Trial of labor versus elective cesarean delivery for patients with two prior cesarean-sections: A retrospective propensity score analysis

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Abstract

Introduction Despite awareness of obstetricians to the constant increase in the number of cesarean sections in recent years, the fear of a uterine scar rupture is still present and influences the choice of the mode of delivery in patients with two previous cesarean sections. However, several clinical studies have suggested that, under certain conditions, vaginal birth after two cesarean sections is usually successful and safe.

Objective The objective of this study was to compare maternal and neonatal issues according to the planned mode of delivery in patients with two previous cesarean sections.

Methods It was a retrospective observational comparative study at Rennes University Hospital between January 1, 2013, and December 31, 2020. We performed a propensity score for the comparison of neonatal outcomes: cord pH, cord lactates, Apgar scores, transfer to neonatal unit and deaths, according to the planned delivery mode. Secondary outcomes were maternal issues: uterine rupture, post-partum hemorrhage, deaths.

Results A total of 410 patients with two previous cesarean section were eligible for our study. Prophylactic cesarean was performed in 358 cases (87.3%). Trial of labor was attempted in the 52 remaining patients (12.7%), 67.3 % of whom were successful. Neonatal weight, APGAR score at 1-5-10 minutes, and pH on cord blood were comparable in both groups. One case of uterine rupture occurred in the trial of labor group.

Conclusion Trial of labor seems to be a reasonable option for women with two previous cesarean sections in a selected population.

Keywords uterine scar; previous cesarean section; mode of delivery; trial of labor; elective cesarean section: neonatal outcomes; maternal outcomes.

Introduction :

Despite obstetricians' awareness of the need to limit cesarean sections, the legitimate fear of uterine rupture influences the choice of delivery route in the case of a patient with a history of two previous cesarean section, and trial of labor in this case is not often offered to women.

However, there are inherent risks to the mother and fetus after a cesarean delivery, both short and long term, especially if repeated[1]. Cesarean delivery is associated with higher rates of maternal mortality, intensive care management, hysterectomy, blood transfusions in the immediate post-partum[1–4]. The consequences of a third cesarean delivery also have a major impact on subsequent pregnancies. Indeed, multiple cesarean sections increase the risk of uterine rupture, placenta accreta spectrum, post-partum hemorrhage, infertility, pelvic adhesions, hysterectomy and premature deliveries [1–4],[5].

From a neonatal point of view, cesarean section would increase neonatal short term morbidity leading to neonatal respiratory distress and would bear a greater risk of severe neonatal asphyxia in future pregnancies[6]. Considering long-term consequences, cesarean sections may be responsible for alterations in the immune system and intestinal microbiota, as well as an increased risk of future obesity and asthma in the child[1,4,7].

A meta-analysis by Tasheen et al. showed that vaginal delivery after two cesareans was not associated with an excess of maternal and neonatal morbidity and mortality compared with a trial of labor after one cesarean section[8]. Trial of labor in patients with two previous cesarean sections was therefore offered to women in some centers, but this offer is still heterogenous[11]. In our center we started to offer the possibility of a trial of labor in selected patients.

Our main objective was therefore to compare neonatal morbidity and mortality after a trial of labor in patients with two previous cesarean section versus an elective cesarean section. Maternal outcomes were analyzed secondarily.

Methods

Study design

This was a single-center retrospective observational study taking place at the University Hospital of Rennes, Obstetric department, between January 1er 2013 and December 31 2020. We compared neonatal outcomes in case of trial of labor versus elective cesarean section in case of two previous cesarean sections, using a propensity score for the comparison of neonatal outcomes according to the planned delivery mode.

Study population and data collection

A total of 466 patients with two previous cesarean sections were found via a computerized file search using the International Classification of Diseases ICD 10O34.2 and ICD 10O75.7; and by searching in local patient records software (DxCare®). All patients who delivered at a term ≥ 37 SA of a singleton fetus in cephalic presentation and who had previously delivered twice by cesarean section were included in the study.

Patients with twin pregnancies, a preterm delivery before 37 weeks of gestation (WG), a fetus with a condition requiring elective cesarean delivery, placenta accreta, uterine malformation, a history of uterine rupture or previous corporal incision were excluded.

Data collection was carried out in agreement with the local Ethics Committee. Each patient was informed individually by mail of the use of her data and non-opposition was confirmed.

The variables collected were maternal age, body mass index and maternal history of hypertension or diabetes, parity, previous vaginal deliveries, indications and course of the two previous cesarean sections, pelvic tomodensitometry, estimated fetal weight at third trimester of pregnancy. Postpartum maternal complications included postpartum hemorrhage, defined as a bleeding greater than 500cc no matter the delivery route was, uterine rupture, defined as rupture of all layers of the uterine wall (including muscle and serosa), and maternal death. Neonatal data collected were cord pH, lactate and APGAR score at 1 minute, 5 minutes and 10 minutes of life, and transfer to intensive care neonatal unit, gestational age, birth weight and neonatal death.

Protocol for trial of labor acceptance in case of two previous cesarean section

The department's protocol for acceptance of a trial of labor was as follows: fetus in cephalic presentation, estimated fetal weight under 90e percentile at the third trimester scan (perfomed between 30 and 35 weeks), previous transverse and segmental cesarean sections. A pelvic tomodensitometry was to be performed with the following limits: promontoretropubic ≥ 10.5cm, bispinal > 10cm, transverse ≥ 12.5cm. Finally, patient had to be keen to a vaginal delivery. Each case had to be validated during staff meeting. Induction of labor was not authorized, although a moderate use of oxytocin to increase labor was possible. If no labor occurred by 41+6 WG, a cesarean section was performed.

Statistical analysis

Categorical variables were represented by counts and percentages and compared by $\chi 2$ test or a Fisher exact test. Continuous variables were tested for normality (Q-Q plots and Shapiro's test), represented by their median [minimum, maximum] and compared by Student's t-test or a Mann-Withney U test as appropriate.

To analyze the effect of the decision "trial of labor" or " elective cesarean delivery" on short-term maternal and neonatal morbidity and mortality, the confounding factors that could affect the decision to agree to vaginal delivery were taken into account by estimating a propensity score. The variables introduced into the model for estimating the propensity score were : maternal age, maternal history of diabetes, history of myomectomy, maternal BMI, indications for the two previous cesarean sections, history of vaginal delivery before and after cesarean section, the presence of maternal pathology related to the pregnancy and in particular gestational diabetes, estimated third trimester fetal weight, pelvic tomodensitometry.

Missing values prior to the decision on the route of delivery were considered as an additional mode of the variable concerned, as its absence could influence decision making. First, we compared different matching and weighting methods for their performance in reducing the imbalance between the two groups with or without a decision of trial of labor. Each pre-decision covariate averaged across decision groups were Patients with or without a decision of trial of labor were compared by estimating the standardized mean differences (SMD) after weighting on Inverse Probability of Treatment Weighting (IPTW), on IPTW truncated at the 95th percentiles and on Matching Weights (MW) which is a variant of the IPTW, and pairwise 1:1 matching 1:1 without replacement on their propensity score within 0.2 standard deviation of the logit of the propensity score[13,14]. The quality of the weighting and matching was verified by estimating the standardized mean differences (SMD) showing the absence of residual imbalance (Figure 3). The matching weights (MW) method, which is a variant of the Inverse Probability of Treatment Weighting (IPTW), performed best with all pre-decision covariate variables having a SMD <0.1 (supplemental data) as shown in Figure 4 [13,14]. Consequently, to reduce the imbalance between the two groups, the MW weighing method was used in subsequent analysis of the outcome after the decision to agree or not to vaginal delivery. The significance level was defined as $p<0.05$. All data were analyzed with R (R Core Team (2021) URL https://www.R-project.org/).

The design and reporting of the study was carried out in accordance with the Strategy for Strengthening Observational Studies in Epidemiology (STROBE) .

Results

Population

We identified 466 patients with two previous cesarean sections, 410 of whom were eligible for our study and met the inclusion criteria. Of these, 95 had a vaginal delivery agreement, and for the other 315 patients a cesarean section was planned. Of those who had a vaginal delivery agreement, 13 patients ultimately refused the trial of labor, 26 did not go into labor spontaneously, 2 patients developed pre-eclampsia, 2 had non cephalic fetal presentations. A total of 52 patients had trial of labor, of whom 35 actually delivered vaginally (67.3%), all under epidural anesthesia (**Figure 1**).

The characteristics of our total and weighted population are shown in **Table 1**. The indications for the two previous cesarean sections were similar in both groups. Estimated fetal weight at the third trimester averaged 65^{e} percentile in the elective cesarean section group versus 46^{e} percentile for trial of labor group (OR 1.02 [1.01 ;1.02] and a $p < 0.001$). The cut-off point for a planned cesarean delivery decision appeared to be around the 75^{e} percentile (Figure 2). Since the introduction of that protocol in October 2012, practices appeared to be homogeneous over time, with notably a stable rate of trial of labor from 2014 onwards (**Figure 2**).

Neonatal and maternal outcomes:

Neonatal outcomes in univariate analysis before and after the propensity score are presented in **Table 2**. Neonatal weight, APGAR score at 1-5-10 minutes, and cord blood pH were comparable in the two groups. Lactatemia was higher in the trial of labor group, significantly at 3.10mmol/L versus 2.20mmol/L ($p < 0.001$). Transfers to neonatology were similar in both groups 3.2% versus 2.5% ($p = 1.00$) before the propensity score. There were slightly more respiratory distress in the newborns born by cesarean section, 3 versus 1 in the group of patients with a vaginal delivery agreement. There were no neonatal deaths.

From a maternal point of view, there was one uterine rupture. The uterine rupture occurred in a G3P2 woman, with a eutrophic fetus (50th percentile). The first stage of labor lasted 9 hours, with oxytocin at a maximum of 6mUI/min. CTG abnormalities developed and an emergency cesarean section was performed. Birth weight was 3305g, APGAR score was 7-9-10 at 1, 5 and 10 minutes, cord blood was: pH = 6.9 lactates 8.1 = mmol/L. The rate of post-partum hemorrhage was 29.9% in the group that did not agree to a vaginal delivery compared with 21.1% in the group that did agree to a vaginal delivery ($p = 0.13$). There were 3 transfusions in each group. There were no maternal deaths. There 2 bladder injuries, 6 additional surgeries (4 intrauterine aspiration and 2 scar revisions), and 2 ileus, all in the planned cesarean section group. There was no bowel injury. The rate of postpartum infections was 2% for patients with a vaginal delivery agreement versus 1.5% for elective cesareans ($p = 0.73$). There was no difference in the length of stay before or after ponderation (**Table 2**).

The gestational age at birth was 39 WG for the elective cesarean section group (SD [37.00; 40.71]) versus 40 WG (SD [37.00; 41.86]) for the vaginal delivery agreement group (p

209 < 0.001).

210 After weighting by the propensity score, we compared maternal and neonatal outcomes
211 between patients who had a trial of labor and those who did not. We had 92 comparable patients,
212 weighted with the MW method. **Table 1** shows that our two weighted populations are
213 completely comparable at the time of the decision for vaginal delivery.

214 Similarly, maternal and neonatal outcomes were comparable, with no significant
215 difference found except for birth term ($p < 0.001$) (**Table 2**). Neonatal birth weights were
216 significantly different, 3379g [2495 ;4520] for patients with a trial of labor versus 3220g [1800
217 ; 4625] for patients with an elective cesarean section ($p = 0.04$).

218 The rate of postpartum hemorrhage was 21.3% for patients with a vaginal delivery
219 agreement versus 31.7% for elective cesareans ($p = 0.18$). Lactatemia was similar in both
220 groups, at 2.60 mmol/L versus 2.20 mmol/L for patients without a vaginal delivery agreement
221 ($p = 0.06$); and APGAR scores at 1 and 10 minutes were similar ($p = 0.16$ and 0.68 respectively).
222 The median APGAR score at 5 minutes showed a significant difference with $p = 0.045$, (10 [8-
223 10] for the vaginal delivery agreement group versus 10 [4-10] for the no vaginal delivery
224 agreement group). There were no more transfers to neonatology, i.e. 2.2% for newborns of
225 patients with a vaginal agreement versus 4.3% for newborns of patients without a vaginal
226 agreement ($p = 0.53$). We then analyzed the cord blood pH at birth in multivariate analysis, the
227 mode of delivery did not significantly modify the cord pH value of the newborns (for elective
228 cesarean section group [-0.01 - 0.02] with $p = 0.64$) (**Table 3**).

229

230 *Predictive factors for successful vaginal delivery*

231 After the multivariate analysis, a vaginal delivery after the two cesarean sections was a positive
232 predictive factor for a successful vaginal delivery (OR = 42.82 [5.48 ; 334.58]p=0,0003) and a
233 BMI ≥ 30 was a negative predictive factor for a successful vaginal delivery (OR =0.76 [0.62 ;
234 0.92] p=0.0065) (**Table 4)**.

Discussion

This study provided a preliminary investigation of the immediate neonatal outcomes of patients with two previous cesarean deliveries by comparing the two possible strategies in this context for the obstetrician: elective cesarean section and trial of labor, after weighing the confounding factors in both groups. The success rate of trial of labor was 67.3% and appeared reasonable in terms of maternal and neonatal safety.

Neonatal outcomes

The immediate neonatal outcomes were similar in our two groups after weighting. The results of lactatemia and cord blood pH at birth were not significantly different ($p = 0.06$ and $p = 0.77$ respectively). The number of APGAR were also similar. There were no more transfers to neonatology for neonates from the vaginal delivery group. Pre-propensity score lactatemia was significantly higher in the vaginal agreement group, but not clinically significant, averaging 3.10 mmol/L [1.40; 10.20] versus 2.20mmol/L [1.20; 9.30] in the no vaginal agreement group ($p < 0.001$). We did not find any cerebral palsy or neonatal death in our series. The differences in time of birth and term of birth between the two groups are explained by the fact that elective Cesarean sections are more likely to be performed in the morning around 10 a.m., at approximately 39 weeks of gestation.

The meta-analysis by Tahseen et al. compared outcomes between women who had trial of labor after 2 cesareans versus after one cesarean section, and also compared trial of labor after two cesareans versus a third elective cesarean section [8]. Although the numbers were too small to draw firm conclusions at the neonatal level, they showed similar reassuring results about trial of labor after two previous cesarean sections. Neonatal admission rates were similar at 8.85% for patients with trial of labor after two cesareans versus 8.49% after one cesarean ($p = 0.57$). The combined rate of neonatal asphyxia and neonatal mortality was 0.09% versus 0.05% ($p = 0.35$)[8].

Another study by Rotem et al. compared neonatal outcomes of patients with trial of labor after one and after two cesarean sections. They also concluded that the overall neonatal outcomes were favorable and comparable when a vaginal delivery was attempted after one versus two cesareans, without neonatal asphyxia or death. [16].

Maternal Outcomes

There appeared to be no excess risk of morbidity and mortality in patients who had a trial of labor, including for those who have had an actual natural delivery, those who had an emergency cesarean section during labor, and those who had an elective cesarean section for no onset of labor.

In particular, the rate of postpartum hemorrhage was not different in our two groups, and was even insignificantly higher in the elective cesarean group (21.3% versus 31.7% $p = 0.18$), and there were no hysterectomies or maternal deaths in our cohort. Also, in our cohort, additional complications occurred in the cesarean section group including 4 additional

intrauterine aspirations, 2 bladder injuries, and 2 ileus. The infection rate appeared to be the same for both strategies.

The 2015 prospective study by Miller et al. including 152 trials of labor and nearly 6000 elective cesarean sections in patients with two previous cesarean sections also found no significant difference in maternal outcomes between trial of labor and iterative cesarean section, in terms of maternal morbidity including transfusions (2% versus 1.8%), hysterectomies (0 versus 0.4%), and uterine ruptures (0.7 versus 0.1%) [17]. The study by Rotem et al. showed a similar rate of postpartum hemorrhage in patients who had trial of labor after one versus two cesarean sections (2.6% versus 3.5% p=0.24), and a similar rate of uterine rupture (0.3% versus 0.6% p=0.24)[16]. The meta-analysis by Tahseen et al. also showed similar rates of hysterectomy and transfusion when comparing outcomes of trial of labor after 1 versus 2 previous cesareans [8]. A French series by Bretelle et al. included 180 patients with two previous cesarean sections who had trial of labor, with one hysterectomy for uterine atony in the trial of labor group[18].

Predictive factors for successful vaginal delivery

Our success rate for vaginal delivery of 67.3% is in line with the literature which found success rates between 62.8% and 74.6%. [8,18–21]. The success of the trial of labor is an important point because cesarean sections during labor might be more morbid than elective cesarean sections [22]. However, vaginal deliveries are also less morbid than elective cesarean sections. It is therefore important to define the patients for whom labor has a good chance of succeeding. To this end, for patients with a unique previous cesarean section, Grobman et al. developed a prediction score for successful vaginal delivery. In their prospective study of over 11,000 patients in different centers, successful vaginal delivery after cesarean section was significantly more likely if the patient was large and/or had a history of vaginal delivery. Conversely, they were less likely to succeed if the reason for the cesarean section was labor arrest or failure to engage, and if they had a history of treatment for chronic hypertension, and in patients of higher weight or age [23]. In our study, diabetes was not an exclusion criterion for trial of labor. However, patient with uncontrolled diabetes with macrosomia were not eligible for trial of labor.

In our study, the pelvic TDM has contributed to a drastic exclusion of 112 patients that were candidates for trial of labor. We cannot tell how would have been the outcomes for these patients if they have had a trial of labor. However, pelvic TDM is no more recommended for women with one previous cesarean and a similar approach may be applied to those with two previous cesareans.

Strengths and Weaknesses

The main strength of our study is that it included only patients with two previous cesarean and compared the two strategies in an intention to treat strategy. Most of the available studies for the management of patients with two previous cesarean sections compare the outcomes of women with one versus two previous cesarean sections deliveries[16,17,19,20,24–26]. Few studies, even national ones, address this issue, as the strategy of allowing vaginal delivery after two cesarean sections is in the minority. [18]. However, the size of our study is

too small to conclude on differences for events as rare as uterine rupture or hysterectomy. Our analysis therefore focused on a simple criterion of judgement which is the neonatal cord pH.

Also, the patients were individually informed about the advantages and risks of both delivery routes, which could have led to information bias.

A randomized study is always ethically difficult to implement with regard to the delivery route. We therefore used a propensity score to mimic a "quasi-randomisation" situation after weighting the patients in the two groups, in order to control for selection and indication bias. This statistical analysis technique, which allowed us to have perfectly comparable groups, was also a methodological strength of our study. However, as with all non-randomized studies, the major limitation of our statistical analyses was the inability to identify all confounding variables. A multicenter prospective study on a national scale and with varied protocols would provide a better answer to this question.

Conclusion

The proposal of a vaginal delivery seems to be a reasonable option in a selected population of patients with two previous cesarean sections, after the patient has been informed of the short and long term benefit/risk balance, in particular the risk of uterine rupture.

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Figure 1. Flow chart

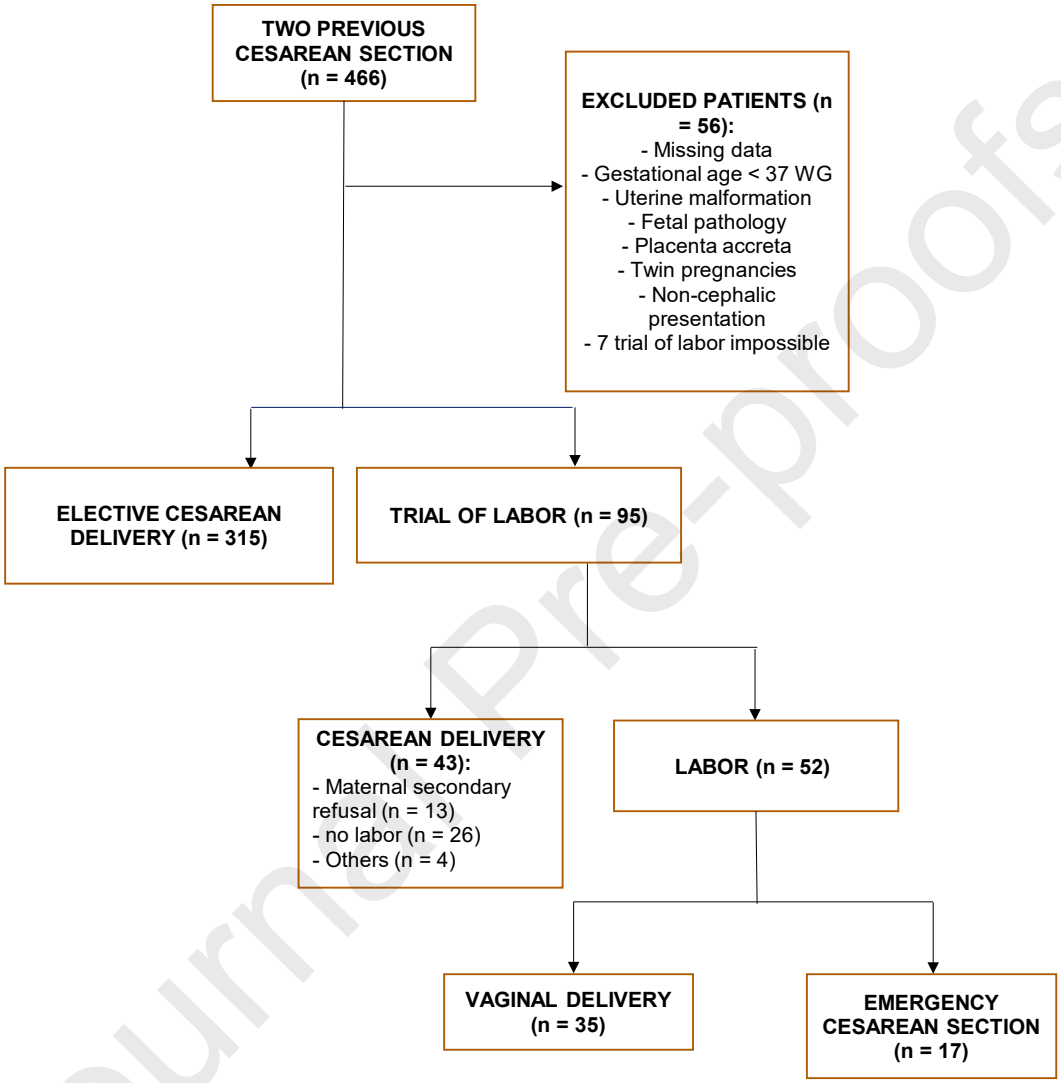

Figure 2. Histogram showing the percentage of vaginal delivery in patients with two previous cesarean sections over time from 2013 to 2020

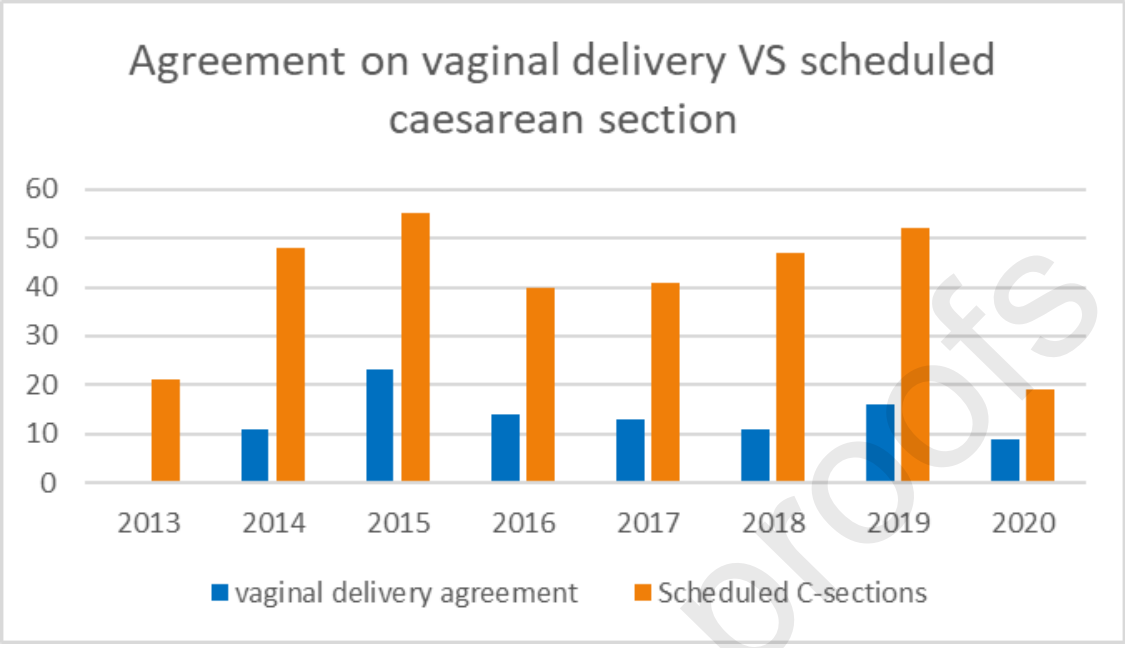

Table 1. Population characteristics before and after propensity score

		Total population (n = 410)			Weighted Population (n = 92)		
		Trial of labor	Elective cesarean section	SMD	Trial of labor	Elective cesarean section	SMD
		n = 95	n = 315		n = 46	n = 46	
Age	<32	31 (32.6)	115 (36.5)	0.207	15.7 (34.1)	15.2 (33.1)	0.070
	32 -35	36 (37.9)	99 (31.4)		18.0 (39.1)	17.0 (36.9)	
	>36	26 (27.4)	99 (31.4)		12.3 (26.8)	13.7 (29.8)	

	Missing data	2 (2.1)	2 (0.6)		0 (0.1)	0 (0.1)	
BMI	Obesity	31 (32.3)	95 (30.1)	0.270	14.3 (30.9)	14.4 (31.4)	0.010
	No obesity	65 (67.7)	210 (66.5)		31.8 (69.1)	31.6 (68.6)	
	Missing data	0 (0)	11 (3.5)		0 (0)	0 (0)	
Maternal history of diabetes	0	91 (95.8)	302 (95.9)	0.175	45.5 (98.8)	45.4 (98.7)	0.007
	1	4 (4.2)	9 (2.8)		0.5 (1.2)	0.6 (1.3)	
	Missing data	0 (0)	4 (1.3)		0 (0)	0 (0)	
Previous myomectomy	0	92 (96.8)	306 (97.1)	0.159	44.1 (95.7)	44.5 (96.6)	0.048
	1	3 (3.1)	6 (1.9)		2.0 (4.3)	1.5 (3.4)	
	Missing data	0 (0)	3 (0.9)		0 (0)	0 (0)	
SVD **before caesarean section**	0	69 (72.6)	278 (88.3)	0.466	36.5 (79.2)	35.4 (77)	0.053
	1	12 (12.6)	26 (8.25)		3.6 (7.8)	3.8 (8.3)	
	2 or more	13 (13.7)	10 (3.17)		5.9 (12.7)	6.6 (14.3)	
	Missing data	1 (1.05)	1 (0.3)		0.1 (0.3)	0.1 (0.3)	
SVD **after two caesarean sections**	0	60 (63.2)	312 (99.0)	1.023	43.3 (94)	43.9 (95.3)	0.060
	1	29 (30.5)	3 (0.95)		2.8 (6)	2.2 (4.7)	
	2	6 (6.32)	0 (0)		0 (0)	0 (0)	
γ C1 indication	CTG anomaly	26 (27.4)	78 (24.8)	0.265	12.8 (27.7)	13.1 (28.6)	0.069

	Stagnation	15 (15.8)	63 (20.0)		9.2 (19.9)	9.9 (21.6)	
	Trigger failure	9 (9.4)	33 (10.4)		5.4 (11.7)	4.9 (10.6)	
	Narrowed pelvis	2 (2.11)	19 (6.03)		1 (2.2)	0.7 (1.6)	
	Other	43 (45.3)	122 (38.7)		17.7 (38.5)	17.3 (37.7)	
γ C2 indication	CTG anomaly	26 (27.4)	41 (13.0)	0.672	9.8 (21.3)	9.9 (21.5)	0.089
	Stagnation	14 (14.7)	42 (13.3)		7.9 (17.2)	9.1 (19.8)	
	Trigger failure	15 (15.8)	34 (10.8)		7.5 (16.4)	8 (17.4)	
	Narrowed pelvis	1 (1.05)	52 (16.5)		1 (2.2)	1 (2.2)	
	Other	39 (41.1)	146 (46.2)		19.8 (43)	18 (39.2)	
Gestational diabetes	Gestational diabetes	21 (22.1)	61 (19.4)	0.064	8.9 (19.2)	9.3 (20.3)	0.026
	No gestational diabetes	74 (77.9)	254 (80.6)		37.2 (80.8)	36.7 (79.7)	
Pregnancy pathology	0	58 (61.1)	199 (63.2)	0.194	31.1 (67.5)	30.1 (65.4)	0.045
	1	37 (38.9)	111 (35.2)		15 (32.5)	15.9 (34.6)	
	Missing data	0 (0)	5 (1.59)		0 (0)	0 (0)	
T3 EFW ultrasound > 90th percentile	Not Macrosome	80 (84.2)	210 (66.7)	0.436	37.4 (81.1)	37.1 (80.6)	0.038
	Macrosome	10 (10.5)	56 (17.8)		4 (8.7)	4.5 (9.7)	
	Missing data	5 (5.2)	49 (15.6)		4.7 (10.2)	4.5 (9.7)	
Pelvi TDM	Narrowed pelvis	39 (41.1)	173 (54.9)	1.070	26.2 (56.9)	26.5 (57.6)	0.044

	Normal	41 (43.2)	15 (4.7)		11 (23.8)	11.4 (24.7)
	No pelvimetry	15 (15.8)	127 (40.3)		8.9 (19.3)	8.1 (17.6)

BMI: Body Mass Index, SVD: spontaneous vaginal delivery, CTG: ardiotocography, EFW Estimated Fetal Weight, SMD: Standardized Mean Difference; TDM Tomodensitometry

Table 2. Maternal and neonatal outcomes. Comparison of the two groups before and after weighting by the MW method based on the propensity score.

		Total population			**Weighted population**		
		Trial of labor	**Elective cesarean section**		**Trial of labor**	**Elective cesarean section**	
		N=95	**N=315**	**p**	**N=46.1**	**N=46.0**	**p**
Gestational Age		40.14 [37.00, 41.86]	39 [37.00, 40.71]	< **0.001**	39.88 [37.00, 41.86]	39 [37.00, 40.71]	< **0.001**
Lactates		3.10 [1.40, 10.20]	2.20 [1.20, 9.30]	< **0.001**	2.60 [1.40, 10.20]	2.20 [1.20, 9.30]	0.06
Lactatemia 6	Lactatemia < 6	82 (92.1)	297 (96.4)	0.15	41.4 (93.2)	44 (96.7)	0.38
	Lactatemia ≥ 6	7 (7.9)	11 (3.6)		3 (6.8)	1.5 (3.3)	
pH		7.28 [6.92, 7.40]	7.30 [6.92, 7.45]	0.23	7.30 [6.95, 7.40]	7.30 [7.01, 7.45]	0.77
pH 7	pH > 7	86 (97.7)	303 (99.3)	0.50	42 (96.1)	45.1 (99.5)	0.30
	pH ≤ 7	2 (2.3)	2 (0.7)		1.7 (3.9)	0.2 (0.5)	
APGAR 1 minute		9 [0, 10]	9 [0, 10]	**0.001**	9 [0, 10]	9 [0, 10]	0.16

APGAR 1 minute	APGAR at 1min ≥ 5	92 (96.8)	311 (99)	0.28	45.2 (98.2)	45.7 (99.5)	0.18
	APGAR at 1 min < 5	3 (3.2)	3 (1)		0.8 (1.8)	0.2 (0.5)	
APGAR 10 minutes		10 [9, 10]	10 [5, 10]	0.74	10 [9, 10]	10 [5, 10]	0.68
APGAR 5 minutes		10 [8, 10]	10 [4, 10]	0.63	10 [8, 10]	10 [4, 10]	**0.045**
APGAR 5 minutes	APGAR 5min ≥ 5	95 (100)	313 (99.7)	1.000	46 (100)	45.9 (99.9)	0.32
	APGAR 5min < 5	0 (0)	1 (0.3)		0 (0)	0.1 (0.1)	
Neonatal resuscitation	No neonatal resuscitation	95 (100)	312 (99.0)	0.78	46.1 (100)	45.9 (99.8)	0.20
	Resuscitation in the delivery room	0 (0)	3 (1.0)		0 (0)	0.1 (0.2)	
Neonatal transfer	No neonatal transfer	92 (96.8)	307 (97.5)	1.00	45 (97.8)	44 (95.7)	0.53
	Born transferred	3 (3.2)	8 (2.5)		1.0 (2.2)	2 (4.3)	
Duration of hospitalization		0 [0, 2]	0 [0, 20]	0.67	0 [0, 2]	0 [0, 20]	0.70
Neonatal death	0	91 (100)	307 (100)	NaN	45.9 (100)	45.8 (100)	NA
	1	0 (0)	0 (0)		0 (0)	0 (0)	
Birth weight		3370 [2495, 4520]	3410 [1800, 4625]	0.72	3379.8 [2495, 4520]	3220.3 [1800, 4625]	**0.04**
zScore Birth weight		-0.23 [-2.66, 2.07]	0.22 [-2.94, 2.55]	< **0.001**	-0.07 [-2.66, 2.07]	-0.03 [-2.94, 2.55]	0.93
Postpartum hemorrhage	0	71 (78.9)	218 (70.1)	0.13	35.2 (78.7)	30.9 (68.3)	0.18
	1	19 (21.1)	93 (29.9)		9.5 (21.3)	14.3 (31.7)	

Uterine rupture	0	94 (98.9)	315 (100)	0.52	45.1 (97.8)	46 (100)	0.31
	1	1 (1.1)	0 (0)		1 (2.2)	0 (0)	
Length of stay	(days)	4.68 [1.00, 16.96]	4.74 [0.00,15.71]	0.773	4.70 [1.00, 16.96]	4.00 [0.00, 15.71]	0.237

Table 3. Multivariate Models of Neonatal Cord Blood pH Analysis

	Model 1 (weighted)			**Model 2 (weighted, adjusted)**			**Model 3 (weighted, adjusted, outliers excluded)**		
Predictors	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*	*Estimates*	*CI*	*p*
Trial of labor agreement (No)	0.01	-0.01 - 0.02	0.459	0.00	-0.02 - 0.02	0.734	0.00	-0.01 - 0.02	0.642
Birth weight (g)				0.01	-0.01 - 0.03	0.386	-0.01	-0.03 - 0.01	0.241
Gestational age at birth (WG)				-0.00	-0.01 - 0.01	0.947	0.01	-0.00 - 0.02	0.155
Comments	393			388			376		
R^2 / R^2 adjusted	0.001 / -0.001			0.021 / 0.011			0.008 / -0.003		
Deviance	0.698			0.676			0.433		

AIC	-30.829	-40.504	-176.437

Correlation between planned mode of delivery and cord pH as a continuous variable.

Among children with complete data. Model 1 was weighted by the MW method based on the propensity score and not adjusted. Model 2 was MW-weighted and adjusted for birth weight, gestational age at birth. Model 3 was adjusted and weighted, after excluding patients with aberrant cord blood pH values.

Table 4. Maternal and neonatal characteristics in the labor group and univariate analysis and multivariate analysis of predictive factor for vaginal delivery success.

Univariate analysis **Variable**	**Successful vaginal delivery** **N=35**	**Cesarean section during labor** **N=17**	**p**	**OR [IC95%]**
Age				
<32	14(40.0)	4(23.5)		
32-35	7 (20 .0)	10(58.8)		
>35	14(40.0)	3(17.6)	p = 0.62	0.97 [0.87 ; 1.09]
BMI				
>30	6(17.1)	14(82.4)		
<30	29(82.9)	3(17.6)	**p = 0.03**	0.88 [0.78 ; 0.99]
Parity	2.8±1.3	2.8±1.3	p = 0.88	0.97 [0.63 ; 1.49]

Number of Previous vaginal deliveries	0.9±1.4	1.1±1.3	p = 0.72	0.93 [0.62 ; 1.39]
VD after first cesarean				
0	8	11	**p = 0.01**	1
1	25	4		6.82 [1.87 ; 24.87]
2	3	1		3.43 [0.34 ; 34.83]
VD after second cesarean			**p = 0.0006**	
0	6	12		1
1	27	2		29.25 [5.18 ; 165.25]
2	3	3		2.17 [0.33 ; 14.06]
Estimated fetal weight (percentile)	51.9±25.4	50.8±28.6	p = 0.59	1.06 [0.85 ; 1.34]
Intergenic period (between last cesarean and present delivery, in years)	4.2±2.2	3.9±1.8	p = 0.84	1.03 [0.76 ; 1.39]
Birthweight C1 (100g)	3166±846	2785±691	p = 0.06	1.07 [1.00 ; 1.15]

Birthweight C2 (100g)	3304±581	2751±860	**p = 0.02**	1.13 [1.02 ; 1.26]

Multivariate analysis		
Variable	**OR [IC95%]**	**P**
VD after 2 cesarean sections	42.82 [5.48 ; 334.58]	p = 0.0003
BMI > 30	0.76 [0.62 ; 0.92]	p = 0.0065

BMI : body mass Index ; VD : vaginal delivery.