Induction of labour : Foley catheter revisited

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FOLEY CATHETER VERSUS VAGINAL PROSTAGLANDIN E2 GEL FOR INDUCTION OF LABOUR AT TERM (PROBAAT TRIAL): AN OPEN-LABEL, RANDOMISED CONTROLLED TRIAL

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ABSTRACT

Background: Induction of labour is a common obstetric procedure. Both mechanical (e.g., Foley catheters) and pharmacological methods (e.g., prostaglandins) are used for induction of labour in women with an unfavourable cervix. We aimed to compare the effectiveness and safety of induction of labour with a Foley catheter with induction with vaginal prostaglandin E2 gel.

Methods: We did an open-label, randomised controlled trial in 12 hospitals in the Netherlands between Feb 10, 2009, and May 17, 2010. We enrolled women with a term singleton pregnancy in cephalic presentation, intact membranes, an unfavourable cervix, an indication for induction of labour, and no prior caesarean section. Participants were randomly allocated by an online randomisation system to induction of labour with a 30 mL Foley catheter or vaginal prostaglandin E2 gel (1:1 ratio). Because of the nature of the intervention this study was not blinded. The primary outcome was caesarean section rate. Secondary outcomes were maternal and neonatal morbidity and time from intervention to birth. All analyses were done on an intention-to-treat basis. We also did a meta-analysis that included our trial. The trial was registered with the Dutch trial registry, number NTR 1646.

Findings: 824 women were allocated to induction of labour with a Foley catheter (n=412) or vaginal prostaglandin E2 gel (n=412). Caesarean section rates were much the same between the two groups (23% vs. 20%, risk ratio [RR] 1.13, 95% CI 0.87–1.47). A meta-analysis including our trial data confirmed that a Foley catheter did not reduce caesarean section rates. We recorded two serious maternal adverse events, both in the prostaglandin group: one uterine perforation and one uterine rupture.

Interpretation: In women with an unfavourable cervix at term, induction of labour with a Foley catheter is similar to induction of labour with prostaglandin E2 gel, with fewer maternal and neonatal side-effects.

INTRODUCTION

Induction of labour is a common obstetric intervention—worldwide, 20–30% of deliveries are induced.[1-3] An unfavourable cervix is identified in a substantial proportion of women in whom labour is induced (e.g., cervical dilation 0 cm, cervical effacement ≤25%, or posterior position of cervix) at the start of induction. In these women, the risk of caesarean section is increased.[4] A range of methods, including mechanical and pharmacological methods, are available for cervical ripening. Mechanical methods, such as transcervical Foley catheters, are among the oldest approaches used for cervical ripening.[5] Although mechanical methods are still used, pharmacological methods, including prostaglandin E1 (misoprostol) and prostaglandin E2 preparations (dinoprostone), have become treatment of choice in many countries.[6-10] However, cervical ripening with a Foley catheter has several advantages over pharmacological methods.[11, 12] This inexpensive method is reported to give a similar caesarean section rate to induction of labour with prostaglandins, but is associated with less hyperstimulation.[11-16] However, differences in rates of fetal distress and post-partum haemorrhage between the two methods are unclear.[13] Although concerns have been raised that the use of a Foley catheter for induction of labour can increase the risk of maternal and neonatal infection,[17] such increases were not recorded in randomised controlled trials.[11, 12, 17]

In view of the frequency at which the intervention is done, the variation in clinical practice, and the varying prevalence of adverse outcomes in mostly underpowered trials,[11, 12] we did this trial to compare the effectiveness and safety of induction of labour with a Foley catheter with induction with vaginal prostaglandin E2 gel in women with a term pregnancy and an unfavourable cervix.

METHODS

Trial design

We did a prospective, open-label, multicentre randomised clinical trial, in 12 hospitals in the Netherlands. The protocol was approved by the Ethics committee of the Academic Medical Centre in Amsterdam (MEC 08/310), and the boards of all participating hospitals. The trial was registered with the Dutch trial registry, number NTR 1646.

Participants

Pregnant women scheduled for induction of labour beyond 37 weeks of gestation with a vital singleton pregnancy in cephalic presentation, intact membranes, and an unfavourable cervix (Bishop score[18] <6) were eligible for inclusion. Women younger than 18 years, with a previous caesarean section, placenta praevia, lethal fetal congenital anomaly, or known hypersensitivity for one of the products used for induction were ineligible.

Randomisation and masking

Women were informed about the study by their obstetrician when planned for labour induction and were enrolled by the attending physician, midwife, or research nurse at the delivery ward. After written informed consent was obtained, assessment of fetal condition by cardiotocography, and assessment of Bishop score, women were randomly allocated to induction with either a Foley catheter or prostaglandin E2 gel by their attending physician, in a 1:1 ratio. The randomisation sequence was computer-generated with an online randomisation programme, with variable blocks of two and four, stratified for centre and parity. The randomisation sequence was not accessible by the recruiters nor the trial coordinator. The allocation code was disclosed after the a patient's initials were entered and inclusion criteria were confirmed on the website; the unique number generated could not be deleted afterwards. This study was open-label because the nature of the intervention meant that masking to intervention was not possible.

Interventions

In the Foley catheter group a 16F or 18F Foley catheter was introduced transcervically with direct visualisation by use of a vaginal speculum. Cleaning of the cervix with an aseptic solution such as iodine or chlorhexidine was advised. After insertion past the internal os, the balloon was inflated with 30 mL of sterile 0.9% NaCl or water, and the external end of the catheter was taped to the thigh, without traction. Women were assigned 1 h of bed rest, while fetal condition and uterine activity were monitored by cardiotocography. When the catheter was expelled from the vagina spontaneously or when a woman's Bishop score was 6 or more, the catheter was removed, amniotomy done, and continuous fetal monitoring started. If uterine activity was insufficient (<3 contractions per 10 min or <200 Montevideo units in case of intrauterine pressure catheter use) oxytocin was continuously infused through a syringe pump (mostly at an initial dose of 3.3 mIU per min, which was increased every 30 min) until 3–4 contractions per 10 min occurred, 200 Montevideo units were recorded, or progression was deemed adequate.

Most of the participating hospitals were already familiar with the use of a Foley catheter and the method of placement. At the start of the study, each centre was instructed in a brief presentation and practical training if needed. When needed, a local research nurse was available to advise the staff on use of the catheter.

If the Foley catheter was not expelled spontaneously, the protocol advised to examine women at 6 h intervals, as in the prostaglandin group. Amniotomy and oxytocin infusion, as established by the attending obstetrician, were started when a woman's Bishop score was 6 or more. If the catheter was expelled but the Bishop score was less than 6, a new catheter was placed.

Women in the prostaglandin E2 group were treated mostly with a starting dose of 1 mg prostaglandin E2 gel, followed by 1 mg after 6 h, with a maximum of two doses per 24 h inserted into the posterior vaginal fornix. An initial dose

of 2 mg was allowed in nulliparous women, as prescribed by the manufacturer (Pfizer, New York, NY, USA). Amniotomy and oxytocin infusion were started when a woman's Bishop score was 6 or more, and at least 6 h after their last dose of prostaglandins. After amniotomy, continuous fetal monitoring was started.

In both groups, if the cervix was still unfavourable for amniotomy after 48 h of treatment, women were generally assigned a day of rest followed by another 48 h of induction. If after these 5 days the cervix was still unfavourable, induction was defined as failed and further management was decided by the treating obstetrician.

Outcomes

The primary outcome was caesarean section rate. Secondary outcomes were instrumental vaginal delivery, reasons for operative delivery, time from induction to delivery, uterine hyperstimulation (>6 contractions per 10 min more than a minimum of two 10 min periods, or a contraction lasting more than 3 min with fetal heart rate changes), uterine rupture (separation of the uterine wall), use of analgesics, use of antibiotics, maternal suspected intrapartum infection (fever ≥38°C during labour or fetal tachycardia [a sustained fetal heart rate of more than 160 beats per min] and start of broad spectrum intravenous antibiotics during labour), maternal post-partum infection (fever ≥38°C and start of antibiotics, urinary tract infection, or endometritis or myometritis proven by positive culture within 1 week post partum), post-partum haemorrhage (estimated blood loss >1000 cc in the 24 h after delivery), and post-partum blood transfusion. Secondary neonatal outcomes were Apgar scores[19] of less than 7 at 1 min and 5 min, an arterial cord blood pH of less than 7.10, neonatal admissions due to suspected infection, or infection proven by positive culture, other admissions to neonatal medium and intensive care. Baseline characteristics, including Bishop score at the start of induction and reason for induction of labour were noted before randomisation. Trained research staff collected data using an online case report form. Serious adverse events were reported to the ethics committee of the Academic Medical Centre with specially designed forms. A data safety monitoring board was established at the start of the trial, an interim analysis was planned at 300 inclusions.

Statistical analysis

We needed a sample size of 406 patients per treatment group to show a reduction in caesarean section rate from 25% to 17% with use of the Foley catheter, with a two sided test (α error=5%; power=80%). This decrease was based on the hypothesis that less uterine hyperstimulation and, as a consequence, less caesarean sections due to fetal distress would be needed. Data were analysed on an intention-to-treat basis. Normally distributed data are presented as means with SDs, skewed distributions are presented as medians with IQRs. For categorical data, the treatment effect is presented as relative risks (RR) with 95% CIs. We calculated p values with the $\chi 2$ test, unless the expected cell count was less than 5, in which case we used Fisher's exact test. For continuous data with a non-normal distribution, we

used the Mann-Whitney U test. For time-to-delivery data, we constructed Kaplan-Meier survival curves and calculated log-rank test and p values.

Calculation of the percentages was based on the number of valid observations. We included footnotes in the tables and figures if 1% or more of information was missing. Because the data were stratified for centre and parity, we also calculated RRs, CIs, and p values, which were adjusted for stratification. We took parity into account as a fixed effect and centre as a random effect in a generalised linear mixed effects model, created with lme4 package (version 0.999375-39).

We did an exploratory subgroup analysis to assess the consistence of the overall treatment effect in nulliparous and multiparous women. We used an interaction term to test the effect of the induction method on caesarean section rate in nullipara and multipara. We also did a post-hoc per-protocol analysis. We calculated RRs adjusted for stratification in R (version 2.12.1), all other statistical analyses were done with SPSS (version 18.0). We considered p values of less than 0.05 to indicate statistical significance.

Role of the funding source

There was no funding source for this study. MJ and KOR had full access to all the data in the study. MJ, KOR, BWM, and KWMB had final responsibility for the decision to submit for publication.

RESULTS

Between Feb 10, 2009, and May 17, 2010, 1111 women were assessed for eligibility and 824 women were included in the trial (figure 1). There were no missing values for the primary outcome. All secondary outcomes had less than 1% of participants missing, except umbilical cord pH, which was missing in 23% of cases (192 of 819), evenly distributed between both groups.

Baseline characteristics were much the same between the two groups (table 1) and representative of the population of Dutch women with induced labour.[20] Post-term pregnancy and hypertensive disorders were the most frequently noted indications for induction of labour (table 1).

None of the participants met the criteria for failed induction. We recorded no difference between the groups in caesarean section rate in unadjusted analysis (table 2) or after adjustment for stratified randomisation (RR 1.14, 95% CI 0.88–1.46). We recorded no statistical difference in the frequency of vaginal instrumental deliveries between the two groups (table 2). Most caesarean sections were done for failure to progress during the first stage of labour, which occurred more often in the Foley catheter group than it did in the prostaglandin group (table 2). When combined, we recorded fewer operative deliveries for fetal distress in the Foley catheter group than in the prostaglandin gel group (table 2).

The median time from start of induction of labour to birth was longer when a Foley catheter was used for labour induction than it was when prostaglandin gel

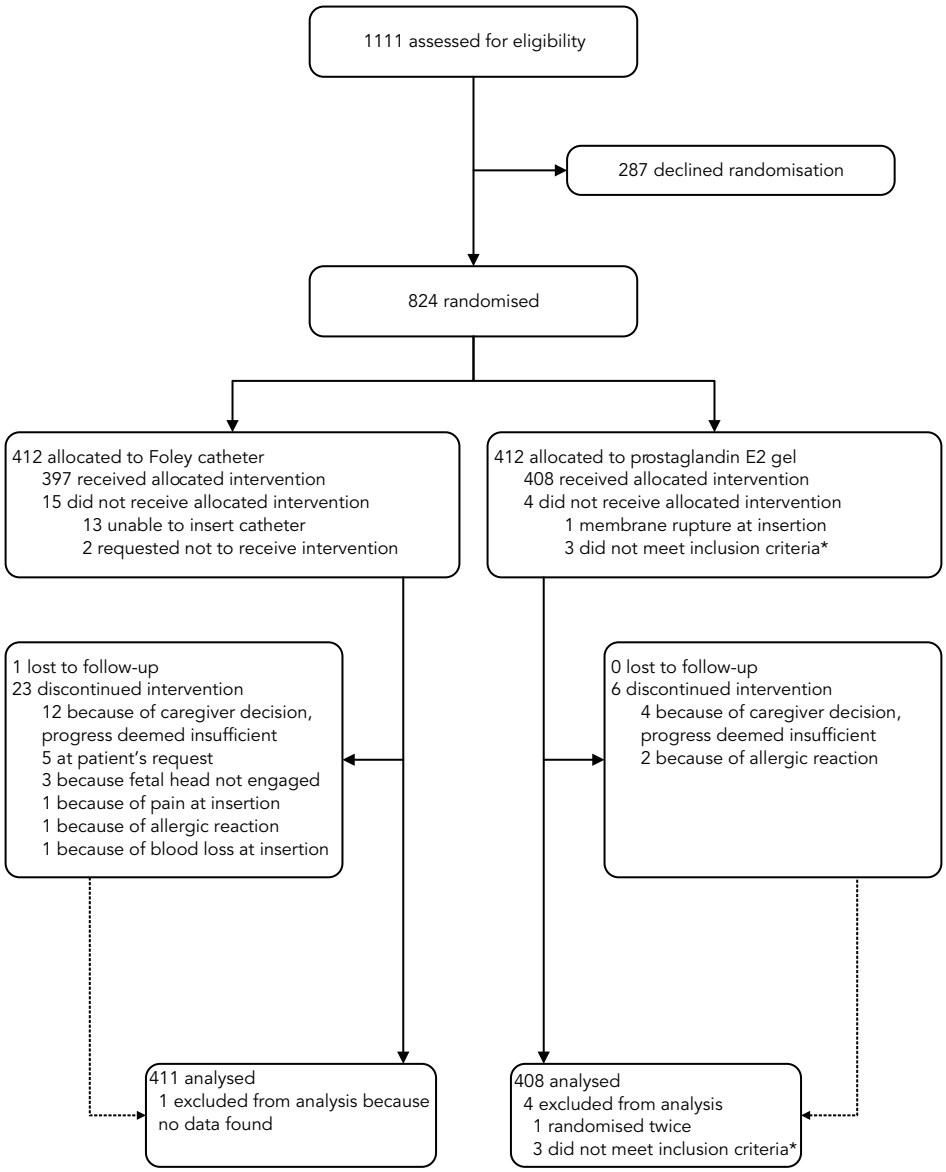

Figure 1. Study profile
*One because gestational age was less than 37 weeks, and two because Bishop score was more than 6

was used (table 2). This difference was only seen in the first 36 h (figure 2), and seems to be caused by the longer interval to active labour in the Foley catheter group (figure 3). Labour was augmented with oxytocin more often when a Foley catheter was used than when prostaglandin gel was used (table 2).

Table 1. Baseline characteristics

	Foley catheter (N=411)	Prostaglandin E2 gel (N=408)
Maternal age (years; mean [SD])	30.9 (4.9)	30.6 (5.0)
Ethnic origin		
White	334 (83%)	335 (83%)
Non-white	70 (17%)	71 (18%)
Body-mass index (median [IQR])	25.3 (22.2–29.3)*	24.8 (21.6–29.4)†
Parity		
0	268 (65%)	263 (65%)
1	99 (24%)	99 (24%)
≥2	44 (11%)	46 (11%)
Bishop score		
0	38 (9%)	52 (13%)
1	103 (25%)	85 (21%)
2	115 (28%)	112 (28%)
3	91 (22%)	83 (20%)
4	53 (13%)	56 (14%)
5	11 (3%)	20 (5%)
Gestational age (weeks; median [IQR])	40.1 (38.3–41.2)	40.0 (38.3–41.3)
Indications for induction of labour‡		
Hypertensive disorders	140 (34%)	140 (34%)
Post-term pregnancy§	147 (36%)	143 (35%)
Intrauterine growth restriction¶	33 (8%)	17 (4%)
Induction for elective reasons (ie, psychosocial reasons)	28 (7%)	23 (6%)
Insulin-dependent diabetes	24 (6%)	34 (8%)
Oligohydramnion	32 (8%)	27 (7%)
Other‖	47 (11%)	54 (13%)

Data are n (%) unless otherwise indicated, *10% missing values (52 of 411 participants), †8% missing values (34 of 408 participants), ‡More than one indication possible, §Defined according to local hospital protocol for induction of labour, which in most cases was a gestational age ≥41 weeks, ¶Defined as estimated fetal weight <10th percentile, ‖In this group, decreased fetal movement, maternal disease, and obstetric cholestasis were seen most often

We recorded two serious maternal adverse events, both in the prostaglandin group—one uterine perforation after insertion of an intrauterine pressure catheter and one uterine rupture during oxytocin augmentation (table 3).

Both neonates were born in good clinical condition but were admitted to the neonatal ward for 6 days because of suspected infection. We recorded four minor adverse events—three women had allergic reactions (one in the Foley catheter group and two in the prostaglandin group) and one had blood loss on insertion of the second catheter (Foley catheter group).

Hyperstimulation was not statistically different between the two groups (table 3). All cases of hyperstimulation in the Foley catheter group occurred during oxytocin augmentation. Six of 12 cases of hyperstimulation in the prostaglandin group occurred after prostaglandin use only (ie, without oxytocin stimulation). We

Table 2. Mode of delivery

	Foley catheter (N=411)	Prostaglandin E2 gel (N=408)	Relative risk (95% CI)	p value
Mode of delivery				
Spontaneous	273 (66%)	272 (67%)	1.00 (0.900–1.10)	0.94
Vaginal instrumental	45 (11%)	54 (13%)	0.83 (0.57–1.19)	0.32
Caesarean section	93 (23%)	82 (20%)	1.13 (0.87–1.47)	0.38
Indication for caesarean section				
Failure to progress in first stage	51 (12%)	31 (8%)	1.63 (1.07–2.50)	0.0218
Failure to progress in second stage	14 (3%)	10 (3%)	1.39 (0.63–3.09)	0.42
Fetal distress	28 (7%)	38 (9%)	0.73 (0.46–1.17)	0.19
Maternal reason	0	2 (<1%)	NA	0.25*
Elective	0	1 (<1%)	NA	0.50*
Indication for vaginal instrumental delivery				
Failure to progress in second stage	22 (5%)	19 (5%)	1.15 (0.63–2.09)	0.65
Fetal distress	22 (5%)	35 (9%)	0.62 (0.37–1.04)	0.07
Maternal complication	1 (<1%)	0	NA	0.50*
Operative deliveries for fetal distress	50 (12%)	73 (18%)	0.68 (0.49–0.95)	0.0218
Oxytocin augmentation	353 (86%)	239 (59%)	1.66 (1.34–1.61)	<0.0001
Time from start of induction to birth (h; median [IQR])*	29 (15–35)	18 (12–33)	NA	<0.0001

Data are n (%) unless otherwise stated. NA=not applicable. *Fisher's exact test

recorded no statistical difference in the occurrence of post-partum haemorrhage between the two groups (table 3). We recorded fewer cases of suspected maternal infection during labour in the Foley catheter group than in the prostaglandin group (table 3). We recorded no statistical difference between the two groups in number of maternal admissions post partum (219 in 411 women in the Foley catheter group vs. 225 in 408 women in the prostaglandin group; RR 0.97, 95% CI 0.85–1.10) or in the median length of admission (table 3).

Fewer neonates were admitted to the neonatal ward after induction with a Foley catheter than they were after induction with prostaglandin, but the number of admissions to a neonatal intensive-care unit was much the same between the two groups (table 3). Indications for neonatal admission did not differ significantly between the groups; the most frequent indication in both groups being suspected infection (table 3). We recorded no difference in umbilical cord pH between groups (table 3).

Post-hoc, per-protocol analysis showed similar results for caesarean section rate (22% of births [82 of 373] with Foley catheter vs. 20% of births [80 of 401] with prostaglandin; RR 1.10, 95% CI 0.84–1.45), all differences in secondary outcomes between the two groups were the same as in the intention-to-treat analysis (data not shown).

In post-hoc analysis, the effect of induction method on caesarean section rate did not differ statistically between nulliparous women (30% of births [81 of 268]

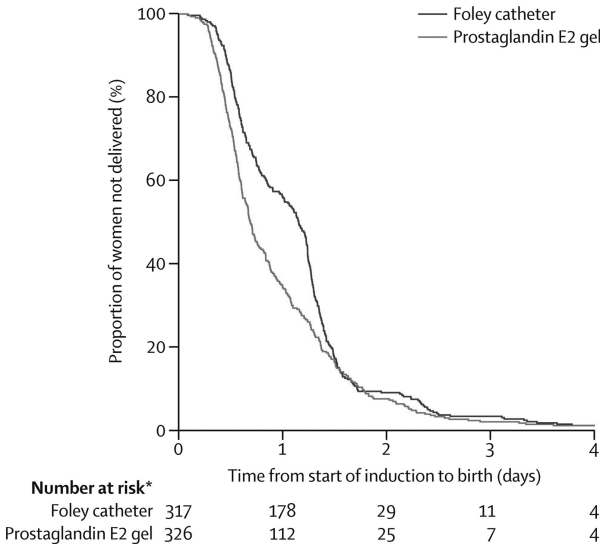

Figure 2. Time from start of induction to birth. *Excluding caesarean deliveries

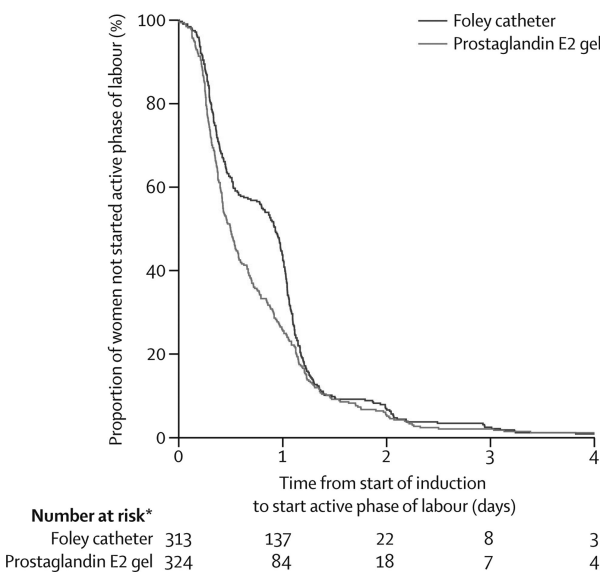

Figure 3. Time from start of induction to start of the active phase of labour. *Excluding caesarean deliveries

in the Foley catheter group vs. 27% of births [72 of 264] in the prostaglandin E2 group; RR 1.11, 0.85–1.45) and multiparous women (8% of births [12 of 143] in the Foley catheter group vs. 7% of births [10 of 144] in the prostaglandin E2 group; RR 1.21, 0.54–2.71; p interaction=0.90). However, in exploratory subgroup analysis the advantages of the Foley catheter seemed most evident for nulliparous women (webappendix p 1). At pre-planned interim analysis, done after 300 participants were enrolled, the data safety monitoring board advised to continue the trial.

Table 3. Maternal and neonatal outcome

	Foley catheter (N=411)	Prostaglandin E2 gel (N=408)	Relative risk (95% CI)	p value
Analgesics				
Pethidine	66 (21%)	61 (19%)	1.11 (0.81–1.52)	0.52
Epidural	122 (36%)	120 (37%)	1.04 (0.85–1.27)	0.68
Other	17 (5%)	10 (3%)	1.74 (0.81–3.75)	0.15
Maternal intrapartum infection				
Temperature ≥38°C during labour	12 (3%)	18 (4%)	0.66 (0.32–1.36)	0.26
Suspected intrapartum infection*	5 (1%)	14 (3%)	0.36 (1.13–0.98)	0.0353
Post-partum haemorrhage (>1000 mL)	26 (6%)	38 (9%)	0.68 (0.42–1.10)	0.11
Post-partum blood transfusion (Y/N)	8 (2%)	15 (4%)	0.53 (0.23–1.24)	0.13
Maternal post-partum infection	5 (1%)	8 (2%)	0.62 (0.21–1.88)	0.39
Other maternal complication				
Hyperstimulation	8 (2%)	12 (3%)	0.66 (0.27–1.60)	0.36
Uterine rupture or perforation	0	2 (<1%)	NA	0.25
Apgar score <7				
1 min	26	35	0.74 (0.45–1.20)	0.22
5 min	5 (1%)	8 (2%)	0.62 (0.21–1.88)	0.39
pH <7.10	25 (8%)†	31 (10%)‡	0.81 (0.49–1.35)	0.42
Neonatal admission				
Ward	49 (12%)	81 (20%)	0.60 (0.43–0.83)	0.0019
Intensive care	3 (1%)	4 (1%)	0.75 (0.17–3.31)	0.73
Reason for admission				
Suspected infection	12 (3%)	18 (4%)	0.66 (0.32–1.36)	0.26
Asphyxia	1 (<1%)	6 (2%)	0.17 (0.02–1.37)	0.07
Dysmaturity	11 (3%)	18 (4%)	0.61 (0.29–1.27)	0.18
Hypoglycaemia	9 (2%)	19 (5%)	0.47 (0.22–1.03)	0.05
IRDS	0	1 (<1%)	NA	0.50
Meconium aspiration	2 (<1%)	1 (<1%)	1.99 (0.18–21.81)	1.0
Other or unknown	19 (5%)	31 (8%)	0.61 (0.35–1.06)	0.08
Length of admission (days) median (IQR)	1 (1–3)	1 (1–3)	NA	0.74

Data are n (%) unless otherwise stated. NA=not applicable. *Body temperature during labour ≥38°C and start of broad spectrum antibiotics due to suspected infection,†24% missing values,‡23% missing values

Caesarean section rates were much the same between induction of labour with a Foley catheter and induction with prostaglandin in a meta-analysis that included our own data (figure 4). However, the reasons for caesarean section differed between the two groups–compared with induction of labour with prostaglandin, suspected fetal distress was recorded less often (odds ratio [OR] 0.63, 95% CI 0.45–0.90) and labour arrest was recorded more often (OR 1.52, 1.12–2.07) after induction with a Foley catheter. Compared with induction of labour with prostaglandin, both hyperstimulation and post-partum haemorrhage occurred less often after induction with a Foley catheter (figure 4).

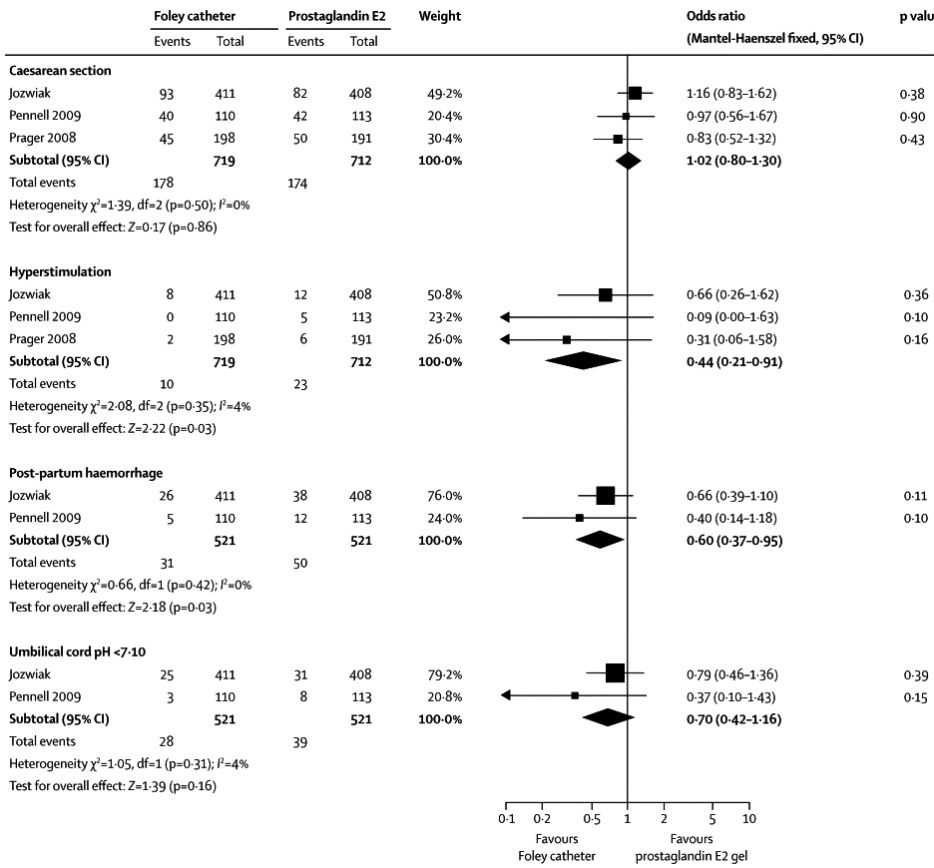

Figure 4. Results from the meta-analysis of studies comparing outcomes after induction with a Foley catheter and induction with prostaglandin E2 gel

DISCUSSION

Use of a Foley catheter did not reduce caesarean section rates when compared with use of prostaglandin E2 gel. After induction with a Foley catheter, the overall number of operative deliveries for suspected fetal distress was lower, fewer mothers were treated with intrapartum antibiotics, and significantly fewer neonates were admitted to the neonatal ward. Induction with a Foley catheter seemed to cause less uterine hyperstimulation and post-partum haemorrhage, but this association was not statistically significant. The time from the start of the intervention to birth was longer when a Foley catheter was used than when prostaglandin E2 gel was used. A meta-analysis (figure 4) including this trial showed no difference in caesarean section rates, and less hyperstimulation and post-partum haemorrhage in the Foley catheter group (panel). We recorded no statistical difference in the umbilical-cord pH between the two groups when our results were pooled with earlier studies.

Interpretation

Findings from our meta-analysis, which included the results of this trial, showed that use of a Foley catheter for induction of labour does not reduce caesarean section rate when compared with use of prostaglandin E2 gel. Because our trial included many patients, we were able to investigate secondary outcomes (i.e., hyperstimulation, post-partum haemorrhage, and umbilical cord pH) in the meta-analysis—all such outcomes were in favour of use of a Foley catheter. Clinicians should consider a Foley catheter for induction of labour in women with an unfavourable cervix at term.

Although this is the largest study to date to compare Foley catheter induction to prostaglandin E2 gel, we recorded no statistical significance in the number of adverse events in each group, probably because the number of adverse events was low. However, point estimates for all side-effects favour the use of the Foley catheter. We postulate that both haemorrhage and fetal distress are related to uterine hyperstimulation, which occurred more frequently after prostaglandin E2 use. Moreover the meta-analysis lent support to our findings.

We acknowledge that the assumed reduction of 8% in the caesarean delivery rate made in the power calculation was optimistic. Before starting the trial, information on the direct comparison between transcervical Foley catheters and vaginal prostaglandin E2 gel was scarce. Only one trial, by Prager and colleagues,[12] studied this comparison. They included 198 women in the Foley group and 191 women in the prostaglandin group. Their total caesarean section rate was, albeit non-significantly, reduced in the Foley catheter group (OR 0.83, 95% CI 0.52–1.32). Prager and colleagues also noted a decrease in caesarean sections done because of fetal distress (OR 0.50, 95% CI 0.27–0.95).[12] We expected the caesarean section rate to be 25%, with 15% of these done because of fetal distress. A reduction of the caesarean section rate due to fetal distress of 50% would then result in a reduction of the overall caesarean section rate from 25% to 17%. We did not, however, anticipate such a high increase in caesarean deliveries done because of labour arrest. In view of our results, a non-inferiority design would have been more appropriate for this trial.

We did not assess the satisfaction of patients. One study[11] assessed satisfaction between women induced with a Foley catheter and prostaglandin E2 gel, and recorded no difference in overall satisfaction but lower pain scores in women induced with a Foley catheter ($p<0.001$), suggesting that Foley catheters would be a woman's preferential choice of labour induction.

Although masking was impossible because of the nature of the intervention, the method of cervical ripening might have affected the caregivers' decision making. We believe that the non-masked nature of the trial did not cause substantial bias, because the clinical decision of doing a caesarean section is a complex one, with many factors involved.

Our findings, along with the results of other randomised controlled trials,[11, 12] show that the Foley catheter and prostaglandin E2 gel give similar vaginal delivery rates,

Panel. Research in context

Systematic review

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (last search done on April 30, 2011) for studies in which women with an unfavourable cervix were randomly allocated to induction with a Foley catheter or vaginal prostaglandin E2 gel. The Cochrane Pregnancy and Childbirth Group's Trials Register contains trials identified from quarterly searches of the Cochrane Central Register of Controlled Trials (CENTRAL); weekly searches of Medline; searches of 30 journals and the proceedings of major conferences; weekly current awareness alerts for a further 44 journals; and monthly BioMed Central email alerts. Trials identified through the searching activities described above are each assigned to a review topic (or topics). The Trials Search Co-ordinator searched the register with the topic list rather than with keywords. The reference lists of trial reports and reviews were manually searched by hand. We did not apply any language or date restrictions. Two reviewers (MJ and MB) identified papers for relevance and quality, and extracted data. We assessed studies for quality with the Cochrane Collaboration's tool for assessing risk of bias.21 Searching of published work yielded 122 results relevant for meta-analysis. Review of the papers indicated that two good quality studies fulfilled the inclusion criteria.11 and 12 Both studies showed that induction with a Foley catheter is safe and effective. Furthermore, the study by Pennell and colleagues11 states that it is the most acceptable method for cervical ripening in nulliparous women with unfavourable cervixes.

although we hypothesised that the Foley catheter would reduce caesarean deliveries. Caesarean deliveries done because of labour arrest were seen more often, whereas caesarean deliveries for fetal distress were seen less often with the use of a Foley catheter compared with use of prostaglandin gel. We think that some caesarean sections done for labour arrest in the Foley catheter group might have been done because of impatience of the attending obstetrician. This could especially be the case with obstetricians to whom Foley catheter use was new and who might have believed that use of prostaglandins was preferential. Time from start of induction to birth was substantially longer in the Foley catheter group. In the Foley catheter group, few women entered the active phase of labour during night time (induction was mostly started in the morning), whereas women in the prostaglandin group continued to start active labour at night (figure 3). First, we believe that induction of labour with a Foley catheter enables separation of the process of ripening of the cervix and start of labour, whereas after the use of prostaglandins these phases occur simultaneously. This occurrence is shown by the more frequent oxytocin use in the Foley catheter group and absence of hyperstimulation when only a Foley catheter was used in this trial.

Second, because few women in the Foley catheter had contractions, artificial rupture of the membranes and start of oxytocin augmentation was possibly postponed to the next morning when the cervix was deemed favourable in the late afternoon or evening, because night-time hospital delivery increases perinatal morbidity.[22]

A trial investigating the efficacy of 12 h of ripening with a Foley catheter compared with 24 h of ripening with a Foley catheter, and ripening with vaginal prostaglandin E2 inserts, showed that shortening ripening time does not substantially affect the caesarean section rate, but shortens the induction-to-delivery interval to an interval similar to that with use of vaginal PGE 2 inserts.[23] We therefore postulate that earlier amniotomy in the Foley catheter group could have shortened the induction-to-delivery interval.

Our unexpected finding of fewer cases of suspected maternal infection in the Foley catheter group could be a consequence of the greater number of vaginal examinations in the prostaglandin group. The recorded decrease in suspected maternal infections could also be a consequence of our definition of suspected maternal infection, in which body temperature plays a part. Because prostaglandin E2 is a mediator of the febrile response,[24] the presence of more suspected infection in the prostaglandin group could partly be explained by this fever-inducing effect. Nevertheless, because we cannot differentiate between pathogen-induced and prostaglandin E2 gel-induced fever, the final result of both scenarios will be the admission of mother and child for treatment with antibiotics.

The dosing regimens used were as recommended by the manufacturer. Dosing was differed between centre and women's parity status. The stratified analysis did not show any change in the estimator of interest (caesarean section rate). Therefore we feel that the presented data will be useful for other countries where the regimens used are the same as those used in this trial.

Because of the low cost and easy storage of the Foley catheter, its use could be suitable for developing countries and low-resource settings. Another advantage of Foley catheters compared with prostaglandin E2 gel is a less stringent need for registration of contractions during cervical ripening because of the absence of hyperstimulation during ripening, which is convenient. Although the use of Foley catheters and prostaglandin E2 has been compared in low-resource settings,[14, 15 , 25] these studies were all too small to address safety issues, and further research is needed.

Prostaglandin E2 analogues were introduced in the 1980s, without appropriately powered RCTs to prove efficacy and safety. Our trial and meta-analysis show that induction of labour with a Foley catheter does not reduce caesarean section rates compared with vaginal prostaglandin E2 gel, however fewer side-effects are reported in the Foley catheter group. We therefore think that a Foley catheter should be considered for induction of labour in women with an unfavourable cervix at term. Prostaglandin E1 is becoming increasingly popular for cervical ripening worldwide. Therefore, future research should focus on the comparison of

Foley catheters with other prostaglandin preparations, such as Misoprostol, and with use of Foley catheters in women with a previous caesarean birth.

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