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Retrospective evaluation of labor induction with scar uterus at the university hospital of Rennes.

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ABSTRACT

Objective: The aim of the study was a retrospective evaluation of labor induction in women with one previous cesarean section. The primary outcome was the mode of delivery. We also studied the severe maternal and neonatal morbidity and identify some prediction factors of vaginal delivery after labor induction after one previous cesarean section.

Study design: This was a retrospective observational monocentric study performed over the period from January 1st, 2016 to April 30th, 2020 at the university hospital of Rennes. We included women with scar uterus because of one previous cesarean section with a viable singleton fetus in cephalic presentation and an induction of labor for medical reason, at term. Multivariate logistic regression analysis was used to analyse prediction of vaginal delivery after labor induction after one previous cesarean section. We also studied maternal (included uterine rupture, loss of blood, obstetrical injury of anus sphincter) and neonatal (APGAR score, arterial umbilical pH after 1 minute of life and eventual admission to neonatal unit) morbidity. We used a stepwise multivariate logistic regression model to select variables for multivariate analysis. The model with the lowest Akaike Index Criteria was chosen.

Results: The study enrolled 353 women with scar uterus: 121 women were induced by balloon catheter, 57 by osmotic cervical dilators, 91 by oxytocin alone, 84 by amniotomy. Vaginal delivery rate was 47,9%. There was 45% of vaginal delivery in the group with Bishop < 6 before induction of labor versus 62% in the group with Bishop \geq 6. There was no statistically significant difference in neonatal and maternal severe morbidities between vaginal delivery and cesarean section: 4,5% of severe maternal morbidities (n = 16). Among their, we highlighted 7 uterine ruptures (3,8%). We observed also 3% of postpartum severe hemorrhage in vaginal delivery group (n = 5) against 1,6% in cesarian section group (n = 3) with no statistical significant difference (p = 0,632). Regarding to the obstetric perineal tears and lacerations we noticed 1,2% of OASIS 3 (n = 2) and 0,6% of OASIS 4 (n = 1). Severe neonatal morbidities were comparable by mode of delivery without significant difference : APGAR score at 5 minutes was similar (p=1), as well as arterial umbilical pH after 1 minute (p=0.719) and admissions to a neonatal unit (p=1). Two variables were statistically associated with vaginal delivery after labor induction in women with scar uterus: Bishop score \geq 6 (OR = 0,44 ; 95%CI : 0,25-0,81) and/or previous vaginal delivery after cesarean section (OR = 0,17 ; 95%CI : 0,08-0,35).

Conclusion: With 47,9% of vaginal delivery after labor induction in women with scar uterus, only 3.8% (n=7/353) of uterine ruptures, less than 1% APGAR <7 at 5 minutes (n=3/353), induction on scar uterus should be consider in obstetrical practice. Bishop score \geq 6 and/or

previous vaginal delivery after cesarean section are associated to vaginal delivery after labor induction.

Keywords: labor induction – scar uterus – BISHOP – delivery – morbidity

Abbreviations:

CNGOF: French National College of Gynecologists and Obstetricians

CS: cesarean section

VD: vaginal delivery

GW: gestation weeks

HELLP: Hemolysis elevated liver enzymes and low platelet

OASIS: Obstetrical anus sphincter injuries

1. INTRODUCTION

Nowadays, all over the world, the main cause of scar uterus is a previous cesarean section (CS). According to the perinatal survey, in 2021 in France, the CS rate was 21.4% (versus 20,3% in 2016) [1], relatively stable since 2003 (2). In France, the frequency of cesareans before labor (planned or not) roses from 9.3 % in 2016 to 10.4% in 2021 [1].

Scar uterus is a risk factor of complications for subsequent pregnancies. It is the main risk factor of uterine rupture. Its occurrence is low, from 0,15% to 5,5% in women with spontaneous labor and from 0,3% to 10,7% in women with labor induction, but the maternal and fetal consequences are serious with 15% of severe maternal morbidity as haemorrhage > 1 liter, hysterectomy or visceral injuries, 3% to 6% of perinatal mortality and 6% to 15% of perinatal asphyxia [2,3]. In literature, two factors influence uterine rupture risk : a previous vaginal delivery (VD) which decreases the risk and a labor induction which increases the risk [4,5]. Moreover, scar uterus exposes to a rise of placenta praevia and accreta occurrence, with odds ratio between 1.5 and 3.9 depending on studies [6]. and to a risk of cesarean scar defect called isthmocele [7–9]. The risk of all these complications is majored in women with multiple previous CS [10]. So, regarding to the risks and according to French clinical practice guidelines, labor trial after one CS would be tried in the majority of cases and most women should be counseled regarding this option (5,12–14).

Around the world management of delivery of scared uterus is different. The clinical practice guidelines of the French National College of Gynecologists and Obstetricians (CNGOF) has specified in December 2012 indications and contraindications to labor trial after previous CS [2]. Labor trial after previous CS is contraindicated for women with previous corporeal uterus section, women with three previous CS and women with previous uterine rupture. Indications for CS before labor trial are the same than usually. However, be that as it may, the patient can choose an iterative CS after she has received all informations about trial labor after previous CS [2]. Three factors are associated to vaginal delivery after labor induction in scared uterus : previous vaginal delivery, favorable cervix and spontaneous labor [11–13].

According to the perinatal survey, in 2016 in France, 22% of women had labor induction (4). Labor induction is decided if labor does not start spontaneously or if delivery is indicated for medical reasons. In literature there is not a higher risk of cesarean during labor induction when compared to spontaneous labor in singleton pregnancies after 37GW [16]. In its clinical

practice guidelines the CNGOF allowed labor induction in women with one previous CS provided that be motivated for medical reasons and accepted by the patient [2,17]. However, there is no consensus about modes of labor induction in women with scar uterus [16]. According to CNGOF clinical practice guidelines, the use of double-balloon catheter, osmotic cervical dilators and oxytocin are possible for labor induction after previous CS and the choice of the method is left to the obstetrician judgment [2]. On the other hand, the use of prostaglandins is contraindicated and the use of misoprostol is only kept in case of labor induction for intra-uterine fetal death or medical pregnancy interruption [2].

As the number of cesarean sections increases, so does the risk of complications from another cesarean section. Current recommendations allow us to consider induction of scarred uterus. It is therefore essential, in view of the need of induction, to consider induction with scar uterus.

Finally, it is difficult to find a global evaluation of proceedings, mode of delivery and maternal and fetal consequences of labor induction in women with one previous CS. Consequently, it is also difficult to give a real quality information to patient. The aim of the study was a retrospective evaluation of labor induction practice in women with one previous CS over the period from January 1st, 2016 to April 30th, 2020 at the university hospital of Rennes. The primary outcome for the study was the mode of delivery. We also studied the severe maternal and neonatal morbidity and tried to find some prediction factors of success of labor induction after one previous CS.

2. MATERIAL AND METHODS

2.1. Study design

Our study was a retrospective observational monocentric study about labor induction in women with one previous CS over the period from January 1st, 2016 to April 30th, 2020 at the university hospital of Rennes (Type 3 maternity hospital with 3 858 births per year). We included women with scar uterus because of one previous CS. All women included were over the age of majority and not sheltered, had a viable singleton fetus in cephalic presentation and had an induction of labor for medical reason regardless of induction methods. Indications held for labor induction were prolonged pregnancy, premature rupture of membrane, suspected macrosomia, non-reassuring fetal heart rate, preeclampsia, HELLP syndrome (defined by hemolysis, thrombopenia and elevated liver enzymes, one complication of preeclampsia), diabetes, cholestasis of pregnancy, intra uterine growth restriction, oligoamnios, metrorrhagia, reduced fetal movements, maternal pathology, fetal pathology. The triggering method was decided at a weekly obstetrics department meeting or by obstetrician on duty (if a quicker decision was needed). We excluded women with scar uterus because of another surgery (myomectomy for example). Were also excluded induction of labor for intra-uterine fetal death or medical pregnancy interruption. The Ethics Committee of the National College of the French Gynecologists and Obstetricians approved the study (reference number: CEROG 2020-OBST-1001).

2.2. Data collection

Maternal characteristics included maternal age, parity, body mass index (BMI) before pregnancy and the presence of comorbidities (preexistent diabetes or arterial hypertension). We also reported informations about previous cesarean (term, cesarean indication), previous vaginal deliveries and current pregnancy pathologies (diabetes, preeclampsia, suspected macrosomia, cholestasis of pregnancy, intra uterine growth restriction, praevia placenta, fetal pathology, maternal pathology). Indication of labor induction (previously detailed), methods of labor induction (double-balloon catheter, osmotic cervical dilatators, amniotomy, oxytocin), used of intravenous oxytocin (introduced before or after a dilatation of 5 cm), presence of maternal fever (superior to 38°C) or meconial amniotic liquid and mode of delivery (vaginal spontaneous birth, vaginal instrumental birth or cesarean section) were collected.

Maternal outcomes included uterine rupture, loss of blood (0 to 499mL, 500mL to 1L, superior to 1L), obstetrical injury of anus sphincter (intact, OASIS 1st to 4rd degree), episiotomy and stay duration.

Neonatal characteristics included gestational age at delivery, birthweight, APGAR score, arterial umbilical pH after 1 minute of life and eventual admission to neonatal unit.

2.3. Induction of labor

Methods used for labor induction depended of cervix examination and based on the Bishop score. Unfavorable cervix maturation was defined by a Bishop score < 6 and favorable cervix maturation by a Bishop score \geq 6. For women with unfavorable cervix and intact waters we used mechanical dilatation by double-balloon catheter or osmotic cervical dilators. The double-balloon was inserted into the cervix. The first balloon was located beyond the internal cervix orifice and inflated with around 80ml of sterile water. The second balloon was located just before the external cervix orifice and inflated with around 80ml of sterile water. The double-balloon was removed after twelve hours and, then, the induction was followed by amniotomy and intravenous oxytocin. Concerning osmotic cervical dilators, three or four dilators were inserted into the cervix. They were removed after four hours and, then, the induction was followed by amniotomy and intravenous oxytocin.

For women with favorable cervix and intact waters the induction of labor protocol consisted of an amniotomy secondarily associated with intravenous oxytocin if needed.

In case of term prelabor rupture of membrane, with favorable or unfavorable cervix, the induction of labor consisted only of intravenous oxytocin after an expectancy period of 24 hours.

The oxytocin perfusion was made with 5 international units (IU) of oxytocin in 500mL of 5% glucosed serum. The intravenous oxytocin was begun at the throughput of 2mUI per minute and progressively increased each 30 minutes to one hour until a satisfactory uterine dynamic. In case of satisfactory uterine dynamic and cervix dilatation midwife could decrease or stop the oxytocin flow. In case of induction labor for scar uterus, the maximum flow rate of oxytocin used was 14 mUI per minute and a the maximum total dose of oxytocin was 5UI during labo

2.4. Outcomes definition

The primary outcome of the study was the mode of delivery: vaginal spontaneous birth, vaginal instrumental birth (with ventouse or forceps) or CS. The secondary outcomes of the study were the severe maternal morbidity included uterine rupture, severe post-partum hemorrhage superior to 1 liter, obstetrical anus sphincter injuries (OASIS) superior or equal to the 3rd degree. Neonatal morbidity included APGAR score inferior to 7 after 5 minutes of life, arterial umbilical pH after one minute of life inferior to 7,10 and admission to a neonatal unit. We had also tried to find some prediction factors of vaginal delivery after labor induction after one previous CS.

2.5. Statistical analysis

Descriptive data are presented as means with standard deviation for continuous variables and as numbers and percentages for categorical variables. To compare women with vaginal delivery and women with cesarean section after induction labor, Student's t-test and a Wilcoxon test were used for continuous variables with and without normal distribution. The Chi-square and Fisher's exact tests were used for categorical variables. All tests were performed with a bilateral hypothesis. Missing data were excluded. Differences were considered significant when the p-value was less than 0,05.

Multivariate logistic regression analysis was used to analyse prediction of vaginal delivery after induction of labor in scarred uterus. We used a stepwise multivariate logistic regression model with variable with p-value less than 0.2 in univariate analysis to select variables for multivariate analysis. The model with the lowest Akaike Index Criteria was chosen. The odds ratio with the associated 95% confidence interval (95%CI) were computed for each risk factor. The same method was then used with a restriction to women with Bishop score less than 6.

Data analysis was performed using R-software version 3.5.3.

3. RESULTS

3.1. Population selection

Over the period from January 2016 to April 2020, 15 794 women gave birth in the university hospital of Rennes: 12 760 had VD (80.8%), 3034 had CS (19.2%) and 2852 women had labor induction (18.1%) (Figure 1).

Among these 15 794 women, 1244 had scar uterus (53.3% had spontaneous labor, 30.4% induction of labor, 15.2% cesarean section before labor because of medical indication and only 1.1% cesarean section because of women rejection of vaginal delivery after information by obstetrician). Among 1244 scar uterus, 378 women had induction of labor being (Figure 1) which 25 patients were excluded: 5 uterus scar because of myomectomy, 1 uterus scar because of cornual ectopic pregnancy, 7 pregnancy interruption because of medical reason, 6 intra-uterine fetal death, 5 multiple pregnancies and 1 file unavailable because of judiciary reason (Figure 1). Finally, 353 women with one previous CS and labor induction over the study period were eligible for inclusion.

3.2. Population description

Whole study population

Concerning our study population, the mean age was 32.7 ± 4.7 years, 12.5% smoked and the mean parity was 1.5 ± 1 . About BMI, 5.7% had $\text{BMI} < 20 \text{ kg/m}^2$, 67.4% BMI between 20 and 30 kg/m^2 , 16.4% BMI between 30 and 35 kg/m^2 and 10.5% $\text{BMI} \geq 35 \text{ kg/m}^2$.

Looking at maternal morbidities, 7 women presented uterine rupture (1.9%), 11 had severe haemorrhage (3.1%) and one was complicated by endometritis.

About new-born, the mean birth weight was $3374 \text{ g} \pm 520 \text{ g}$. Three newborns (0.85%) had $\text{APGAR} < 7$ at 5 minutes and 14 an arterial $\text{pH} < 7.1$ (4%). Thirty were hospitalized in neonatology (8.5%).

Comparison between women with vaginal delivery and women with cesarean section

After induction of labor, 47.9% of women had vaginal delivery and 52.1% had cesarean section.

Table 1 describes the comparison between women with vaginal delivery and women with cesarean section. Women with vaginal delivery were more likely to have a $\text{BMI} < 35 \text{ kg/m}^2$ (5.3% $\text{BMI} \geq 35 \text{ kg/m}^2$ in VD group versus 15.2% in CS group, $p=0.002$) and to have a

previous successful vaginal birth after cesarean (31,4% versus 7,4%, $p < 0.001$) than women with CS. There was no difference about previous vaginal delivery prior to cesarean (17,6% in VD group versus 14,1% in CS group). Estimated fetal weight at 32 gestational weeks (GW) was lower in VD group (54^e percentile versus 63^e percentile, $p = 0.001$).

In this study the vaginal delivery rate was 47,9% ($n = 169$): 70,4% spontaneous, 29,6% instrumental (Table 3).

3.3. Labor induction and mode of delivery

Concerning labor inductions, the majority of them were indicated for prolonged pregnancy: 28,4 % in VD group ($n = 48$) and 26,6% in CS group ($n = 49$) and term prelabor rupture of membranes: 19,5% in VD group ($n = 33$) and 14,1% in CS group ($n = 26$) (Figure 2) and it was comparable between two groups.

In VD group 28,9% of women had Bishop ≥ 6 ($n = 49$) against 17,3% in CS group ($n = 30$) ($p = 0,012$) (Table 2). Regarding to induction methods: 121 women were induced by balloon catheter, 57 by osmotic cervical dilatator, 91 by oxytocin alone, 84 by amniotomy (Table 2). Thirty patients did not received oxytocin (20 in VD group (11,8%), 10 in CS group (5,4%)) (Table 2). There were more inductions by balloon catheter and osmotic cervical dilators in CS group than in VD group (41,3% and 21,2% vs 26,6% and 10,7% respectively) and there were more inductions by amniotomy and oxytocin alone in VD group than in CS group (32,5% and 30,2% vs 15,8% and 21,7% respectively) (Table 2). There was no difference between the two groups about epidural analgesia (97,0% in VD group and 98,9% in CS group, $p = 0.380$), meconial amniotic fluid (4,1% in VD group and 9,2% in CS group, $p = 0.091$) and maternal fever during labor (5,9% in VD group and 4,3% in CS group, $p = 0.669$).

Indications for cesarean section during labor were principally labor induction failure: 47% ($n = 87$), non-reassuring fetal heart rate: 25% ($n = 46$) and stagnancy during the second labor phase: 11% ($n = 21$) (Table 2).

3.4. Maternal and neonatal outcomes according to mode of delivery

Concerning maternal morbidity, we noticed 4,5% of severe maternal morbidities ($n = 16$). Among their, we highlighted 7 uterine ruptures (3,8%) (Table 3). All patients with uterine rupture had a cesarean section for non-reassuring fetal heart rate. Regarding neonatal outcomes after uterine rupture, we observed: 6 newborn babies with APGAR > 10 at 5

minutes, 5 with pH>7.1 (1 newborn with pH=7.03 and the other with pH=6.84). Only one newborn was hospitalized in neonatology because of respiratory distress and a clinical course without sequelae and no one died.

We observed also 3% of postpartum hemorrhage in VD group (n = 5) against 1,6% in CS group (n = 3) with no statistical significant difference (p = 0,632) (Table 3). Regarding to the obstetric perineal tears and lacerations we noticed 1,2% of OASIS 3 (n = 2) and 0,6% of OASIS 4 (n = 1) (Table 3). The episiotomy rate was 13% (n = 23) (Table 3).

Severe neonatal morbidities were comparable by mode of delivery without significant difference (Table 3). Overall, we noticed 8% admissions to a neonatal unit (n = 31) (Table 3). Among them, 15 were admitted because of respiratory distress, 8 because of prematurity, 4 because of fetal pathology, 2 because of weak weight, 4 because of other reasons (2 severe allo-immunizations, 1 premature jaundice, 1 clavicle fracture).

3.5. Prediction of mode of delivery after labor induction

Variables with p-value less than 0,2 in univariate analysis were: BMI status, previous cesarean section during labor, time since previous birth, previous successful vaginal delivery after cesarean, gestational diabetes, estimated fetal weight at 32GW, Bishop score, meconial amniotic liquid, duration of labor, non-reassuring fetal heart rate, oxytocin use (Table 1).

After stepwise regression, we selected BMI status, previous cesarean section during labor, previous successful vaginal delivery after cesarean, gestational diabetes, estimated fetal weight at 32GW, Bishop score, meconial amniotic liquid, duration of labor and non-reassuring fetal heart rate for multivariate analyses (Table 4).

On multivariate analysis, two variables were statistically associated with vaginal delivery after induction labor : Bishop score ≥ 6 (OR = 0,44 ; 95%CI : 0,25-0,81) and previous vaginal delivery (OR = 0,17 ; 95%CI : 0,08-0,35) (Table 4). BMI status, previous cesarean section during labor, gestational diabetes, estimated fetal weight at 32GW, meconial amniotic liquid, duration of labor and non-reassuring fetal heart rate were not statistically associated with the mode of delivery after induction of labor in scared uterus (Table 4).

3.6. Analysis stratified for Bishop score

There was significant difference on VD rate according to the Bishop score: 45% of VD (n = 117) in the Bishop score < 6 group against 62% of VD (n = 49) in the Bishop score ≥ 6 group (p = 0,012) (Table 5).

There was no significant difference of severe neonatal and maternal morbidities according to the Bishop score (Table 5). We noticed a rate of admissions to a neonatal unit of 10.0% in Bishop < 6 group (n = 26) against 5.1% in Bishop \geq 6 group (n = 4) with no statistical significant difference (p = 0,260) (Table 5).

When restricted to women with defavorable cervix, only a previous vaginal delivery was associated with a successful labor induction after previous cesarean section (OR = 0,15; 95%CI: 0,06-0,35), BMI, gestational diabetes, meconium amniotic fluid, labor duration and non-reassuring fetal heart rate were not (Table 6).

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4. DISCUSSION

Our study population included 353 women with one previous CS and induction of labor. Vaginal delivery was obtained for 47,9% of them. We noticed 45% of VD in the group with Bishop < 6 versus 62% in the group with Bishop \geq 6. We had no significative difference for neonatal and maternal severe morbidities according to mode of delivery (vaginal delivery or cesarean section) in our population of women with induced labor and history of one previous cesarean section. Among their, we highlighted a rate of uterine ruptures of 3,8%. We found two variables statistically associated with a vaginal delivery after labor induction in women with scar uterus: Bishop score \geq 6 and/or previous vaginal delivery. BMI status, previous cesarean section during labor, gestational diabetes, estimated fetal weight at 32GW, meconial amniotic liquid, duration of labor and non-reassuring fetal heart rate were not statistically associated with the mode of delivery after induction of labor in scared uterus.

The vaginal delivery rates of 47,9% in women undergoing labor induction after previous CS in our study is comparable to previous reported rates in literature. In their study published in 2018 Gobillot and al. found a delivery rate of 58,5% after labor induction by oxytocin, whatever the Bishop score, in women with previous CS. This rate is higher than our but the difference could be explicated by most favorable cervix conditions among their patient (86/154 (55,8%)). Indeed, when we focused on their patients with a Bishop < 6 the rate of VD is the same than our, 47% [17]. Amitai and al. in 2020 (induction by balloon catheter, artificial rupture of membrane or oxytocin) and Facchinetti and al. in 2015 (induction by artificial rupture of membranes, oxytocin, dinoprostone per vagina or combination of these methods) found similar VD rates than our that is to say 52% [18] and 51,3% [13] respectively, with smallest study populations.

Scared uterus is a risk factor of complications for subsequent pregnancies and especially of uterine rupture. In literature, its occurrence is low, from 0,15% to 5,5% in women with spontaneous labor and from 0,3% to 10,7% in women with labor induction [2,19]. The risk of uterine rupture is higher among women with previous CS undergoing labor induction when compared to expectant management [20]. The uterine rupture rates of 3,8% in women undergoing labor induction after previous CS in our study is comparable to previous reported rates in literature. In 2018, Wallstrom and al. related an uterine rupture rate of 3% after labor induction in women with scar uterus [21], Vecchioli and al. in 2020 a rate of 3,6% [22] and Gobillot and al. in 2018 a rate of 3,23% [17].

We found no significative difference regarding neonatal morbidity between the groups of our population (VD versus CS), consistent with literature. Indeed, in their study published in

2020, Vecchioli and al. showed that resuscitation in the delivery room was more frequent in neonates from mothers with scar uterus who were induced than mothers with spontaneous labor (18,9% versus 9,6%, $p = 0.02$) but they found no significative trend to higher rate of admission to a neonatal unit (14,4% versus 8,3%, $p = 0.08$) [22]. When compared VD and CS after labor induction in women with scar uterus, Facchinetti and al. found that neonates with a 5 minutes Apgar score < 7 (4/234 (1,7%)) or with acidosis and subsequent transfers to neonatal unit (5/234 (2,1%)) were similar among the two groups [13].

In our study, Bishop score ≥ 6 and/or previous vaginal delivery were the two factors statistically associated with vaginal delivery after labor induction in women with scarred uterus. This result is consistent with literature which relate three factors associated with success of labor trial after previous CS : previous vaginal delivery, favorable cervix and spontaneous labor [2,13,23,24]. Some teams try to develop scores to predict the risk of cesarean delivery after labor induction. They are based on mathematical models [25–27]. For example Sevrin and al. showed in their study that, based on the studied characteristics and combinations of variables, a cervical length $> 3\text{cm}$ and a Bishop < 2 were the best predictors of induction failure [28]. For the moment, these models come under experimentation, but could be interesting in future to guide patients information about probability of success or failure of labor induction in women with scar uterus.

Regarding the induction methods in our study there were more inductions by balloon catheter and osmotic cervical dilators in CS group than in VD group and there were more inductions by amniotomy and oxytocin alone in VD group than in CS group. Indeed, this assessment matches with the most favorable Bishop score in VD group. However, in our study, with 45% of VD and no statistically significative difference for neonatal and maternal severe morbidities in the group with Bishop < 6 , labor induction in women with previous CS and unfavorable cervix seems to be worthwhile. Thus, in 2017, De Bonrosto and al. showed that the double-balloon catheter seems to be effective for cervical ripening in women with previous CS and unfavorable cervix. Indeed, in their study, 89,5% of women improved their initial Bishop score with the double-balloon catheter and 20,8% of them went into spontaneous active labor. Finally, in this study, 51,4% of the women achieved a vaginal delivery [23]. Then, when we compared double-balloon catheter versus oxytocin alone for labor induction in women with previous CS and unfavorable cervix, double-balloon catheter tend to be associated with higher probability of vaginal delivery (50% versus 37%, $p = 0,05$) [29]. In 2019, Boisen and al. showed a similar success rates of approximately 50% of VD after induction of labor with a double-balloon catheter in women with and without prior cesarean section [30]. Finally, in literature, in women with previous CS, labor induction with double-balloon catheter does not result in a significant increase in adverse maternal and neonatal outcomes as compared with

planned cesarean section [31]. So, in women with previous CS and unfavorable cervix, balloon catheter seems to be an effective and safe method to induce delivery.

The strength of our study lies in our well defined study population which includes only women with labor induction after one previous CS contrary to the majority of studies which compared spontaneous and induced labor. Then, the size of our study population is comparable even largest than other studies. To finish, despite the retrospective nature of our study we had to note few missing data.

However, some limitations should be considered. First, some bias in the analysis can result from the retrospective nature of our study. Then, it is a single-center study and it could potentially limit the external validity of our study in comparison to multi-center studies.

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5.5. Conclusion

With 47,9% of vaginal deliveries after labor induction in women with scar uterus (45% in the Bishop score < 6 group and 62% in the Bishop score \geq 6 group), and increased risk of complications after multiple previous CS, we conclude that labor induction after one previous CS would be consider by obstetricians even if Bishop score is unfavorable. Obviously, labor induction in women with scar uterus requires the consent of couple after clear and honest information about proceedings and risks of uterine rupture especially.

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Figures

Figure 1. Flow chart.

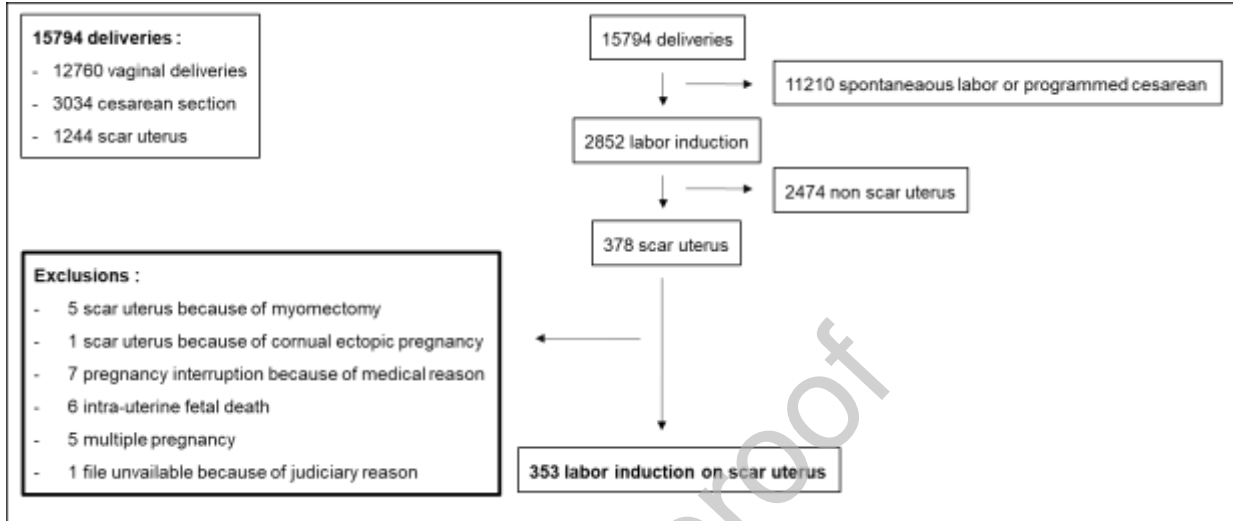
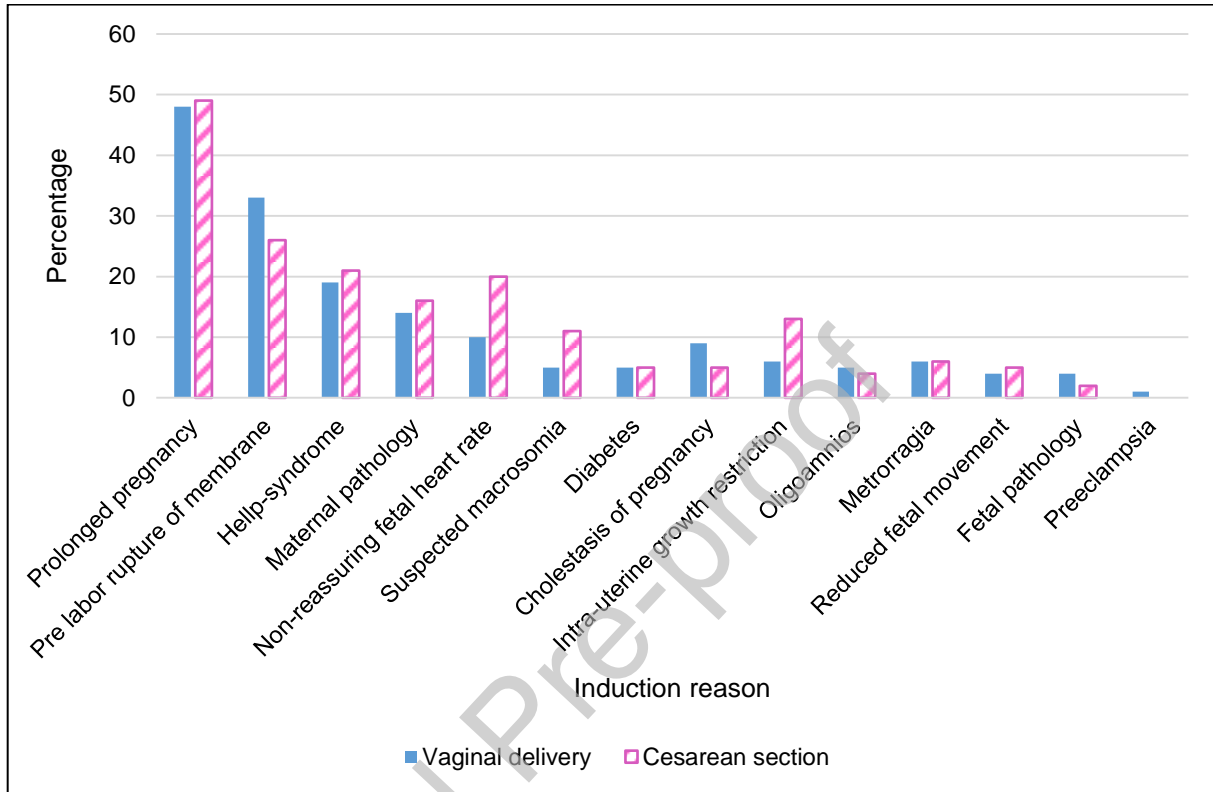


Figure 2. Indications of labor induction in women with scar uterus.

Tables

Table 1. Demographic and obstetrical characteristics.

Mean \pm SD, n (%)	Vaginal delivery (n=169 being 47.9%)	Cesarean section (n=184 being 52.1%)	p-value
Demographic and obstetrical characteristics			
Maternal age (years)	32.18 \pm 4.67	31.98 \pm 4.84	0.703
Body mass index :			0.002
< 20	11 (6.5)	9 (4.9)	
[20-30[128 (75.7)	110 (59.8)	
[30-35[21 (12.4)	37 (20.1)	
\geq 35	9 (5.3)	28 (15.2)	
Smoking	19 (11.2)	25 (13.6)	0.614
Pregestational diabetes	6 (3.6)	12 (6.5)	0.305
Chronic hypertension	4 (2.4)	9 (4.9)	0.329
Parity	1.7 \pm 1	1.4 \pm 0.9	0.001
Gestational age at previous cesarean GW ^a)	38.36 \pm 3.45	37.93 \pm 4.03	0.292
Previous successful vaginal birth after cesarean	53 (31.4)	14 (7.4)	<0.001
Previous vaginal delivery prior to cesarean	30 (17.6)	26 (14.1)	0.433
Pregnancy characteristics			
Fertility treatment	10 (5.9)	5 (2.7)	0.221
Time since previous birth (months)	64.41 \pm 42.96	56.75 \pm 35.85	0.069
Gestational age at delivery (gestational weeks)	39.77 \pm 1.7	39.65 \pm 1.83	0.53
Pregnancy complicated by hypertensive disorders	22 (13.0)	32 (17.4)	0.321
Pregnancy complicated by diabetes	43 (25.4)	64 (34.8)	0.073
Cholestasis of pregnancy	5 (3.0)	7 (3.8)	0.885
Intra uterine growth restriction	12 (7.1)	9 (4.9)	0.5148
Fetal anomalies	2 (1.2)	1 (0.5)	0.941
Estimated fetal weight at 32GW ^a (percentile)	53.98 \pm 25.18	63.30 \pm 26.03	0.001

^aGW: gestation weeks

Table 2. In-labor characteristics.

Mean \pm SD, n (%)	Vaginal delivery (n=169 being 47.9%)	Cesarean section (n=184 being 52.1%)	p-value
In-labor characteristics			
Bishop \geq 6	49 (29.5)	30 (17.3)	0.012
Induction method :			<0.001
- Balloon catheter Cook®	45 (26.6)	76 (41.3)	
- Osmotic cervical dilator Dilapan®	18 (10.7)	39 (21.2)	
- Oxytocin	51 (30.2)	40 (21.7)	
- Amniotomy	55 (32.5)	29 (15.8)	
Epidural analgesia	164 (97.0)	182 (98.9)	0.380
Duration of labor (hours)	8.10 \pm 3.69	8.87 \pm 3.58	0.051
Non-reassuring fetal heart rate	44 (26.0)	66 (35.9)	0.06
Oxytocin use:			0.103
- No	20 (11.8)	10 (5.4)	
- Before 5 cm dilatation	141 (83.4)	167 (90.8)	
- After 5 cm dilatation	8 (4.7)	6 (3.3)	
Total oxytocin during labor (UI)	2.32 \pm 2.02	2.83 \pm 1.74	0.01
Meconial amniotic liquid	7 (4.1)	17 (9.2)	0.091
Maternal fever during labor	10 (5.9)	8 (4.3)	0.669
Indications for cesarean section			
- Labor induction failure		87 (47.3)	
- Stagnancy during the first labor phase		11 (6.0)	
- Stagnancy during the second labor phase		21 (11.4)	
- Cord prolapse		3 (1.6)	
- Non-reassuring fetal heart rate		46 (25.0)	
- Non engagement at complete expansion		8 (4.3)	
- Dystocic presentation		4 (2.2)	
- Instrumental delivery failure		1 (0.5)	

^(b) Hemolysis elevated liver enzymes and low platelet

Table 3. Maternal and neonatal outcomes after induction of labor in women with scar uterus according with mode of delivery.

Mean \pm SD, n (%)	Vaginal delivery (n=169, 47.9%)	Cesarean Section (n=184, 52.1%)	p-value
Maternal outcomes			
Length of hospitalisation (days)	4.17 \pm 1.99	5.16 \pm 2.2	<0.001
Uterine rupture	0	7 (3.8)	0.028
Delivery spontaneous	119 (70.4)		
Delivery instrumental	50 (29.6)		
Perineal tears and lacerations			
- Oasis ^(c) 1	73 (43.2)		
- Oasis 2	36 (21.3)		
- Oasis 3	2 (1.2)		
- Oasis 4	0 (0.6)		
- Intact Perineum	33 (19.5)		
- Episiotomy	23 (13.6)		
Postpartum haemorrhage > 1 liter	5 (3.0)	3 (1.6)	0.632
Endometritis	0	1 (0.5)	1.00
Neonatal outcomes			
Birthweight (g)	3341 \pm 542	3404 \pm 576	0.291
Apgar 5min < 7	1 (0.6)	2 (1.1)	1.00
Arterial pH < 7.1	6 (3.6)	9 (4.9)	0.719
Neonatology hospitalisation	15 (8.9)	16 (8.7)	1.00

^(c) *Obstetrical anus sphincter injuries*

Table 4. Multivariate analysis prediction of success of trial of labor after previous cesarean section.

Variables	OR
BMI < 20	0.37 (0.11-1.19)
BMI ≥ 30 et < 35	0.86 (0.23-3.16)
BMI ≥ 35	1.63 (0.39-6.71)
Cesarean section during labor	1.33 (0.66-2.66)
Vaginal delivery after previous cesarean section	0.17 (0.08-0.35)
Gestational diabetes	1.22 (0.69-2.17)
Estimated fetal weight at 32GW ^a (percentile)	1.01 (1.00-1.02)
Bishop score ≥ 6	0.44 (0.25-0.81)
Meconial amniotic liquid	2.48 (0.89-6.99)
Labor duration	1.03 (0.96-1.11)
Non-reassuring fetal heart rate	1.60 (0.92-2.77)

^aGW: gestation week

Table 5. Neonatal and maternal outcomes after induction of labor in women with scar uterus according with Bishop score.

Mean \pm SD, n (%)	Bishop score < 6 (n=260)	Bishop score \geq 6 (n=79)	p-value
Neonatal outcomes			
Birthweight (g)	3345.96 \pm 578.86	3483.70 \pm 480.99	0.058
APGAR 5min < 7	2 (0.8)	1 (1.3)	1.00
Arterial pH < 7.1	10 (3.8)	4 (5.1)	0.878
Neonatology hospitalisation	26 (10.0)	4 (5.1)	0.260
Maternal outcomes			
Vaginal delivery	117 (45.0)	49 (62.0)	0.012
Length of hospitalisation (days)	4.80 \pm 2.32	4.35 \pm 1.67	0.113
Uterine rupture	4 (1.5)	3 (3.8)	0.433
Postpartum haemorrhage > 1 liter	7 (2.7)	4 (5.1)	0.497
Endometritis	1 (0.4)	0	1.00

Table 6. Multivariate analysis prediction of success of trial of labor after previous cesarean section restricted in women with Bishop score < 6.

Variables	OR (95% CI)
BMI < 20	0.49 (0.14-1.77)
BMI ≥ 30 et < 35	1.27 (0.29-5.45)
BMI ≥ 35	1.89 (0.39-9.24)
Cesarean section during work	1.68 (0.76-3.71)
Vaginal delivery after previous cesarean section	0.15 (0.06-0.35)
Gestational diabetes	1.39 (0.72-2.69)
Meconial amniotic liquid	1.01 (1.00-1.03)
Labor duration	1.03 (0.95-1.11)
Non-reassuring fetal heart rate	1.43 (0.77-2.65)

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.