD "on demand" for lifestyle reasons. As a consequence, for the last 20 years, lowering the rate of CD has become a national goal.[3] Although in the 1980s' growing concerns related to a continuing increase in the rate of CD resulted in establishment of a national strategy to address this trend, the CD rate in 2003 for all primiparous women reached an unprecedented national level of 27.1%; for low-risk women, the rate was 23.6%.[3] Yet, in some individual medical centers between the years 2000 to 2003, the rate of CD increased to almost 60%.[11] In response to this dramatic increase in the rate of CD, the U.S. Department of Health and Human Services issued recommendations aimed at reversing or at least halting the trend.[12] Interestingly, for the first time, the objective changed from lowering the overall CD rate to reducing only the rate for low-risk women, setting new targets at 15% for primary and at 63% for repeat CDs. Specific and clear guidelines for trial of labor and labor management, continual labor support, strong physician leadership, and intradepartmental distribution of outcomes are proposed strategies to reach the goal.[13] Development of a large-scale obstetric quality improvement program, which considers outcomes globally, rather than individually (maternal vs. fetus), was recommended.[14]

Regardless of any recommendations or policies, it is of utmost importance that the outcomes of all deliveries (for both mothers and their fetuses) be closely monitored to assure that changes in the mode of delivery or guiding principles do not put women and their children at risk. Nevertheless, arguments concerning vaginal delivery versus CD remain unresolvable as a result of our limited knowledge of the physiopathology of fetal adaptation to labor and short- and long-term outcomes of the fetus and its mother.

The Fetus

There has been a considerable reduction in the neonatal and perinatal mortality rate for the last 50 years.[15] However, the specific relationship between CD and perinatal mortality and morbidity is not well defined, questioning whether CD before labor or attempted labor and vaginal delivery is more beneficial to the unborn fetus.[16] Researchers have spent decades trying to define the complex process of human labor.[17] Labor is currently viewed as the result of a physiological release from an inhibitory effect of pregnancy on the myometrium rather that an active process mediated by contractile agonists.[18–23] Despite the current lack of understanding of the precise sequence of molecular events leading to the onset of uterine contractions, there are some features of parturition common to all species.[21]

The normal contractile waves of labor originate at the uterine fundus and spread rapidly.[24] Whereas contractile forces must be uniformly distributed inward toward the uterine cavity, the syncytial structure of the myometrium requires the dominant expulsive vector during active labor to be oriented from the fundus toward the cervix at the expense of vascular collapse.[25] The anatomy of the uterine vascular tree may profoundly alter blood flow. Doppler assessment of maternal uterine and fetal umbilical artery blood flow suggests that fetoplacental blood flow of compromised babies may be

profoundly altered during labor contractions, but not during Braxton Hicks contractions, questioning whether the degree of interruption or reduction in blood flow may be related to the intensity of uterine contractions.[26,27] Studies on fetal middle cerebral artery blood flow also suggest that intracranial hemodynamics could change dramatically even in the normal fetus.[28] Experimental evidence suggests alterations in uterine circulation could be even more dramatic in fetuses with growth restriction.[29] Therefore, it makes sense to assume the fetus manifests well-integrated defense mechanisms aimed to protect it from injury.

BENEFICIAL IMPACT OF LABOR ON NEONATAL RESPIRATORY MORBIDITY

There is substantial evidence to suggest that CD is associated with a high risk of short- and long-term complications.[30,31] Respiratory distress syndrome (tachypnea, dyspnea, intercostal retractions, cyanosis, nasal flaring) along with prematurity represents the leading cause of admission to the neonatal intensive care units (NICUs).[32] A considerable amount of research has focused on the origin of neonatal respiratory morbidity both at term and preterm.[33–35] The observation of a possible association between an increased incidence of respiratory distress syndrome in infants delivered by CD dates back to the 1940s.[36] Several explanations have been offered, including aspiration of amniotic fluid or blood at the time of surgery or prevention of significant fetal placental perfusion at the time of CD.[36–38] The original work of Usher and his collaborators[36] captured the attention of numerous investigators, so for the past 30 years, a significant number of studies confirmed a higher incidence of neonatal respiratory morbidity with respiratory distress from the CD group, especially elective CD,[39–42] although the underlying mechanisms remain obscure.

Several studies hypothesized that CD increases the risk of postnatal respiratory complications by preventing the thoracic compression associated with vaginal delivery.[43] Others hypothesized that the concentration of lecithin–sphingomyelin and surfactant protein A concentrations are lower when infants are delivered by elective CD compared with the infants born vaginally or by CD after onset of labor.[44] In his original work, Morrison determined that the risk of neonatal respiratory morbidity at term was 2.2 per 1000 deliveries. The incidence of transient tachypnea was 5.7 per 1000 deliveries. According to their analysis, the incidence of respiratory morbidity was significantly higher for the group delivered by CD before the onset of labor compared with CD during labor (35.5 vs. 12.2 per 1000 deliveries) or compared with women delivered vaginally (35.5 vs. 12.2 vs. 5.3 per 1000 deliveries). Moreover, there was almost a doubling in the risk of respiratory morbidity with each week if an elective CD is performed at less than 39 to 40 weeks of gestation. The authors concluded that a significant reduction in neonatal respiratory morbidity would be obtained if an elective CD was performed in the 39th week of pregnancy rather than earlier.[39] Similar conclusions were drawn by other investigators who suggested that infants who were delivered by CD at 37 to 38 weeks were more likely to require greater respiratory support (mechanical ventilation for surfactant deficiency and oxygen therapy) than infants who were delivered vaginally. Conversely, Annibale found that the increased incidence of neonatal respiratory morbidity occurs independently of whether infants are delivered vaginally or by repeat elective CD.[45] Despite the controversy, there is consensus that delaying the time of elective procedure from 37 to 38 weeks to 39 to 40 weeks will reduce the risk of respiratory morbidity in healthy neonates. Similarly, there is consensus that performance of a planned CD at labor onset is a rational policy.[46,47]

A wealth of data reveals that conditions in utero affect the health of the fetus before and after birth.[48] For example, stress may increase the risk of a child to develop diseases

later in life. Notwithstanding the marked genetic component of asthma, genetic factors cannot fully explain its rapid increase in frequency.[49] Labor may be an immunologically beneficial process for the neonate,[50] and thus because the activity of several immunologic factors such as neutrophils and natural killer cells could be modulated by labor, several authors expressed concern that a rise in the incidence of asthma could be explained by the parallel increase in the frequency of CD.[42,51] In a 2002 study, Kero and his collaborators[40] followed a cohort of 164 women who underwent CD. The cumulative incidence of asthma at the age 7 was significantly higher in the study group than those delivered vaginally (odds ratio [OR] = 1.27, 95% confidence interval [CI] = 1.13–1.42). In 2004, a study by Smith et al evaluated whether neonatal respiratory morbidity at term is associated with an increased risk of asthma in childhood.[42] The authors examined the Scottish Morbidity Record for a period of 3 years (1992–1995). Infants who experienced neonatal respiratory morbidity were at increased risk of hospital admissions with a diagnosis of asthma in late childhood.[42] Their analysis was also supportive of a trend for stronger association between neonatal respiratory morbidity among babies delivered by CD. The association between neonatal respiratory morbidity and later asthma was not significantly different according to whether the procedure was planned or emergency.

Several other studies evaluated prospectively the relationship between CD and the risk of asthma in adulthood. A study by Xu et al successfully followed over 6000 patients up to 31 years of age. At the conclusion of their study, the authors demonstrated that there was a strong association between CD and asthma (OR = 3.2, 95% CI = 1.53–6.80). This association was not established for other immunologic disorders such as atopy, hay fever, or atopic eczema. In summary, a number of studies indicate that infants born by elective CD have a greater risk of neonatal respiratory morbidity. Delaying the performance of CD after onset of labor may reduce the risk of respiratory distress.

BENEFICIAL IMPACT OF TERM LABOR ON THE ANTIOXIDANT RESERVE OF THE HUMAN FETUS

Oxidative homeostasis is required to prevent injury to cellular components. Oxygen-derived free radicals are normal byproducts of aerobic metabolism.[52] Most living organisms have developed well-integrated antioxidant defense mechanisms aimed to scavenge free radicals and control their intracellular concentration.[53] The mechanisms include enzymes (eg, superoxide dismutases, catalase, and glutathione peroxidases) and small, soluble molecules (eg, β-carotene, vitamin C [ascorbic acid], vitamin E, and glutathione).[54] A loss of balance between free radicals and antioxidants is one mechanism of cell injury in diseases associated with hyperoxygenation, ischemia/reperfusion, and inflammation.[55] During labor in healthy women at term, uterine contractile activity may generate reactive oxygen species through the process of repetitive ischemia and reperfusion. We previously proposed that oxygen-free radicals are central to the process causing fetal compromise associated with diseases of high oxidative stress such as intrauterine or maternal inflammation.[56] Consequently, we and others[57] projected that the fetal and/or maternal reserve of antioxidants during labor would determine, to at least some extent, the ability of the neonate to adapt ex utero. We tested aspects of this hypothesis by investigating whether the first line of defense against free radicals, nonenzymatic antioxidant reserve in either mother or fetus, was altered by delivery route (vaginal vs. cesarean without labor) or gestational age (term vs. preterm). The results of our investigation demonstrate that nonenzymatic antioxidants (glutathione), which are the first line of defense against free radicals, differ in the plasma and erythrocyte compartments of mother and child (Fig. 1). We further conclude that normal term labor is associated with glutathione loading of both

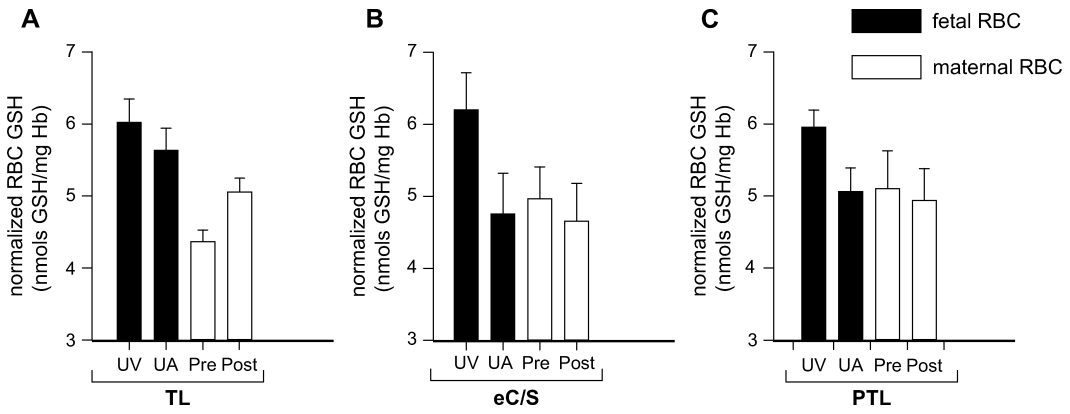

FIGURE 1. Glutathione content of fetal red blood cells from the umbilical artery (UA) and umbilical vein (UV) and of maternal red blood cells from maternal venous blood collected pre-(Pre) and postdelivery (Post). (**A**) Labor at term (TL, n = 22); (**B**) elective cesarean section (eC/S, n = 8), and (**C**) labor preterm (PTL, n = 11).

maternal and fetal red blood cells. Women who labored at term experienced an upregulation in red blood cells glutathione content (Fig. 1A) compared with elective CD (Fig. 1B), whereas their fetuses had significantly lower red blood cell glutathione consumption (Fig. 2). In contrast, there was consumption of antioxidants as illustrated by increased nonenzymatic antioxidant reserve consumption in newborns delivered by cesarean.

However, the preterm neonates did not respond to labor as does the term neonate (Fig. 1C). There was consumption of plasma antioxidants in preterm fetuses, indicating that glutathione metabolism is affected by prematurity (Fig. 2). In summary, our novel observations indicated that labor triggers an upregulation of glutathione in term fetuses and demonstrated that labor itself may play a significant fetal protective role against oxidant injury in early life. This added protection was lost with elective CD. Time will decide whether alterations of the nonenzymatic antioxidant reserve in conjunction with maternal hyperoxygenation encountered at the time of CD bear any long-term consequences for the human fetus.

STILLBIRTH

The rate of fetal deaths, especially early fetal deaths (less than 28 weeks of gestation), increased almost 1% from 2001 compared with 2002.[58] In parallel, the U.S. infant mortality rate increased slightly from 6.8 infant deaths per 1000 live births in 2001 to 7.0 in 2002. This was the first increase in more than 40 years. Changes in medical management of pregnancy, including the increase in the incidence of induction of labor or CD, were assumed to be responsible. However, the idea that CD in the first pregnancy might be associated with an increased occurrence of unexplained stillbirth in the second pregnancy was not considered before the study of Smith and his collaborators.[59] The risk of unexplained stillbirth associated with prior CD differed significantly with gestational age and became apparent from 34 weeks of pregnancy. The absolute risk of unexplained stillbirth at 39 weeks for women who had a prior CD was 1.1 per 1000 women. This risk was significantly higher compared with the women who had no surgery in the past. Interestingly, the risk of stillbirth in the second pregnancy was not dependent of whether the first CD was performed before

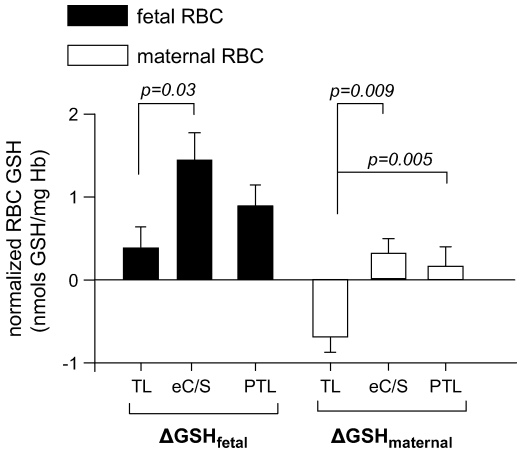

FIGURE 2. Glutathione gradients ΔGSHfetal (indicator of peripartal fetal GSH consumption: UV-UA GSH) and ΔGSHmaternal (indicator of maternal peripartal GSH consumption: maternal pre–postdelivery GSH) in women who delivered by labor at term (TL, n = 22); elective cesarean section (eC/S, n = 8), or labor preterm (PTL, n = 11).

or after onset of labor, and neither did it vary with a prior operative vaginal delivery (forceps or vacuum extraction) or with the duration of labor. Several explanations are biologically plausible. It is probable that a prior CD results in ligation of major uterine blood vessels, which may in turn result in a high-resistance blood flow pattern. Consequently, this phenomenon may further impact on implantation and placentation during a subsequent pregnancy. Development and routine clinical use of Doppler techniques improved our knowledge in the area. Today, there is substantial evidence to suggest that abnormal tissue oxygenation and high vascular impedance could result in maldevelopment of the villous tree,[60] which may secondarily explain a possible association between a prior CD, abnormal placentation, and an increased risk of stillbirth. Consistent with this interpretation, stillborn fetuses in women with prior CD were smaller compared with those of other women.[59] The findings of Smith's paper seem to suggest that birth by CD carries sufficient risk for the future offspring to adopt a cautious approach to CD in the first pregnancy.[61] Arguments about the importance of the absolute and relative risk of an elective CD at term have been a feature of several public debates, including the recent findings by Bahtiar et al who did not verify an increased risk of stillbirth in women with prior CD in the United States.[5,62] Still, if women are being counseled about CD on demand versus vaginal delivery, the potential risk of stillbirth in a subsequent pregnancy should also be discussed.

NEONATAL TRAUMA

It is well known that the rate of complications in unplanned surgery is higher than that of planned CD.[6] Infant injury during birth, whether vaginal or abdominal, is a constant threat. Along with respiratory compromise and delayed neurologic adaptation of the neonate,[63] iatrogenic trauma of the infant at the time of surgery is also an adverse outcome of the CD.[64] Fetal injury at the time of CD is not rare, especially when it is performed for nonvertex presentation or because of an emergency.[65] A minority of obstetric records show documentation of such lacerations, suggesting that this complication often may not be recognized by obstetricians. Nor does CD protect against other complications such as brachial plexus palsy.[66] The mechanism behind such injury is acute stretching of the brachial plexus against which a CD appears to be nonprotective.

NEONATAL ADAPTATION

The endocrine and metabolic adaptation of the fetus to extrauterine life is a complex phenomenon. With the transition from intrauterine to extrauterine life, several changes occur in the function of the hypothalamic–pituitary–adrenal axis.[67] It was previously suggested that the modality of delivery may significantly impact on the fetal thyroid and adrenal response to stress, which may in turn be responsible for higher or lower

postnatal morbidity.[68] For example, the mean umbilical plasma concentrations of thyroxine and triiodothyronine were significantly higher and cortisol concentration was lower after elective CD compared with fetuses delivered vaginally.[69] Nevertheless, the mean umbilical plasma thyroid-stimulating hormone concentration was significantly lower after vaginal delivery compared with elective CD. Otamiri et al[63] observed that infants born after elective CD were less excitable and had significantly reduced number of optimal responses during the first 2 days after delivery compared with babies delivered vaginally. As a consequence, the investigators researched the relationship between catecholamine surge at birth and neurobehavior 1, 2, and 5 days after birth stratified by delivery mode (CS vs. vaginal). They concluded that the mean values of catecholamines were lower in the CS infants as compared with the vaginally delivered infants, postulating that the adrenaline and noradrenaline surge might be of importance for the neurologic adaptation of the infant after birth. Yet, the long-term consequences of a lower level of neurologic adaptation in the immediate postpartum period (48 hours) of infants delivered by CD has yet to be determined.

The Mother

MATERNAL–INFANT INTERACTION

Studies suggest the majority of women have a preference for vaginal delivery and not for CD.[70,71] Several implicated factors are associated with a high degree of maternal satisfaction, including personal control over delivery and an improved maternal–infant interaction at the time of delivery.[72,73] An early study by Marut et al followed 50 women, of which 30 delivered vaginally.[74] Women's satisfaction with their birth experience was significantly lower if delivery occurred by CD as well as among those who had general anesthesia. This evidence suggests that CD may have a negative impact on mothers' perceptions about delivery in general.

The first few hours after delivery are considered to be critical for establishment of a healthy mother–infant interaction.[75] Routine health practices that surround the time of delivery contribute to early mother–infant bonding. Holding the baby for 15 to 20 minutes after delivery increases the ability of the mother to take care of her infant and improves the mother–infant interaction 3 to 12 months later.[76] Such practice is clearly much easier to be implemented subsequent to vaginal delivery.

After birth, mothers and newborns engage in mutually beneficial interactions. The practice of skin–skin interaction has evolved worldwide as an intervention strategy in neonatal intensive care units aiming to improve the interaction between premature infants and their mothers.[77,78] The practice of immediate skin-to-skin interaction relates to better infant physiological and neurobehavioral outcomes, positive attachment relationships, and maternal breast-feeding success.[79] However, although several methodological quality issues have engendered questions about some of the benefits (maternal breast milk maturation, infant heart rate), most recently, there is consensus that early skin-to-skin contact carries some clinical benefits, especially regarding breast-feeding outcomes and infant crying.[80] Moreover, a successful vaginal delivery is tolerated psychologically better and, with virtually no surgical recovery time, the policy of early breast feeding may be easier to implement compared with women delivered by CD.

MATERNAL MORTALITY

Despite advances in modern obstetrics, maternal morbidity and mortality remains an international problem. Maternal mortality in the year 2000 reached a global rate of 400 per 100,000 live births,[82] with these deaths being almost equally divided between Africa and Asia. In 2002, the reported maternal mortality in the United States

reached 8.9 per 100,000 live births, virtually unchanged from the preceding years.[81] Thus, minimizing maternal morbidity and mortality remains a worldwide goal.[82] The 2010 objective for maternal mortality was identified as 3.3 maternal deaths per 100,000 live births. To reach this target, any potentially modifiable risk factor should be first recognized and then eliminated.

CD has a higher risk of maternal mortality compared with vaginal delivery.[83,84] However, this relationship was challenged by the argument that an increased maternal mortality rate can be attributable to medical or surgical conditions that lead to the decision to use the surgical approach rather than the procedure itself.[85] A study by Harper et al examined the relationship among medical risk factors, pregnancy-related death, and mode of delivery.[86] After adjusting for age, heart disease, pregnancy-induced hypertension, diabetes, and preterm labor, the adjusted odds ratio for pregnancy-related death for CD versus vaginal delivery was 3.9 (95% CI = 2.5–6.1). Similar data from United Kingdom suggested that the case fatality rate for vaginal delivery was 6 times lower than that of a CD.[85] Even after adjusting for elective CD, the rate remained almost 3 times lower than that of an elective CD. After analysis of the results of his study, Hall concluded that any decision to undertake major surgery should be cautiously considered. Moreover, physicians who recommend CD must bear in mind that even the higher maternal mortality rate associated with the procedure fails to take into account the additional risk of maternal death related to long-term consequences of uterine surgery such as uterine rupture or abnormal placentation.

INTRAPARTUM COMPLICATIONS OF WOMEN WITH VAGINAL VERSUS CESAREAN SECTION DELIVERY

Pain relief remains one of the central themes of labor management. Today, there is consensus that each form of pain relief presents unique problems to which parturients are potentially exposed, whether they attempt vaginal, instrumental, or surgical delivery. Therefore, the advantages of pain relief in labor must offset all its disadvantages.

Several studies have demonstrated an increased risk of CD in nulliparous women who attempted vaginal birth and who received epidural analgesia before 5 cm of cervical dilatation.[87,88] Conversely, several other randomized trials comparing "early" versus "late" epidural analgesia reported no differences in terms of instrumental deliveries or rate of CD.[89,90] In women who are attempting a vaginal delivery, epidural analgesia remains the most frequent form of pain relief and its use continues to rise.[91] An analysis of the unintended adverse effects on the mother and fetus showed that epidural analgesia appears to be effective in reducing pain during labor at the expense of an increased risk of having an instrumental delivery but did not appear to have an immediate effect on neonatal status as determined by Apgar scores.[92] The safety record of epidural analgesia in women who deliver vaginally remains excellent, and the potentially serious adverse effects characteristic to general anesthesia (respiratory depression, aspiration of gastric contents, subarachnoid bleeding) have little if any impact on maternal mortality.[93,94]

Anesthesia-related maternal mortality apparently accounts for only approximately 3% of total maternal mortalities.[95] The number of deaths associated with regional anesthesia declined markedly since 1990 despite that regional anesthesia was used more often for CD.[96] Unfortunately, most maternal deaths resulting from complications of anesthesia occur not related to vaginal births, but rather during general anesthesia for CD.[97] Although this conclusion may have a degree of uncertainty resulting from potential bias in reporting the cause of death or comorbid maternal conditions that led to performing a CD under general anesthesia in the first place, clearly, a vaginal delivery performed under regional anesthesia, even if instrumental or breech, appears to be safer for the mother and fetus.[95,98]

CD remains one of the most important surgical procedures performed in the interest of the mother and its fetus. However, as a result of the steady increase in its use and the risk of intraoperative complications, identification of the appropriate candidates for vaginal delivery versus CD remains critical and absolutely necessary. Several studies sought to investigate the maternal and fetal morbidity after vaginal delivery versus CD at full dilatation. After their review of over 10,000 deliveries, Murphy and colleagues identified 393 women on whom CD was performed in 209, whereas 184 had a successful instrumental vaginal delivery.[99] Interestingly, CD was performed more frequently after a failed vacuum application rather than a failed forceps. Women undergoing CD were more likely to have major hemorrhage and extended hospital recovery (>48 hours) compared with women who delivered vaginally. The degree of hemorrhage was less for the CD group if the surgery was performed by a senior operator. Two infants had subgaleal and subarachnoid hemorrhage, respectively, which both occurred after failed vaginal instrumental delivery. Neonates were less likely to be admitted to the intensive care unit if delivered vaginally. Thus, the authors concluded that vaginal delivery remains desirable when there are no signs of cephalopelvic disproportion and delivery is performed by a skilled obstetrician.

In the interest of objectivity, it is important to also acknowledge that vaginal deliveries do not occur without risks. Bergholt et al reported an incidence of anal sphincter laceration rate of 5.6%.[100] A policy restrictive in episiotomy use decreased the risk of anal sphincter laceration attributable to episiotomy by approximately 50%. In a different study, postpartum hemorrhage occurred with an incidence of 5.2%.[101] In women who are attempting vaginal delivery, early identification of risk factors such as race (more frequent in Asians), maternal blood disorders, prior postpartum hemorrhage, history of retained placenta, multiple pregnancy, antepartum hemorrhage, genital tract lacerations, macrosomia (>4 kg), induction of labor, chorioamnionitis, intrapartum hemorrhage, stillbirth, compound fetal presentation, epidural anesthesia, prolonged first/second stage of labor, and forceps delivery after a failed vacuum may permit prophylactic treatment of such women with marked reduction of morbidity.

As unsafe as this may sound, the risk of intrapartum complications in laboring women with CD is in some series almost double compared with the women who ultimately delivered vaginally. Intraoperative surgical complications occur between 12% and 15%,[102,103] whereas the overall rate in some series was almost 22%.[104] The risk of complications in an emergency CD is much higher (14.5% to 32.6%) compared with the risks of an elective procedure (6.8%).[103,104] Uterocervical lacerations, blood loss more than 1 L, and need for blood product transfusion were the most frequent intraoperative complications.[103] Other intraoperative complications included bladder lacerations (0.14% to 0.94%) and ureteral injuries.[105–108] Bowel injuries occurred rarely and were apparently more common in the women with a repeat CD resulting from the presence of dense intraabdominal adhesions.[107]

Performing an elective CD has traditionally been perceived as ethically inappropriate.[5,109] Recent surveys show that obstetricians would grant patients' requests for elective primary cesarean delivery, and some of these professionals would prefer that mode of delivery for themselves or their partners.[110,111] Therefore, studies aimed to compare the birth experience of women who had an elective CD versus spontaneous vaginal delivery are needed. In 2003, a study by Schindl et al enrolled prospectively 1050 pregnant women.[112] Psychologic factors, pain levels, and birth experience were investigated using a self-designed questionnaire and 3 established psychologic tests given at 38 weeks of gestation, as well as 3 days and 4 months postpartum. Of 903 women with planned vaginal birth, minimal perineal surgery had to be performed after birth in

484 women (53.6%). Forty-one women (4.5%) had vacuum deliveries, and in 93 cases (10.3%), emergency CD had to be performed. In the 147 elective CS, a significantly lower rate of maternal and fetal complications was observed when compared with vaginal birth (5.4% vs. 19.3%). Birth experience was significantly better in elective CD compared with vaginal delivery but worse in women with emergency CD and worst in those with vacuum delivery. A significant number of women (83.5%) who delivered vaginally responded that they would choose the same mode of birth again. Conversely, only 30.1% of women with emergency CD expressed their desire to receive CD at the next birth. The authors concluded that the results of an elective CD are comparable with that of an uncomplicated vaginal delivery and far superior to intervention such as vacuum delivery or emergency CD.[112]

POSTPARTUM COMPLICATIONS OF WOMEN WITH VAGINAL VERSUS CESAREAN DELIVERY

Seventy-two hours after delivery, pain was significantly lower in women who delivered vaginally than by CD.[112] It is thus not surprising to learn that women who are delivering vaginally usually recover faster and as a consequence are discharged home earlier.[140] No differences in pain were apparent at 4 months postpartum.

Postpartum endometritis continues to be a major cause of infectious morbidity in the obstetric patient. Its incidence can reach 1.6%.[113] Careful timing of amniotomy and limited vaginal examinations are practices that may help reduce its incidence in women who attempt vaginal delivery. However, compared with the vaginal delivery, primary CD with a trial of labor conferred a 21-fold increase risk of endometritis. This risk remained significantly higher even when the CD was performed electively.

Previous studies also suggest anemia was more common among women who had a CD compared with the women who delivered spontaneous vaginally.[114] This was indeed confirmed by Burrows et al who determined that the risk of transfusion was 4.2 times higher in women delivered by primary CD compared with the spontaneous vaginal group.[113] Pneumonia and deep venous thromboses also occurred with a much higher frequency in the CD group. In 2004, Seffah investigated the indications, management, and outcomes after reopening of the abdomen during the puerperium after CD.[115] After review of over 6000 CD cases, the author concluded that in developing countries, the rate of relaparotomy occurs with an incidence of 0.7% of all CD. Along with several postpartum complications, which may occur with both vaginal and/or abdominal delivery (hemorrhage from uterine atony), several complications such as myomectomy and hemorrhage from anterior abdominal wound dehiscence are unique to CD. Mortalities caused by excessive hemorrhage and severe sepsis also occurred.

In 2000, Lydon-Rochelle and collaborators evaluated the relationship in over 3000 women between method of delivery and maternal rehospitalization within 60 days of delivery among primiparous women.[116] The most frequent reasons for rehospitalization included endometritis (27%), postpartum hemorrhage (21%), gallbladder disease (18%), genitourinary complications (12%), breast infection (11%), wound infections (8%), mental health disorders (6%), thromboembolic complications (4%), and pelvic injury (3%). Using multivariate analysis, the authors concluded that women with CD were twice as likely to be rehospitalized (relative risk = 1.8; 95% CI = 1.2–1.4) compared with the women who delivered vaginally. Women with CD experienced postpartum complications much earlier than the vaginal group, as reflected by a shorter time between delivery of the baby and readmission to the hospital. Uterine infection played an important role as women with CD were more likely to be rehospitalized with endometritis. Conversely, women with vaginal delivery had an increased number of readmissions as a result of pelvic injury, whereas

women who had a form of vaginal instrumental were more likely to be rehospitalized for hemorrhage. The authors finally concluded that women with CD and assisted vaginal delivery are at increased risk of rehospitalization and particularly at risk for infectious morbidities.

Maternal obesity is considered an important independent contributor to infectious morbidity post-CD for both elective[117] and nonelective cases.[118,119] Importantly, a study by Myles et al not only identified obesity as the most important risk factor for postoperative infection in women with CD, but confirmed that obese patients have higher rates of infectious morbidity despite the use of prophylactic antibiotics. Thus, whereas a vaginal delivery is desired in obese women as a result of reduced risk of infectious morbidity, obstetric indications and not obesity should dictate the appropriate route of delivery.

Special consideration should be paid to the impact of mode of delivery on future sexual function.[120] Almost 50% of women resume sexual intercourse within 8 weeks after delivery. The incidence of pain was much higher for women who delivered with a form of instrumental delivery or had an episiotomy, whereas 6 months postpartum, the incidence of dyspareunia was similar in women who delivered vaginally without lacerations or by uncomplicated CD.[121]

LONG-TERM MORBIDITY

The long-term benefits for women undergoing vaginal delivery are emphasized by negating the risks of having a prior CD. Long-term morbidity characteristic for a CD continues to be reported such as hemorrhage followed by hysterectomy,[122] abdominal wall endometriosis,[123] increased hospital readmission for infectious morbidities,[116] intermenstrual bleeding,[124] possible infertility,[125] ectopic pregnancy,[126] uterine rupture,[127] and multiple placental abnormalities in subsequent pregnancies (accreta, percreta, previa, abruption).[128] Thus, the decision to recommend a CD for the current pregnancy may significantly impact on the woman's health and future reproductive life.

The belief that vaginal childbirth inevitably and irreversible damages the pelvic floor of a woman continues to divide our specialty.[5,46] The prevalence of urinary incontinence in women 65 and over is 11.6%,[129] whereas the lifetime risk of corrective surgery reaches 11.1%.[130] The proponents of elective CD have argued that pelvic floor disorders (urinary incontinence, fecal incontinence, pelvic organ prolapse) are more frequently associated with vaginal delivery.[131,132] Yet, researchers most recently identified using molecular techniques such as microarray analysis that hereditary predisposition rather than parturition and vaginal delivery prompt women to develop stress incontinence.[133–135] In summary, although there might be an argument that CD will diminish later development of urinary and fecal incontinence, this may apply to only a minority of women.[46]

Although there are no prior studies linking vaginal deliveries to chronic pelvic pain, this is not true for women undergoing a CD. Alarmed by the significant rise in the rate of CS in Brazil, Almeida et al conducted a study to verify the association between CD and development of chronic pelvic pain occurring independently of the presence of other conditions such as pelvic adhesions, endometriosis, sequelae of pelvic inflammatory disease, leiomyoma, and pelvic varices.[136] All women enrolled in the study underwent laparoscopy. Two thirds of symptomatic cases had a history of CD in the past, whereas only one third of asymptomatic women were delivered by CD. The authors concluded that chronic pelvic pain is a debilitating condition and that women requesting an elective CD should be made aware of this risk before the surgery.

Conclusion

During the last decade, obstetric practice has profoundly changed as a result of several published studies aimed to improve clinical practice.[5,137–139] However, as attractive as it

may sound, practicing maternal–fetal medicine in the midst of controversies is not an easy task. The passionate wide range of opinions regarding the best mode of delivery continues today, still hampered by insufficient and inadequate published data concerning short- and long-term outcomes of spontaneous vaginal, instrumental, or cesarean birth. To randomize women to CD versus vaginal spontaneous or vaginal instrumental delivery will likely not prove feasible or ethical.[140] Currently, there is no evidence to suggest that elective CD is safer than labor. Should such proof be forthcoming, then undoubtedly all women should be offered elective CD. The rapidly rising rate of CS based on "myths" may hurt generations to come. Therefore, we all have to rely on high-quality studies that can guide our decision-making and make obstetric practice safer for both the short- and the long-term future. We believe that establishment of clinical protocols aimed at identifying cases appropriate for vaginal delivery or for CS should become a clear objective of each department, and that consistent implementation of these guidelines would significantly improve maternal and infant outcomes.

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