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Trends in Cesarean Section

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Abstract

Cesarean section (CS) is part of the standard of care in modern obstetrics. Its availability, practicability, high acceptance among patients, and the permanent improvement in surgical techniques, anesthesia, blood replacement, and neonatal care have popularized the procedure as a safe and reasonable alternative to vaginal delivery for any individual born in the twenty-first century. Beyond an established recommended rate of 15% for all births, presently the main challenge in obstetrical care is to limit its use to patients that need the procedure in order to keep an adequate perinatal outcome. The rate of CS has been used in many healthcare settings as an indicator of an individual or institutional obstetrical performance. The issue of overuse of CS as a birth alternative beyond clear maternal or fetal indications has received extensive analysis not only from the reproductive medicine point of view but also from neonatal, ethical, financial, and public health stakeholders. Its place in modern obstetrics, and its impact on short-and long-term maternal and neonatal outcomes, health financial budgets, and in public health policies, have positioned CS a mayor issue to take care of in modern medicine.

Keywords: cesarean, perinatal outcome, maternal outcome, cesarean upon maternal request, medical autonomy

1. Introduction

Cesarean section (CS) is part of the standard of care in modern obstetrics. During the last 50 years, institutionalization of delivery pretended to make childbirth a safer event. The wide availability of cesarean section has been intended to favor maternal and neonatal outcomes in certain clinical situations in which vaginal delivery is not a safe alternative. Today, CS is an active part of obstetrical practice with aims to improve clinical performance and perinatal indicators. The indications for a cesarean section as an alternative to vaginal delivery have evolved over the centuries. From remote anecdotal references in the history of medicine, CS

has evolved to be part of the standard of obstetrical care today. Its practicity, disponibility, and apparent safeness have placed CS a first-line procedure in many clinical scenarios.

The rate of CS has been used in many healthcare settings as an indicator of an individual or institutional obstetrical performance. However, the worldwide reported CS rate seems to draw back from the World Health Organization recommendation. Significant variations are apparent between first-and third-world economies, health models, the standard of obstetrical care, reimbursement, obstetrical risk factors, and cultural influences. Other factors related to the type of practice in modern obstetrics have contributed to the popularization of cesarean section: liberalization of the use of a relatively safe procedure under a pragmatic point of view, limited training in instrumented vaginal delivery among the younger generations of obstetricians, optimization of time, minimizing possible legal medical complications, and evident improvements in surgical and anesthetic safety. Finally, new phenomena like acceptance of CS upon maternal request without any medical indications as a valid indication and the loss of medical autonomy in the modern practice of obstetrics will be addressed in this chapter as contributors to changes in CS rates [1, 18].

Over the last decades, obstetrics has evidenced a notorious increase in the rate of cesarean sections. The progressive institutionalization of birth has resulted in evident improvements not only in fetal and neonatal care but also in a growing number of cesarean sections [1]. Trends in rates have evolved in the United States from one digit numbers, 5% in 1970, and into 32.7% for 2014 [1, 6]. Unfortunately, this growing trend has not always corresponded to a warrant of quality improvement in perinatal outcome indicators. This worldwide concerning phenomenon of a growing cesarean rate has been reported and analyzed not only from the perspective of reproductive medicine but also as a neonatal, financial, public health, legal, and ethical issue.

The indications for a cesarean section as an alternative to vaginal delivery have evolved over the centuries. From remote anecdotal references in the history of obstetrics, CS is reported in many clinical scenarios as the most common way to be born.

2. Historical background

CS has been reported throughout the history of mankind. The term “*cesarean*” most probably comes from the Roman term “*caeso matris*,” which meant cutting a fetus out of the maternal womb. The law *Lex Regia* (Numa Pompilius-715 BC) or *Lex Cesarea* ordered the fetal extraction out of the maternal uterus in case of maternal death for an individual burial. Jacques Guillemeau (1598) was the first author to use the term “section” to refer to the cesarean intervention as a birth choice.

The main indication for practicing a CS has not always been maternal and fetal health. There are reports of religious indications in ancient Egypt (3000 BC) and in India (1500 BC). The Jewish Mishnah (140 BC) established that for twins, birth by CS for both products had privileges to claim primogeniture. The Council of Colonia (1280) determined mandatory to perform cesarean section when the mother died. In the Republic of Venice (1608), penalties were

imposed on physicians who failed to make an attempt to save a soul in cases of maternal death. In the United States (1769–1833), it was mandatory for the Franciscan missionaries to have the knowledge and dexterity of how to practice a section [2, 5].

3. The evolution of the cesarean section

Francois Roussette (1530–1603) was the first physician to refer cesarean section as a procedure for living women (Paris-1581: *Traitté nouveau de l'hysterotomotokie, ou enfantement caesarien*). His report included 10 cases, even though he only participated in six of them since he was not a surgeon. Roussette referred for historical purposes the story of Jacob Nufer (1500), a swine castrator from Switzerland, apparently was the first documented man to perform a successful CS. Elizabeth Alice Pachin, his wife had a prolonged and dystocic labor during her first pregnancy. The intervention of 13 midwives was not successful and Nufer, after two requests to the town's mayor, was authorized to proceed to operate. He performed an abdominal and uterine incision with a blade, extracted the fetus and sutured the abdominal wall. The patient survived and subsequently had vaginal deliveries, including twins. The newborn lived until the age of 77 years [5].

However, cesarean sections as a surgical option in cases of dystocia historically were delayed in the practice of obstetrics due mainly to three elements:

- (1) It was a late procedure in a patient already complicated,
- (2) Infection, and
- (3) Hemorrhage.

Trautmann of Wittenberg (Nurtemberg, Germany-1610) practiced the first medically documented CS in a living woman. The patient died 25 days later due to sepsis. By 1865, the maternal mortality rate secondary to CS practiced for maternal indications was estimated to be around 85% [2, 5].

In the historical evolution of CS practiced for maternal indications, some important milestones for the reduction of complications and increase in survival are: [3, 4].

- The description of a transverse incision technique by Ferdinand Adolf Lehrer (1881).
- Joseph Lister (UK-1860) description of the use of carbolic acid as an antiseptic.
- Eduardo Porro (Italy-1876) practiced the first CS with supravaginal hysterectomy.
- Use of silver and silk sutures for peritoneal closure by Max Sänger (1882).
- Abdominal incision by Hermann Johannes Pfannenstiel (1900).
- CS extra-peritoneal and transverse low by Krönig (1912).
- Munro Kerr (UK-1929) described the transversal incision on the uterine segment.

Later in medicine, the implementation and improvement of surgical techniques, anesthesia, blood transfusion, and antibiotics impacted positively in the performance and prognosis of CS as an alternative option to vaginal delivery.

In 1846, at the Massachusetts General Hospital, the dentist William T.G. Morton was the first to use diethyl ether to operate a facial tumor. Since then analgesia-anesthesia was used for many surgical procedures. However, this did not happen so fast in obstetrics. The belief, according to the Biblical mandate, that women in compensation for Eve's sin should suffer "birth in pain" was popularized. This argument lost value when Queen Victoria of England, head of the English church received chloroform during the birth of their children Leopoldo (1853) and Beatriz (1857) [5].

From 1880 through 1925, several techniques of extra-peritoneal CS and vaginal cesarean were described in order to decrease infection. The need of these techniques disappeared after 1928, with the discovery of penicillin, which became available in 1940.

The CS rate in the United States has changed dramatically during the last 50 years [6, 8].

1970: 5%,

1990: 23.5%, and.

2016: 31.9% (low-risk patients: 26.9%).

Worldwide CS rates have nearly doubled since 1990 (from 14.5 to 27.2%) [11].

In 1985, the WHO stated that the CS should not exceed 15% in any population group [8]. In the last decades, an invariable upward trend has been evident mainly in low-and middle-income countries. China (64.1%), Colombia (46.4%), Dominican Republic (56.4%), Egypt (51.8%), Iran (47.9%), and Brazil (55.6%, 80% for second deliveries) – when the first was by cesarean, are some examples [7, 11, 15].

Among countries of the organization for economic cooperation and development (OECD) the rate varies widely from 45 to 50% (Mexico and Turkey) to 15–17% (Netherlands, Sweden, and Norway). In other European countries like France the CS rate has been relatively stable: 20.4% in 2003, 21.1% in 2010, and 20.4% in 2016 [9, 11, 14].

Although CS is widely available, the main recommendation and challenge are to limit its practice to patients that may have a clear benefit from the intervention. Quality assurance in labor and delivery should be part of the standard of care in any clinical scenario and assure a reasonable CS rate.

In 2001, Robson [10] proposed to adopt a standard classification system so that CS rates would no longer be thought of as being too high or too low, but rather whether they are appropriate or not, in the context of all information about clinical variables, including maternal satisfaction. The 10-group classification system (TGCS or Robson classification) is a method that provides essential information regarding common factors for a determined obstetric population where perinatal events and outcomes can be established, measured, compared, and audited.

The 10 Robson classification groups have been thoroughly used by many research groups with the intention to standardize and eventually regulate the CS rate in a specific obstetric scenario.

The 10-group classification system–Robson groups [10]:

1. Nulliparous, single cephalic, ≥ 37 weeks, spontaneous labor.
2. Nulliparous, single cephalic, ≥ 37 weeks, induced or cesarean before labor.
3. Multiparous (excluding previous cesareans), single cephalic, ≥ 37 weeks, spontaneous labor.
4. Multiparous (excluding previous cesareans), single cephalic, ≥ 37 weeks, induced or cesarean before labor.
5. Previous cesarean, single cephalic ≥ 37 weeks.
6. All nulliparous breeches.
7. All multiparous breeches (including previous cesareans).
8. All multiple pregnancies (including previous cesareans).
9. All abnormal lies (including previous cesareans).
10. All single cephalic, ≤ 36 weeks (including previous cesareans).

This system implies that the information collected must be clinically relevant, carefully defined and collected, and timely and permanently available. This information should be used to permanently audit and standardize indications for inductions and to practice cesarean sections. It should be used as a parameter for monthly critical analysis and reference in time and with other obstetrical units. Also, each parameter can be further subdivided for more detailed analysis [10, 12].

In most studies, the main contributors to explain the increase in CS rates are groups 1, 2, and 5 [12].

This classification, however, only takes part of the variables of an obstetric population into account. Important information like maternal age or body mass index (BMI), are not part of the classification.

Although the 1985 WHO recommendation on the CS continues to be a referred indicator in obstetric literature, recent evidence based on demographic differences across the 194 WHO member countries suggest that the optimal global CS rate may be around 20% [13]. In countries like France, that have been successful in keeping CS rates stable, the main difference has been lowering sections before initiation of labor and in women with one previous cesarean section (57.5% in 2010 and 50.2% in 2016) [14].

Other nonmedical factors have also been reported: supply-side demand induction, decision issues related to professional convenience, and optimization of time and predilection for CS in private versus public hospitals [16, 17].

With the inclusion of obstetric protocols of systematic use of prenatal diagnosis and fetal surveillance techniques during pregnancy and delivery, the number of CS secondary to fetal indications has increased. Even though there is no evidence that the universal use of intrapartum

fetal surveillance has had a positive impact on perinatal morbidity and mortality in low-risk obstetric population in the last 30 years, its use is part of the daily routine in any obstetrical ward [16, 29, 30].

Unfortunately, high CS rates are not always correlated to better maternal-fetal outcomes. Several systematic reviews have shown that, although CS can be a truly life-saving procedure in some cases, it's also associated with anomalous short-term immune response in the newborn, and a greater risk of developing immune-mediated diseases such as asthma, allergies, or DM type 1. From a financial perspective, globally, the cost of practicing CS without a clear medical indication has been estimated at \$2.32 billion [15, 16].

4. Cesarean delivery under maternal request

An important contributor to the rising trend of CS worldwide, and particularly in Latin America, is the surge of cesarean section upon maternal request (CSMR). The most accepted definition of this indication is a CS performed in an obstetric patient with a singleton, term pregnancy, by maternal request, and with no medical indication [19]. The performance of this surgery without any medical indication has given rise to in-depth medical, legal, ethical, and financial debates, especially when the use of limited health resources is a concerning issue for an elective and frequent procedure [20]. Despite a presumable under-registered data, CSMR is estimated to correspond to 4–15% of all deliveries in the United States. As much as 82% of obstetricians in the United States recognize having performed at least one CSMR [21, 22]. In addition, a high degree of variation in the use of CSMR, ranging between 6% in the United Kingdom and up to 80% of deliveries in Brazil has been reported [23, 24].

Diverse factors including patients and health providers have been reported as contributors to the increase in CSMR. Referred patient factors are fear of pain, a sense of safeness, and confidence, a hypothetical control over a somewhat unpredictable event, and a false perception of a reduced risk of urinary incontinence in the obstetric patient and/or hypoxic encephalopathy in the newborn [25]. Factors depending on medical personal include a pragmatic view of birth, efficiency in working time, and finally a hypothetical avoidance of medical and legal complains. Advances in surgical and anesthetic protocols may also be important issues in safety matters [26].

Presently there is controversy deeming the safety of CSMR for both, the mother, and the neonate. A summary of the evidence was presented by the United States National Institutes of Health, referring that CSMR might be associated to a diminished risk of bleeding or need for transfusion, and a lower risk of trauma and organ damage. However, there is still uncertainty about the short-term impact of CSMR on perinatal outcomes, as well as in future pregnancies [26]. Direct evidence about the risks of CSMR, particularly when compared to cesarean sections, is limited.

On behalf of these facts and since the evidence to recommend or ban the practice of CSMR is mostly based on retrospective analyses, our group realized a 4-year period research study based in our hospital obstetric low-risk population [18]. Our objectives were to compare, in

a prospective observational setting, the following results: (a) multiple maternal outcomes among low-risk women who intended to have CSMR versus vaginal delivery, and (b) multiple neonatal outcomes derived from the same obstetric population. We hypothesized to find the different frequency of maternal and neonatal outcomes between CSMR and vaginal deliveries in our low-risk obstetric population.

We developed a prospective observational study that included obstetric patients aged 18–45 with low-risk term pregnancies that delivered at our hospital. Previous board ethical committee approval, patients requesting CSMR were individualized to receive further information, after what all of them signed an information consent form before being admitted to the study. The presence of any of 5 pre-specified adverse maternal outcomes and of any of 17 pre-specified adverse neonatal outcomes was compared between CSMR and vaginal births. Induced vaginal births were analyzed separately. All recruited patients were offered the same standard of medical care. The effect of confounders was adjusted using multivariate logistic regression. The demographic characteristics of our participants showed healthy, actively working women, mostly in their early 1930s, married, and with private health insurance coverage, who presented for delivery with a term, low-risk pregnancy.

The study incorporated 214 patients with CSMR, 341 with spontaneous vaginal delivery (SVD), and 376 with induced vaginal delivery (IVD). Relative to the spontaneous delivery arm, the multivariate-adjusted odds ratios for adverse maternal outcomes were 0.21 (95% CI: 0.05–0.97) in the CSMR group and 0.93 (95% CI: 0.42–2.06) in the IVD arm. The multivariate ORs for adverse neonatal outcomes were 0.59 (95% CI: 0.36–0.93) for CSMR and 0.84 (95% CI: 0.59–1.21) for IVD. The frequency of hospital admission for the newborn was lowest in the cesarean delivery group (10.3% compared to 15.8% for spontaneous deliveries and 16.2% for induced vaginal deliveries).

Our preliminary results suggested that among low-risk pregnancy patients that received a standardized obstetric care protocol, CSMR was associated with a lower rate of adverse perinatal outcomes when compared to spontaneous vaginal delivery. Due to our limited number and type of population additional studies are needed to assess the long-term safety of CSMR.

Despite that all three groups were very similar at inclusion we found a lower absolute rate of adverse maternal and neonatal outcomes among obstetric patients who chose CSMR over a vaginal delivery. Furthermore, when the effects of variables with the highest potential were adjusted to be considered confounders, this result continued to be significant, in some cases yielding even lower estimates of the odds ratio. Despite the perception that cesarean sections implied longer hospitalizations, the absolute difference in the total days of hospital admission between the CSMR and spontaneous vaginal birth groups was on average 0.5 days, a difference that has minimal clinical implications.

In the same way, the rate of primary neonatal poor outcome was also lower for the CSMR group, a difference that also persisted after correction with multivariate models. We consider this a noteworthy result since multiple related adverse neonatal outcomes were identified and registered. Moreover, newborns from CSMR women were admitted significantly less and had slightly higher APGAR scores than those born vaginally. Stunningly, our results

disagree with those of the WHO Global Survey on Maternal and Perinatal Health [27]. In their report, cesarean sections were associated with an increased risk of severe adverse maternal outcomes. An explanation for the result discrepancy may be the fact that in the WHO study as in many others, elective and emergency, term and preterm, low and high risk, cesarean sections have been included for analysis as a single group.

We recognized a low rate of obstetric hemorrhage requiring blood transfusion in all groups (0.3% in spontaneous vaginal, 1.3% in induced vaginal, and 0.5% in CSMR). In a retrospective review of more than 400,000 births, Holm et al. found a lower risk of severe post-partum hemorrhage with CSMR in both nulliparous patients and in those with a previous cesarean section [28]. There is evidence that the frequency of hemorrhage and obstetric shock is generally lower with elective sections, and that the overall risk of blood transfusion is low, except when associated with antepartum established anemia and placenta previa. In a Canadian population-based revision of vaginal delivery versus cesarean section practiced for breech presentation, maternal morbidity was similar between groups, but neonatal morbidity was lower among babies born by cesarean [20]. In the same way, in a retrospective analysis of almost 30,000 deliveries in the United States, the incidence of persistent pulmonary hypertension was 3.7/1000 live births among neonates born by elective section, but only 0.8/1000 live births among neonates delivered vaginally [22]. Part of the inconsistency among results from different studies may be explained in association with the role of gestational age as a confounding factor. This is shown by the fact that when elective cesarean sections are performed after 39 weeks, clinical variables of neonatal respiratory morbidity are not increased compared to vaginal delivery [23].

Our results seem to point out that under specific optimal low-risk obstetric population conditions, CSMR may be a clinical procedure with an equivalent impact on both mother and neonate compared to vaginal birth.

The main assets of our study embrace its prospective nature, the cautious and widespread documentation of outcomes and covariates, and the use of homogeneous high-quality care protocols that allow to better evaluate the advantages and disadvantages of each mode of delivery.

In contrast, our main methodological drawback lies in the undersized postpartum follow-up, which does not permit us to evaluate long-term postpartum complications. CSMR may be associated with numerous potential risks, which can be classified as immediate, late, and long-term. We did not find an added incidence of short-term risks (infection, hemorrhage, intra-operative genital/urinary lesions, other intra-abdominal complications, and anesthetic risks or death). However, we cannot rule out late (thromboembolic disease, prolonged recovery, hospital readmission, adhesions, and incisional hernias) or long-term (abnormal placental implantation, uterine scar dehiscence/rupture, hysterectomy, infertility, early fetal loss, ectopic pregnancy, and intrauterine growth retardation) complications in these patients. Undouble, extended prospective studies are needed in order to validate our results.

In conclusion, in this prospective investigation that only included the term, low-risk pregnancies of women with a very specific demography and chosen with strict inclusion criteria, CSMR was associated with a lower rate of adverse perinatal outcomes for both mother and newborn, compared to vaginal birth. While these results may look promising, this evidence

must not be used to suggest or advice CSMR as a first line alternative for childbirth. Our results have been used to launch a formal protocol in our hospital for cases of CSMR and to accurately inform our patients about birth options; their respective short-and long-term complications are a critical element in the consent form. In our hospital, all patients that request a CS are individualized for counsel and further information. It has discouraged hospital under recording of CS indications, has contributed to the exactness of surgical indications on medical records and has turned a previous individualize practice into a controlled institutional protocol of medical attention that is permanently audited and followed up. Also, this model has endorsed us to keep low indicators of maternal, neonatal, and anesthetic complications without a negative impact on financial issues.

5. Loss of medical autonomy as a factor affecting CS

Medical autonomy is understood as the self-determination of professional behaviors, according to individual values based on professional ethics, supported by the best available scientific evidence, giving priority to the interests of the patient, and without external interference or coercion. The modern concept of autonomy is based on the ideas of Kant (1788), according to which morality is based on consciousness and reason as the fundamental elements and “what man should do” [31].

On the other hand, the profession as a work activity derives its name from “professing” or declaring society a commitment to behavior.

Medicine as a profession is based on four fundamental elements:

- (1) missionary and vocational activity,
- (2) knowledge and expertise,
- (3) an ethical code of behavior, and
- (4) self-regulation.

In the twenty-first century, professional autonomy is articulated by three factors such as:

- (1) self-assessment and self-regulation of medical practice,
- (2) responsible use of technology, and
- (3) financial factors.

These three factors cannot conflict with the element of quality of care.

Under this frame of reference, the behavior of the cesarean rate can be a magnificent example of the loss of medical autonomy in certain practice scenarios. The exercise of modern obstetrics within the current social paradigms becomes a very complex task. Modern times have imposed as a fundamental principle the fact that “time is money” for which we always live in a hurry, there is no time for communication or patient medical relationship, moral relativism, and pragmatism of behavior predominates. Thus, although birth is a profound and powerful

human experience and for women generates feelings of empowerment, success and personal achievement, the excessive increase in the cesarean rate is a consequence of the medicalization of birth and a change in attitude of the patient and the doctor within the new social model that undoubtedly impacts professional practice.

Undoubtedly, any of the above may have a medical field of discussion in the indication and relevance; however, the last two are the ones that generate great controversy today due to the laxity in its acceptance, its underreporting in the clinical history, and ethical considerations in your practice. The rate of CS in Colombia reached 46% in 2014, moving further away from the universal recommendation of 15% of the WHO. Having a preference for its practice in specific geographical areas where it can reach percentages greater than 70% and with a clear predilection for private institutions.

Medical autonomy is being affected by a series of factors that threaten the full exercise of obstetrics. Optimization of time, remuneration, disinformation of the patient with inappropriate use of their autonomy, fear of legal medical suits, the misuse of medical technology, therapeutic pragmatism, and finally poor medical training with limitations in the expertise of the care of the vaginal delivery. In addition to these factors that undermine medical autonomy, others that can contribute to understanding this phenomenon are the aforementioned loss of the physician-patient relationship, the model of medicalized care, demographic changes (the role of women in today's society), the standard of obstetric care with the programming of birth, and the negative perspective about the vaginal delivery that new generations of patients and obstetricians have.

A separate mention deserves the media who have contributed through inaccurate information or decontextualized cultural and social myths about supposed benefits of surgical delivery that feed a social behavior that tends to be replicated.

Highlighting the value of informed consent, explained and discussed with the patient in a quiet environment during prenatal care and never on the scenario of a delivery room, is that it rationalizes the decision, informs objectively, and allows the patient to choose the right decision, which is not always the easiest.

Proposals for intervention to regain medical autonomy in obstetric practice:

1. Institutionalization of obstetric care: follow-up indicators and protocols,
2. Health team practice supported by midwives,
3. Training of residents and health personnel,
4. Rational use of methods of fetal surveillance,
5. Routine use of informed consent,
6. Patient education,
7. Permanent availability of analgesia and anesthesia,
8. Individualized care of cases of CS by maternal request,
9. Vaginal delivery as a public health policy, and
10. Working with the media.

Medicine is a moral activity, exercised by individuals who adhere to a code of behavior. Medical autonomy should be the result of the balance of the factors that affect the practice. Trust is the fundamental principle of medical professionalism and the basis of the social contract between the obstetrician and the society [32].

6. Conclusion

The indications for the cesarean section have changed throughout history. They have been shaped by religious, cultural, economic, professional, and technological reasons that have impacted medicine. CS originated as a precept for saving the soul, if not the life of the fetus. From the nineteenth century, it changed to save the obstetric patient. Finally, since the end of twentieth century, Western obstetric medicine has focused on the maternal and fetal benefits of the procedure. In the last 30 years, the fetal indications of the procedure have triggered its frequency with a definite impact on the model of modern obstetric practice.

Attempts to reduce CS rates in underdeveloped countries have not been efficient. Its place in today's obstetric practice, its impact on short-and long-term maternal and neonatal outcomes, health financial budgets, and in public health policies, has positioned CS a major issue in modern obstetrics.

Our goal as health providers is to assure that CS is practiced on patients and neonates that will benefit from it. Women should be adequately informed and brought into the conversation about the benefits and disadvantages, both short and long term, of birth by cesarean delivery [13].

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