

## REVIEW

# New Views on Cesarean Section, its Possible Complications and Long-Term Consequences for Children's Health

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**H**istorical developments and advancements in cesarean section techniques and logistics have reduced the maternal and neonatal risks associated with the procedure, while increasing the number of operatively completed pregnancies for medically unjustifiable reasons. The uncritical attitude towards cesarean section and the fast emergence of 'modern' diseases such as obesity at a young age, asthma, type 1 diabetes mellitus and various forms of dermatitis have stimulated researches associating cesarean section with these diseases. Intestinal flora of the children born by cesarean section contains less bifidobacteria, i.e. their intestinal flora is similar to the intestinal flora in diabetic individuals. In children born by cesarean section, the 'good' maternal bacterial that are normally found in the maternal birth canal and rectum are lacking, while the 'bad' bacteria that may endanger the child's immune system are frequently present. In children born by vaginal delivery, the 'good' maternal bacteria stimulate the newborn's white blood cells and other components of the immune system, which has been taken as a basis for the hypotheses explaining the evident association of the above morbidities and delivery by cesarean section. **Key words:** cesarean section, complications, obesity, asthma, dermatitis, type 1 diabetes mellitus

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Cesarean section is the most common major obstetric surgery and the oldest operation in the field of abdominal surgery, used for delivering the newborn and the placenta through the abdominal wall incision (laparotomy) and uterus incision (hysterectomy), followed by suture of the uterus and abdominal wall layers. Until the 17<sup>th</sup> century, cesarean section was exclusively lethal operation for the mother, performed to save the newborn's life from dead or dying mother. Although the term 'cesarean' was long believed to derive from the Roman emperor Gaius Julius Caesar (100-44 B.C.), according to legend born by cesarean section, it is now considered quite unlikely because

his mother was found to have lived for years after the delivery. In the first half of the 19<sup>th</sup> century, maternal mortality after cesarean section was 60%-100%; at the beginning of the 20<sup>th</sup> century, cesarean section was associated with 25% maternal mortality and 24% neonatal mortality, mostly due to sepsis or exsanguination. The operating technique has gone through a millennial evolution, having developed according to professional achievements of the time and depending on improvements in asepsis, abdominal surgery, anesthesia, and transfusion medicine. There have been a number of laparotomy modifications (e.g., lower medial laparotomy, Pfannenstiel, Pandolf, Maylard, pararectal

Kullisen, Joel-Cohen laparotomy), extraperitoneal and transperitoneal access to gravid uterus, various types of hysterotomy (classic longitudinal Sän-ger corporeal, longitudinal Selheim isthmic, cross Kerr isthmic incision), various techniques of uterus suture (hysterotomy non-suture, multi-row, double-row and single-row suture), suturing materials (wire, catgut, silk, synthetic absorbable materials, etc.), and suture of laparotomy layers. Dörffler made a breakthrough in the then operating techniques in 1929, when he published a description of the cesarean section technique, which has been used down to the present in some hospitals. Dörffler unified Pfannenstiel laparotomy and Kerr hysterotomy, and inaugurated a new technique, *sectio caesarea transperitonealis isthmica in situ sec. Dörffler*, which then considerably reduced the overall maternal mortality while enabling future deliveries after cesarean section either by repeat cesarean section or by vaginal delivery (1,2).

Improvements in the obstetric surgical techniques based on modern, scientifically evidenced concepts were made in the last decades of the 20<sup>th</sup> century, having led to a simpler and less traumatizing approach to cesarean section with better postoperative recovery and outcome. Starck has rationalized all the new approaches and introduced a new technique of cesarean section, Misgav Ladach cesarean section, named

after the hospital in Jerusalem where the method had been developed from 1983 and published in 1994, since when it has been accepted all over the world (3,4). This new method of cesarean section is based on Joel-Cohen laparotomy from the 1970s, originally intended for abdominal hysterectomy respecting structural anatomy and following the principles of surgical minimalism (5). Misgav Ladach cesarean section is the result of critical assessment of each surgical step, with the aim to cause minimal tissue damage, eliminate unnecessary and some harmful steps, and improve the procedure safety, simplicity and efficiency. Blunt abdominal entry is preferred, which is achieved mostly by tissue stretching by fingers and minimal use of sharp surgical instruments, while suturing of the abdominal wall layers is reduced to only three layers (uterus, muscular fascia and skin). In this way, the likelihood of postoperative adhesions within the abdominal cavity is reduced because the amount of surgical stitches that induce foreign body reaction in spite of all advancements is by far lower. In addition, the length of operation, and thus of anesthesia, as well as the loss of blood and the need of antibiotics, analgesics and antipyretics are reduced, along with earlier patient mobilization, faster recovery and earlier discharge from the hospital. Cesarean section performed by the Misgav Ladach method is closer to the natural, vaginal delivery. Misgav Ladach cesarean section can also be called a minimally invasive cesarean section, and currently it is the cesarean section method of choice. Its value has been demonstrated by numerous evidence based medicine reports and its utilization in daily practice all over the world for more than 15 years now (1,6-8).

The rate of cesarean section has been on a continuous increase for justifiable as well as unjustifiable medical and non-medical reasons, and this trend should preferably be discontinued. The recommended rate of cesarean sections is around 15% in the largest and best-equipped obstetric tertiary centers with a high concentration of gestational and obstetric pathology, whereas in smaller maternity units it should be even lower (1). Although the

operative technique and logistics have considerably improved, thus reducing the morbidity and mortality associated with cesarean section, it should still be borne in mind that cesarean section remains a serious operation burdened with certain risks and complications, as well as with long-term consequences for both the mother and the child. The incidence of intraoperative complications is estimated to 12%-15%; complications are less common during elective cesarean section (2.6%-6.8%) versus emergency cesarean section (5.2%-14.8%) (9). The possible intraoperative complications include fetal head impaction in the pelvis (head extraction impossible), uterocervical lacerations with hemorrhage, damage to the peritoneal vasculature on the inferior uterine segment incision, bleeding from the placental bed, invasive malplacenta, uterine atony, lesions of the urinary bladder, ureter and intestine, neonatal lesions, and complications associated with anesthesia (1). The most common early postoperative complications are wound infection (in 3%-15% of patients), seroma, wound dehiscence, anterior abdominal wall hematoma, endometritis (13%), very rarely necrotizing fasciitis, which is associated with a high maternal mortality, and pelvic vein thrombophlebitis. The incidence of septic thrombophlebitis is 1 per 9000 deliveries in vaginal delivery and 1 per 800 deliveries in cesarean section (10). The incidence of deep vein thrombosis is 1 per 1000 deliveries; in cesarean section, it is 20-fold that recorded in vaginal delivery. Pulmonary embolism occurs in 1% of cases with deep vein thrombosis. The incidence of postpartum urinary infection and hemorrhage is 2%-4% and 5%-8%, respectively (10). Scar rupture during subsequent pregnancy or delivery should be taken in consideration as a possible late postoperative complication. The incidence of scar rupture varies according to the type of cesarean section scar, as follows: classic incision 4%-9%; T-incision 4%-9%; low vertical incision 1%-7%; and low transverse incision 0.2%-1.5% (11). In subsequent pregnancies, *placenta previa*, *placenta accreta*, *placenta increta* and *placenta percreta* are more commonly found after previous cesarean section. The

women with a history of cesarean section are at a 2- to 5-fold greater risk of *placenta previa*, with the risk increasing with the number of previous cesarean sections (12). Endometriosis in the cesarean section scar is found in 0.03%-0.4% of cases (13), while the incidence of ectopic pregnancy within the previous cesarean section scar is estimated to 1 per 2000 pregnancies (14). The incidence of postoperative complications is 35.7%, with minor complications accounting for 23.7% in elective cesarean section and for 34% in emergency cesarean section. In case of massive postpartum hemorrhage threatening the mother's life, laparotomy and hysterectomy are indicated, the latter being 13 times more frequently performed in deliveries completed by cesarean section as compared with vaginal deliveries (1). In cesarean section, neonatal lesions occur in 1.1% of cases, most frequently superficial incisional wounds of the leading part inflicted by the scalpel (0.7%), cephalhematoma (0.2%), fractures of the skull and other bones with peripheral nerve lesions (0.02%), lesions of the brachial plexus (0.02%), and facial nerve palsy (0.03%) (15). The children born by cesarean section may have a lower Apgar score, mostly due to anesthesia. They may also suffer breathing difficulties, which may occur in the first few hours of the procedure. Cesarean section as an unnatural type of delivery definitely implies neonatal stress and shock because the neonate does not pass through the birth canal; that is why in the past, these newborns used to be called 'cut out' (*caesones*) or 'unborn' (*nonatus*). In case of erroneous gestational age assessment, immature children are being born by cesarean section (1). The risk for the neonate is only reduced but not eliminated by cesarean section, while maternal morbidity and mortality are increased 3 to 8 times relative to spontaneous delivery (8). In addition to the potential maternal and neonatal intraoperative and early postoperative complications of cesarean section listed above, the issue of long-term consequences for the child born by cesarean section has been increasingly tackled in recent years. As cesarean section for unjustified reasons still shows a rising tendency in many countries (e.g.,

in China and Brazil, where it is related to the socioeconomic status), a number of studies investigating the long-term consequences in children born by cesarean section have been launched (16). Some large studies found correlation of the type of delivery completion and numerous today's morbidities such as obesity, asthma, various forms of dermatitis, type 1 diabetes mellitus, etc. (15,17-20). As reported by Ziegler *et al.*, based on the results obtained in their BABYDIAB study, the children born by cesarean section have a twofold risk of developing type 1 diabetes mellitus recorded in children born by vaginal delivery (incidence 4.8% vs. 2.2%). The mechanism by which a delivery by cesarean section increases the risk of developing type 1 diabetes mellitus remains obscure. It has been postulated that the intestinal flora of these children contains a lower number of bifidobacteria, i.e. that their intestinal flora is similar to that of diabetic individuals. Bifidobacteria belong to the most important group of efficient intestinal bacteria (21). Studies conducted in Brazil and Norway demonstrated the association between the type of delivery and development of obesity, asthma and various forms of dermatitis in children born by cesarean section. Results of the Brazilian studies indicate the prevalence of obesity in children born by cesarean section to be higher by 33% and in those aged 19 years by even 50% in comparison with children born by vaginal delivery, while Norwegian studies suggest the prevalence of asthma to be significantly higher in the first 36 months of life in children born by cesarean section (17-19).

There are two hypotheses on the possible causation and association of the mode of delivery and the mentioned diseases. According to one hypothesis, during delivery, the children born by vaginal delivery come in contact with the maternal 'good' bacteria, which are normally found in the maternal birth canal and rectum. When these bacteria are transferred to the newborn, they pass along the newborn's gastrointestinal system and settle in the small and large intestine. In children born by vaginal delivery, the maternal 'good' bacteria stimulate neonatal white blood cells

and other components of the immune system (production of type 1 and type 2 T-helper cytokines in particular) for body's defense (19,22). On the other hand, the children born by cesarean section are deprived of coming in contact with the bacteria mostly found in the maternal birth canal and rectum. In case of elective cesarean section, there is no contact of the newborn with maternal bacteria, whereas in emergency cesarean section such a contact may still occur. In these children, their gastrointestinal system is colonized by cutaneous and nosocomial bacteria (19). They lack the 'good' maternal bacteria, while 'bad' bacteria that may aggravate the neonatal immune system are frequently present. According to some studies, these children have a higher incidence of neonatal respiratory infections, which are associated with the development of asthma, obesity, type 1 diabetes mellitus, various forms of dermatitis, etc., later in life (17,18,20,22).

While the historical development of the cesarean section techniques and logistics has reduced the rate of maternal and neonatal complications associated with the procedure, it has also entailed an uncritical increase in the rate of operative pregnancy completion irrespective of indications. This uncritical attitude towards cesarean section, along with the fast emergence of the 'modern' diseases such as young age obesity, asthma, type 1 diabetes mellitus and various forms of dermatitis, have suggested the possible association between the mode of delivery and these morbidities. The studies cited above have hypothesized and pointed to this association. In many countries, a variety of the potential short- and long-term complications associated with cesarean section described over time did not result in critical reduction of the procedure; however, the long-term unfavorable consequences observed in children born by cesarean section should urge us to turn to a clearer and more rational reasoning. Results of the mentioned studies on the potential long-term consequences in children born by cesarean section should be re-evaluated and additionally corroborated in future studies. The newer, simple and sparing Misgav Ladach method of cesarean section

is closer to the natural, vaginal delivery and currently is the method of choice, its value being demonstrated by many evidence based medicine studies, as well as by its utilization in daily routine all over the world for more than fifteen years now.

**CONFLICT OF INTEREST: NONE DECLARED.**

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