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Mechanical vs. pharmacological cervical ripening in intrauterine growth restriction (FGR): A propensity score-weighted cohort study

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Abstract

Objective

To compare obstetric and neonatal outcomes following mechanical versus pharmacological cervical ripening in pregnancies complicated by fetal growth restriction (FGR) and an unfavourable cervix.

Study design

We conducted a single-centre retrospective cohort study including all women with FGR who underwent labour induction between January 2017 and December 2022. Women were classified according to the initial ripening method: Cook® balloon (mechanical) or prostaglandins (vaginal dinoprostone or oral misoprostol). The primary outcome was vaginal delivery. The secondary outcome was a composite neonatal morbidity endpoint including 5-minute Apgar score < 7, umbilical arterial pH < 7.15, or neonatal intensive care unit admission. Propensity score weighting was applied for the primary outcome. Neonatal outcomes were analysed using adjusted logistic regression models accounting for gestational age and mode of delivery.

Results

A total of 133 women were included (66 balloon; 67 prostaglandins). After propensity score weighting, no difference was observed in vaginal delivery rates between groups (weighted OR 1.01, 95% CI 0.38–2.72). For neonatal outcomes, no significant association was observed in unadjusted analyses. In adjusted models, a non-significant trend toward increased neonatal morbidity was observed in the prostaglandin group (aOR 2.57, 95% CI 0.96–7.54). In exploratory subgroup analysis, oral misoprostol was associated with a higher risk of adverse neonatal outcome compared with the balloon group (aOR 9.47, 95% CI 2.74–38.2), whereas vaginal prostaglandins were not.

Conclusion

In this exploratory cohort of pregnancies complicated by FGR, mechanical and pharmacological cervical ripening resulted in similar vaginal delivery rates. A signal toward increased neonatal morbidity was observed with prostaglandins, particularly oral misoprostol, although estimates were imprecise and based on small numbers. These findings should be considered hypothesis-generating and require confirmation in adequately powered prospective studies.

INTRODUCTION

Intrauterine growth restriction (FGR) is defined as an abnormality in foetal growth. It is suspected when the estimated foetal weight using the Hadlock formula is below the 10th percentile, and is confirmed

using prescriptive curves, such as the WHO biometric curves, which are now recommended in antenatal care (1, 2). Recent recommendations published by the ISUOG have enabled the development of a standardised definition of FGR, based on criteria including biometry, Doppler ultrasound and growth kinetics. (3).

According to the 2021 National Perinatal Survey, intrauterine growth restriction (FGR) affects 5.2% of births and is associated with a significant increase in perinatal morbidity, such as acidosis and foetal heart rhythm abnormalities, and neonatal morbidity, such as hypoxia and neurological complications. Especially when birth weight falls below the third percentile, the risk is significantly heightened (4, 5).

In response to this increased morbidity, labour induction is often considered before the baby is due. However, no national or international recommendations advocate a specific method of induction for FGR. (6). The FGR foetus, which is often haemodynamically fragile, presents an increased risk of labour intolerance, making induction management particularly complex, especially in the presence of an unfavourable cervix (Bishop score ≤ 5). This often results inan immediate caesarean section. (7), although recent data suggest that induction, even in cases of immature cervix, does not alter obstetric or neonatal outcomes if adequate monitoring is provided. (8).

Mechanical induction methods, such as the balloon, may be associated with lower foetal morbidity compared to prostaglandins. (9). Their advantages include reduced cost, improved stability during storage and a lower risk of side effects, particularly hyperkinesia or foetal heart rate abnormalities. Their effectiveness is based on direct mechanical action but also on neuroendocrine mechanisms (Ferguson reflex) that promote the spontaneous onset of labour. (10).

Studies have compared mechanical methods with local prostaglandins, but none have specifically evaluated the Cook® balloon or included oral prostaglandins (Angusta®), which were recently introduced. The intracervical balloon has gradually become the standard option for fragile foetuses, due to its better tolerance and lower risk of uterine hyperstimulation compared to prostaglandin E2 (PGE2) (11). No studies compare Angusta® and the balloon in the context of FGR.

The aim of our study was to evaluate the impact of the method of induction (Cook® balloon versus local or oral prostaglandins) on the mode of delivery, by comparing the rates of vaginal deliveries and caesarean sections.

PATIENTS AND METHODS

Study design and inclusion criteria

We conducted a single-centre, retrospective observational cohort study at the type III maternity unit of Amiens Picardie University Hospital (France). The study included all patients with intrauterine growth restriction (FGR) who underwent labour induction for FGR, regardless of gestational age, with an unfavourable cervix, between January 1, 2017, and December 31, 2022.

We compared the efficacy and tolerance of the Cook® balloon (Cooper Medical FRANCE), oral misoprostol Angusta® (Pharma Blue laboratory, 06 906 Sophia Antipolis, France), used since 20 February 2020, and dinoprostone, used previously, either as a gel, namely Prostine® E2 1 or 2 mg/3 g vaginal gel (Pfizer laboratory, 75 668 Paris Cedex 14, France) or as a vaginal device, namely Propess® 10 mg vaginal delivery system (Ferring laboratory, 94250 Gentilly, France).

Inclusion criteria

Eligible patients had a diagnosis of FGR based on ISUOG criteria and the international Delphi consensus (3), confirmed by ultrasound and Doppler findings. Patients were included regardless of gestational age, provided cervical ripening was indicated (Bishop score ≤ 5).

Exclusion criteria

Exclusion criteria were: intrauterine foetal death, multiple pregnancies, spontaneous labour onset, pre-labour caesarean section, breech presentation, scarred uterus, and patients who underwent maturation using both techniques.

Exposure groups

Patients were assigned to two groups according to the first method used for cervical ripening:

- Mechanical group: intracervical Cook® balloon
- Pharmacological group: vaginal dinoprostone (Prostine® or Propess®) or oral misoprostol (Angusta®)

For subgroup analysis, the pharmacological group was also stratified by route of administration (oral vs. vaginal).

Endpoints

Primary endpoint

The primary endpoint was the rate of vaginal delivery.

Secondary endpoints

Secondary endpoints included assessment of tolerance through a neonatal composite outcome including : a low Apgar score at birth (< 7 at 5 minutes), acidosis with an arterial cord blood pH at birth (< 7.15), and the need for transfer to a Neonatal Intensive Care Unit (NICU).

Due to the small number of patients, we did not conduct a specific subgroup analysis to compare the different prostaglandin modalities (local versus oral) separately, in order to assess any differences according to the route of administration for the neonatal outcome.

Collected data

Medical records were retrieved from the hospital database (RUM codes with ICD-10: O36.5, P05.0, P05.1; CCAM procedures: JJFC001–004). Additional patients were identified via foetal medicine unit consultations for suspected or confirmed FGR. Maternal, obstetric, and neonatal data were extracted.

Definitions

FGR was defined according to the ISUOG 2020 criteria: estimated foetal weight (EFW) using the Hadlock formula below the 10th percentile (2). EFW < 3rd percentile, or EFW < 10th percentile associated with at least one marker of placental insufficiency (abnormal UA Doppler, abnormal CPR, or oligohydramnios) (3). Maternal conditions were recorded as comorbidities, not as etiological criteria.

Oligoamnios was not a criterion for the aetiological classification of FGR.

Foetal Doppler abnormality was defined as an umbilical resistance index above the 95th percentile according to the Pourcelot index (12), with or without a cerebral resistance index below the 5th percentile. Cerebro-placental inversion was defined as a ratio of the umbilical resistance index to the cerebral resistance index below the 5th percentile for gestational age. (12).

Oligoamnios was defined as a largest cistern less than 2 cm.

Procedure

The protocols for monitoring and inducing complicated pregnancies involving FGR at our centre followed the recommendations of the CNGOF (French National Committee of Obstetricians and Gynaecologists) (13).

Follow-up protocol

Foetal surveillance included ultrasound estimation every 2–3 weeks, CTG monitoring, and Doppler assessment adapted to FGR severity.

Induction was indicated for abnormal Doppler, oligohydramnios, or growth arrest, as per CNGOF guidelines (13). In the absence of these criteria, pregnancies were managed expectantly until term.

Induction of labour protocol

Labour induction was initiated during hospitalisation and guided by the Bishop score. When the score was ≤ 5, cervical ripening was performed using a Cook® balloon for 12 to 24 hours, particularly in cases of severe foetal compromise (estimated foetal weight < 3rd percentile, abnormal Doppler findings, or

oligohydramnios). Alternatively, vaginal 10 mg dinoprostone (Propess®) or 1 mg or 2 mg PGE2 gel (Prostine®) or, since 2021, oral misoprostol (Angusta® 25 µg) was used. The patient's opinion was considered in the choice of technique.

If the cervix remained unfavourable after initial ripening (either at the end of an initial 24-hour Cook® balloon maturation stage or after failure of one or two phamacological cervical maturation techniques), labour was continued with amniotomy and oxytocin. For patients with a Bishop score > 5, induction was performed directly with oxytocin in the delivery room.

Each patient was assigned to a study group according to the first method used for cervical ripening.

To avoid treatment contamination, patients who received prostaglandins after a Cook® balloon because of persistent cervical immaturity were excluded from the analysis. Conversely, women in the pharmacological group who required repeated prostaglandin administrations were retained, provided that no mechanical method was used. The proportion of women exposed to more than one pharmacological ripening line is reported in the Results.

Induction was discontinued in the event of significant fetal heart rate abnormalities, which, depending on their severity, could either lead to transfer to the delivery room or indicate the need for a caesarean section; Failure to progress, is defined as the absence of cervical change after ≥ 6 hours of amniotomy and optimal oxytocin infusion, despite adequate uterine contractions.

Statistical analysis and ethical considerations

Due to the retrospective design, no a priori sample size calculation was performed. The study includes all eligible patients who were managed during the study period. All statistical tests were two-sided, with a significance threshold set at 5% ($p < 0.05$).

Patient characteristics were compared between the two groups (balloon vs. prostaglandins) and further described according to prostaglandin subtypes. Baseline group balance was assessed using standardised mean differences (SMDs) for each covariate, with an SMD > 10% considered indicative of clinically relevant imbalance. The primary outcome was vaginal delivery. Secondary outcome is a neonatal composit outcome including an Apgar score < 7 at 5 minutes, an umbilical cord pH < 7.15, or an admission to the neonatal intensive care unit (NICU). No missing data were reported.

For the analysis of the primary endpoint, variables associated with the mode of delivery in univariate analysis were included in the propensity score model. This pragmatic threshold was chosen to avoid excluding potentially relevant confounders, particularly in the context of an observational study with limited sample size (14). These variables included: BMI, ultrasound-estimated foetal weight (EFW), Fetal doppler abnormality, Vascular aetiology of the FRG, Severe FGR, prognostic variables identified in the literature for mode of delivery, such as maternal age, gestational age, initial bishop score, use of oxytocin, the reason of labour induction and parity, were also incorporated into the model (Fig. 2) (15).

A logistic regression model was used to estimate each patient's probability of undergoing balloon maturation. To balance the treatment groups, weighted logistic regression models (IPTW) based on the propensity score was applied to each patient. Balance after weighting was evaluated using standardised mean differences (SMDs), with a threshold of < 10% considered acceptable (14).

Univariate analyses were then performed using IPTW-weighted models to evaluate the primary outcome. For secondary outcomes, a composite neonatal outcome was used, including Apgar score < 7 at 5 minutes, umbilical arterial pH < 7.15, or admission to the neonatal intensive care unit (NICU). Comparisons were adjusted for gestational age, ripening method, and mode of delivery. The magnitude of between-group differences was expressed as effect sizes using odds ratios (ORs) and their corresponding 95% confidence intervals (CI). Different analytical approaches were used for obstetric and neonatal outcomes. While IPTW was applied to balance baseline severity for the analysis of mode of delivery, neonatal outcomes were evaluated using a simpler adjusted model, reflecting the limited number of events and the exploratory nature of this analysis.

Statistical analyses were conducted using R Studio version 4.4.0.

Ethics Approval and Consent to Participate

This study received approval from the local Clinical Research and Innovation Delegation (DRCI) of Amiens Picardie University Hospital and was registered under reference number PI2025_843_0126, and conducted in accordance with the ethical standards of the Helsinki Declaration. In accordance with French legislation for retrospective studies using anonymised data, written informed consent was not required. All data were fully anonymised prior to analysis.

This manuscript was prepared in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for cohort studies.

RESULTS

Population

Between January 2017 and December 2022, our centre recorded 14,472 deliveries, including 1,856 induced labours. Among these, 192 patients were eligible for inclusion. After applying the exclusion criteria, 133 patients were finally included in our study: 67 in the prostaglandin group (34 local, 33 oral) and 66 in the balloon group **(Figure 1).**

Baseline characteristics

Maternal demographic characteristics did not differ significantly between groups (Table 1). However, estimated foetal weight was significantly lower in the balloon group (median 1956 g) compared to the prostaglandin group (2200 g), **(Table 1).**

Induction-related characteristics

Foetal heart rate abnormalities prior to induction were more frequent in the balloon group (31%) compared to the prostaglandin group (12%). Prematurity (< 37 weeks) was also more common in the balloon group (48% vs. 10%). In contrast, inductions due to growth curve arrest were more frequent in the prostaglandin group (33% vs. 17%). **(Table 1).**

Cervical ripening duration was longer in the balloon group (median 15 hours) compared to the vaginal (6 hours) and oral prostaglandin groups (12 hours). Success of labour induction occurred more frequently with prostaglandins (41% vaginal, 58% oral) than with the balloon (32%). There was no difference in Bishop scores after device removal. Notably, 33% of patients in the prostaglandin group required a second-line cervical ripening agent **(Table 1 and 4)**.

Delivery and neonatal outcomes

Birth weight was significantly lower in the balloon group (median 2010 g [1140–2960]) compared to the prostaglandin group (2390 g [1560–3020]). No differences were observed in delivery mode or overall neonatal outcomes. However, a trend toward higher rates of severe acidosis (pH < 7.00) was noted in the prostaglandin group (4.5%) (including 9% in the oral group) compared to the balloon group (0%) **(Table 1 and Table 4)**.

Propensity score-weighted analysis

Primary endpoint

After weighting by propensity score, univariate analysis showed no significant difference in the probability of vaginal delivery between the balloon and prostaglandin groups [OR = 1.01 (0.38; 2.72)] (**Table 2**). These results were consistent with those obtained in simple logistic regression, with a crude odds ratio of 1.72 (0.82–3.67).

Secondary endpoints

In univariate analysis, no significant differences in foetal well-being were observed between groups [OR = 0.96 (0.44–2.07)]. However, in the adjusted multivariate model (accounting for gestational age, and delivery mode), poorer fetal tolerance was observed in the prostaglandin group compared to the balloon group [OR = 2.57 (0.96–7.54)]. In the exploratory subgroup analysis, no significant difference was observed between the balloon and vaginal prostaglandin groups after adjustment. In contrast, oral misoprostol was associated with a significantly higher risk of adverse neonatal outcome compared with the balloon group in both the unadjusted [OR = 2.18 (0.91–5.26)] and adjusted models [aOR = 9.47 (2.74–38.2)] (**Table 3**).

DISCUSSION

Key findings

Our study did not reveal any significant difference between mechanical methods (Cook® balloon) and pharmacological methods (vaginal and oral prostaglandins) in terms of the rate of vaginal delivery, even after propensity score weighting. However, mechanical induction was associated with better neonatal tolerance, even after adjustment for prematurity, birth weight, and mode of delivery.

Efficacy of induction methods

These results are consistent with the literature on the general population: the study by Vaknin *et al.* (16) and the meta-analysis by Fox *et al.* (16), did not show any method to be superior to another in terms of neonatal outcomes and vaginal delivery rates. The study by Boulvain *et al.* (17) corroborated our observations, with mechanical catheters being less effective in inducing labour within 24 hours. Only the study by Duro-Gomez *et al.,* which also used the Cook® balloon, converged with our data in not observing any significant difference (18).

We observed more frequent use of oxytocin during labour in the balloon (65%) and vaginal prostaglandin (59%) groups, which is consistent with the data from Vaknin et al., suggesting lower efficacy in the PGE2 (local prostaglandins) subgroup or dystocia of the first stage with the use of the balloon in these situations (19).

Neonatal safety

After adjusting for confounding factors, we observed poorer foetal tolerance in the prostaglandin group compared to the balloon group, probably due to their hyperstimulatory effect. Although based on small numbers, the subgroup analysis suggests that the association between prostaglandins and poorer neonatal tolerance may be mainly driven by the oral misoprostol subgroup. This finding should be interpreted with caution due to the limited sample size and wide confidence intervals, but it raises the hypothesis that the pharmacodynamic profile of oral prostaglandins, associated with more frequent uterine hyperstimulation, could be less well tolerated in haemodynamically fragile FGR fetuses. This could be explained by the profile of oral prostaglandins, which cause hyperkinesia of frequency and intensity and sometimes even uterine hypertonia (20), particularly in FGR foetuses, already at risk of hypoxia, which may increase the risk of neonatal acidosis due to a decrease in foetal pH during faster labour (20).

The maturation time was longer with the balloon, but this method required a second line much less often, suggesting satisfactory primary efficacy nonetheless. (19).

Several factors may have led to an underestimation of the balloon's apparent effectiveness of the balloon group. Indeed, the reweighting of foetuses with haemodynamic (particularly vascular) impairment may have attenuated the observed effect of this induction method in this subgroup. This initial imbalance was probably due to indication bias, with practitioners likely favouring the use of the balloon in these more fragile foetuses. This hypothesis is supported by a higher prevalence of low foetal weight and foetal heart rate abnormalities before induction in this group ($p < 0.05$), recognised markers

of compromised haemodynamics and foetal vulnerability, associated with an increased risk of emergency caesarean section (21,22).

Although mechanical methods resulted in similar obstetric outcomes to prostaglandins, they appeared to offer improved neonatal safety indicators. Their more gradual action on the cervix and moderate impact on placental perfusion could make them a relevant option for the most fragile foetuses, as suggested by Fox *et al*. with a lower rate of tachysystole (16,23). Provided there is no significant difference in the mode of delivery, the balloon could therefore be preferred in foetuses with FGR associated with significant haemodynamic impairment, provided that a longer maturation period is accepted in exchange for a better neonatal safety profile.

However, the association between prostaglandins and poorer neonatal tolerance must be interpreted with extreme caution. The number of events was small, the confidence interval wide, and residual confounding likely. These findings should be considered hypothesis-generating only.

Clinical implications and perspectives

The innovative nature of our study lies in the introduction, for the first time, of Angusta® as a method of induction in FGR foetuses. Due to its recent market launch (2020) and current practice habits, the balloon remains the most widely used method in maternity wards, despite the already documented efficacy and tolerability of oral misoprostol (24,25). Our population is also distinguished by an increased proportion of vulnerable foetuses, particularly due to lower estimated foetal weight, which is likely to reflect chronic foetal hypoxia. Unlike other studies, we assessed the duration of maturation rather than that of complete labour. Finally, our cohort included both FGR ≥ 37 weeks and < 37 weeks, which better corresponds to the clinical reality, where the indication to induce before 37 weeks remains frequent. It is very common to have to consider the birth of FGR foetuses before 37 weeks, as evidenced by the large number they represent in our study (29%). The composite neonatal endpoint was chosen because no single component outweighed the others clinically, and because the low event rate for each individual outcome limited the feasibility of separate analyses. This approach, although imperfect, allowed us to capture global neonatal vulnerability in this high-risk population.

The choice to adjust for prematurity and birth weight may be debated, as these variables could theoretically act as mediators. However, in our setting, they primarily reflect baseline fetal vulnerability rather than consequences of the ripening method itself. Given the limited number of outcome events, a parsimonious model was deliberately used in accordance with methodological recommendations (26-28).

Limitations

Our study had limitations and biases inherent in all retrospective observational studies evaluating the effectiveness of induction methods, even though the use of a propensity score seeks to reduce their impact. As an observational retrospective study, our sample size was not predetermined but reflected

the total number of eligible cases over the study period. This limits the statistical power to detect small between-group differences and supports an exploratory, hypothesis-generating interpretation of the results. Indeed, despite the application of the IPTW method to adjust for differences in baseline severity, residual confounding factors cannot be entirely excluded. Moreover, early- and late-onset FGR were not separated due to the limited sample size and the exploratory nature of the study; this is addressed as a major limitation. The single-centre cohort ensures consistency in practices but limits generalisability.

Prospective, multicentre studies with comparable groups in terms of FGR severity are needed to better assess the comparative effectiveness of induction methods in this context.

CONCLUSION

In this exploratory cohort, no difference in vaginal delivery rates was observed between mechanical and pharmacological cervical ripening in FGR. A signal toward increased neonatal morbidity in the prostaglandin group was observed, but this finding is fragile and requires confirmation in adequately powered prospective studies. Despite a longer ripening duration, the balloon was associated with fewer signs of fetal distress, reinforcing its potential safety advantage in haemodynamically fragile fetuses. These findings support the use of mechanical methods as a first-line option in selected FGR cases.

While these results are encouraging, prospective multicentre trials (PROBIN, Bordeaux University Hospital) are needed to confirm the optimal induction strategy in this high-risk population, especially with the increasing use of oral misoprostol (Angusta®). Until then, clinical decision-making should remain individualised, considering fetal status, maternal history, and cervical maturity.

Abbreviations

95% CI : 95% confidence interval

APS : Antiphospholipid syndrome

BMI : Body mass index

CI : Confidence Interval

CNGOF : French National College of Gynaecologists and Obstetricians

CPR : cerebroplacental ratio

CTG : Cardiotocogram

CU : Uterine contractions

EFW : Estimated fetal weight

FHR : Fetal heart rate anomaly

HAS : French National Authority for Health

HTA : High blood pressure

IPTW : Inverse probability of treatment

FGR : Fetal growth restriction

MF : Foetal death

NICU : Neonatal intensive care unit

OR : Odds ratio

PGE : Prostaglandins

PI : Pulse index

SMD : Mean standardised difference

UA : Uterine artery

WHO : World Health Organisation

Declarations

DECLARATION OF 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

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Author Contribution

AV: Conceptualization; Methodology; Data curation; Formal analysis; Writing – original draft.JV: Methodology; Data management; Statistical analysis; Writing – review & editing.CD: Data collection; Writing – review & editing.CP: Project administration; Writing – review & editing.LG: Data validation;

Writing – review & editing.CB: Data collection; Writing – review & editing.AF: Supervision; Methodology; Writing – review & editing.All authors approved the final manuscript.

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Tables

Table 1

Baseline characteristics

	Before iptw			After iptw		
	Balloon N = 65	**Prostaglandin N = 67**	**SMD[1]**	**Balloon N = 130**	**Prostaglandin N = 124**	**SMD[1]**
Population						
Age			-0.07			-0.02
Median [Min; Max]	30 [17; 41]	28 [16; 42]		30 [17; 41]	28 [16; 42]	
BMI			-0.02			0.01
Median [Min; Max]	24.1 [14.1; 54.0]	24.8 [14.5; 42.2]		23.8 [14.1; 54.0]	24.8 [14.5; 42.2]	
Primiparity, n (%)	30 (46%)	30 (45%)	0.03	55 (42%)	62 (50%)	-0.16
Previous history of FGR, n (%)	4 (6.2%)	5 (7.5%)	-0.05	6 (4.5%)	10 (7.9%)	-0.14
Previous history of diabetes, n (%)	4 (6.2%)	3 (4.5%)	0.07	7 (5.5%)	7 (6.0%)	-0.02
Toxic consumption, n (%)	15 (23%)	20 (30%)	-0.15	33 (26%)	26 (21%)	0.10
Previous history of aneuploidy, n (%)	1 (1.5%)	5 (7.5%)	-0.29	1 (1.0%)	10 (8.5%)	-0.37
Previous history of vascular disease, n (%)	10 (15%)	8 (12%)	0.10	18 (14%)	16 (13%)	0.02
Characteristics of FGR						
Foetal weight estimation			-0.74			-0.07
Median [Min; Max]	1,956 [1,086; 2,850]	2,220 [1,500; 2,993]		2,100 [1,086; 2,850]	2,141 [1,500; 2,993]	
Severe FGR, n (%)	54 (83%)	56 (84%)	-0.01	106 (82%)	102 (83%)	-0.03
Fetal doppler abnormality, n (%)	26 (40%)	32 (48%)	-0.16	47 (37%)	56 (45%)	-0.17
Abbreviation: CI = Confidence Interval						

	Before iptw			After iptw		
	Balloon N = 65	**Prostaglandin N = 67**	**SMD[1]**	**Balloon N = 130**	**Prostaglandin N = 124**	**SMD[1]**
Oligoamnios, n (%)	19 (29%)	22 (33%)	-0.08	32 (25%)	43 (35%)	-0.21
Vascular aetiology, n (%)	44 (68%)	34 (51%)	0.35	79 (61%)	72 (58%)	0.05
Trigger indication						
Fetal heart rate abnormalities, n (%)	20 (31%)	8 (12%)	0.47	31 (24%)	21 (17%)	0.18
Fetal doppler abnormality, n (%)	24 (37%)	32 (48%)	-0.22	45 (35%)	56 (45%)	-0.20
Break in growth curve, n (%)	11 (17%)	22 (33%)	-0.37	39 (30%)	34 (27%)	0.06
Pre-eclampsia, n (%)	10 (15%)	3 (4.5%)	0.37	13 (9.9%)	10 (8.0%)	0.06
Characteristics of labour onset						
Initial bishop score			-0.19			0.02
Median [Min; Max]	3.00 [0.00; 5.00]	3.00 [0.00; 6.00]		2.00 [0.00; 5.00]	3.00 [0.00; 6.00]	
Prostaglandin repetition, n (%)	0 (0%)	22 (33%)	-0.99	0 (0%)	40 (32%)	-0.97
Succes of labour induction, n (%)	21 (32%)	33 (49%)	-0.35	46 (35%)	50 (40%)	-0.10
Final bishop score			-0.11			0.15
Median [Min; Max]	5.00 [0.00; 8.00]	6.00 [1.00; 8.00]		5.00 [0.00; 8.00]	6.00 [1.00; 8.00]	
Unknown	15	24		30	34	
Use of oxytocin, n (%)	42 (65%)	33 (49%)	0.31	86 (67%)	73 (59%)	0.16
Duration of labour			0.34			0.36
Median [Min; Max]	15 [0; 24]	9 [0; 36]		12 [0; 24]	8 [0; 36]	
Abbreviation: CI = Confidence Interval						

	Before iptw			After iptw		
	Balloon N = 65	**Prostaglandin N = 67**	**SMD[1]**	**Balloon N = 130**	**Prostaglandin N = 124**	**SMD[1]**
Delivery						
Caesarean section, n (%)	24 (37%)	17 (25%)	0.25	44 (34%)	41 (33%)	0.00
Prematurity, n (%)	31 (48%)	7 (10%)	0.90	37 (29%)	31 (25%)	0.09
Birth weight			-0.94			-0.21
Median [Min; Max]	2,010 [1,140; 2,960]	2,390 [1,560; 3,020]		2,180 [1,140; 2,960]	2,230 [1,560; 3,020]	
Composite neonatal outcome, n (%)	18 (28%)	18 (27%)	0.02	30 (23%)	30 (24%)	-0.02
Low APGAR score (< 7), n (%)	4 (6.2%)	8 (12%)	-0.20	6 (4.5%)	19 (15%)	-0.37
Acidosis (pH < 7.15), n (%)	4 (6.2%)	5 (7.5%)	-0.05	4 (3.3%)	6 (4.6%)	-0.05
Severe acidosis (pH < 7), n (%)	0 (0%)	3 (4.5%)	-0.31	0 (0%)	3 (2.7%)	-0.19
Admission to neonatal unit, n (%)	13 (20%)	10 (15%)	0.13	23 (18%)	16 (13%)	0.13
[1]Standardized Mean Difference						
Abbreviation: CI = Confidence Interval						

Table 2

Primary outcome

	Crude OR		Weighted OR	
	OR	**95% CI**	**OR**	**95% CI**
Balloon	—	—	—	—
Prostaglandin	1.72	0.82, 3.67	1.01	0.38, 2.72
Subgroup analysis	OR	95% CI	OR	95% CI
Balloon	—	—	—	—
Local prostaglandin	2.73	1.04, 8.14	1.17	0.31, 4.43
Oral prostaglandin	1.17	0.49, 2.89	0.81	0.29, 2.28
Abbreviations: CI = Confidence Interval, OR = Odds Ratio				

Table 3

Secondary outcomes

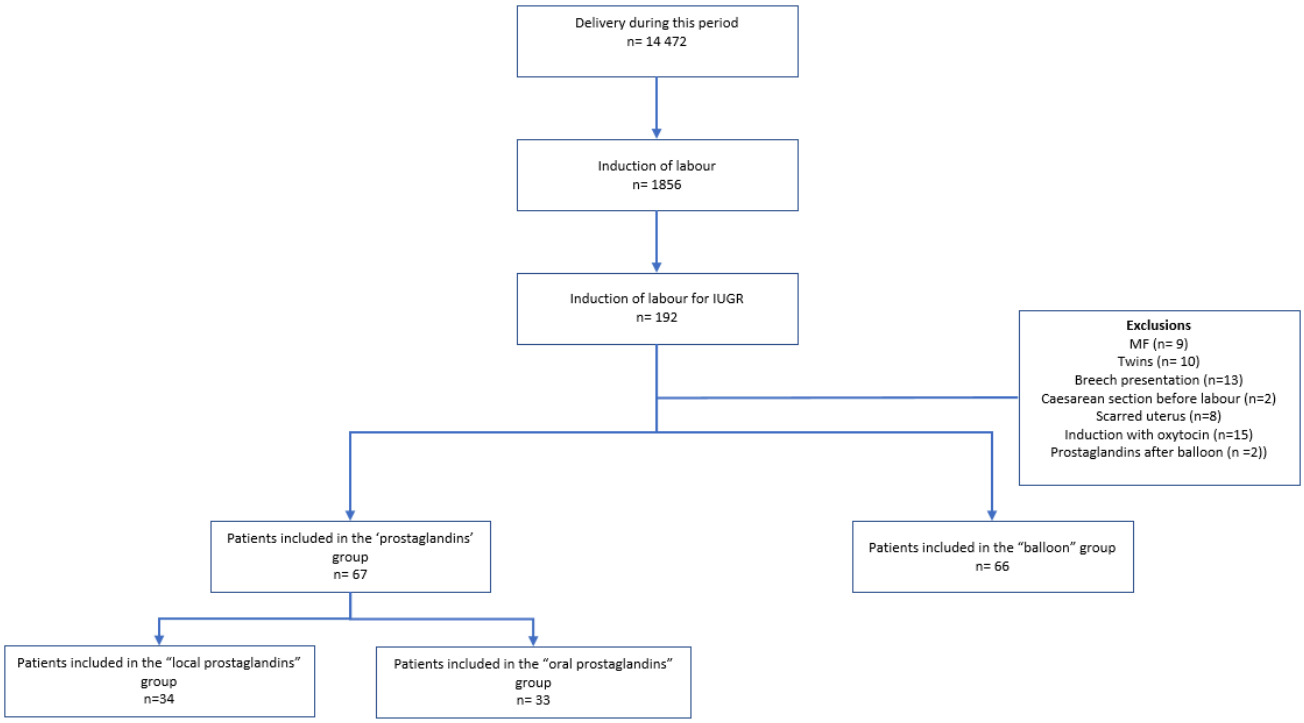
	Crude OR		Weighted OR	
	OR	**95% CI**	**OR**	**95% CI**
Balloon	—	—	—	—
Prostaglandin	0.96	0.44, 2.07	2.57	0.96, 7.54
Subgroup analysis				
Balloon	—	—	—	—
Local prostaglandin	0.25	0.06, 0.83	0.65	0.12, 2.68
Oral prostaglandin	2.18	0.91, 5.26	9.47	2.74, 38.2
Abbreviations: CI = Confidence Interval, OR = Odds Ratio Adjustment on gestational age and mode of delivery				

Table 4
Subgroup analysis

	Prostaglandines locales N = 34	**Prostaglandines orales N = 33**
Age		
Median [Min; Max]	28 [18; 40]	27 [16; 42]
BMI		
Median [Min; Max]	22.0 [14.5; 35.0]	27.0 [15.6; 42.2]
Primiparity, n (%)	12 (35%)	18 (55%)
Previous history of FGR, n (%)	2 (5.9%)	3 (9.1%)
Previous history of diabetes, n (%)	3 (8.8%)	0 (0%)
Toxic consumption, n (%)	6 (18%)	14 (42%)
Previous history of aneuploidy, n (%)	3 (8.8%)	2 (6.1%)
Previous history of vascular disease, n (%)	7 (21%)	1 (3.0%)
Foetal weight estimation		
Median [Min; Max]	2,210 [1,500; 2,993]	2,278 [1,576; 2,620]
Severe FGR, n (%)	27 (79%)	29 (88%)
Fetal doppler abnormality, n (%)	15 (44%)	17 (52%)
Oligoamnios, n (%)	14 (41%)	8 (24%)
Vascular aetiology, n (%)	20 (59%)	14 (42%)
Fetal heart rate abnormalities, n (%)	4 (12%)	4 (12%)
Fetal doppler abnormality, n (%)	15 (44%)	17 (52%)
Break in growth curve, n (%)	13 (38%)	9 (27%)
Pre-eclampsia, n (%)	3 (8.8%)	0 (0%)
Prematurity, n (%)	5 (15%)	2 (6.1%)
Initial bishop score		
Median [Min; Max]	3.00 [0.00; 6.00]	3.00 [1.00; 5.00]
Prostaglandin repetition, n (%)	13 (38%)	9 (27%)
Succes of labour induction, n (%)	14 (41%)	19 (58%)

	Prostaglandines locales N = 34	**Prostaglandines orales N = 33**
Final bishop score		
Median [Min; Max]	6.00 [2.00; 8.00]	5.00 [1.00; 7.00]
Unknown	12	12
Use of oxytocin, n (%)	20 (59%)	13 (39%)
Duration of labour		
Median [Min; Max]	6 [0; 36]	12 [4; 26]
Caesarean section, n (%)	6 (18%)	11 (33%)
Birth weight		
Median [Min; Max]	2,265 [1,560; 2,996]	2,420 [1,840; 3,020]
Composite neonatal outcome, n (%)	3 (8.8%)	15 (45%)
Low APGAR score (< 7), n (%)	3 (8.8%)	5 (15%)
Acidosis (pH < 7.15), n (%)	0 (0%)	5 (15%)
Severe acidosis (pH < 7), n (%)	0 (0%)	3 (9.1%)
Admission to neonatal unit, n (%)	3 (8.8%)	7 (21%)

Figures



IUGR : intrauterine growth retardation ; MF: Foetal death

Figure 1

Flow chart of the study population

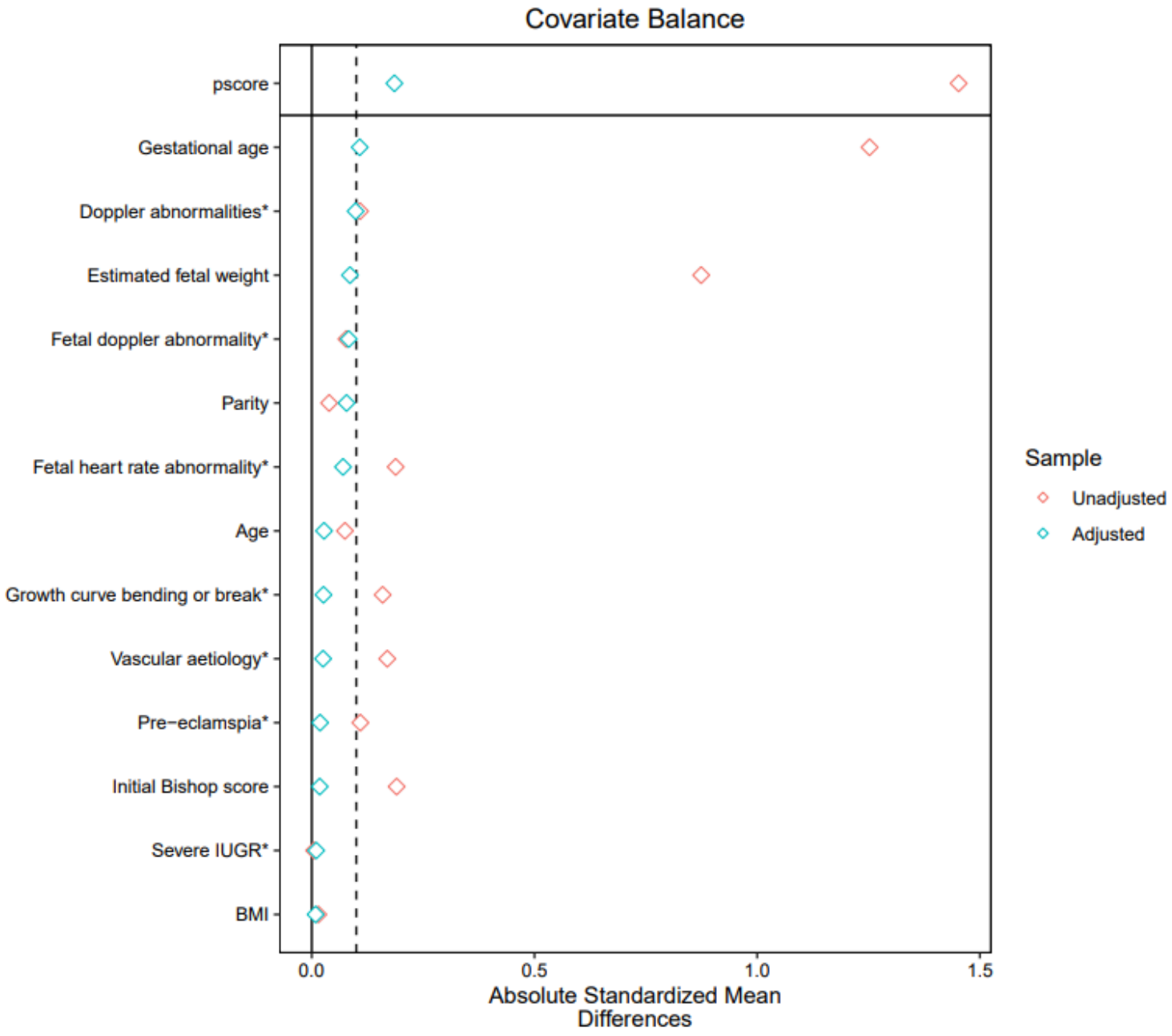


Figure 2

Loveplot

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SI.pdf