Clinical parameters for prediction of successful labor induction after application of intravaginal dinoprostone in nulliparous Chinese women

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Summary

Background: The aim of this study was to compare the possible clinical parameters for prediction of successful labor induction in Chinese nulliparous women.

Material/Methods: A retrospective, observational trial of labor induction was performed, using a single dose of 10 mg controlled-release dinoprostone for preinduction cervical ripening in 127 nulliparous women (gestational age 38–42 weeks, singleton cephalic presentations). The characteristics of the women with successful labor induction (defined as vaginal delivery achieved on the day of admission; n=80) and failed labor induction (n=47) were compared.

Results: The main differences observed between the groups were gravidity (P<0.05), induction-active labor interval (5.16±2.98 vs. 8.40±3.41; P<0.05) and birth weight (3421.11±368.14 vs. 3566.36±345.16; P<0.05). Logistic regression demonstrated that gravidity (P<0.05) and induction-active labor interval (P<0.05), but not Bishop score, were significant and independent contributing factors for successful labor induction. In the receiver operating characteristic curves for the prediction of successful labor induction, the best cut-off value for gravidity was 3 (95% confidence interval [CI] 0.64–0.83, P=0.000), and the best cut-off value for the induction-active labor interval was 7.96 (95%CI 0.66–0.85, P=0.000).

Conclusions: Less gravidity and shorter induction-active labor interval predict successful labor induction with reasonable accuracy.

key words: Bishop score • gravidity • labor induction • nulliparous women

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BACKGROUND

Induction of labor is a safe and efficacious method for vaginal delivery, but there is an increased risk of failed induction and subsequent cesarean delivery [1]. Moreover, an unplanned emergency cesarean delivery during labor poses increased risk for maternal morbidity and mortality in comparison with a planned elective cesarean delivery [2–4]. Therefore, several attempts have been made to predict the outcome of labor induction.

Traditionally, the assessment of the status of the cervix before labor induction has been accomplished using the Bishop score. In addition to this, it has been suggested that a variety of other maternal and fetal factors, as well as screening tests, can be used to predict the success of labor induction. Certain characteristics of the woman (parity, age, weight, height and body mass index), and of the fetus (birth weight and gestational age) have been associated with the success of labor induction [5–10], but there has been no research into this in Chinese women. Dinoprostone is the most commonly used agent for preinduction cervical ripening in China, the effects and properties of which have been extensively investigated [11–15]. The purpose of this study was to identify the clinical parameters that can be used to predict the outcome of induction of labor in nulliparous Chinese women.

MATERIAL AND METHODS

Patient characteristics

From January 2008 to January 2009, 127 nulliparous women were prospectively recruited into the study. The investigation was approved by the Institutional Ethics Committee. All patients gave written consent prior to cervical assessment. The study included nulliparous women between 38 and 42 weeks of gestation (assessed by rigorous menstrual history or an ultrasound conducted before 20 weeks), with singleton pregnancy, cephalic presentation, Bishop score ≥6 and absence of active labor. Exclusion criteria were uterine scar due to previous cesarean delivery or myomectomy, placenta previa, allergy or asthma in response to prostaglandins, abnormal non-stress test result before the induction, and gestational age (Table 1). The gravidity in the successful labor induction group was lower than in the failed labor induction group (P<0.05). Indications for labor induction were impaired glucose tolerance (IGT) or gestational diabetes mellitus (GDM; n=38), postdates (n=36), premature rupture of membranes (n=19), macrosomia (n=8), hypertension disorders (n=6) and other medical or fetal problems necessitating delivery (n=20). The indications did not differ between the failed and successful labor induction groups. Mean induction-active labor interval in the successful labor induction group was shorter than in the failed labor induction group (5.16±3.41 vs. 8.40±3.41; P<0.001; Table 2). Mean birth weight in the successful labor induction group was lower than in the failed labor induction group (3421.11±368.14 vs. 3566.36±345.16; P<0.05).

Of the 127 women recruited, 80 (63%) delivered vaginally within 24 h of labor induction. Of the remaining 47 women classified as having failed induction, 16 (34%) delivered vaginally the next day after rest for a night and repetition of the same induction protocol, and 31 (66%) underwent cesarean delivery. The indications for cesarean section were patient request for social reasons (n=19), arrest of cervical dilation (n=4), intrapartum repetitive late and/or severe variable fetal heart rate decelerations (n=3), meconium-stained amniotic fluid (n=3) and arrest of fetal descent (n=2).

Logistic regression

In a univariate logistic regression model that included all variables that might have an effect on the success of labor induction, induction was defined as successful only if vaginal delivery was achieved by induction protocols started on the day of admission. Patients who were given night rest and had the procedures restarted the next day were classified as failed induction, even if they subsequently delivered vaginally. The induction-active labor interval was defined as the period from the administration of dinoprostone to the establishment of regular uterine activity.

Statistical analysis

Data were entered into the statistical software program SPSS13.0. Normally distributed data were analyzed via the Kolmogorov-Smirnov test. Results are presented as the mean ±SD or median. The Wilcoxon rank sum test was used for ranked data, and measurement data were compared with t-test or non-parametric rank sum test. In order to deal with uncertainty in estimation, 95% confidence intervals (CI) were generated for post-test probabilities around the point estimate. Univariate and multivariate logistic regression analysis was performed to determine the variables that contributed to the prediction of labor. Receiver operating characteristic (ROC) curves were used to assess the ability of clinical parameters to predict labor induction. For 2-sided tests, P<0.05 was considered statistically significant.

RESULTS

General results

Baseline characteristics of both treatment groups are presented in Tables 1, 2. There were no statistically significant differences in race, maternal age, gestational age, body mass index, the fetal sex or the Bishop score at the time of admission (Table 1). The gravidity in the successful labor induction group was lower than in the failed labor induction group (P<0.05). Indications for labor induction were impaired glucose tolerance (IGT) or gestational diabetes mellitus (GDM; n=38), postdates (n=36), premature rupture of membranes (n=19), macrosomia (n=8), hypertension disorders (n=6) and other medical or fetal problems necessitating delivery (n=20). The indications did not differ between the failed and successful labor induction groups. Mean induction-active labor interval in the successful labor induction group was shorter than in the failed labor induction group (5.16±3.41 vs. 8.40±3.41; P<0.001; Table 2). Mean birth weight in the successful labor induction group was lower than in the failed labor induction group (3421.11±368.14 vs. 3566.36±345.16; P<0.05).

For the purpose of the study analysis, the women were divided into 2 groups, with either successful or failed induction of labor.
labor induction, gravidity (OR=0.61, 95%CI 0.408–0.892; P=0.011) and induction-active labor interval (OR=0.85, 95%CI 0.769–0.937; P=0.001) correlated significantly with successful induction. The 5 components of the Bishop score alone, and the total Bishop score were, however, not associated with successful vaginal delivery within 24 h of induction (Table 3).

Multiple logistic regression analysis also showed that only the gravidity and induction-active labor interval, and not the Bishop score or any of its individual parameters, were independent predictors of successful labor induction (Table 3).

**ROC analysis**

In ROC curves, the best cut-off point for the prediction of successful induction of labor was 3 for gravidity, and 7.96 for induction-active labor interval. The area under the curves (AUC) of the ROC for gravidity (AUC=0.738; P<0.001) and for induction-active labor interval (AUC=0.753; P<0.001) were greater than that for the Bishop score (AUC=0.520; P=0.706) in predicting a successful labor induction (Figures 1, 2).

**Discussion**

The condition of the cervix at the start of induction is an important predictor, with the modified Bishop score being a widely used scoring system. However, the present study indicates that the Bishop score appeared to have poor predictive value for the success of labor induction. These observations are consistent with the study of fetal fibronectin by Blanch et al. [16], who demonstrated that only in the multiparous women could the fetal fibronectin test be correlated...
with the length of the latent phase, as well as with the induction to delivery interval. Our findings are also in accordance with the results of a report by Roman et al. [17], who showed that cervical status prior to induction of labor was associated with the length of the latent phase of labor, but not that of the active phase, and that the performance of cesarean delivery for dystocia was specifically indicated only in women in the active phase of labor.

In a prospective study by Reis et al. [18], obstetric history (previous vaginal delivery), but not cervical length measurement, accurately predicted successful labor induction. Likewise, Gonen et al. [19] prospectively evaluated 86 women and found that parity was an independent predictor of vaginal delivery in induced labor. Wing et al. [20] also reported that the clinical characteristic of parity predicted the likelihood of success of cervical ripening and labor induction with intravaginal misoprostol administration. Park [21] reported that in terms of previous obstetric history, women with only previous midtrimester loss or preterm delivery had a significantly higher risk of failed labor induction than those with at least 1 previous term delivery. In the present study, gravity, but not parity, was associated with successful labor induction. Because of family planning, most pregnant Chinese women are nulliparous; however, some women have a history of 1 or more abortions, so the details of previous pregnancies were recorded. Our results show that gravity correlated significantly with successful induction – the higher the gravity of a woman, the higher the hazard of failed induction. This observation implies that the response to labor induction in parous women depends mainly on the period of gestation at which they experienced cervical ripening and dilatation phases in previous pregnancies, but the response to induction of labor in nulliparous women may be influenced by abortion history in those who have not experienced cervical ripening, as cervical injury may have occurred. The result also suggests that the sensitivity of response to prostaglandin was not increased in women with a history of abortion. Further studies are required to determine whether women with higher previous gravidity have a significantly higher risk of failed labor induction. The present study also showed that the mean induction-active labor interval in the successful labor induction group was shorter than in the failed labor induction group. This finding, which has not previously been reported, suggests that the performance of a woman in the

| Variable          | Univariate analysis |          |          |          |          |          |          |
|-------------------|---------------------|----------|----------|----------|----------|----------|----------|
|                   | Odds ratio (95% CI) | P        | Odds ratio (95% CI) | P        |
| Gestational age   | 1.010 (0.885–1.152) | 0.882    |          |          |          |          |
| Gravity           | 0.603 (0.408–0.892) | 0.011*   | 0.653 (0.433–0.983) | 0.041**  |
| Bishop score total| 1.053 (0.779–1.423) | 0.738    |          |          |          |          |
| Dilatation        | 0.993 (0.939–1.050) | 0.816    |          |          |          |          |
| Effacement        | 1.017 (0.633–1.635) | 0.943    |          |          |          |          |
| Consistency       | 1.155 (0.647–2.060) | 0.626    |          |          |          |          |
| Position          | 1.060 (0.534–2.104) | 0.868    |          |          |          |          |
| Station           | 0.955 (0.479–1.904) | 0.896    |          |          |          |          |
| Induction-active labor interval | 0.849 (0.769–0.937) | 0.001*   | 0.857 (0.775–0.947) | 0.002**  |

* P<0.05 by univariate analysis; ** P<0.05 by multivariate analysis.
initial phase of induction may be indicative of her eventual response to the induction of labor.

CONCLUSIONS

Several investigators have reported that birth weight is an independent factor for the risk of primary cesarean delivery. Pevzner et al. [22] reported that birth weight below 4000 g was a significant factor in the prediction of successful induction of labor. Crane et al. [23] reported that birth weight was associated with vaginal delivery within 24 h of induction, which is in agreement with our findings. Since this information is not known before delivery, from a practical point of view, accurate methods for the prenatal estimation of actual birth weight would be useful in predicting which women will have a successful induction of labor.

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