Prediction of successful induction of labour with dinoprostone in a homogeneous group of patients

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Objectives. The aim of the present study was to compare the efficiency of transvaginal ultrasonography and the Bishop's scoring system in predicting the success of labour induction.

Methods. Transvaginal ultrasonography for cervical evaluation and cervical palpation for Bishop scoring were performed in all patients by the same obstetrician. This prospective study was conducted in the Perinatology and Maternity Care Unit of Etlik Zübeyde Hanim Maternity and Women's Health Teaching and Research Hospital between September 2007 and February 2008. Eighty-four patients induced with prostaglandin E_2 (dinoprostone) for medical indications were included in the study.

Results. No significant association was found between transvaginal measurement of cervical length and the success of labour induction (p=0.201). We found no statistically significant difference between failure of labour induction and successful labour induction in terms of transvaginal measurement of cervical length (area under the curve (AUC) 0.583; 95% confidence interval (CI) 0.452 - 0.714). A significant association between the Bishop's score and failure of labour induction (p=0.029) was found. A statistically significant relationship was found between failure of labour induction and successful labour induction in terms of the Bishop's score (AUC 0.632; 95% CI 0.513 - 0.751). The best cut-off point for predicting successful labour induction was a Bishop's score of 2 or more. The sensitivity and specificity levels associated with this point were 82.4% and 44.9%, respectively (positive predictive value 50.9% and negative predictive value 78.6%).

Conclusions. Bishop's scoring system was more successful than assessment of cervical length by ultrasound in predicting failed induction in a homogeneous group of patients in whom labour was induced with prostaglandin E_2.

The purpose of labour induction is achieving childbirth through the stimulation of uterine contractions. About 20 - 30% of all pregnancies require labour induction.[1]

Studies have been conducted for many years to develop new methods for cervical ripening and induction of labour. The importance of favourable cervical status has been known for about 70 years. According to the literature, 22 - 24% of inductions of labour when cervical status is unfavourable end in caesarean deliveries.[2] Labour induction is difficult and time-consuming with an unripe cervix, resulting in increased caesarean section and instrumental delivery rates and contributing to morbidity and mortality among mothers and infants.

Several systematic reviews have shown that prostaglandins are superior to placebo and oxytocin alone in ripening the cervix. In recent years locally applied prostaglandin E_2 (PGE2) preparations, particularly dinoprostone, have found wide use in clinical practice for this indication.[3]

Traditionally the Bishop's score is used to measure cervical status.[4] This score evaluates the fetal station and the consistency, position, dilation and effacement of the cervix. It has been shown that even when induction of labour is performed, the rate of vaginal deliveries remains unchanged among patients with high Bishop's scores.[4] However, some studies have pointed out that the Bishop's score may fail in predicting the success of labour induction, particularly in patients with an unfavourable cervical status.[5] New and potentially more accurate methods to predict the success of labour induction have therefore been sought. One of these methods is evaluation of cervical status through transvaginal ultrasonography. It has been shown that transvaginal ultrasonography is easier than vaginal examination and may be more accurate in predicting success of labour induction.[6-8]

The aim of the present study was to compare the efficiency of transvaginal ultrasonography and the Bishop's scoring system in predicting success of labour induction.

Materials and methods

A prospective study was conducted in the Perinatology and Maternity Care Unit of Etlik Zübeyde Hanim Maternity and Women's Health Teaching and Research Hospital between September 2007 and February 2008. Patients induced with PGE2 (dinoprostone) for medical indications were included in the study.

Women with singleton live fetuses with cephalic presentation, at a gestational age of about 37 weeks or more (according to the last menstrual period), whose membranes were intact and who had Bishop's scores of ≥5 were asked to participate in the study and gave written informed consent. Exclusion criteria were the generally accepted contraindications to labour induction, namely previous caesarean section or uterine surgery, having more than 1 uterine contraction in 10 minutes, polyhydramnios, breech presentation, vasa praevia or complete placenta praevia, umbilical cord prolapse, abnormal fetal heart rate patterns not necessitating emergency delivery, cephalopelvic disproportion, maternal heart disease or prostaglandin allergy, and other contraindications to vaginal delivery.[9]

We used the 24-hour vaginal ovule containing 10 mg dinoprostone (Propess) for labour induction. During the last hour before induction, transvaginal ultrasonography for cervical evaluation was performed in all patients by the same obstetrician. After this, all patients had Bishop's scores[4] determined to evaluate cervical status. Before ultrasonography, the bladders of all patients were emptied and care was taken to not exert any pressure on the cervix by the probe. Fundal or subrapubic pressure was not applied. Ultrasound measurements were made in the sagittal plane. Both cervical length and cervical funnelling were evaluated. Cervical length was determined by the simultaneous visualisation of the internal and external cervical os and their measurement across the endocervical channel. Funnelling was defined as a protrusion of the amniotic membranes 3 mm or more into the internal os. The five parameters of the Bishop's scoring system (the fetal station and the consistency, position, dilation and effacement of the cervix) were evaluated via cervical palpation.

After insertion of the dinoprostone vaginal ovule, patients were instructed to rest in bed for 30 minutes. All were followed up until the onset of cervical dilatation and contractions. The follow-up examinations were performed every 3 hours and included fetal monitoring, recording of uterine activity and cervical examination. Patients whose labour had begun were followed up with vaginal examinations at 2-hour intervals. One dose (5 U) of oxytocin diluted in 500 ml saline (SF, Isolyte S) was administered via an infusion pump to patients whose contractions were deemed insufficient. According to low-dose protocols, the initial dose of oxytocin, which was 1 - 2 mU/min, was increased by 2 mU/min every 15 minutes until a maximum dose of 20 mU/min was reached. A second dinopostrone vaginal ovule was administered to patients in whom cervical ripening was not achieved and labour could not be induced. Induction was deemed unsuccessful when labour could not be stimulated after the two attempts, and these patients underwent caesarean section. Successful induction was defined as vaginal delivery achieved in 24 hours.

Patients with hypertonic contractions or who showed signs of uterine hyperstimulation were turned on their left side and given 500 ml crystalloid fluid solution by bolus infusion. The dinoprostone ovule was removed if the fetal heart rate pattern did not return to normal limits in spite of supplemental oxygen given by nasal cannula or facemask. After the administration of 3 - 5 mg diluted ritodrin subcutaneously, the uterine activity of these patients returned to normal.

Data analysis

The data were analysed using the SPSS 11.5 (Statistical Package for Social Sciences, SPSS Inc., Chicago, IL, USA) software package. A Shapiro-Wilk test was used to determine whether the distribution of continuous variables was normal. Descriptive statistics were presented as means, standard deviations (SDs) and ranges for continuous variables, and frequencies and percentages for categorical variables.

In this study, cervical measurements of length and Bishop's scores did not show a normal distribution, so a Mann-Whitney U-test was used in the evaluations. To determine whether there were differences between the groups (successful v. unsuccessful induction) with regard to categorical variables, Pearson's chi-square test was used. Logistic regression was used to establish a measure of the effect size (odds ratio).

Receiver operator characteristic (ROC) curves were constructed for both scores. The area under the curve (AUC) was then calculated and a *p*-value and confidence intervals (CIs) for this area established. Suitable cut-off points for the prediction of an unsuccessful induction were established by calculation of the Youden index. Sensitivity and specificity at different cut-off points were calculated for both cervical length and Bishop's score. A *p*-value of <0.05 was considered to be statistically significant.

Results

Eighty-four patients were included in the study. The most common indications for labour induction were post-date pregnancy (*N*=54) and oligohydramnios (*N*=10). The mean age of the patients was 24.60 years and the mean body mass index (BMI) 29.03. Sixty-nine per cent of the patients were nulliparous and 31% were multiparous. Their demographic characteristics are set out in Table I.

Fifty-nine patients (70.2%) had normal vaginal deliveries, and 25 (29.8%) had caesarean sections. In 12 of these patients (48%) the caesarean section was for fetal distress, in 8 (32.0%) for cephalopelvic disproportion, in 2 (8.5%) for cord prolapse and in 1 (4.0%) for poor labour progress. In 2 patients (8.5%) labour could not be induced despite administration of a second dinoprostone vaginal ovule, so caesarean section was performed. Intravenous oxytocin infusion was administered to 29 patients (34.5%) for augmentation of contractions.

The successful and unsuccessful labour induction groups were similar in terms of parity (Table II) and funnelling. By definition none of the patients in whom labour induction was successful had

Table I. Demographics and indications for induction of labour in the study population

Variables	
Age (mean (SD), range)	24.7 (4.75), 18 - 40
BMI (mean (SD), range)	29.0 (4.08), 20.7 - 40.6
Gestational age (mean (SD), range)	
LMP – days	284.5 (6.70), 259 - 295
USG – days	267.0 (10.73), 227 - 286
Parity (*N* (%))	
Nulliparous	58 (69.0)
Multiparous	26 (31.0)
Indications for induction (*N* (%))	
Post-term	54 (64.3)
Oligohydramnios	10 (11.9)
Intra-uterine death	1 (1.2)
Pre-gestational diabetes mellitus	1 (1.2)
Post-term+ gestational diabetes	1 (1.2)
Post-term + oligohydramniosis	5 (6.0)
Post-term+ polyhydramnios	2 (2.4)
Gestational diabetes mellitus	1 (1.2)
Pregnancy and urinary tract infection	1 (1.2)
Intra-uterine growth retardation	6 (7.1)
Pre-eclampsia	2 (2.4)
Delivery mode (*N* (%))	
Vaginal delivery	59 (70.2)
Caesarean delivery	25 (29.8)

LMP = last menstrual period; USG – ultrasonography.

caesarean sections, while 71.4% of the patients in whom induction was unsuccessful gave birth via caesarean section ($p<0.001$).

Of the 25 patients who had caesarean sections due to unsuccessful labour induction, 19 (76%) were nulliparous and 6 (24%) multiparous.

No significant association was found between transvaginal measurement of cervical length and the success of labour induction ($p=0.201$) (Table III). Comparison of the ROC curves demonstrated that there was no statistical difference between failure of labour induction and successful labour induction in terms of transvaginal measurement of cervical length ($p=0.201$). The AUC was calculated as 0.583 (95% CI 0.452 - 0.714). Each unit of increase in cervical length was associated with a 1.04-fold increase (95% CI 0.98 - 1.09) in the likelihood of an unsuccessful induction.

A significant association was found between the Bishop's score and failure of labour induction ($p=0.029$). Comparison of the ROC curves demonstrated that there was a statistical difference between failure of labour induction and successful labour induction in terms of the Bishop's score ($p=0.042$). The AUC for the Bishop's score was 0.632 (95% CI 0.513 - 0.751). Each unit of increase in the Bishop's score was associated with a 1.86-fold increase (95% CI 1.06 - 3.26) in the likelihood of an unsuccessful induction.

The best cut-off point for predicting successful labour induction was a Bishop's score of 2 or more. The sensitivity and specificity levels associated with this point were 82.4% and 44.9%, respectively, while the positive and negative predictive values associated with it were 50.9% and 78.6%, respectively.

Discussion

Induction of labour has become increasingly common in modern obstetric practice. Being able to predict the outcome of medical induction in women with unfavourable cervices is important in planning management. Transvaginal ultrasonography is commonly used to predict preterm deliveries, and in recent years it has also been used to predict the outcome of labour induction with varying success. The most common method used to determine the outcome of labour induction is the Bishop's scoring system. Using vaginal delivery within 24 hours as the definition of a successful labour induction,[10] our study found no association between cervical length

Table II. Mode of delivery and parity distribution between successful (vaginal delivery within 24 hours) and failed induction of labour

Variables	Successful induction (*N*=49)	Failed induction (*N*=35)	*p*
Mode of delivery (*N* (%))			
Vaginal delivery	49 (100.0)	10 (28.6)	<0.001
Caesarean delivery	0	25 (71.4)	
Parity (*N* (%))			
Nulliparous	33 (67.3)	25 (71.4)	0.690
Multiparous	16 (32.7)	10 (28.6)	

Table III. Effect on delivery of cervical length and Bishop's score over 24 hours

Variables	Successful induction (*N*=49) (mean (SD), range)	Failed induction (*N*=35) (mean (SD), range)	*p*	Odds ratio (95% CI)
Cervical length (mm)	30.4 (7.31), 14.1 - 45.2	32.7 (9.45), 11.4 - 46.9	0.201	1.04 (0.98 - 1.09)
Bishop's score	2.4 (0.93), 1 - 4	2.0 (0.70), 1 - 4	0.029	1.86 (1.06 - 3.26

measured by transvaginal ultrasonography and successful labour induction, but a significant association with the Bishop's score.

In the current study, ROC analysis performed to investigate the effect of the Bishop's score on failed labour induction found the AUC to be statistically significant (p=0.042). The AUC and the 95% CI were determined as 0.632 and 0.513 - 0.751, respectively. The best cut-off value of the Bishop's score for predicting failed induction was equal to or less than 2. The sensitivity and specificity levels of this cut-off point were calculated as 82.4% and 44.9%, respectively. ROC analysis of cervical length measured by transvaginal ultrasonography found the AUC not to be statistically significant (p=0.201).

Chandra *et al.* compared digital and ultrasonographic examination of the cervix in post-term pregnant women,[11] finding cervical palpation to be more successful than transvaginal ultrasonography in predicting the success of labour induction. This result was consistent with ours. A similar result was reported by Watson *et al.*,[12] who also showed that cervical dilatation assessed through clinical examination was accurate in predicting the success of labour induction. In a study involving 106 patients, Roman *et al.* found that measurement of the cervical length by transvaginal ultrasonography was not a good indicator in determining whether vaginal delivery will be successful.[13] This result is also consistent with ours. In a study by Çalişkan *et al.* involving 74 patients, it was found that measurement of cervical length was far from ideal in predicting failure of labour induction.[14] Gonen *et al.* found a significant correlation between Bishop's scores and parity, but no significant relationship between cervical length, method of delivery and the time until delivery.[15]

In a study by Rane *et al.* examining post-date pregnancies it was found that parity and cervical length measurement were independent variables in terms of accurately predicting the probability of caesarean section.[10] They found a sensitivity of 84% and a specificity of 59% when they set the threshold value at 24 mm. Additionally, they showed that the rate of caesarean section increased threefold when vaginal delivery did not take place within 24 hours after induction.[10] In their case series, Pandis *et al.* determined that cervical length, parity and Bishop's score were independent variables in predicting vaginal delivery within 24 hours after labour induction.[6] They concluded that cervical length measured by ultrasound is a better predictor of successful induction than the Bishop's score. Gabriel *et al.* found there to be a relationship between a cervical length less than 26 mm and a low caesarean section rate. The sensitivity and specificity of the 26 mm cut-off value were reported as 62% and 61%, respectively.[7] Ware and Raynor concluded that ultrasonographic cervical assessment was more successful than clinical examination in predicting successful induction of labour.[8]

Previous studies of labour induction have used different induction agents, such as misoprostol and dinoprostone, and most of the studies in the literature are of heterogeneous groups. These factors complicate comparison of the results. Our study group was homogeneous and all patients received dinoprostone, strengthening the findings of the study. We conclude that the Bishop's scoring system is more successful than transvaginal ultrasonography in predicting failed induction in a homogeneous group of patients whose labour was induced with PGE2 (Propess 24-hour form).

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