The impact of cesarean birth on subsequent fertility

Engin Oral[a] and Koray Elter[b]

Purpose of review

Recently, the rate of cesarean delivery has increased to 25–30% of all births, the highest rate ever reported in the USA. Primary cesarean deliveries, especially elective procedures, mainly contribute to this increase. Currently, controversy concerning elective cesarean delivery is an area of growing debate. Women should be well informed about the benefits and risks of on-demand cesarean delivery. This may be problematic, however, due to the limited current scientific data on the benefits and risks. One of the issues causing debate is the association between cesarean section and subsequent infertility. In the present review, we aim to analyze the evidence for the impact of cesarean delivery on subsequent fertility.

Recent findings

Cesarean section has been reported to be associated with decreased subsequent fertility. Recent studies, which have tried to explain this association, suggest that this is most probably voluntary or due to some other biases, or possible confounding factors, which are due to organic or psychosocial effects of an emergency cesarean section or labor preceding the cesarean delivery.

Summary

Elective cesarean section does not appear to cause infertility. What we need now, however, are more qualitative studies to determine the contribution of cesarean section *per se* on fecundity.

Keywords

cesarean delivery, infertility, sexual function, tubal factor

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[a]Division of Reproductive Endocrinology, Department of Obstetrics and Gynecology, Istanbul University Cerrahpasa School of Medicine, Istanbul, Turkey and [b]EuroFertil Center for Reproductive Health, Istanbul, Turkey

Correspondence to Prof. Dr Engin Oral, Cerrahpasa P.T.T PK 31, 34301 Istanbul/Turkey
Tel: +90 532 6132611; fax: +90 212 343 20 02; e-mail: eoral@superonline.com

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Introduction

Evidence suggests that cesarean birth rates are high and increasing in some developed and developing countries [1,2]. Recently, the rate of cesarean delivery has increased to 25–30% of all births, the highest rate ever reported in the USA [1]. After falling between 1989 and 1996, the cesarean rate has risen by one-third in the USA [1]. Cesarean section is the most frequent major surgical procedure performed in the USA [3]. Previously, it has been an 'American problem', but now, it is becoming an international crisis. The cesarean section rate in Norway increased from 2% in 1968 to 12.6% in 1990 and reached 13.4% in 2000 [4]. In Europe and the UK, the increase has also been dramatic, doubling from 11% of all deliveries in the 1990s to over 22% in 2001 [5,6]. Puerto Rico has a rate of 31%, whereas Brazil has reached an all-time record of 35% [7].

Primary cesarean deliveries, especially elective procedures, mainly contribute to this increase. Currently, controversy concerning elective cesarean delivery is an area of growing debate [8,9]. Until recently, the option of elective cesarean delivery has not been considered in most countries. Moreover, the International Federation of Gynecologists and Obstetricians maintains that elective cesarean delivery is not ethically justified [10]. Recently, this view has been challenged, and patient's choice concerning mode of delivery has been supported [11,12]. A recent sounding board has declared that, for a well informed patient, elective primary cesarean delivery may be performed [11]. Also, the American College of Obstetrics and Gynecology (ACOG) has already issued guidance based on currently available data, and has stated that if physicians believe that cesarean delivery promotes the overall health and welfare of women and fetuses more than vaginal birth, they are ethically justified in performing a cesarean delivery [13]. These opinions, however, are made problematic by the limitations of the current scientific data on the benefits and risks of cesarean section. One of the issues causing debate is the association between cesarean section and subsequent infertility. In the present review, we aim to analyze the evidence for the impact of cesarean delivery on subsequent fertility.

Cesarean section and subsequent infertility

In one of the earliest studies, Zdeb *et al.* [14] analyzed the frequency, spacing and outcome of pregnancies in 5513 women, who have had a live birth via cesarean section at their initial pregnancy. The authors reported

that primary cesarean delivery is associated with a reduction in future child bearing. Hemminki *et al.* [15] compared the subsequent fertility of 406 women who had undergone their first delivery by cesarean section with that of 406 matched control women in a retrospective cohort study by using the cross-sectional data of the 1982 National Survey of Family Growth in USA. The authors reported that the number of subsequent pregnancies and time to the subsequent pregnancy were significantly different between groups, and that the women who had undergone a cesarean section had more problems in conceiving. Subsequently, Hemminki [16] also analyzed the Swedish registry, and reported the analysis of a larger sample in this latter study. The results were in concordance with the previous US study [15,16]. The above studies showed a decrease of around 10% in fecundity following a primary cesarean delivery.

These studies, however, did not address the reasons for such a reduction, that is whether it was voluntary or whether factors leading to cesarean section contributed to this decrease. Some authors have suggested, rather than infertility, a psycho-social mechanism, in which negative factors associated with cesarean delivery contribute to reluctance to become pregnant again. Antepartum, intrapartum and postpartum experiences of cesarean sectioned women (including neonatal problems) may be different from those of women who had a vaginal delivery. Also, the risks for the subsequent pregnancy are different between women who had undergone a cesarean section for their first pregnancy compared with those who had delivered vaginally [17], which may influence the desire for another child. In addition, cesarean section has a higher maternal morbidity and mortality rate than vaginal delivery, although an elective cesarean section is safer than an emergency procedure [17]. Therefore, a feeling of fear of vaginal birth after cesarean or a repeat cesarean may discourage women from having further children.

In 1962, Baird and Cook [18] first suggested a relative infertility following cesarean section. At that time, the cesarean delivery rate was low, and it was only considered for more difficult labors. The decrease in fecundity was most probably due to the bad experience and the complications of labor. Studies describing emotions regarding the cesarean delivery [19–21], issues in marital adjustment [22], and problems in bonding and breastfeeding would support this reasoning [23]. For example, Jolly *et al.* [24] surveyed women who had undergone cesarean, spontaneous vaginal, and instrumental delivery and found that cesarean and vaginal instrumental delivery resulted in fear of future childbirth. Among mothers with one child, those who had their only child by cesarean section were more likely to have tried but not been successful in having further children compared with mothers who had normal deliveries. Also, Hall *et al.* [25] analyzed whether there was a difference in fertility after different modes of delivery – spontaneous vaginal, instrumental and cesarean section. They confirmed that women who have had a cesarean section have fewer pregnancies than those who have spontaneous vaginal delivery. They observed that this rate was also lower than those women who had instrumental delivery. These data suggest that the psychological burden of an experience of intrapartum emergency and an invasive procedure, as well as subsequent fear of a further pregnancy, could not explain the decreased rate of pregnancies following cesarean section. In a recent study, Mollison *et al.* [26] confirmed previous results that fertility decreased following cesarean section, and they also observed no difference between women who had had a vaginal delivery and those who had undergone an instrumental delivery.

In a small but prospective study, Garel *et al.* [21] compared mothers' health, desire for subsequent pregnancies, attitudes in child rearing, and the children's health and psychologic development in women who delivered by cesarean and those who delivered vaginally ($n = 103$ in each group) after a 4-year follow up. After a cesarean section, mothers tended to have fewer children, and just after delivery, mothers who stated that they did not want another child were more numerous in the cesarean group, although not significantly so. Analysis of the long-term maternal health effects of cesarean section revealed that women who had had their first delivery by cesarean had somewhat higher long-term morbidity, measured by the use of hospital services, than those who had vaginal delivery [27]. These women, however, had already used hospitals more before their cesarean section. This suggests that the higher use of health services, either because of poor health or for other reasons, is a risk factor for cesarean section.

It is difficult to determine the impact of cesarean section *per se* on the decreased fecundity in these studies since there may be many confounding factors; that is, factors that led to the operation may be responsible for the differences. It is well known that infertile women have a higher rate of cesarean delivery than fertile women. LaSala and Berkeley [28] have analyzed the incidence of certain factors that may be associated with infertility – previous infertility, occurrence of infection, length of ruptured membranes and indication of cesarean section. The authors observed that significantly more patients who suffered with infertility after cesarean section had a history of infertility prior to that delivery compared with those who did not have infertility after cesarean section. Other factors were comparable between groups [28]. The literature also suggests that women who have a period of primary infertility are more likely to deliver by cesarean section [29,30]. Smith *et al.* [31••] have demonstrated a negative association between operative births, including

assisted vaginal and cesarean cesarean deliveries, and the likelihood of further pregnancies among 110 000 women. They demonstrated that after adjustment for maternal and obstetric characteristics, there was no significant association with either assisted vaginal delivery or planned cesarean section for breech presentation. These data suggest that the association between cesarean birth and subsequent subfertility is more likely to be caused by confounding than by a causal relationship [31••].

Cesarean section, tubal factor and ectopic pregnancy

Decreased rate of deliveries and, therefore, a lower number of children following a primary cesarean section may be related to the rate of ectopic pregnancies. It has been suggested that cesarean section is a risk factor for ectopic pregnancies [27,32]. A history of cesarean section increases the risk of subsequent intraabdominal adhesions and adhesion-related small bowel obstruction, although this increase is smaller than that associated with other abdominal operations [33]. Any increase in intraabdominal adhesions increases the risks from any subsequent abdominal operations. More recent studies, however, have reported no association between cesarean section and ectopic pregnancy [34,35]. Although implantation of a pregnancy within a caesarean scar is considered to be the rarest form of ectopic pregnancy, and only small case series have been reported [36], cesarean section causes this life-threatening complication and the increasing number of caesarean sections will further increase its incidence.

To evaluate whether cesarean section plays a role in tubal factor infertility, Wolf *et al.* [37] analyzed the history of cesarean delivery in a population-based case–control study of women with secondary tubal infertility. They observed that the risk of tubal infertility was not elevated in women who had undergone a previous cesarean section. Nather *et al.* [38] analyzed the effect of peritoneal nonclosure on future fertility to test the hypothesis that it decreases fertility through increasing adhesions. They compared 119 women without closure of the parietal peritoneum with the results of 264 women with peritoneal closure at cesarean delivery with respect to number of subsequent deliveries within the 3-year period following surgery. Among the women without peritoneal closure, the 3-year probability of further delivery was 33.4%; in those with peritoneal closure, the rate was 29.9% and these rates were comparable [38].

Can any confounding factor explain the association between cesarean section and subsequent infertility?

The above-mentioned studies have confirmed an association between cesarean section and infertility, and suggest decreased fecundity following cesarean section. Recent data confirm this observation [39••]. Age and obesity are two common risk factors for both infertility and cesarean section [40–43]. As mentioned above, previous infertility may increase the likelihood of cesarean section [29,30,44]. Infertility treatment increases the multiple pregnancy rate and the number of children may clearly influence the desire for further children.

In a recent study, Bhattacharya *et al.* [45] investigated whether absence of conception following cesarean section is voluntary or involuntary. They compared women who had had their first child by cesarean section, those who had a spontaneous vaginal delivery and those who had an instrumental vaginal delivery between 1980 and 1995 but had no further viable pregnancies by December 2000. The authors analyzed questionnaires completed by 3204 women to determine the extent to which not conceiving after their first child was voluntary and the reasons for avoiding further pregnancies. Absence of conception was voluntary in 69–72% of women [45]. Few women (between 8% and 11%) considered seeking fertility treatment [45]. These rates were comparable between groups. The authors concluded that, irrespective of the mode of delivery, not conceiving following the birth of the first child was mainly voluntary.

More recently, a causal link between cesarean section and the decrease in subsequent pregnancies has been studied more extensively. Gottvall and Waldenstrom [46] investigated whether women's experiences of their first birth affects future reproduction. They observed that women with a negative experience of their first delivery had fewer subsequent children and there was a longer interval to the second birth. Murphy *et al.* [47] analyzed the relationship between cesarean section and subfertility in a population-based sample of 14 541 pregnancies. They confirmed the previously reported association between maternal history of subfertility and subsequent delivery by cesarean section and also the association between previous cesarean section and subsequent decreased rate of conception. The latter association was stronger for women of higher parity. This may be due to a cumulative effect of repeat cesarean sections. Murphy *et al.* [47] suggested that women who had their first child by cesarean section may take longer to conceive because of pelvic adhesions, infections or placental bed disruption, which in turn may be influenced by the indication for cesarean section.

Cesarean section and sexual function

Evidence strongly suggests an association between assisted vaginal delivery and sexual dysfunction [48–54]. All studies which analyzed perineal pain reported that the greatest risk for increased perineal pain occurred among women with assisted vaginal delivery [48,50,51]. Reported associations between cesarean delivery and perineal pain,

dyspareunia, and delay in resumption of sexual intercourse postpartum, however, were inconsistent [48,50,52,53]. Two studies [48,52] reported that spontaneous vaginal delivery was associated with decreased sexual problems compared with assisted vaginal delivery or cesarean delivery. Although there are possible mechanisms that could argue for improved sexual functioning among women following cesarean section, information about sexual functioning remains unclear.

Alternative hypotheses may explain the link between cesarean section and its negative impact on sexual functioning. Hemminki [55] argued that some adverse maternal health outcomes are unintended consequences of cesarean section, which involves surgical incision of the abdomen wall, entry into the peritoneal cavity, and anterior uterine wall incision for delivery of the fetus. Factors related to abdominal surgery and the development of maternal morbidity include uterine infection, obstetric surgical wound complications, adhesions of the bladder and round ligament, and cardiopulmonary and thromboembolic conditions [56–59]. In turn, these factors may result in the development of complications contributing to poor maternal health. Valenzuela [60] suggested a role of postpartum endometriosis after cesarean section in affecting future fertility. Hurry *et al.* [61] reported that postoperative pelvic abscess following cesarean section was associated with a significant reduction in fertility.

Most studies on the effect of method of delivery on sexual functioning were retrospective analyses, they lacked validated tests, or measured short-term outcomes, making it difficult to draw a clinical conclusion from the findings [54]. Furthermore, it was not possible to determine whether sexual problems were, in fact, preexisting, because minimal data were collected on antenatal sexual health [48]. In a recent trial, van Brummen *et al.* [62] analyzed factors that determined sexual activity and satisfaction with the sexual relationship 1 year after the first delivery in 377 nulliparous women. In a multiple logistic regression analysis [62], dissatisfaction with the sexual relationship 1 year after childbirth was associated with not being sexually active at 12 weeks of gestation and with an older maternal age at delivery. Satisfaction with the sexual relationship did not seem to depend on pregnancy and parturition-associated factors [62]. This finding supports the importance of preexisting or earlier sexual function on postpartum sexual function.

All studies about sexual functioning following delivery have used postpartum questionnaires mailed after childbirth, which may increase recall bias [54]. Furthermore, because sexual problems fluctuate after birth, the timing of surveys will influence results [54]. Notably, because women with sexual problems often have multiple subclinical and clinical diseases and consequent morbidity, it would be rare for a single aspect of health status or obstetric intervention to be the sole predictor of sexual problems [54]. Although women who have undergone cesarean delivery have been noted to have diminished pelvic floor trauma relative to women who have had vaginal delivery, if the cesarean is performed prior to 8 cm dilation, they have also been shown to have increased chronic pelvic pain [63,64].

Are there any randomized studies that have compared the mode of delivery with subsequent fertility?

A large international randomized controlled trial [65] comparing planned cesarean delivery and planned vaginal birth among women with breech presentation reported contradictory findings regarding postpartum sexual functioning. Among women randomized to the planned cesarean delivery group, pain was reported more frequently during sex at 3 months postpartum by women who had undergone a cesarean delivery than for women who delivered vaginally (18% versus 10%), whereas there was no difference by method of delivery among women randomized to the planned vaginal delivery group [65]. The same authors reported the results at 2 years postpartum [66]. The Term Breech Trial [66], which avoided selection bias because of randomization, provided a unique opportunity to assess the effects of planned method of delivery on maternal outcomes 2 years after the birth. The study was undertaken to compare maternal outcomes at 2 years postpartum after planned cesarean section and planned vaginal birth for the singleton fetus in breech presentation at term. A total of 917 mothers from 85 centers completed a follow-up questionnaire at 2 years postpartum. The number of pregnancies and deliveries after the index birth were comparable between groups [66]. In addition, there was no impact of planned cesarean section on resumption of sexual relations, pain during sex, or satisfaction with sexual relations. To our knowledge, there are no other reports of sexual function or fertility after random assignment to vaginal or cesarean delivery. Therefore, much of what we know about sexual function and fertility after delivery comes from observational studies.

Conclusion

The results of the only randomized study that studied the effect of elective cesarean section on different outcomes suggest that the surgical impact of cesarean delivery on subsequent delivery is negligible. The effect of cesarean section on subsequent fertility, as observed in observational studies, is most probably voluntary or due to some other biases, that is possible confounding factors, or due to the organic or psychosocial effects of an emergency cesarean section or labor preceding the cesarean delivery. Unfortunately, it seems that infertility

does not appear to be an obstacle in this era of rising cesarean rates. What we need now, however, are more qualitative studies to determine the contribution of the cesarean section *per se* on fecundity.

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

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Additional references related to this topic can also be found in the Current World Literature section in this issue (p. 294).

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