Delayed versus immediate pushing in the second stage of labor in women with neuraxial analgesia: a systematic review and meta-analysis of randomized controlled trials

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Introduction

Several variables in management of the second stage of labor have been shown to influence maternal and perinatal outcomes, such as parity, use of neuraxial analgesia or of oxytocin, maternal characteristics, fetal position, and birthweight, and therefore many strategies for proper management of the second stage have been evaluated.[1–3]

Timing of pushing in the second stage is controversial. Women can push soon after the diagnosis of complete cervical dilatation when the second stage starts, or can delay such pushing, even for 1 or

OBJECTIVE: The aim of this systematic review and meta-analysis of randomized controlled trials was to evaluate the effect of delayed versus immediate pushing in the second stage of labor on mode of delivery and other outcomes in women with neuraxial analgesia.

DATA SOURCES: The research was conducted using MEDLINE, EMBASE, Web of Sciences, Scopus, ClinicalTrial.gov, OVID, and the Cochrane Library as electronic databases, from the inception of each database to August 2019. No restrictions for language or geographic location were applied.

STUDY ELIGIBILITY CRITERIA: Selection criteria included only randomized controlled trials in pregnant women randomized to either delayed or immediate pushing during the second stage of labor.

STUDY APPRAISAL AND SYNTHESIS METHODS: The primary outcome was mode of delivery. The summary measures were reported as relative risk or as mean difference with 95% confidence intervals using the random effects model of DerSimonian and Laird. An I^2 (Higgins I^2) value of greater than 0% was used to identify heterogeneity.

RESULTS: Twelve randomized controlled trials, including 5445 women with neuraxial analgesia randomized to delayed versus immediate pushing during the second stage of labor, were included in the meta-analysis. Of the 5445 women included in the meta-analysis, 2754 were randomized to the delayed pushing group and 2691 to the immediate pushing group. No significant difference between delayed and immediate pushing was found for spontaneous vaginal delivery (80.9% versus 78.3%; relative risk, 1.05; 95% confidence interval, 1.00–1.10; 12 randomized controlled trials, 5540 women), operative vaginal delivery (12.8% versus 14.6%; relative risk, 0.89; 95% confidence interval, 0.75–1.08; 11 randomized controlled trials, 5395 women), and cesarean delivery (6.9% versus 7.9%; relative risk, 0.89; 95% confidence interval, 0.73–1.07; 11 randomized controlled trials; 5395 women). Women randomized to the delayed pushing group had a significantly shorter length of active pushing (mean difference, −27.54 minutes; 95% confidence interval, −43.04 to −12.04; 7 randomized controlled trials, 4737 women) at the expense of a significantly longer overall duration of the second stage of labor (mean difference, 46.17 minutes; 95% confidence interval, 32.63–59.71; 8 studies; 4890 women). The incidence of chorioamnionitis (9.1% versus 6.6%; relative risk, 1.37, 95% confidence interval, 1.04–1.81; 1 randomized controlled trial, 2404 women) and low umbilical cord pH (2.7% versus 1.3%; relative risk, 2.00; 95% confidence interval, 1.30–3.07; 5 randomized controlled trials, 4549 women) were significantly higher in the delayed pushing group.

CONCLUSION: In women with spontaneous or induced labor at term with neuraxial analgesia, delayed pushing in the second stage does not affect the mode of delivery, although it reduces the time of active pushing at the expense of a longer second stage. This prolongation of labor was associated with a higher incidence of chorioamnionitis and low umbilical cord pH. Based on these findings, delayed pushing cannot be routinely advocated for the management of the second stage.

Key words: delayed pushing, immediate pushing, labor, second stage

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AJOG at a Glance

Why was this study conducted?

There is conflicting evidence about the effectiveness and safety of delayed versus immediate pushing in the second stage of labor.

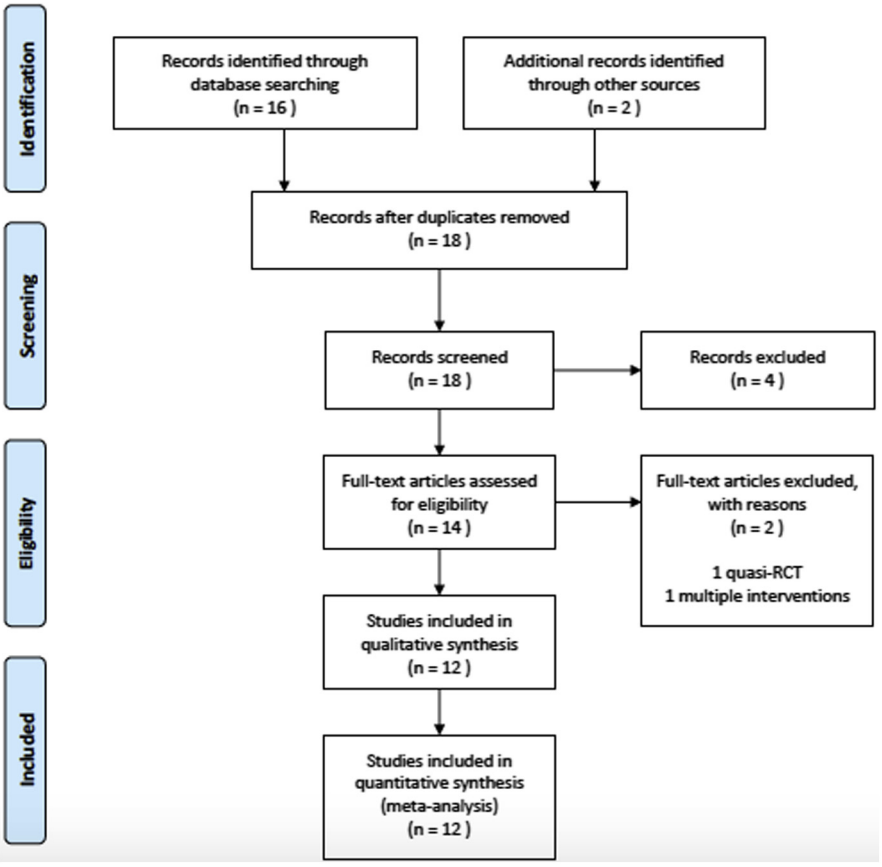
Key findings

Delayed pushing during the second stage of labor did not affect the mode of delivery, although it reduced the time of active pushing at the expense of a longer second stage. The incidence of chorioamnionitis and low umbilical cord pH were significantly higher in the delayed pushing group.

What does this add to what is known?

Our meta-analysis shows that delayed pushing in the second stage in women with uncomplicated, singleton pregnancies and neuraxial analgesia does not affect the mode of delivery, although it reduces the time of active pushing at the expense of a longer second stage. This prolongation of labor was associated with a higher incidence of chorioamnionitis and low umbilical cord pH. Based on these findings, delayed pushing cannot be routinely advocated for the management of the second stage.

FIGURE 1
Flow diagram of studies identified in the systematic review (Preferred Reporting Item for Systematic Reviews and Meta-analyses [PRISMA] template)



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more hours; however, the evidence on the effect of these 2 different approaches is conflicting. A prior meta-analysis showed that delayed pushing in women with neuraxial analgesia was associated with an increased incidence of spontaneous vaginal delivery, a reduction in the time of active pushing and with a longer second stage,[4] whereas a recent large randomized controlled trial (RCT) did not show a significant effect of delayed pushing on the mode of delivery and instead reported an association with chorioamnionitis and postpartum hemorrhage.[5]

Objective

The aim of this systematic review and meta-analysis of RCTs was to evaluate the effect of delayed vs immediate pushing in the second stage of labor on the mode of delivery and other outcomes in women with neuraxial analgesia.

Materials and Methods

Search strategy

This meta-analysis was performed according to a protocol recommended for systematic reviews.[6] The review protocol was designed a priori defining methods for collecting, extracting and analyzing data. The research was conducted using MEDLINE, EMBASE, Web of Sciences, Scopus, ClinicalTrial.gov, OVID, and the Cochrane Library as electronic databases. The trials were identified with the use of a combination of the following text words: "immediate pushing" OR "delayed pushing" AND "second stage" OR "labor" AND "delivery" and randomized controlled trial as publication type, from the inception of each database to August 2019. Review of articles also included the abstracts of all references retrieved from the search. No restrictions for language or geographic location were applied.

Study selection

Selection criteria included only RCTs of pregnant women randomized to delayed vs immediate pushing in the second stage of labor. We included only RCTs reporting mode of delivery as an outcome. Quasi-randomized trials (ie, trials in which allocation was done on

FIGURE 2

Assessment of risk of bias. (A) Summary of risk of bias for each trial. Plus sign denotes low risk of bias; minus sign, high risk of bias; question mark, unclear risk of bias. (B) Risk of bias graph about each risk of bias item presented as percentages across all included studies

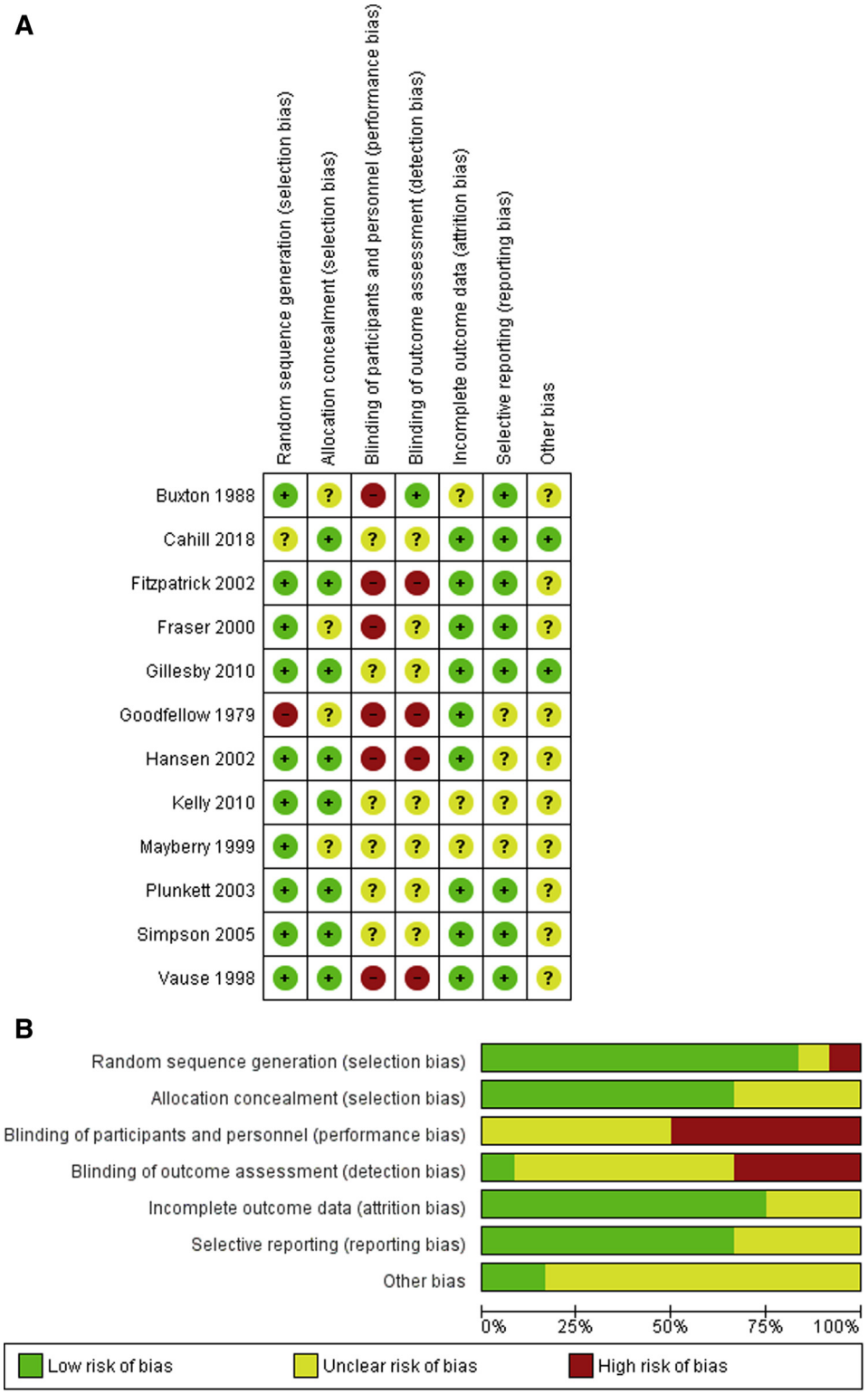

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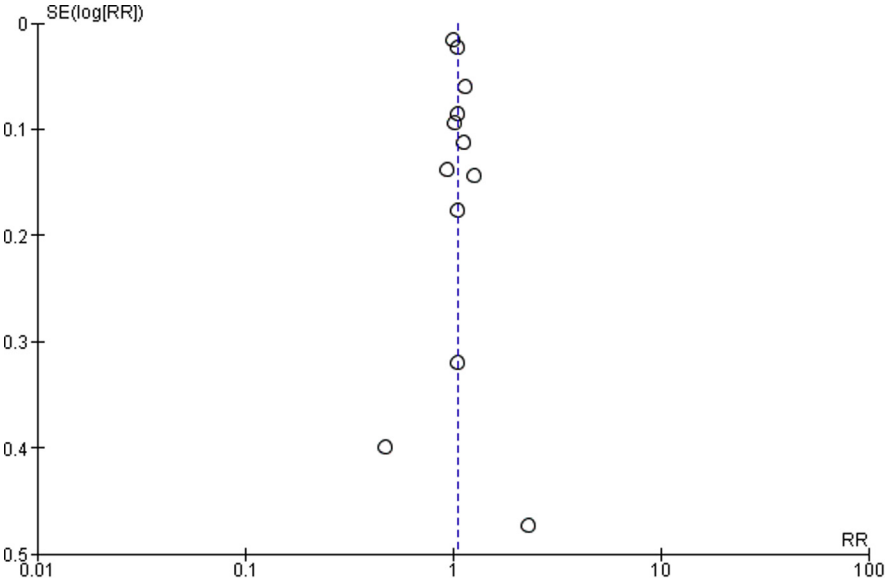
FIGURE 3
Funnel plot for the risk of publication bias



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the basis of a pseudo-random sequence, eg, odd/even hospital number or date of birth, alternation) were excluded.

Risk of bias assessment

The risk of bias in each included study was assessed by using the criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions.[7] Seven domains related to risk of bias were assessed in each included trial, as there is evidence that these issues are associated with biased estimates of treatment effect: 1) random sequence generation; 2) allocation concealment; 3) blinding of participants and personnel; 4) blinding of outcome assessment; 5) incomplete outcome data; 6) selective reporting; and 7) other bias. Review authors' judgments were categorized as "low risk," "high risk," or "unclear risk" of bias. [7]

Primary and secondary outcomes

The primary outcome was mode of delivery, including spontaneous vaginal delivery (SVD), operative vaginal delivery (OVD), cesarean delivery (CD), and operative delivery (OD), defined as either OVD or CD. We also performed a post hoc subgroup analysis on SVD by duration of pushing delay. The secondary outcomes were overall duration of the second stage of labor, time of active pushing in the second stage of labor, chorioamnionitis, intrapartum fever (defined as a maternal temperature of $\geq$38°C), endometritis, postpartum hemorrhage (PPH) (defined as a blood loss of $\geq$500 mL after vaginal birth or $\geq$1000 mL after CD, or as defined by authors), rate of episiotomy and severe perineal lacerations (third degree or higher), low umbilical cord pH (as defined by authors), Apgar score of $<$7 at 5 minutes, respiratory morbidity (defined as the presence of respiratory distress syndrome, respiratory difficulties, or need for intubation), and admission to the neonatal intensive care unit (NICU).

Data extraction

Two authors (DDM, GS) independently assessed inclusion criteria, risk of bias, data extraction, and data analysis. Disagreements were resolved by discussion with a third reviewer (VB). Data from each eligible study were extracted without modification of original data onto custom-made data collection forms. Differences were reviewed, and further resolved by common review of the entire process.

Quality of the body of evidence

Overall quality of the body of evidence for the primary and secondary outcomes was assessed by using the GRADE criteria (study limitations [ie, risk of bias], consistency of effect, imprecision, indirectness, and publication bias).[7]

Data analysis

Data analysis was completed using Review Manager 5.3 (Copenhagen: The Nordic Cochrane Center, Cochrane Collaboration, 2014). The summary measures were reported as summary relative risk (RR) or as summary mean difference (MD) with 95% of confidence interval (CI) using the random effects model of DerSimonian and Laird. An I^2 (Higgins I^2) value greater than 0% was used to identify heterogeneity.

Potential publication biases were assessed graphically by using the funnel plot.

The meta-analysis was reported following the Preferred Reporting Item for Systematic Reviews and Meta-analyses (PRISMA) statement.[8]

Results

Study selection and study characteristics

A total of 5445 women with neuraxial analgesia in 12 RCTs, randomized during the first or second stage of labor to either delayed or immediate pushing during the second stage of labor, were included in the meta-analysis (Figure 1).[5,9–19] Of the 5445 women included in the meta-analysis, 2754 (50.6%) were randomized to the delayed pushing group and 2691 (49.4%) to the immediate pushing group.

Most of the included studies used a computer-generated table of random numbers and had low to moderate risk of bias in "incomplete outcome data." No method of blinding as to group allocation was reported (Figure 2). Publication bias was not apparent by funnel plot analysis (Figure 3).

TABLE 1
Characteristics of the included trials

	Goodfellow 1979[9]	Buxton 1988[10]	Vause 1998[11]	Mayberry 1999[12]	Fraser 2000[13]	Fitzpatrick 2002[14]	Hansen 2002[15]	Plunkett 2003[16]	Simpson 2005[17]	Gillesby 2010[18]	Kelly 2010[19]	Cahill 2018[5]	Total
Study Location	UK	UK	UK	USA	Canada	Ireland	USA	USA	USA	USA	USA	USA	—
Sample size	37 (21 vs 16)	41 (22 vs 19)	135 (68 vs 67)	153 (81 vs 72)	1862 (936 vs 926)	178 (88 vs 90)	252 (130 vs 122)	202 (117 vs 85)	45 (23 vs 22)	77 (38 vs 39)	59 (26 vs 33)	2404 (1204 vs 1200)	5445 (2754 vs 2691)
Population	Nulliparous; singleton; term; vertex	Nulliparous/ multiparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous/ multiparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	Nulliparous; singleton; term; vertex	—
Nulliparous women[a]	21/21 vs 16/16	20/23 vs 16/19	68/68 vs 67/67	81/81 vs 72/72	936/936 vs 926/926	88/88 vs 90/90	64/130 vs 65/122	117/117 vs 85/85	23/23 vs 22/22	38/38 vs 39/39	26/26 vs 33/33	1204/1204 vs 1200/1200	2686/2755 (97.5%) vs 2631/2691 (97.8%)
Spontaneous onset of labor[a]	21/21 vs 16/16	17/23 vs 13/19	NR	NR	654/936 vs 634/926	55/88 vs 65/90	NR	94/117 vs 53/85	0/23 vs 0/22	22/38 vs 21/39	NR	652/1204 vs 642/1200	1515/2450 (61.8%)vs 1444/2397 (60.2%)
Maternal age (mean)[a]	NR	24.9 ± 4.8 vs 23.5 ± 4.1	36.1 vs 27.8	NR	27.6 ± 5.0 vs 27.7 ± 4.8	30 (18-40) vs 28 (18-38)	NR	29.9 ± 5.7 vs 29.9 ± 6.1	27.2 ± 5.7 vs 23.7 ± 5.2	24.9 ± 5.2 vs 25.4 ± 5.1	28.1 ± 1.0 vs 28.6 ± 0.8	26.6 ± 6.2 vs 26.5 ± 5.9	28.16 vs 26.64
Gestational age (mean)[a]	NR	39.5 ± 1.3 vs 39.8 ± 1.0	40.19 vs 40.14	NR	39.4 ± 1.2 vs 39.5 ± 1.2	40.86 vs 40.57	NR	39.9 ± 1.1 vs 40.1 ± 1.2	NR	NR	40.8 ± 0.3 vs 39.9 ± 0.2	39.4 ± 1.2 vs 39.5 ± 1.2	40.0 vs 39.9
Neuraxial analgesia	4-10 mL 0.25% Bupivacaine	NR	NR	0.12-0.25 mg Bupivacaine; Fentanyl	0.125% Bupivacaine; Fentanyl	0.1% Bupivacaine; Fentanyl	Bupivacaine	Combined spinal-epidural[b]	0.125% Bupivacaine; fentanyl	NR	0.125% Bupivacaine; Fentanyl	NR	-
Oxytocin use in second stage[a]	21/21 vs 16/16	12/23 vs 12/19	43/68 vs 40/67	NR	NR	71/88 vs 76/90	NR	NR	23/23 vs 22/22	24/38 vs 28/39	NR	936/1201 vs 956/1199	1130/1462 (77.3%) vs 1150/1452 (79.2%)
Definition of low umbilical cord pH	NR	Arterial umbilical cord pH <7.2	Venous umbilical cord pH <7.25	NR	Arterial <7.1 and/or venous <7.15 umbilical cord pH	NR	NR	Arterial umbilical cord pH <7.1	NR	NR	NR	Arterial umbilical cord pH <7.1	—
Time of randomization	At the beginning of the second stage of labor	At the beginning of the second stage of labor	During the first stage of labor or within 1 h from full dilatation	During the first stage of labor	At the beginning of the second stage of labor	At the beginning of the second stage of labor	During the first stage of labor	At the beginning of the second stage of labor	At the beginning of the second stage of labor	At the beginning of the second stage of labor	During the first stage of labor	At the beginning of the second of labor	—

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(continued)

TABLE 1
Characteristics of the included trials *(continued)*

	Goodfellow 1979[9]	Buxton 1988[10]	Vause 1998[11]	Mayberry 1999[12]	Fraser 2000[13]	Fitzpatrick 2002[14]	Hansen 2002[15]	Plunkett 2003[16]	Simpson 2005[17]	Gillesby 2010[18]	Kelly 2010[19]	Cahill 2018[5]	Total
Intervention	Delayed pushing for up to 1 h; Increase in oxytocin	Delayed pushing for up to 3 h or until the vertex became visible	Delayed pushing for up to 3 h or until the vertex became visible	Delayed pushing either after 1 h or in the presence of involuntary pressure / urge to bear down	Delayed pushing for ≥2 h unless the patient felt an irresistible urge to push or the fetal head was seen during inspection of perineum	Delayed pushing up to 1 h	Delayed pushing up to 2 h in nulliparous and 1 hour in multiparous or until the head was seen at the introitus	Delayed pushing until feeling a strong urge to push or up to 90 min	Delayed pushing until feeling a strong urge to push or up to 2 h	Delayed pushing until feeling a strong urge to push or up to 2 ho	Delayed pushing until feeling a strong urge to push or up to 90 min	Delayed pushing for 1 h or until feeling a strong urge to push	—
Control	Pushing immediately after diagnosis of full cervical dilatation; no increase in oxytocin	Pushing immediately after diagnosis of full cervical dilatation	Pushing within 1 h, whether the vertex was visible or not	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing within 15 min after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	Pushing immediately after diagnosis of full cervical dilatation	—
Main outcome	Mode of delivery	Duration of second stage	Mode of delivery	Mode of delivery	Rate of difficult delivery	Mode of delivery	Duration of second stage	Total pushing time	Fetal well-being	Total pushing time	Total pushing time	Rate of spontaneous vaginal delivery	—
Intention to treat	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	—

NR, not reported.

[a] Data are presented as total number or as mean ± standard deviation (number in the delayed pushing group vs number in the immediate pushing group); [b] Bupivacaine 2.5 mg/fentanyl 25 μg; epidural: 0.125%; bupivacaine; fentanyl.

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TABLE 2
Exclusion criteria of the trials included in the review

	Exclusion criteria
Goodfellow 1979[9]	Women with inadequate analgesia or complications such as fetal distress
Buxton 1988[10]	Occult fetal acidosis before randomization
Vause 1998[11]	Women with a nonvertex presentation, or any complication that might influence second stage management, such as raised blood pressure, heart disease, or a dural tap
Mayberry 1999[12]	Evidence of fetal complication before randomization
Fraser 2000[13]	Women already pushing spontaneously; fever with a temperature >38°C; pregnancy complication such as hypertension, recent hemorrhage, suspicion of fetal malformation, or intrauterine growth restriction; any condition that necessitated shortening of the second stage of labor
Fitzpatrick 2002[14]	Patients with diabetes, irritable bowel syndrome, or other bowel or neurological disorder
Hansen 2002[15]	Refusal of epidural; first epidural dose after complete dilatation; known fetal anomaly; multiple gestation; nonvertex presentation; gestational age <37 wk or >42 wk; pregnancy complications such as pregnancy-induced hypertension, heart disease, or insulin-dependent diabetes
Plunkett 2003[16]	Women with gestational or pre-gestational diabetes mellitus or a contraindication to pushing in the second stage
Simpson 2005[17]	Women with medical or obstetric complications or a maternal condition that could potentially influence oxygen saturation, including history of smoking, asthma, chronic or acute pulmonary disease, or cardiac disease
Gillesby 2010[18]	Scheduled cesarean delivery; administration of magnesium sulfate therapy, and/or maternal cardiac condition; maternal weight ≥275 lb
Kelly 2010[19]	First epidural dose after complete dilation; known fetal anomaly before birth; multiple gestation; nonvertex presentation; maternal heart disease; administration of magnesium sulfate; poor comprehension of English
Cahill 2018[5]	Multiparous patients; scheduled cesarean deliveries; multiple gestations; major fetal anomalies; nonreassuring fetal status

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Types of participants included women with uncomplicated, singleton pregnancies and vertex presentation (Tables 1 and 2). Nulliparous women represented 96.3% of the sample size. All the studies included women admitted for spontaneous or induced labor at term (37−42 weeks of gestation), except 1 trial, which included women from 36 weeks of gestation.[18] The most commonly used neuraxial technique for labor analgesia was epidural analgesia with bupivacaine, often combined with fentanyl.

Women were mainly (8/12, 67%) randomized at the beginning of the second stage,[5,9,10,13,14,16−18] when complete (10-cm) cervical dilatation was reached, or during the first stage of labor (3/12, 25%).[12,15,19] In 1 study, women were randomized during the first stage or within 1 hour from the diagnosis of full dilatation.[11]

Women randomized in the intervention group were instructed to delay pushing from 1 hour to as many as 3 hours unless they felt an irresistible urge to push, if the fetal head was seen during obstetric examination of the perineum, or in case of any medical indication.

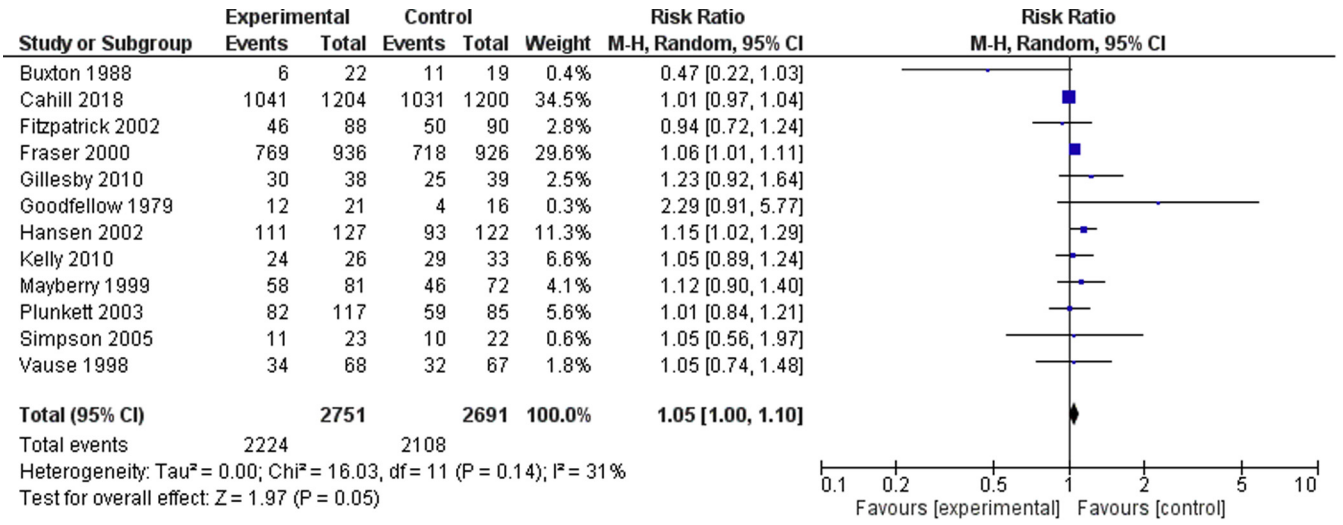
Women randomized in the control group were invited to start pushing immediately after the diagnosis of complete cervical dilatation,[5,9,10,12−17,19] or within 15 minutes in 1 trial[18] and 1 hour in another trial.[11] Of the 4 studies[11,12,15,19] that randomized women in the first stage, 2 reported data as intention to treat,[11,12] and 2 excluded those who had CD before complete dilatation,[15,19] as they could not receive the intervention. In 3 of these studies,[11,15,19] when the number of deliveries before the second stage was reported, the incidence was 6.7% (30/446). Therefore, it was impossible to do an intention-to-treat analysis for all the trials, or to exclude those who delivered before the second stage.

Synthesis of results

For the primary outcome, we found no significant difference between delayed and immediate pushing for either SVD (80.9% vs 78.3%; RR, 1.05; 95% CI, 1.00−1.10 [Figure 4]; 12 RCTs, 5540 women), OVD (12.8% vs 14.6%; RR, 0.89; 95% CI, 0.73−1.08 [Figure 5]; 11 RCTs, 5395 women), CD (6.9% vs 7.9%; RR, 0.89; 95% CI, 0.75−1.07 [Figure 6]; 11 RCTs, 5395 women) or OD (19.1% vs 21.2%; RR, 0.91; 95% CI, 0.78−1.05 [Figure 7]; 12 RCTs, 5440 women) (Table 3). No difference was found also when considering only CD performed in the second stage (5.5% vs 6.2%; RR, 0.90; 95% CI, 0.73−1.12).

Women randomized to the delayed pushing group had a significantly

FIGURE 4
Forest plot for the risk of spontaneous vaginal delivery



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shorter length of active pushing (MD −27.54 minutes; 95% CI, −43.04 to −12.04 [Figure 8]; 7 RCTs, 4737 women) at the expense of a significantly higher overall duration of the second stage (MD 46.17 minutes; 95% CI, 32.63−59.71 [Figure 9]; 8 RCTs, 4890 women). The rate of chorioamnionitis was significantly higher in the delayed pushing group (9.1% vs 6.6%; RR, 1.37; 95% CI, 1.04−1.81 [Figure 10]; 1 RCT, 2404 women), although these results were obtained from a single RCT (Table 3).

Regarding secondary maternal outcomes, no difference between intervention and control groups was found in the rate of intrapartum fever, endometritis, PPH, episiotomy, and severe perineal lacerations. Regarding neonatal outcomes, a significantly higher incidence of low umbilical cord pH was found in the delayed pushing group (2.7% vs 1.3%; RR, 2.00; 95% CI, 1.30−3.07 [Figure 11]; 5 RCTs, 4549 women) with no difference in Apgar score <7 at 5 minutes, respiratory morbidity, or admission to the NICU (Table 3).

Quality of evidence

The quality of evidence for the primary and secondary outcomes as assessed by the GRADE criteria was low, because it

FIGURE 5
Forest plot for the risk of operative vaginal delivery

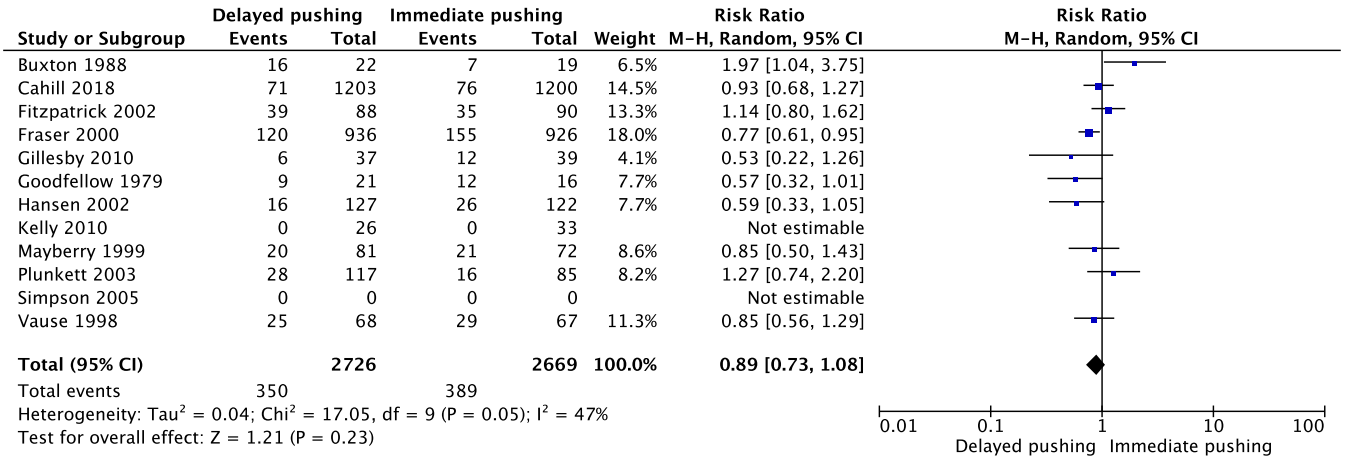

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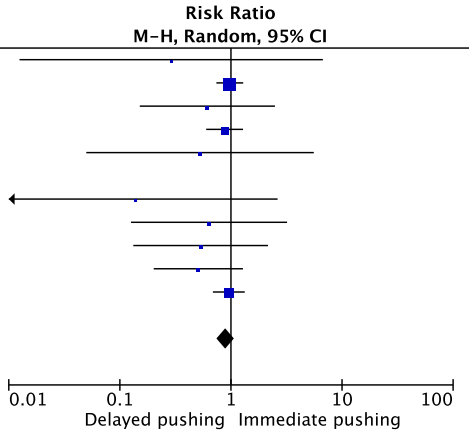
FIGURE 6
Forest plot for the risk of cesarean delivery

Study or Subgroup	Delayed pushing Events	Total	Immediate pushing Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Buxton 1988	0	22	1	19	0.3%	0.29 [0.01, 6.72]
Cahill 2018	91	1203	93	1200	40.6%	0.98 [0.74, 1.29]
Fitzpatrick 2002	3	88	5	90	1.6%	0.61 [0.15, 2.49]
Fraser 2000	47	936	53	926	21.4%	0.88 [0.60, 1.29]
Gillesby 2010	1	37	2	39	0.6%	0.53 [0.05, 5.57]
Goodfellow 1979	0	21	0	16		Not estimable
Hansen 2002	0	127	3	122	0.4%	0.14 [0.01, 2.63]
Kelly 2010	2	26	4	33	1.2%	0.63 [0.13, 3.20]
Mayberry 1999	3	81	5	72	1.6%	0.53 [0.13, 2.15]
Plunkett 2003	7	117	10	85	3.7%	0.51 [0.20, 1.28]
Vause 1998	34	68	35	67	28.7%	0.96 [0.69, 1.33]
Total (95% CI)		**2726**		**2669**	**100.0%**	**0.89 [0.75, 1.07]**
Total events	188		211			

Heterogeneity: Tau² = 0.00; Chi² = 5.25, df = 9 (P = 0.81); I² = 0%
Test for overall effect: Z = 1.25 (P = 0.21)



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was downgraded by 1 level for inconsistency and 1 level of indirectness due to the high heterogeneity within the included trials.

Post hoc subgroup analyses

At the post hoc subgroup analysis on SVD by duration of pushing delay, we found a significantly higher rate of SVD (81.1% vs 75.7%; RR, 1.07; 95% CI, 1.02−1.12) when pushing was delayed for 2 hours, whereas no difference was found when assessing other durations of delay (Table 4).

In subgroup analyses including only the 10 trials that enrolled only nulliparous women,[5,9,11−14,16−19] delayed pushing compared to immediate pushing was associated with similar rates of SVD (81.0% vs 78.6%; RR, 1.03; 95% CI, 1.00 −1.06) and CD (7.3% vs 8.2%; RR, 0.90; 95% CI, 0.76−1.08).

Post hoc sensitivity analyses

A post hoc sensitivity analysis for only US trials[5,12,15−19] showed that delayed pushing compared to immediate pushing was associated with similar rates of SVD (84.1% vs 82.2%; RR, 1.05; 95% CI, 0.99−1.11) and CD (6.5% vs 7.5%; RR, 0.88; 95% CI, 0.68−1.14).

Comment

Main findings

In this meta-analysis of 12 RCTs including 5445 mostly nulliparous women with uncomplicated singleton gestations, vertex, at or near term, with neuraxial analgesia, delayed pushing during the second stage of labor was not associated with a significant increase in the rate of SVD or with a reduction in the

FIGURE 7
Forest plot for the risk of operative delivery, either operative vaginal delivery or cesarean delivery

Study or Subgroup	Delayed pushing Events	Total	Immediate pushing Events	Total	Weight	Risk Ratio M-H, Random, 95% CI
Buxton 1988	16	22	8	19	5.3%	1.73 [0.96, 3.10]
Cahill 2018	162	1203	169	1200	17.6%	0.96 [0.78, 1.17]
Fitzpatrick 2002	42	88	40	90	12.0%	1.07 [0.78, 1.48]
Fraser 2000	167	936	208	926	18.5%	0.79 [0.66, 0.95]
Gillesby 2010	7	37	2	39	1.0%	3.69 [0.82, 16.63]
Goodfellow 1979	9	21	12	16	5.6%	0.57 [0.32, 1.01]
Hansen 2002	16	127	29	122	5.7%	0.53 [0.30, 0.93]
Kelly 2010	2	26	4	33	0.9%	0.63 [0.13, 3.20]
Mayberry 1999	23	81	26	72	7.6%	0.79 [0.50, 1.25]
Plunkett 2003	35	117	26	85	8.5%	0.98 [0.64, 1.49]
Simpson 2005	12	23	12	22	5.9%	0.96 [0.55, 1.65]
Vause 1998	34	68	35	67	11.5%	0.96 [0.69, 1.33]
Total (95% CI)		**2749**		**2691**	**100.0%**	**0.91 [0.78, 1.05]**
Total events	525		571			

Heterogeneity: Tau² = 0.02; Chi² = 18.23, df = 11 (P = 0.08); I² = 40%
Test for overall effect: Z = 1.28 (P = 0.20)

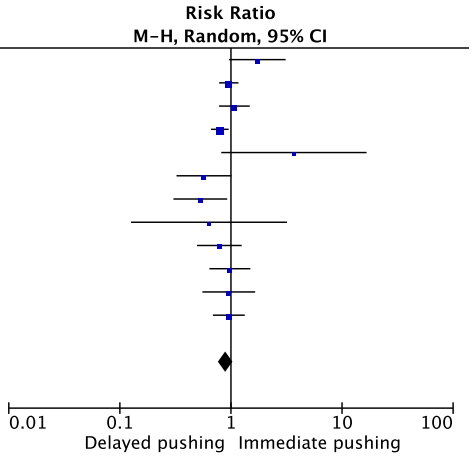

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TABLE 3
Primary and secondary outcomes

	Goodfellow 1979[9]	Buxton 1988[10]	Vause 1998[11]	Mayberry 1999[12]	Fraser 2000[13]	Fitzpatrick 2002[14]	Hansen 2002[15]	Plunkett 2003[16]	Simpson 2005[17]	Gillesby 2010[18]	Kelly 2010[19]	Cahill 2018[5]	Total	RR or MD (95% CI)	I^2	GRADE quality of evidence[a]
SVD	12/21 vs 4/16	6/22 vs 11/19	34/68 vs 32/67	58/81 vs 46/72	769/936 vs 718/926	46/88 vs 50/90	111/127 vs 93/122	82/117 vs 59/85	11/23 vs 10/22	30/37 vs 25/39	24/26 vs 29/33	1041/1203 vs 1031/1200	2224/2749 (80.9%) vs 2108/2691 (78.3%)	1.05 (1.00 −1.10)	33%	Low
OVD	9/21 vs 12/16	16/22 vs 7/19	25/68 vs 29/67	20/81 vs 21/72	120/936 vs 155/926	39/88 vs 35/90	16/127 vs 26/122	28/117 vs 16/85	NR	6/37 vs 12/39	0/26 vs 0/33	71/1203 vs 76/1200	350/2726 (12.8%) vs 389/2669 (14.6%)	0.89 (0.73 −1.08)	47%	Low
CD	0/21 vs 0/16	0/22 vs 1/19	9/68 vs 6/67	3/81 vs 5/72	47/936 vs 53/926	3/88 vs 5/90	0/127 vs 3/122	7/117 vs 10/85	NR	1/37 vs 2/39	2/26 vs 4/33	91/1203 vs 93/1200	188/2,726 (6.9%) vs 211/2669 (7.9%)	0.89 (0.75 −1.07)	0%	Low
OD[b]	9/21 vs 12/16	16/22 vs 8/19	34/68 vs 35/67	23/81 vs 26/72	167/936 vs 208/926	42/88 vs 40/90	16/127 vs 29/122	35/117 vs 26/85	12/23 vs 12/22	7/37 vs 2/39	2/26 vs 4/33	162/1,203 vs 169/1,200	525/2,749 (19.1%) vs 571/2691 (21.2%)	0.91 (0.78 −1.05)	40%	Low
CD in the second d stage[c]	0/21 vs 0/16	0/22 vs 1/19	1/68 vs 2/67	NR	47/936 vs 53/926	3/88 vs 5/90	0/127 vs 3/122	2/117 vs 2/85	NR	1/37 vs 2/39	0/26 vs 0/33	91/1,203 vs 93/1200	145/2,645 (5.5%) vs 161/2597 (6.2%)	0.90 (0.73 −1.12)	0%	Low
Duration of second stage	NR	209 ± 81 vs 118 ± 50	214 (149 −252) vs 119 (89 −155)	119.65 ± 65.32 vs 105.97 ± 73.48	193.5 ± 65.88 vs 135.75 ± 57.75	120 (57 −225) vs 60 (0−148)	116.95 ± 44.18 vs 49.94 ± 32.04[e]	99 (48 −160) vs 69 (42 −135)	139 ± 39 vs 101 ± 55.9	166.3 ± 64.2 vs 107.2 ± 56.3	117.6 ± 12.1 vs 87.1 ± 8.6	134.2 ± 76.3 vs 102.4 ± 79.6		46.17[f] (32.63 −59.71)	93%	Low
Time of active pushing	NR	79 ± 44 vs 81 ± 48	52 (31−90) vs 73 (48−115)	NR	82 ± 46.08 vs 136.25 ± 73.5	56 (8−130) vs 60 (0 −148)	35.46 ± 29.19 vs 49.94 ± 32.04[e]	57 (34 −126) vs 62 (33 −112v)	59 ± 25.4 vs 101 ± 55.9	68.2 ± 46.2 vs 93.8 ± 56.9	38.9 ± 6.9 vs 78.7 ± 7.9	74.5 ± 70.7 vs 83.7 ± 76.8		−27.54[f] (−43.04, −12.04)	96%	Low
Chorioamnionitis	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	110/1,204 vs 80/1,200	110/1,204 (9.1%) vs 80/1,200 (6.6%)	1.37[f] (1.04 −1.81)	—	Low
Intrapartum fever	NR	NR	NR	NR	80/936 vs 42/926	NR	NR	23/117 vs 18/85	NR	NR	NR	NR	103/1,053 (9.8%) vs 60/1,011 (5.9%)	1.36 (0.68 −2.73)	78%	Low
Endometritis	NR	NR	NR	NR	NR	NR	0/127 vs 0/122	NR	NR	NR	NR	4/1,204 vs 7/1,200	4/1,331 (0.3%) vs 7/1,322 (0.5%)	0.57 (0.17 −1.94)	—	Low

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(continued)

TABLE 3
Primary and secondary outcomes *(continued)*

	Goodfellow 1979[9]	Buxton 1988[10]	Vause 1998[11]	Mayberry 1999[12]	Fraser 2000[13]	Fitzpatrick 2002[14]	Hansen 2002[15]	Plunkett 2003[16]	Simpson 2005[17]	Gillesby 2010[18]	Kelly 2010[19]	Cahill 2018[5]	Total	RR or MD (95% CI)	I^2	GRADE quality of evidence[a]
PPH	NR	NR	12/68 vs 11/67	NR	163/936 vs 155/926	NR	NR	3/117 vs 2/85	NR	NR	NR	48/1,204 vs 27/1,200	226/2325 (9.7%) vs 195/2278 (8.6%)	1.21 (0.90 −1.63)	30%	Low
Episiotomy	NR	NR	40/68 vs 42/67	NR	380/936 vs 387/926	61/85 vs 66/85	NR	NR	NR	4/38 vs 7/39	NR	NR	485/1,127 (43%) vs 502/1,117 (44.9%)	0.95 (0.87 −1.04)	0%	Low
Severe perineal lacerations	NR	NR	NR	5/81 vs 5/72	87/936 vs 88/926	6/85 vs 9/85	NR	11/117 vs 10/85	NR	0/38 vs 3/39	1/26 vs 2/33	558/1,204 vs 551/1,200	668/2,488 (26.8%) vs 668/2,440 (27.4%)	1.00 (0.92 −1.08)	0%	Low
Low umbilical cord pH[d]	NR	3/23 vs 0/19	4/18 vs 3/23	NR	37/934 vs 15/926	NR	NR	5/117 vs 3/85	NR	NR	NR	14/1,204 vs 9/1,200	63/2296 (2.7%) vs 30/2253 (1.3%)	2.00[f] (1.30 −3.07)	0%	Low
Apgar <7 at 5 min	NR	0/22 vs 0/19	0/68 vs 0/67	NR	NR	NR	NR	0/117 vs 2/85	NR	NR	NR	NR	0/207 (0%) vs 2/171 (1.2%)	0.15 (0.01 −3.00)	—	Low
Neonatal respiratory morbidity	NR	NR	0/68 vs 1/67	NR	26/934 vs 28/926	NR	NR	NR	NR	NR	NR	25/1,204 vs 30/1200	51/2206 (2.3%) vs 59/2193 (2.7%)	0.86 (0.60 −1.25)	0%	Low
NICU admission	NR	NR	5/68 vs 3/67	NR	46/934 vs 47/926	NR	NR	2/117 vs 3/85	NR	NR	NR	78/1,204 vs 63/1,200	131/2323 (5.6%) vs 116/2278 (5.1%)	1.12 (0.88 −1.42)	0%	Low

Data are presented as total number or as mean ± standard deviation (number in the delayed pushing vs immediate pushing group).

CD, cesarean delivery; *CI,* confidence interval; *MD,* mean difference; *NICU,* neonatal intensive care unit; *NR,* not reported; *OD,* operative delivery; *OVD,* operative vaginal delivery; *PPH,* postpartum hemorrhage; *RR,* relative risk; *SVD,* spontaneous vaginal delivery.

[a] Downgraded by 1 level for inconsistency and 1 level of indirectness because of the high heterogeneity within the included trials; [b] Operative delivery, either operative vaginal delivery or cesarean delivery; [c] Cesarean deliveries performed in the second stage of labor; [d] As defined by study (see Table 1); [e] Mean time between nulliparous and multiparous women; [f] Statistically significant.

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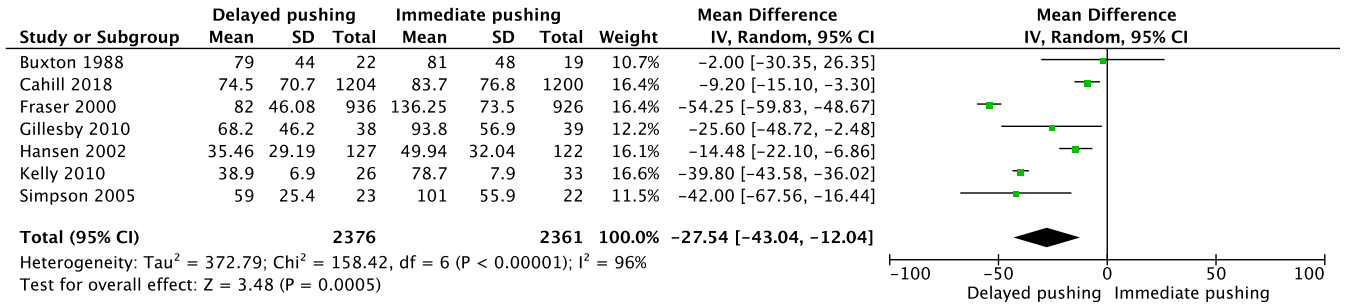
FIGURE 8
Forest plot for the mean of length of active pushing



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incidence of operative and cesarean delivery. Delayed pushing significantly shortened the time of active pushing, increasing the overall duration of the second stage. The rate of chorioamnionitis and low umbilical cord pH were significantly higher in the delayed pushing group, whereas other maternal and neonatal outcomes were not significantly affected by the timing of pushing in the second stage of labor.

Comparison with existing literature

Different prior reviews have been published on this topic (Table 5). A 2017 Cochrane review on timing and technique for pushing in the second stage of labor showed that delayed pushing was associated with an increase in the incidence of SVD and no difference in the rates of OVD and CD. Despite a higher incidence of low umbilical cord pH, Apgar score and NICU admission rates were found to be similar in both the delayed and immediate pushing groups.[4]

Results in terms of mode of delivery in 3 more meta-analyses[20–22] reported a modest but significant increase in SVD in 2 studies,[20,21] whereas no difference in CD and OVD rates was reported in all except 1 study,[21] which showed a 33% reduction in OVD in the delayed pushing group.

All meta-analyses were consistent in demonstrating a significant increase in the overall duration of second stage and shortening of the time of active pushing associated with delayed pushing.[4,20–22]

When focusing on maternal and neonatal outcomes, the above-mentioned meta-analyses[20–22] demonstrated no significant difference between delayed and immediate pushing in the rate of adverse events, except for 1 review,[20] which reported a 2-fold higher incidence of maternal fever among women who delayed pushing in a dose–response relationship with the duration of delay; this might be related to the higher rate of chorioamnionitis that was found in the present meta-analysis, although the incidence of intrapartum fever and endometritis was similar in both groups in our study. Indeed, it has been reported that a large RCT disagrees with prior meta-analyses of smaller RCTs 35% of the time.[23]

Strengths and limitations

Our study has several strengths. This meta-analysis included all RCTs published so far on the topic. To our knowledge, no prior meta-analysis on the timing of pushing in the second stage of labor is as up-to-date or comprehensive. In addition, publication bias was

FIGURE 9
Forest plot for the mean of total length of the second stage of labor

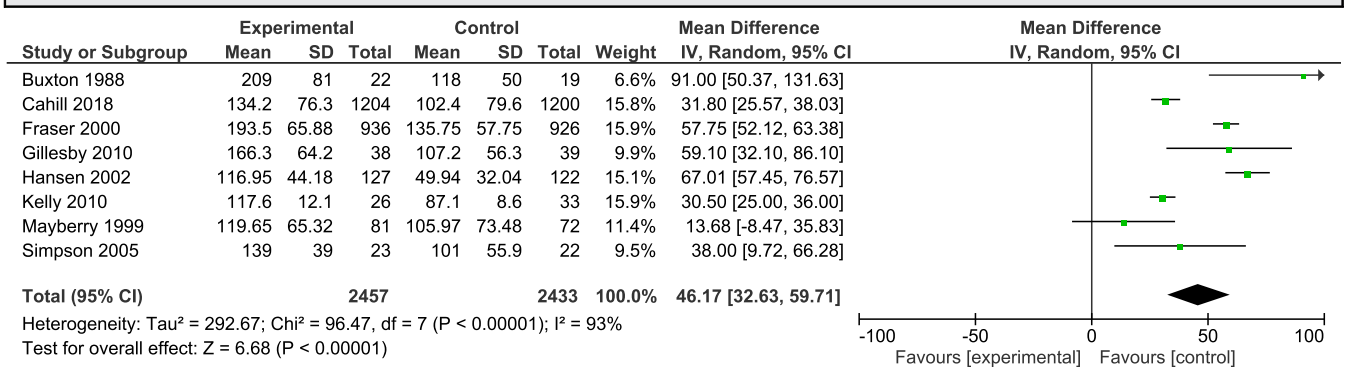

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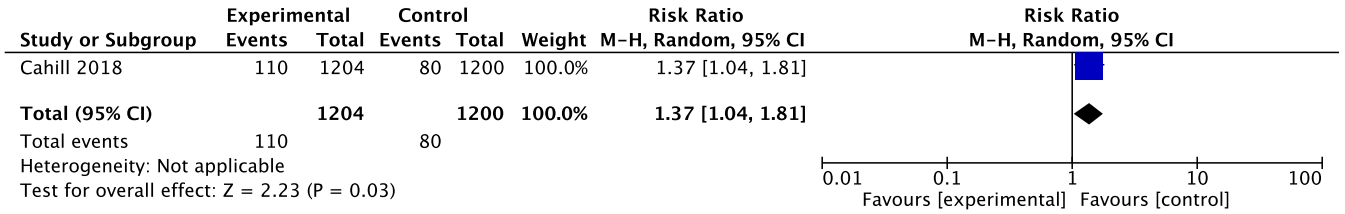
FIGURE 10
Forest plot for the risk of chorioamnionitis



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not apparent by funnel plot analysis. These are key elements that are needed to evaluate the reliability of a meta-analysis.[7]

Limitations of our study are mostly inherent to the limitations of the included studies. The quality of evidence as well as the quality of the included trials was moderate. We used a random effect model in all analyses, given the high statistical heterogeneity within the trials. Two[5,13] of the 12 included RCTs included more than half of the total sample size. Furthermore, some of the included studies date back a long time: changes and advances in the intrapartum management of the second stage might make them less relevant currently. In 4 studies,[11,12,15,19] some women were randomized in the first stage and never reached the second stage of labor. An intention-to-treat analysis, or an analysis excluding these women, was not feasible; however, the number of women randomized before the second stage was 6.7% in the 3 studies[11,15,19] that reported these numbers, and this represents only 0.6% (30/5445) of the women included in the meta-analysis. The definition of low umbilical cord pH was different in the studies that reported this outcome, although all but 1 study[11] used arterial umbilical cord pH <7.2 or less as a threshold to define low pH. In 1 study, women were randomized during the first stage or within 1 hour from the diagnosis of full dilatation.[11] More than the 40% of the included women came from 1 large RCT.[5] Finally, because of small sample size and event number, the quality of evidence for the primary and secondary outcomes was low.

Implications

An abnormal progression of the second stage of labor is 1 of the leading indications for CD, and many efforts to prevent CD in labor are focused on the second stage.[1–3] As we found that neither delayed pushing nor immediate pushing in the second stage affected the mode of delivery, timing of pushing cannot be considered as an effective strategy to prevent primary CD in labor.

In 2018, the World Health Organization (WHO) recommended delayed pushing for women with neuraxial analgesia as a practice for a positive childbirth experience, in the context in which resources are available for longer duration in second stage and perinatal hypoxia can be adequately assessed and managed.[24] This recommendation is concordant with the 2017 National Institute of Health and Care Excellence (NICE) guidelines that suggest delayed pushing for at least 1 hour in women with neuraxial analgesia.[25] Conversely, the American College of Obstetricians and Gynecologists (ACOG) supported, in 2019, immediate pushing in nulliparous women with neuraxial analgesia, and highlighted the potential risks of delayed pushing when counselling patients who are considering such an approach.[26] In our meta-analysis, compared to immediate pushing, delayed pushing in the second stage in women with neuraxial analgesia was associated with a significant higher incidence of chorioamnionitis (although

FIGURE 11
Forest plot for the risk of low umbilical cord pH

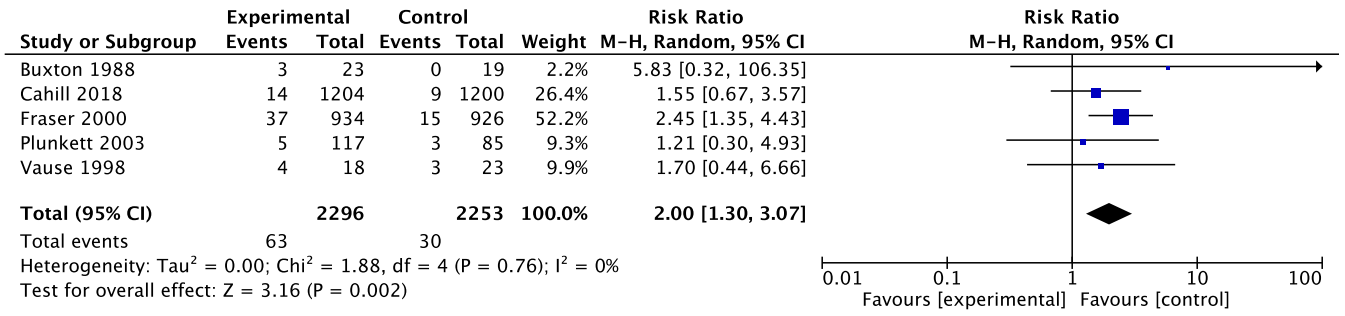

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TABLE 4
Subgroup analysis on spontaneous vaginal delivery by duration of pushing delay

Duration of pushing	No. of studies (references)	Total	RR or MD (95% CI)	*P* value	I^2
1 h	5 (5, 9, 12, 14, 15)[a]	1220/1458 (83.7%) vs 1179/1433 (82.3%)	1.05 (0.96–1.14)	.26	41%
1.5 h	2 (16, 19)	106/143 (74.1%) vs 88/118 (74.6%)	1.03 (0.91–1.17)	.62	0%
2 h	4 (13, 15, 17, 18)[a]	858/1058 (81.1%) vs 798/1054 (75.7%)	1.07 (1.02–1.12)	.003[b]	0%
3 h	2 (10, 11)	40/90 (44.4%) vs 43/86 (50%)	0.76 (0.35–1.64)	.49	70%

CI, confidence interval; *MD,* mean difference; *RR,* relative risk.

[a] Duration of delay in Hansen 2002 was different between nulliparous (2 h) and multiparous (1 h) women, and data were reported accordingly; [b] Statistically significant.

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TABLE 5
Results for mode of delivery and primary outcome of the prior meta-analyses

	Spontaneous vaginal delivery	Instrumental delivery	Cesarean delivery	Primary outcome	Included studies (n)	RCTs (n)	Non-RCTs (n)
Roberts 2004[22]	NR	0.92 (0.84–1.01)	0.77 (0.55–1.08)	Instrumental delivery	9	8[9–16]	1[27] (letter to editor)
Brancato 2008[21]	1.08 (1.01–1.15)	0.77 (0.71–0.85)	0.80 (0.72–1.07)	Spontaneous vaginal delivery	7	7[11–17]	0
Tuuli 2012[20]	1.09 (1.03–1.15)	0.89 (0.76–1.06)	0.85 (0.63–1.14)	Spontaneous vaginal delivery	12	11[9–19]	1[28] (quasi-RCT)
Lemos 2017[4]	1.07 (1.02–1.11)	0.89 (0.74–1.07)	0.83 (0.65–1.05)	Duration of second stage	12	11[9–19]	1[28] (quasi-RCT)
Current review	1.05 (1.00–1.10)	0.89 (0.73–1.08)	0.91 (0.78–1.05)	Mode of delivery	12	12[5,9–19]	0

NR, not reported; *RCT,* randomized controlled trial.

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evidence comes from a single RCT) and low umbilical cord pH, with no other significant maternal or neonatal effect except longer length of labor and shorter active pushing phase.

Conclusion

In summary, based on the evidence from this meta-analysis, delayed pushing cannot be routinely advocated for the management of the second stage of labor. Counseling regarding the decision to push immediately or to delay pushing for 1 hour or more should include the risks of longer second stage, chorioamnionitis, and low umbilical cord pH associated with delayed pushing. ■

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