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Original Article

Cesarean during labor: Is induction a risk factor for complications?

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ABSTRACT

Introduction: Evaluate the impact of labor induction on maternal complications following cesarean section during labor.

Material and methods: Retrospective, single-center study between 2015 and 2017. Were included singleton pregnancies who had cesarean section during labor after 37 WG. Labor induction procedures included either transcervical balloon catheters or prostaglandins. Degree of emergency of the cesarean was decided according to color code (green, orange and red). We identified and compared intra and postoperative complications according to the mode of labor onset, and then to the mode of labor induction.

Results: 882 patients were included, 416 with spontaneous labor and 464 with labor induction. No significant difference was found for postoperative complications between the two groups. Patients with spontaneous labor had fewer green-code caesareans than patients with elective induction (29.3% vs. 40.3% $p < 0.001$) and had more uterine pedicle injuries (6.3% vs. 3.0% $p = 0.022$). Nevertheless, no difference was found for postpartum hemorrhage (PPH) between these two groups (41.59% vs. 43.32% $p = 0.60$). The subgroup study of patients with labor induction showed that those necessitating 2 methods of labor induction had more severe PPH (22.2% vs. 8.1% p after Bonferroni correction = 0.002).

Conclusions: Elective induction does not result in an increased risk of cesarean section during labor complications. Only the use of prostaglandin following transcervical balloon catheter increased the risk of severe postpartum hemorrhage.

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Introduction

In 2016, 22.0% of women had induction of labor and the cesarean section rate was 20.2% in France according to the national report [1]. Van Ham showed that “major” complications were significantly more frequent during cesarean sections during labor than during elective cesareans before labor. Onset, 23.4% of women with cesarean sections during labor had intraoperative complications and 7.3% in the other group [2]. Women in labor also showed significantly more postoperative complications compared to women with elective cesarean.

In recent studies, elective induction at 39 weeks, compared to expectative, is associated with a lower rate of C-section in nulliparous and also multiparous [3]. Compared to spontaneous labor, induction is associated with higher rate of post partum

hemorrhage (PPH) [4]. Indeed, we hypothesized that in case of cesarean during labor, blood loss, or other complication, will be different in the group spontaneous labor compared to induced labour.

Thus, the main objective of our study was to evaluate the maternal morbidity following a cesarean section during labor in women with labor induction compared to those with spontaneous labor. Secondly, we aimed to evaluate this morbidity according to the type of induction.

Material and methods

This is a retrospective study in one tertiary center (Lille, France,) including all women with single pregnancy who had cesarean section during labor (cephalic or podalic) after 37 WG between January 2015 and April 2017. Elective cesareans and multiple pregnancies were excluded. The rate of cesarean during labor in 2018 was 11% in this center, and the rate of induction 26%. The study was approved by the local committee of the CNIL (National

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In our center, labor induction methods were chosen according to modified Bishop score (MBS) [5], i.e. adding parity to the Bishop score. A score greater than or equal to 4 allowed management of labor by amniotomy and oxytocin. For a score below 4, cervical ripening could be done either by a mechanical method (double-balloon catheter or single balloon 18 ch catheter), or prostaglandins (PG). Transcervical balloon were preferred as first method of induction. After mechanical induction, in case of favorable cervix MBS (≥ 4) or after spontaneous fall of the balloon catheter, induction was pursued in labor ward. In the opposite case, a complementary cervical ripening by prostaglandins was proposed.

Datas were collected manually, obstetrical files were reading and we collected postoperated complication in the post-partum page of this file. There were maternal characteristics, type of onset of labor, cesarean section characteristics (indication, cervix dilatation at Csection) and color code of the cesarean section. In our center, the color codes protocol is inspired by that described by Dupuis et al. [2]. Red code corresponded to an objective of decision-to-delivery interval of less than 20 min, orange code less than 30 min, and green code cesarean section corresponded to non-urgent cesarean. For each woman, intra and postoperative complications were recorded, we checked the post-partum part of the obstetrical file for each women.

Dystocia was defined as arrest of labor during 4 h during active phase and 6 h during latent phase. The postoperative complications were also classified according to the ClavienDindo classification [6]. This classification consists in five grades: Grade I includes women with any adverse postoperative event that does not require medical, surgical, endoscopic or radiological treatment. Only antiemetic drugs, antipyretics, analgesics, diuretics, electrolytes and physiotherapy are allowed. Grade II includes complications requiring unauthorized medical treatment in Grade I. Grades III to V represent complications requiring surgical, endoscopic or radiological treatment, and life-threatening complications requiring intensive care or leading to death.

Statistics

Qualitative data are expressed in numbers and percentages. Quantitative data were expressed as mean and standard deviation. The normality of the numerical parameters was verified graphically and by the Shapiro-Wilk test. The two cesarean comparison groups, "Spontaneous Labor" and "Labor induction", were compared by Chi-square or Fisher exact tests on qualitative

parameters and by the Mann-Whitney U test on quantitative parameters. We then focused on cesarean procedure with induced labor population. In this population, we compared the different modes of induction (PG, mechanical method +/- PG, amniotomy and oxytocin) according to the complications by Chi-square exact Fisher tests. For significant comparisons, we performed post hoc analyzes with Bonferroni correction (two by two comparison) between the different induction modes. The significance threshold used was set at 5%. Statistical analysis was performed using SAS software, version 9.4 (SAS Institute, Cary, NC, USA).

Results

Eight hundred and eighty two women (851 cephalic and 31 breech presentations) were included, of which 416 (47.3%) had spontaneous labor and 464 (52.7%) induced labor and two were unknown.

Table 1 presents demographic characteristics of the population. In the labor induction group mean Body max index was higher (27.0 ± 6.8 vs. 25.4 ± 5.8 kg / m², $p < 0.001$). The proportion of women with diabetes mellitus or pre-eclampsia was higher in the induced labor group (respectively 9.9 vs 1.5%, $p < .0001$ and 10.6% vs 1.9%, $p < 0.001$). There were no differences regarding parity, previous cesarean section, hypertension, gestational diabetes, or premature rupture of membranes. Of the 464 women in the labor induction group, 186 (40%) had a postdate pregnancy, 108 (23.3%) a premature rupture of the membranes, 49 (10.6%) a pre-eclampsia, 8 (1.7%) a cholestasis, 46 (10%) a diabetes mellitus, and 134 (28.9%) a chronic disease.

Table 2 shows the characteristics of cesarean sections during labor in both groups. The main indications for women with induction of labor were cervical dystocia (38.2%), the occurrence of fetal heart rate (FHR) abnormalities (36.2%), and the combination of FHR abnormalities and cervical dystocia (15.3%). In case of spontaneous labor, the abnormal fetal heart rate was the first indication (39.7%), then cervical dystocia (17.1%) and finally FHR abnormalities and cervical dysfunction association (16.4%), the others indications (18.3%) were: unknown breach presentation, proclivencia, retroplacental hematoma, uterine rupture, umbilical cord proclivencia, placenta praevia with perpartum hemorrhage. Cervical dilatation on cesarean section was less in the labor induction group (4.7 ± 2.6 vs. $5.9 \text{ cm} \pm 2.8$, $p < .001$). Duration of labor was shorter for women in spontaneous labor group (463.7 ± 244.8 vs. 409.7 ± 269.5 min $p < 0.001$).

Uterine pedicle injuries made during the hysterotomy were the only complication with a significant difference between the 2

Table 1
Population characteristics.

Characteristics	Total (n=882)	Labor onset		
		Induced (n=464)	Spontaneous (n=416)	P
Age (y)	31.1 ± 7.1	30.8 ± 5.8	31.4 ± 8.3	0.62
BMI (kg/m ²)	26.2 ± 6.4	27.0 ± 6.8	25.4 ± 5.8	<0.001
Parity	1.5 ± 0.8	1.4 ± 0.8	1.6 ± 0.9	0.07
Gestational age	39.8 ± 1.3	39.9 ± 1.4	39.8 ± 1.1	0.28
Previous C Section	153 (17.4)	77 (16.6)	76 (18.3)	0.51
Diabetes mellitus	52 (5.9)	46 (9.9)	6 (1.5)	< 0.001
Aterial hypertension	21 (2.4)	15 (3.2)	6 (1.4)	0.08
Smoking	130 (14.7)	56 (12.1)	74 (17.8)	0.017
Gestational diabetes	203 (23.0)	113 (24.4)	90 (21.6)	0.58
Preeclampsia	57 (6.5)	49 (10.6)	8 (1.9)	< 0.001
PROM	223 (25.3)	108 (23.3)	115 (27.6)	0.14

Results expressed as mean +/- standard deviation or number (percentage).

BMI: body mass index (defined as weight (kg)/ size² (m²)).

AHT: Arterial hypertension.

PROM: Premature rupture of membranes.

NA: non applicable.

Table 2
Cesarean section characteristics and bivariate comparisons.

Characteristics	Total (n = 882)	Labor onset		P
		Induced (n = 464)	Spontaneous (n = 416)	
Indication				<0.001
FHR anomalies	333 (37.8)	168 (36.2)	165 (39.7)	
Cervical dystocia	248 (28.2)	177 (38.2)	71 (17.1)	
FHR and cervical dystocia	139 (15.8)	71 (15.3)	68 (16.4)	
Failed instrumental extraction	53 (6.0)	17 (3.7)	36 (8.7)	
Other	107 (12.2)	31 (6.7)	76 (18.3)	
Cervix dilatation at C section (cm)	5.3 ± 2.8	4.7 ± 2.7	5.9 ± 2.8	< 0.001
Color code				<0.001
Green Orange	310 (35.15) 535 (40.2)	187 (40.30) 180 (38.9)	122 (29.33) 173 (41.6)	
Red	219 (24.83)	94 (20.26)	124 (29.81)	

Results expressed as mean +/- standard deviation or number (percentage).

FHR: FHR anomalies.

CD: cervical dystocia.

groups (3.0% vs. 6.3%, $p=0.02$) (Table 3). No difference was found for postpartum hemorrhage (blood loss over 500 mL), postpartum infectious or thrombotic complications.

According to the Clavien Dindo's classification, no difference was found between women with spontaneous labor or those with induced labor (grades I : 91.0% vs 87.5%; grades II : 7.8% vs 9.6% ; grades III : 1.3% vs 2.9% ; $p=0.14$) (Table 4).

The method used was mechanical method for 248 (53.6%), prostaglandin alone for 60 (13.0%), oxytocin for 65 (14.0%), and double method (mechanical and PG) for 90 (19.4%).

Comparison of complications according to the modes of labor induction showed no significant difference, except for severe PPH. There were more PPH more than one liter in the double method group than in the mechanical method alone group (22.2% vs. 8.1% p after Bonferroni 0.002 correction). There was no significant difference when comparing double method vs PG alone (22.2% vs. 11.7% p after Bonferroni correction=0.5952) or in case of oxytocin (22.2% vs. 18.5% p after correction of Bonferroni = 1)

Discussion

Labor induction is a common obstetrical practice with a rate of 22% according to the 2016 French Perinatal Study [1]. In recent studies, elective induction at 39 weeks, compared to expectative, is

associated with a lower rate of C-section in nulliparous and also multiparous (3). However, "major" complications are significantly more frequent during cesareans during labor than during elective cesareans before labor [7]. We were therefore interested in the occurrence of complications in women with induced versus spontaneous labor in case of "emergency" cesarean section. In our study, no significant difference was found for complications according to onset of labor. However, a difference was noted according to the indication for c-section. Cervical dystocia was the main indication in the induction group resulting in more green-code cesareans than in the spontaneous labor group. According to the method of induction, use of mechanical method in association with prostaglandin led to a higher risk of severe PPH.

In France, between 1995 and 2016, the mode of onset of labor remained stable with labor induction rates around 20–22% [1]. The rate of cesarean section has increased from 15.9% to 20.4% in 20 years with a slight increase in the rate of elective cesareans from 8.5 to 9.4% [1]. Studies on the impact of labor induction on the delivery route are controversial in the literature. According to several studies, the risk of cesarean section may increase significantly in induced labor [8–11]. One of the most predictive factors would be cervical dilatation before induction [8]. For others authors, this risk would not be higher, and would even be decreased especially in the absence of medical indication for

Table 3
Complications according to mode of labor onset.

Characteristics	Total (n = 882)	Labor onset		P
		Induced (n = 464)	Spontaneous (n = 416)	
Intra-operative	374 (42.5)	201 (43.3)	173 (41.6)	0.60
Post partum hemorrhage				
Post partum hemorrhage >1 L	106 (12.1)	59 (12.7)	47 (11.3)	0.52
Bladder injury	13 (1.5)	5 (1.1)	8 (1.9)	0.30
Fetal injury	5 (0.6)	1 (0.2)	4 (1.0)	NA
Uterine pedicle injury	40 (4.6)	14 (3.0)	26 (6.3)	0.02
Postoperative	60 (6.8)	25 (5.4)	35 (8.4)	0.08
Hyperthermia				
Sepsis	26 (3.0)	11 (2.4)	15 (3.6)	0.28
Phlebitis	10 (1.1)	4 (0.9)	6 (1.4)	0.53
Scar disunion	37 (4.2)	20 (4.3)	17 (4.1)	0.87
Bound infection	48 (5.5)	21 (4.5)	27 (6.5)	0.20
Profound infection	12 (1.4)	4 (0.9)	8 (1.9)	0.18
Second intervention	14 (1.6)	5 (1.1)	9 (2.2)	0.20
Intensive care unit transfer	3 (0.3)	2 (0.4)	1 (0.2)	NA
Clavien Dindo				0.14
I	787 (89.2)	422 (91.0)	364 (87.5)	
II	77 (8.7)	36 (7.8)	40 (9.6)	
>III	18 (2.0)	6 (1.3)	12 (2.9)	

Results expressed as mean +/- standard deviation or number (percentage).

NA non applicable.

Table 4
Analysis of cesarean after induced labor- complications according to mode of labor induction.

Characteristics	Mode of labor induction					p
	Total (n = 463)	PG (prostaglandin) (n = 60)	Ballooncatheter (n = 248)	Oxytocin (n = 65)	Double method (n = 90)	
Intra operative PPH	201 (43.4)	23 (38.3)	105 (42.3)	27 (41.5)	46 (51.1)	0.39
PPH >1 L	59 (12.7)	7 (11.7)	20 (8.1) ¹	12 (18.5)	20 (22.2) ¹	0.003
Post operative	25 (5.4)	4 (6.8)	15 (6.1)	2 (3.1)	4 (4.4)	0.78
Hyperthermia						
Sepsis	11 (2.4)	1 (1.7)	7 (2.8)	1 (1.5)	2 (2.2)	1.00
Phlebitis	4 (0.9)	0 (0.0)	0 (0.0)	0 (0.0)	4 (4.4)	NA
Scar disunion	20 (4.3)	5 (8.3)	10 (4.0)	1 (1.5)	4 (4.4)	0.34
Bound infection	21 (4.5)	5 (8.3)	10 (4.0)	2 (3.1)	4 (4.4)	0.49
Profound infection	4 (0.9)	0 (0.0)	4 (1.6)	0 (0.0)	0 (0.0)	NA
Clavien Dindo						NA
I	421 (90.9)	50 (83.3)	233 (94.0)	59 (90.8)	79 (87.8)	
II	36 (7.8)	9 (15.0)	11 (4.4)	6 (9.2)	10 (11.1)	
>III	6 (1.3)	1 (1.7)	4 (1.6)	0 (0.0)	1 (1.1)	

Results expressed as mean +/- standard deviation or number (percentage).

PPH: postpartum hemorrhage.

NA: non applicable.

¹ Indicates significant difference for two-by-two comparisons after Bonferroni correction.

labor induction [12,13]. In a meta-analysis, Gobman et al. demonstrated that elective induction of labor at 39 weeks, compared with expectant management beyond that gestational age, was associated with a significantly lower risk of cesarean delivery [3].

The rates of serious complications vary according to their different definitions. If we consider severe thromboembolic complications, surgical revision procedures or transfers in intensive care unit (Clavien-Dindo, grade II), our study is in line with the literature with a severe complication rate of 10.7% [14]. Intraoperative complications (excluding PPH) were similar to those observed by Van Ham et al. [7]. Uterine pedicle injuries occurred more frequently in the spontaneous labor group and was the only significant difference found in our study. A higher proportion of “emergency” indications (red- and orange-code cesareans) in this group may explain this.

The occurrence of PPH was similar between the 2 groups. PPH rate greater than 1L observed (12.02%) was higher than that reported by Van Ham et al. in 1997 [7], but was consistent with a more recent study [15] and with the evolution of PPH over time as observed by several authors, including all delivery routes [16]. One of the hypotheses of this increase would be the improvement of the quantification of peripartum bleeding. In our center, compresses are weighed, a collection bag is placed under the woman and aspiration allows exact quantification of blood loss. The induction of labor would be associated with a higher risk of PPH in low-risk women [4], all delivery routes combined. In our study, we didn't find this difference, this could be because of the unknown of oxytocin dose in each group. For Belghiti et al., oxytocin during labor appears to be an independent risk factor for severe PPH [17]. The time between stopping oxytocin and the beginning of cesarean could be another interesting data. The more we stopped early the oxytocin, the less we may have PPH [18].

The strength of our study lies in its specific focusing on the complications of cesarean section during labor depending on the mode of onset of labor. In fact, many studies have examined the complications of cesarean section compared to the vaginal route, according to cervical dilation, before or during labor, depending on maternal age or the consequences of the onset of labor (delivery route, neonatal, maternal complications), but to our knowledge none has studied the complications of cesarean sections during labor in women with labor induction [19–23]. The main limitation of our study is the absence of data related to the amount of oxytocin received. Indeed, prolonged exposure to oxytocin

increases the risk of PPH [24]. Other limits could be confusion because of the differences between the two groups, a low statistical power for rare events.

Conclusion

Labor induction does not result in a higher risk of complications for cesarean during labor when compared to spontaneous labor. The use of two methods of induction was responsible for more frequent occurrence of severe postpartum hemorrhage.

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