

Risk of cesarean delivery in ongoing pregnancies of nulliparous women after 37 weeks of gestation: a prospective cohort study

Thibaud Quibel¹, Camille Bouyer¹, Patrick Rozenberg², and Jean Bouyer³

¹CHI Poissy-Saint-Germain-en-Laye

²CHI Poissy-St Germain

³Inserm

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Abstract

Objective: To study the risk of CD for each gestational week among ongoing pregnancies of nulliparous women at term. **Design:** A retrospective, population-based cohort study from January 1, 2016, through December 31, 2017 **Setting:** a French perinatal network of the Yvelines district, France **Population:** 11 308 nulliparous women with a singleton fetus in a cephalic presentation and delivered at term ([?]37-week +0 day) **Methods:** for each week of gestation at term, we defined ongoing pregnancies as all pregnancies undelivered at the start of each week. Regression models adjusted by maternal characteristics and hospital status were used to compare the CD risk between ongoing pregnancies and the pregnancies delivered the preceding week. The same methods were applied to subgroups defined by the mode of labor onset. **Main outcome measure:** The caesarean delivery rate (CD) **Results:** Ongoing pregnancies > 40 weeks+0 days were associated with a higher risk of CD compared with pregnancies delivered the previous week: 24.3% in ongoing pregnancies [?] 40 weeks +0 days versus 19.9% in deliveries between 39 weeks +0 days and 39 weeks+6 days (Odd ratio adjusted of 1.28, 95%CI [1.15-1.44]; 30.4% in ongoing pregnancies [?] 41 weeks +0 days versus 19.6% in deliveries between 40 weeks +0 days and 40 weeks+6 days (OR 1.73, 95%CI [1.51-1.96]). This was also shown for all modes of labor onset and in every maternity unit. **Conclusions:** CD rates increased starting at 40 weeks +0 days in ongoing pregnancies, regardless of the mode of labor onset.

Introduction

Cesarean delivery (CD) rates have increased substantially over the past three decades in low, middle, and high-income countries.¹⁻² This is a worldwide public health problem as CDs can lead to short and long-term health consequences for both newborns and mothers.³⁻⁴ For decades, health care professionals, researchers, and policy-makers have failed to provide a clear-cut answer about the “optimal” population level frequency of CD. Research is now focusing on optimizing CD use, by selecting targeted populations in which interventions might reduce or at least stabilize the number that are unnecessary.⁵⁻⁸

Many drivers play a role in the excess use of CD: some are related to the clinical status of the mother or the fetus, to the beliefs of the mother and of society more broadly, to the beliefs, preferences, and experience of health care professionals, to the organization of health care systems, facilities, and especially funding mechanisms.⁹⁻¹¹ One relevant question recently raised is that of the optimal timing of delivery of term pregnancies. A large randomized trial of low-risk nulliparous women found that induction of labor at 39 weeks was associated with a decreased risk of CD and thus suggests that expectant management past 39 weeks might thus be a risk factor for CD.¹² Observational comparative studies have reported similar findings.^{13,14} These studies, however, all focused on elective induction of labor as a potentially protective act against CD, neglecting the documentation of the CD risk when pregnancies are managed expectantly at term. The timing of delivery itself may constitute a risk factor for CD, in particular for ongoing pregnancies

(OPs) in full and late term. That is, continuation of the pregnancy may increase the risk that it will end by a CD.

This study therefore aimed to evaluate the risk of CD for each additional week of gestation for nulliparous women with OPs that have reached 37 weeks + 0 days.

Methods

Design of the study and study population

This study used data from a population-based cohort of births from January 1, 2016, through December 31, 2017, in the MYPA (Maternités en Yvelines et Périnatalité Active) perinatal network, which includes all maternity units in the district of Yvelines (west of Paris) and manages more than 16,000 deliveries per year. It comprises 10 maternity facilities (referred to here as A through J), including one academic maternity unit (A), affiliated with a university (Université Versailles-Saint Quentin). Half the establishments are public (A, B, C, E, and H) and half private (D, F, G, I, and J). Only two (A and B), both including a neonatal intensive care unit (NICU), manage all types of pregnancies. The other eight (C–J) are level-1 departments intended to serve only low-risk pregnancies.

Data source and study exposure variables

The CoNaissance Program 78 was initially established in 2008 in collaboration with local authorities (Conseil Départemental des Yvelines), l'Agence Régionale de Santé Île-de-France (Regional Health Agency), and Inserm Unit 953 to monitor maternal and perinatal morbidity and mortality prospectively in a French perinatal network. It collects continuously recorded data for all deliveries occurring after 24 weeks of gestation, including from two health certificates:

The first health certificate (PCS: premier certificate de santé) of infants born in the network's maternity units, which is completed during a nationally mandatory medical examination performed within eight days after birth, usually in the maternity ward.

A complementary health certificate, specifically developed within the MYPA network and reporting additional data such as severe maternal morbidity, family social characteristics, fetal deaths, and terminations of pregnancy for medical reasons at and after 22 weeks of gestation.

We restricted this study to nulliparous women with a singleton fetus in cephalic presentation still ongoing at 37 weeks + 0 days. In accordance with French guidelines, pregnancies dating used the crown-rump length measured during the first-trimester ultrasound scan, routinely performed in France.

Ethics Approval

The National Committee for Data Protection (Commission Nationale de l'Informatique et des Libertés, registration number 1295794) approved the study, which was conducted in accordance with French legislation. Under French law, the study was exempt from informed consent requirements because patients received standard care and because the dataset contained no information that could enable patient identification. Similarly, ethics committee approval was not required because the study used an anonymized database and had no influence on patient care.

Caesarean delivery rate in ongoing pregnancies

Our objective was to examine the risk of CD when expectant management has been decided. In observational studies, however, it is difficult to identify the clinician's intention to manage a pregnancy expectantly given that decisions for elective delivery involve inductions of delivery for both medical and non-medical reasons. Moreover, plans for expectant management of a pregnancy may well change as it continues. Therefore, we used OPs as a proxy for expectant management. At the start of each gestation week (those at +0 days), OPs were those of all women still pregnant who gave birth at any time thereafter. Thus, for example, the OP group at 37 weeks, the start of our study period, are all women who had not given birth before 37 weeks + 0

days who finally did give birth at or after that day (through the end of the pregnancy). The OP group thus grows progressively smaller each week and is not limited to the pregnancies delivered in any given week.

Statistical analysis

Descriptive statistics were used to provide an overview of the study population and estimate the global risk of CD in nulliparous women at term for the women with OPs each week. Maternal characteristics and maternity unit status (public or private) were compared for each gestational age at delivery, with either chi-square statistics or Fisher's exact test for categorical variables and with Student's t test for continuous variables.

For a given week of pregnancy, we considered two groups of pregnancies (see Figure 1): those delivered the previous week, and those not delivered, that is, the OPs, and we compared the percentage of CDs in each group. For the first group, delivery (CD or not) occurred in the previous week, and for the second group it occurred any time from the first day of the week studied to the end of the study period (which could be several weeks later). In both groups, all deliveries were considered, regardless of the mode of onset of labor (spontaneous, induced, or a prelabor CD). The difference in CD rates of these delivered and ongoing pregnancies were computed with their 95% confidence intervals, compared with chi-square tests, and reported as ORs. Adjusted ORs were estimated by logistic regression, after adjustment for maternal age, educational level, severe preeclampsia, and maternity unit status.

We also sought to ascertain how CD rates evolve with gestational age according to the mode of labor onset. CD rates among nulliparous women who gave birth after spontaneous labor were calculated for each gestational week of OPs by dividing the number of CDs after spontaneous labor by all births that occurred after spontaneous labor among the women with OPs. We used the same procedure for CDs after induction of labor.

All analyses were performed with R Studio version 1.0.136. Significance was defined by $P \leq 0.05$.

Results

During the two-year study period, 32,766 women gave birth in one of MYPA's 10 maternity units at a gestational age ≥ 24 weeks. The overall CD rate in the network was 25.8%. Our study included 11,308 nulliparous women with a singleton fetus in cephalic presentation who did not give birth before 37 weeks + 0 days. The CD rate in this population was 22.5% and varied highly between maternity units (range 15.4%–40.2%). The rates of labor induction and prelabor CD were respectively 28.1% (range 20.6%–41.4%) and 4.4% (1.3%–19.2%) and differed significantly between units. Like the overall CD rates, CD rates after spontaneous labor varied widely between network members (range: 8.4%–21.3%), but CD rates after induction of labor did not (range 29.1%–39.7%, non-significant). (Table 1).

Characteristics of the study population are summarized in Table S1. Women who gave birth at ≥ 40 weeks+0 days were less likely to be older than 35 years, to have completed high school, or to have had pregnancies uncomplicated by severe hypertensive disorders or diabetes mellitus. Deliveries in a private maternity unit were most frequent at 38 or 39 weeks of gestation.

Figure 1 presents the flow chart of the 11,308 pregnancies ongoing at 37 weeks + 0 days. Nearly half the nulliparous women had not given birth at that point, and 20% of them had a late-term pregnancy (≥ 41 weeks + 0 days). Figure 1 helps to explain how the CD risk by gestational age can be interpreted in different ways, depending on how the CD rate is calculated. The left part of Figure 1 reports the ratio between the number of CDs in a given week and all the deliveries that same week, that is, with delivered pregnancies as the denominator. Taking the week of delivery into account by using this denominator shows that CD rates were lowest for deliveries in weeks 39 and 40, but highest in week 41. These results are explained by the high rate of spontaneous labor in weeks 39 and 40, while the CD rate in week 41 (and later) was associated with a high proportion of inductions of labor. Therefore, when the denominator is the pregnancies delivered a given week of delivery, CD rates vary widely according to the proportions of spontaneous and induced labor. The CD rates in the OPs, that is, with OPs as the denominator, however, are different, notably when pregnancies

reach full term: CD rates rose as pregnancies were reaching 40 weeks+0 day. (Table 2). More precisely, the CD rates in OPs were influenced by the proportion of pregnancies still to be delivered at late term ([?]41 weeks+0 day) and the CD rates observed in this late population. These results were found in each maternity unit, regardless of its overall CD rate or overall induction rate. (Appendix A)

The odds ratio comparing the CD rates in OPs with the deliveries of the previous week was statistically significantly higher after 39 weeks. This result remained consistent after adjustment for maternal age, educational level, severe preeclampsia, and maternity unit status (Table 3) and was similar in each maternity unit.

In the group of women who gave birth after spontaneous labor, CD rates were stable for ongoing pregnancies reaching 37 weeks + 0 days, 38 weeks + 0 days, and 39 weeks + 0 days, at around 13.5%, but began rising at 40 weeks + 0 days and reaching 20% in late-term pregnancies. Among the women with OPs who gave birth after induction of labor, the CD rates also increased with each week of gestation (Table S2). Importantly, these findings too were consistent within each maternity unit (Appendix B).

Discussion

Main findings

This analysis of more than 11,000 deliveries in 10 maternity units of a perinatal network found a higher risk of CD among nulliparous women with ongoing pregnancies beyond 39 weeks + 6 days. Moreover, this finding was also observed in every maternity unit in the network. These findings are explained by the relative size of the group of deliveries that took place at [?]41 weeks + 0 day among the OPs, regardless of the mode of labor onset.

Strengths and limitations

The strengths of this study include a very large sample from a well-defined population, that of an entire perinatal network. The quality of the data is high, since they were abstracted prospectively by trained personnel and the database was checked by regular audits.¹⁵

Although the overall CD rate in this perinatal network (26.5%) may differ significantly from that of other perinatal networks and other countries, some results of this study emphasize the external validity of our study. Most importantly, the higher risk we observed in the perinatal network for OPs at or beyond 40 weeks+0d was similar in every maternity facility in this network, even though their overall rates of CDs and of labor inductions varied substantially from one to another. Moreover, we found that the CD rate for ongoing pregnancies at 39 weeks + 0 day was 22.7%, which is quite similar to the CD rate in the expectant management group in the Arrive trial (22.2%) and in other observational studies.¹² Moreover, Brennan, comparing CD rates for nine maternity units from different countries, showed that the mean CD rate for nulliparous women with a fetus in cephalic presentation who gave birth at term ([?]37 weeks + 0 day) was 21% (range: 13.8%-30.6%), just slightly lower than our results (22.5%).¹⁶

Our study, nonetheless, has several limitations. First, the statistical analysis we used to compare the CD rates in ongoing pregnancies deserves an explanation. Cumulative probabilities and life table analysis are usually appropriate for exploring the risk of an adverse outcome that varies across time, such as the CD risk does here. Although these models have been described for evaluating the risks of stillbirth by gestational age, they have not provide comprehensive data on the risk of CD for OPs.^{17,18} Standard regression models are also inappropriate for comparing CD rates for each week of ongoing pregnancies, as patients can be classified into nested groups (*i.e.*, a woman delivered at 39 weeks + 3 days could also have been classified into ongoing pregnancies[?] 37 weeks + 0 days, but also at 38 weeks + 0 days and 39 weeks + 0 days). Therefore, the only way to evaluate the CD risk for ongoing pregnancies was to compare CD rates in ongoing pregnancies with the CD rates of patients who gave birth the week before. Nevertheless, as we mentioned above, results were consistent at all 10 maternity units in our network: the CD risk rose with gestational age and specifically for late term deliveries, that is, at 40 weeks +0 days. These findings thus support our

hypothesis that gestational age at delivery could become a risk factor for CDs, especially for OPs at late term.

Furthermore, our objective was to approach the risk of CD for women for whom expectant management was planned. This study is subject to the limitations of all observational studies that use cross-sectional data to address a longitudinal question. As no data were available about indications for induction of labor, it was impossible to know whether the clinician had planned to manage the pregnancy expectantly or had intended to induce labor electively. In France the national authority for health (Haute Autorite de Sante) recommends that elective deliveries for nonmedical reasons (that is, for maternal request) not be performed until at least 39 weeks of gestation and only with a favorable cervix.¹⁹ Epidemiological data about elective early deliveries for nonmedical reasons in France are sparse, but the HAS conditions for inductions that are not medically indicated are rarely present in nulliparous women, even after 39 weeks.²⁰ We therefore considered OPs as a proxy for expectant management, notably for ongoing pregnancies at and after 39 weeks+0 d.

Interpretation in light of other evidence

The question of the optimal timing of delivery was initially raised to improve perinatal morbidity and mortality, since late term pregnancies have been associated with higher risks of stillbirth and neonatal morbidity.²¹⁻²³ The hypothesis in the ARRIVE trial was to test whether elective induction of labor at 39 weeks of gestation compared with expectant management among low-risk nulliparous women could reduce the risk of a composite outcome of perinatal morbidity. The difference in the primary criterion did not reach significance between the two groups, but the authors found a significant reduction in the CD rate in the elective induction of labor group, compared with the group managed expectantly (18.6% vs 22.2%; RR, 0.84; 95% confidence interval, 0.76-0.93; $P < .001$).¹² Although this trial was based on a large population (with 6108 nulliparous women) and took place in a large number of academic and community hospitals, its external validity and its generalizability to other institutions and other countries is still being debated, especially since CD rates in the United States are considered among the highest among high-income countries. Indeed, the proportion of CDs in the expectant management of the ARRIVE trial appeared high at first sight, especially because many perceive expectant management to be associated with spontaneous labor, which is obviously the mode of labor onset associated with the lowest CD rates. In our study, only two thirds of ongoing pregnancies at 39 weeks+0 days were delivered after a spontaneous labor. More, this rate consistently declines to less than 50% for prolonged pregnancies ([?]41 weeks+0 days)

This study was not designed and does not attempt to define the optimal age for delivery. It was performed instead to examine the risk of CD in OPs as term advances. In the past few years, as efforts have been made to explore the potential benefit of a policy of elective induction of labor on CD rates, issues in the population expectantly managed have not adequately emphasized. OPs can serve as a proxy for expectant management and are an appropriate method for investigating adverse outcomes in OPs. Moreover, this study, by its simple method of deconstructing CD rates for each week of OPs, helps us to understand how the risk of CD increases in OPs, in particular, in full, late term, and post-term pregnancies ([?]40 weeks + 0 day).

Adverse outcomes, such as macrosomia, chorioamnionitis, meconium staining, and hypertensive disorders, all rise beyond 38 weeks+0 days, and may be part of the explanation for the increase in CDs rates in full and late term pregnancies.²⁴ We also provided additional data illustrating the effect of gestational age when the mode of labor onset was taken into account. Surprisingly, this has not been explored in studies, and clinicians might well think that the gestational age has no influence on the risk of CD during either spontaneous or induced labor. The CD risk rises for both modes of labor onset; this rise was most pronounced in spontaneous labors.

Conclusion

In all, the risk of CD increases as pregnancies reach full or late term in nulliparous women. Further research is needed to investigate this risk in OPs of parous women and ascertain whether the influence of gestational age of delivery is similar or different in these women.

Disclosure of interest : The authors of this manuscript (TQ, CB, JB, PR) have no conflicts of interest to disclose.

Author contribution: T.Q developed the research question, facilitated analysis of the samples, designed the study and analytic plan, analyzed and interpreted the data, and drafted the manuscript. C.B participated to collect all data. P.R contributed to writing the manuscript. All authors edited, read and approved the final manuscript.

Details of ethics approval : The National Committee for Data Protection (Commission Nationale de l'Informatique et des Libertés, registration number 1295794) approved the study, which was conducted in accordance with French legislation. Under French law, the study was exempt from informed consent requirements because patients received standard care and because the dataset contained no information that could enable patient identification. Similarly, ethics committee approval was not required because the study used an anonymized database and had no influence on patient care.

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Table 1: Proportions of modes of onset of labor and the CD rates for each in the perinatal network maternity units.

Table 2: Risk of cesarean delivery per week of gestation

Table 3: Table 3: Odds ratios (crude and adjusted) and their 95% intervals for CD rates for ongoing pregnancies compared with those for women who gave birth in the previous week of gestation.

Figure 1: Deliveries from January 1, 2016–December 31, 2017 in nulliparous women with a singleton fetus in cephalic presentation with an ongoing pregnancy at 37 weeks^{+0 d}. (the left part reports the CDs

Table S1: Maternal, obstetric, and hospital status according to week of delivery

Table S2: Cesarean delivery rates in ongoing pregnancies according to the mode of onset of labor

Appendix S1: Caesarean delivery rates in ongoing pregnancies within each maternity of the perinatal network

Appendix S2: Cesarean delivery rates in ongoing pregnancies after spontaneous onset of labor or induction of labor

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