ORIGINAL RESEARCH

Bishop Score and Risk of Cesarean Delivery After Induction of Labor in Nulliparous Women

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OBJECTIVE: **To quantify the risk and risk factors for cesarean delivery associated with medical and elective induction of labor in nulliparous women.**

METHODS: **A prospective cohort study was performed in nulliparous women at term with vertex singleton gestations who had labor induced at 2 obstetrical centers. Medical and elective indications and Bishop scores were recorded before labor induction. Obstetric and neonatal data were analyzed and compared with the results in women with a spontaneous onset of labor. Data were analyzed using univariate and multivariable regression modeling.**

RESULTS: **A total of 1,389 women were included in the study. The cesarean delivery rate was 12.0% in women with a spontaneous onset of labor (n = 765), 23.4% in women undergoing labor induction for medical reasons (n = 435) (unadjusted odds ratio [OR] 2.24; 95% confidence interval [CI] 1.64–3.06), and 23.8% in women whose labor was electively induced (n = 189) (unadjusted OR 2.29; 95% CI 1.53–3.41). However, after adjusting for the Bishop score at admission, no significant differences in cesarean delivery rates were found among the 3 groups. A Bishop score of 5 or less was a predominant risk factor for a cesarean delivery in all 3 groups (adjusted OR 2.32; 95% CI 1.66–3.25). Other variables with significantly increased risk for cesarean delivery included maternal age of 30 years or older, body mass index of 31 or higher, use of epidural analgesia during the first stage of labor, and birth weight of 3,500 g or higher. In both induction groups, more newborns required neonatal care, more mothers needed a blood transfusion, and the maternal hospital stay was longer.**

CONCLUSION: **Compared with spontaneous onset of labor, medical and elective induction of labor in nulliparous women at term with a single fetus in cephalic presentation is associated with an increased risk of cesarean delivery, predominantly related to an unfavorable Bishop score at admission. (Obstet Gynecol 2005;105:690–7. © 2005 by The American College of Obstetricians and Gynecologists.)**

LEVEL OF EVIDENCE: II-2

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Induction of labor is a common procedure in modern obstetrics. In the United States, the rate of labor induction increased gradually from 9.5% to 19.4% for all births between 1990 and 1998.[1] Although in the Netherlands the labor induction rates remained constant (approximately 15%) between 1993 and 2002, remarkable differences have been demonstrated in the frequencies of labor induction rates in Dutch hospitals, even after adjustment for population differences.[2] Reasons for these differences relate to the widespread availability of cervical ripening agents, pressure from patients, convenience for physicians, logistic factors, psychosocial reasons, and litigious constraint.[3]

Induction of labor is associated with an increased risk of cesarean delivery.[4] This has been demonstrated not only for medically indicated inductions, but also for elective inductions.[5–8] Nulliparous women are particularly at increased risk.[9,10] It is well known that the successful induction of labor is related to cervical ripeness.[11] Nevertheless, since the introduction of cervical ripening agents like prostaglandins, cervical status no longer seems to be a factor in the decision-making process regarding labor induction. Studies not including the Bishop score for cervical ripeness in the analysis report a significantly increased risk of cesarean delivery.[5–7,9,10] Most studies that do include the Bishop score find an increased risk of cesarean delivery when labor is induced with a low Bishop score.[4,12–14] One study including the Bishop score, however, found an increased risk of cesarean delivery with a low Bishop score and not with induction per se.[15]

The present prospective cohort study was performed to quantify the risk and risk factors for cesarean delivery after induction of labor for a medical or elective indication, compared with spontaneous labor onset, in nulliparous women.

MATERIALS AND METHODS

All nulliparous women with a term single fetus in vertex presentation who underwent induction of labor in

0029-7844/05/$30.00
doi:10.1097/01.AOG.0000152338.76759.38

Table 1. Indications for Induction of Labor

	n (%)
Medical induction group	435 (100)
Gestational age ≥ $42^{0/7}$ weeks	144 (33.1)
Prolonged rupture of the membranes (≥ 24 h)	116 (26.7)
Hypertension (diastolic 1× ≥ 110 mm Hg or 2× ≥ 90 mm Hg)	74 (17.0)
Preeclampsia (hypertension + proteinuria ≥ 0.3 g/L)	61 (14.0)
Fetal growth restriction (estimated fetal weight by ultrasound ≤ p 2.3)	19 (4.4)
Macrosomia (estimated fetal weight by ultrasound ≥ p 97.7)	9 (2.1)
Nonreassuring fetal heart rate pattern	8 (1.8)
Diabetes mellitus	3 (0.7)
Active blood group incompatibility	1 (0.2)
Elective induction group	189 (100)
Impending postterm pregnancy ($40^{0/7}$ weeks up to $41^{6/7}$ weeks)	62 (32.8)
Psychosocial reasons	39 (20.6)
Suspected fetal growth restriction (but estimated fetal weight by ultrasound > p 2.3)	19 (10.1)
Suspected decreased amniotic fluid (but pockets 2–8 cm by ultrasound)	19 (10.1)
Decreased sensation of fetal movements (but normal fetal heart rate pattern and ultrasonogram)	6 (3.2)
Pelvic instability	6 (3.2)
Mild hypertension	5 (2.6)
Suspected macrosomia (but estimated fetal weight by ultrasound < p 97.7)	4 (2.1)
Other reasons	29 (15.3)

p, percentile.

Atrium Medical Center, Heerlen, between January 1, 2000, and October 31, 2002, or in VieCuri Medical Center, Venlo, between January 1, 2001, and October 31, 2002, participated in this prospective study. Excluded were multiparous women; women with multiple gestations, fetal anomaly, or breech or transverse lie; preterm deliveries (< $37^{0/7}$ weeks); planned cesarean deliveries (for elective, medical, or obstetric reasons); and women who were referred during delivery by a primary care midwife for any reason.

At the outpatient department, or at least at admission to the labor ward, the actual reason for induction was recorded. As shown in Table 1, women with a medical indication for labor induction were assigned to the medical induction group, whereas all other women who were induced without a medical indication constituted the elective induction group. Other reasons for assignment into the elective induction group included difficult external fetal monitoring (n = 3), mild pulmonary disease (n = 3), uncertain gestational age (n = 3), meconium stained amniotic fluid (n = 3), edema (n = 2), gestational diabetes (n = 2), and several indications that were mentioned only once (n = 13). Induction was performed using either prostaglandin E_2 vaginal gel alone, amniotomy alone, oxytocin in combination with or without amniotomy, or prostaglandin E_2 vaginal gel followed by oxytocin, or amniotomy, or a combination of both. Based on the Bishop score at admission, the attending obstetrician decided which method of induction should be performed. In case of an unfavorable cervix, induction was usually started with prostaglandin E_2 vaginal gel for ripening.

Women in whom spontaneous onset of labor was diagnosed at admission were assigned to the spontaneous onset group, which served as the control group. The criteria used to diagnose spontaneous onset of labor were regular, painful uterine contractions together with either changes in cervical status or rupture of the membranes.

Continuous electronic fetal monitoring, either internal or external, was used in all cases. The analgesics used were mostly nalbuphine and pethidine. Epidural analgesia, if given, was a continuous infusion of ropivacaine with fentanyl.

The attending obstetrician or midwife recorded antepartum, intrapartum, and neonatal data on a labor and delivery data sheet at the time of each delivery. The investigators, who also checked all data for completeness, recorded postpartum information. At the end of the study, all data were entered into a SPSS database (SPSS Inc, Chicago, IL).

Statistical analyses were performed using SPSS 11.5. Univariate analyses included the χ^2 test and analysis of variance, followed by Scheffé test for differences between groups. Known prognostic variables were included in a multivariable logistic regression analysis. A final model of risk factors for cesarean delivery was created using the maximum likelihood estimation ($P < .05$). Adjusted odds ratios (ORs) were reported for the variables that were statistically significant.

RESULTS

During the study period, 3,532 term nulliparous women delivered in the 2 centers. Exclusion criteria were found in 2,143 of them, so a total of 1,389 women (39.3%) were qualified for inclusion into the study. Labor was induced for medical reasons in 435 women (31.3%), elective labor induction was performed in 189 women (13.6%), and 765 women (55.1%) had a spontaneous onset of labor.

Characteristics of the study population at admission are shown in Table 2, according to the 3 different groups. There were no significant differences in age,

Table 2. Characteristics of the Study Population at Admission (N = 1,389)

	Spontaneous Onset Group (n = 765)	Medical Induction Group (n = 435)	Elective Induction Group (n = 189)	*P*
Age (y)				
≤ 19	31 (4.1)	15 (3.5)	9 (4.8)	.095*
20–24	121 (15.8)	62 (14.3)	35 (18.5)	
25–29	262 (34.2)	169 (38.9)	66 (34.9)	
30–34	239 (31.2)	148 (34.0)	49 (25.9)	
≥ 35	112 (14.6)	41 (9.4)	30 (15.9)	
Mean (± SD)	29.4 (5.2)	29.1 (4.7)	29.0 (5.2)	.523†
Body mass index (kg/m^2)				
< 20	12 (1.6)	5 (1.2)	0	< .001*
20–25	228 (30.2)	75 (17.9)	47 (25.3)	
26–30	309 (40.9)	158 (37.6)	71 (38.2)	
≥ 31	206 (27.3)	182 (43.3)	68 (36.6)	
Mean (± SD)	28.7 (5.2)	30.7 (5.6)	29,9 (5.6)	< .001‡
Ethnicity				
White	663 (87.1)	375 (87.4)	161 (87.0)	.947*
Mediterranean	37 (4.9)	24 (5.6)	11 (5.9)	
Other European	20 (2.6)	9 (2.1)	4 (2.2)	
Other	28 (3.7)	20 (4.7)	9 (4.9)	
Abortion				
None	599 (78.3)	360 (82.8)	145 (76.7)	.137*
1 or 2	156 (20.4)	74 (17.0)	41 (21.7)	
≥ 3	10 (1.3)	1 (0.2)	3 (1.6)	
Gestational age (wk)				
$37^{0/7}$ to $37^{6/7}$	51 (6.7)	38 (8.7)	11 (5.8)	< .001*
$38^{0/7}$ to $38^{6/7}$	128 (16.7)	77 (17.7)	27 (14.3)	
$39^{0/7}$ to $39^{6/7}$	180 (23.5)	68 (15.6)	19 (10.1)	
$40^{0/7}$ to $40^{6/7}$	229 (29.9)	69 (15.9)	33 (17.5)	
$41^{0/7}$ to $41^{6/7}$	161 (21.0)	35 (8.0)	93 (49.2)	
≥ 42	16 (2.1)	148 (34.0)	6 (3.2)	
Mean (± SD)	39.9 (1.2)	40.3 (1.6)	40.5 (1.4)	< .001‡
Hospital				
Heerlen	497 (65.0)	228 (52.4)	119 (63.0)	< .001*
Venlo	268 (35.0)	207 (47.6)	70 (37.0)	
Dilatation (cm)				
0	12 (1.6)	169 (39.6)	65 (34.6)	< .001*
1–2	210 (27.6)	229 (53.6)	114 (60.6)	
3–4	279 (36.7)	24 (5.6)	9 (4.8)	
≥ 5	259 (34.1)	5 (1.2)	0 (0)	
Effacement (%)				
0–30%	11 (1.5)	124 (29.1)	48 (25.5)	< .001*
40–50%	84 (11.1)	178 (41.8)	88 (46.8)	
60–70%	102 (13.5)	54 (12.7)	19 (10.1)	
≥ 80%	560 (74.0)	70 (16.4)	33 (17.6)	
Bishop score				
≤ 5	144 (18.9)	351 (80.9)	154 (81.5)	< .001*
6–8	294 (38.6)	70 (16.1)	34 (18.0)	
≥ 9	323 (42.4)	13 (3.0)	1 (0.5)	
Mean (± SD)	7.9 (2.6)	3.3 (2.5)	3.2 (2.3)	< .001‡
Range	0–13	0–12	0–9	

SD, standard deviation.

Data are expressed as n (%), except where otherwise indicated.

* Chi-square test.

† Analysis of variance.

‡ Analysis of variance, followed by Scheffé test; both induction groups differ from the spontaneous onset group.

race, and number of abortions among the groups. However, compared with the medical induction group, more women in the elective induction group were younger (< 25 years) or older (≥ 35 years) (P = .037). The body mass index (BMI) was significantly higher in both induction groups than in the spontaneous onset group. The gestational age in the spontaneous onset group was significantly lower than in the 2 other groups, whereas

Table 3. Labor Characteristics

	Spontaneous Onset Group (n = 765)	Medical Induction Group (n = 435)	Elective Induction Group (n = 189)	*P*
Membrane rupture (h)				
Mean (± SD)	13.9 (16.7)	21.4 (26.2)	9.9 (10.5)	< .001*
Range	0.0–101.0	0.0–133.8	0.0–64.2	
Meconium-stained amniotic fluid				
Yes	132 (17.3)	64 (14.9)	36 (19.4)	.349†
No	629 (82.7)	365 (85.1)	150 (80.6)	
Oxytocin stimulation				
No	529 (69.2)	295 (68.4)	138 (73.0)	.109†
Yes, during first stage	204 (26.7)	128 (29.7)	48 (25.4)	
Yes, during second stage	31 (4.1)	8 (1.9)	3 (1.6)	
Analgesia				
None	417 (55)	218 (50)	84 (44)	.001†
Analgesics	259 (34)	145 (33)	63 (33)	
Epidural analgesia	26 (3)	28 (7)	20 (11)	
Analgesics plus epidural analgesia	61 (8)	43 (10)	22 (12)	
Second stage (h)				
Mean (± SD)	0.67 (0.44)	0.67 (0.48)	0.61 (0.42)	.317‡
Range	0–3.58	0–4.45	0–2.05	
Mode of delivery				
Spontaneous birth	512 (66.9)	240 (55.2)	107 (56.6)	
Instrumental vaginal birth	161 (21.0)	93 (21.4)	37 (19.6)	.629†
Vacuum	130 (17.0)	78 (17.9)	29 (15.3)	
Forceps	31 (4.1)	15 (3.4)	8 (4.2)	
Cesarean	92 (12.0)	102 (23.4)	45 (23.8)	< .001†
Birth weight (g)				
< 2,500	19 (2.5)	35 (8.0)	11 (5.8)	< .001†
2,500–2,999	163 (21.3)	73 (16.8)	28 (14.8)	
3,000–3,499	290 (37.9)	136 (31.3)	57 (30.2)	
3,500–3,999	224 (29.3)	133 (30.6)	64 (33.9)	
4,000–4,499	62 (8.1)	54 (12.4)	28 (14.8)	
≥ 4,500	7 (0.9)	4 (0.9)	1 (0.5)	
Mean (± SD)	3,360 (470)	3,365 (570)	3,435 (542)	.183‡

SD, standard deviation.
Data are expressed as n (%), except where otherwise indicated.
* Analysis of variance, followed by Scheffé test; differences among the 3 groups.
† Chi-square test.
‡ Analysis of variance.

the gestational age was usually 41 weeks in the elective induction group and 42 weeks in the medical induction group. Although the elective induction rates in the 2 centers were almost equal, patients were induced for a medical reason more often in Venlo than in Heerlen ($P <$ .015). Compared with the women in the spontaneous onset group, the medically and electively induced women had significantly less dilatation and effacement, and significantly lower Bishop scores at admission. However, there was no difference in dilatation ($P = .240$), effacement ($P = .536$), and Bishop score ($P = .146$) between the medical and the elective induction groups.

No significant differences in the methods of induction were found between the 2 induction groups ($P = .111$). In the medical induction group and in the elective induction group, prostaglandin E_2 vaginal gel was applied in 55.7% and 53.4% of women, respectively; amniotomy alone in 5.8% and 10.6%, respectively; oxytocin with or without amniotomy in 23.8% and 22.2%, respectively; and prostaglandin E_2 vaginal gel, followed by intravenous oxytocin or amniotomy, or a combination of both, in 14.7% and 13.8%, respectively.

Labor characteristics are described in Table 3. Duration of membrane rupture was significantly longer in the medical induction group than in the spontaneous onset group, which was again significantly longer than in the elective induction group. No significant differences were found in meconium-stained amniotic fluid, oxytocin stimulation during the first or second stage of labor, the use of analgesics, or the duration of the second stage. Compared with the spontaneous onset group, epidural analgesia was more frequently given to women in both

induction groups, though this difference was not significant ($P = .240$) between both induction groups.

The percentage of instrumental vaginal deliveries was almost equal among the 3 groups. Compared with the spontaneous onset group, however, the number of cesarean deliveries was almost doubled in both the medical and the elective induction group. The most common indication for cesarean delivery was failure to progress (58.0%), followed by fetal distress (26.3%), or a combination of both (15.7%). No significant differences in cesarean delivery indication among the 3 groups could be demonstrated ($P = .237$). In all 3 groups, most cesarean deliveries were performed during the first stage of labor (84.9%) ($P = .297$).

Compared with the spontaneous onset group, more children with a birth weight less than 2,500 g and 4,000 g or higher were born in both the medical and the elective induction groups. The birth weight of the babies between both induction groups was not different ($P = .720$). No significant differences among the 3 groups were found in neonatal sex, 1-minute and 5-minute Apgar scores, or umbilical artery pH. However, newborns in the medical and elective induction groups required more frequent oxygen insufflation (16.8% and 12.2%, respectively), were more often referred to a pediatrician (87.6% and 71.4%, respectively), and were more often admitted to the neonatal department (24% and 25.9%, respectively) than children in the spontaneous onset group (9%, 62.7% and 14.8%, respectively). Compared with the elective induction group, more children in the medical induction group were referred to a pediatrician ($P < .001$).

Blood transfusion was necessary in 41 women (9.4%) in the medical induction group, which was not significantly different from 20 women (10.6%) in the elective induction group ($P = .655$). In the spontaneous onset group, however, only 44 women (5.8%) needed a blood transfusion, which was significantly less frequent ($P = .016$). Mean (± SD) maternal hospital stay in the spontaneous onset group was 2.7 ± 2.0 days, which was significantly ($P < .001$) shorter than the mean hospital stay in both the medical induction group (3.7 ± 1.9 days) and the elective induction group (3.5 ± 2.1 days). The maternal hospital stay between both induction groups was not different ($P = .203$).

Compared with the spontaneous onset group, the unadjusted OR for a cesarean delivery was 2.24 in the medical induction group (95% confidence interval [CI] 1.64–3.06), and 2.29 in the elective induction group (95% CI 1.53–3.41). In a multivariable logistic regression model without the Bishop score at admission, medical and elective induction of labor continued to be associated with adjusted ORs of 1.96 (95% CI 1.33–2.90) and 1.98 (95% CI 1.25–3.14), respectively. Looking at the Bishop score at admission, however, a significant correlation with the cesarean delivery rate could be demonstrated in all 3 groups. The subgroup of all patients whose Bishop score was less than or equal to 5 had a higher rate of cesarean delivery (25.0%) than the 6–8 subgroup (13.6%) and the 9 or higher subgroup (6.2%) ($P < .001$). In the multivariable logistic regression model (as shown in Table 4), with the Bishop score at admission included as an extra covariable, the difference in the cesarean delivery rate among the 3 groups was no longer significant. The adjusted OR was 1.35 for the medical induction group (95% CI 0.87–2.11) and 1.23 for the elective induction group (95% CI 0.75–2.02). Other in-

Table 4. Adjusted Odds Ratios for a Cesarean Delivery After Including the Bishop Score at Admission in the Multivariable Logistic Regression Model

Risk Factor	Adjusted OR (95% CI)
Labor groups	
Spontaneous onset	1.0
Medical induction	1.35 (0.87–2.11)
Elective induction	1.23 (0.75–2.02)
Maternal age (y)	
≤ 19	0.24 (0.05–1.07)
20–24	0.54 (0.31–0.94)*
25–29	1.0
30–34	1.59 (1.10–2.30)*
≥ 35	2.37 (1.50–3.76)†
Body mass index (kg/m^2)	
≤ 25	1.0
26–30	1.26 (0.80–1.99)
≥ 31	2.87 (1.84–4.48)†
Gestational age (wk)	
$37^{0/7}$ to $37^{6/7}$	0.42 (0.19–0.94)*
$38^{0/7}$ to $38^{6/7}$	0.46 (0.27–0.79)†
$39^{0/7}$ to $39^{6/7}$	0.65 (0.40–1.05)
$40^{0/7}$ to $40^{6/7}$	1.0
$41^{0/7}$ to $41^{6/7}$	0.77 (0.50–1.21)
≥ 42	0.79 (0.47–1.32)
Bishop score	
≤ 5	2.32 (1.66–3.25)†
> 5	1.0
Epidural analgesia	
None	1.0
At dilatation < 4 cm	3.63 (2.06–6.40)†
At dilatation ≥ 4 cm	2.15 (1.34–3.43)†
Birth weight (g)	
< 2,500	1.33 (0.53–3.36)
2,500–2,999	1.51 (0.92–2.46)
3,000–3,499	1.0
3,500–3,999	1.66 (1.12–2.47)*
≥ 4,000	2.38 (1.45–3.91)†
Hospital	
Heerlen	1.0
Venlo	1.48 (1.08–2.04)*

OR, odds ratio; CI, confidence interval.
* $P < .05$.
† $P < .01$.

dependent risk factors for a cesarean delivery were maternal age, BMI, gestational age, epidural analgesia, birth weight, and hospital of delivery. Finally, the Bishop score at admission was removed from the multivariable model and dilatation and degree of effacement were added in its place. Only dilatation, and not the degree of effacement, was a statistically significant predictor of cesarean delivery rate. Compared with dilatation of 5 cm or more, the adjusted ORs for a cesarean delivery were 2.68 (95% CI 1.34–5.38) for 3–4 cm, 4.46 (95% CI 2.34–8.52) for 1–2 cm, and 6.81 (95% CI 3.42–13.45) for 0 cm.

DISCUSSION

The present study was designed to investigate whether induction of labor in nulliparous women with a term single fetus in cephalic presentation predisposes to a higher risk of cesarean delivery than does spontaneous onset of labor. As medical indications could have an additional risk for instrumental delivery, all women with accurately defined medical indications were assigned to the medical induction group before the start of induction. The elective induction group consisted of women without a specific medical indication. Women with a spontaneous onset of labor at admission formed the control group.

Although the percentage of instrumental vaginal deliveries in the 3 groups was almost equal, the cesarean delivery rate in women whose labor was induced was almost twice as high as in women with a spontaneous onset (23.6% versus 12.0%). This is in agreement with many other studies.[4,5,7–10,14] Indeed, a 3-fold risk[6] and even an 8-fold risk[16] of cesarean delivery has been reported. The double cesarean delivery rate was found in both the medical (23.4%) and the elective (23.8%) induction groups. Therefore, women who undergo an elective induction of labor have essentially the same risk of cesarean delivery as women who have a medical indication for induction. The same finding was reported by Seyb et al,[9] who found a 7.8% cesarean delivery rate in women experiencing spontaneous labor, whereas women undergoing elective labor induction had a 17.5% cesarean delivery rate (adjusted OR 1.89, 95% CI 1.12–3.18) and women undergoing medically indicated labor induction had a 17.7% cesarean delivery rate (adjusted OR 1.69, 95% CI 1.13–2.54).

In all 3 groups, the cesarean delivery rate was significantly related to the Bishop score at admission; dilatation was the most important item, and failure to progress during the first stage was the most common indication for cesarean delivery. After including the Bishop score as an extra covariable in the multivariable logistic regression model, no significant differences in cesarean delivery rate among the 3 groups could be demonstrated. Therefore, a Bishop score at admission of 5 or lower, and not the induction per se, is associated with a more than double risk in cesarean delivery rate, regardless of whether the labor is induced for a medical or an elective reason. This is in agreement with the study of Prysak and Castronova,[15] but in contrast with many other studies that reported both labor induction and cervical ripeness as being of significance.[4,12–14] The Bishop score in our study was assigned only by digital examination, but its accuracy in predicting the successful induction of labor in nulliparous patients has been demonstrated again very recently.[17] A possible limitation of this study was the absence of a prospectively determined method of induction in case of a certain Bishop score. In case of an unfavorable cervix, however, induction was usually started with prostaglandin E_2 vaginal gel for ripening.

No significant differences in maternal age, race, and abortion rate were found among the 3 groups. Maternal age was a significant independent risk factor for cesarean delivery. The higher the maternal age, the higher the risk for cesarean delivery, as found by many other investigators.[6,14,18,19] Compared with the spontaneous onset group, women in both induction groups had a higher BMI. Body mass index was also an independent risk factor for cesarean delivery. Increased BMI was associated with an increase in the cesarean delivery rate, as demonstrated by others.[9,20,21] Because impending postterm pregnancy with its accompanying psychosocial problems was an indication for elective induction, and because postterm pregnancy was an indication for medical induction, it could have been expected that the lowest gestational age was found in the spontaneous onset group and the highest gestational age in the medical induction group. A gestational age of less then 39 weeks was associated with a decreased risk of cesarean delivery, as mentioned by others.[15] Meconium-stained amniotic fluid, oxytocin stimulation during the first and second stages, and duration of the second stage were similar in the 3 groups. Because prolonged rupture of the membranes was an indication for medical induction, the duration of ruptured membranes was longest in the medical induction group. Moreover, as spontaneous onset of labor often starts with membrane rupture, duration of membrane rupture was longer in the spontaneous onset group than in the elective induction group. None of these factors had an independent relation to the cesarean delivery rate.

Compared with the spontaneous onset group, epidural analgesia was more frequently given to women in both induction groups. It remains unknown whether

epidural analgesia was merely given for increased pain during induction or also on request by the laboring women. Epidural analgesia was also an independent risk factor for cesarean delivery. The earlier epidural analgesia was given during labor, the higher the probability of a cesarean delivery later on, confirming the results of other studies.[9,10,22] As could be expected, more children with a birth weight below 2,500 g or 4,000 g or higher were born in the induction groups than in the spontaneous onset group. Birth weight was also an independent risk factor for cesarean delivery. Birth weight of 3,500 g or higher was associated with an increased cesarean delivery rate, again as mentioned by others.[6,9,14,15] The higher cesarean delivery rate at the obstetric unit in Venlo seems to be related to the significantly higher percentage of medical inductions in this center compared with the obstetric unit in Heerlen.

The neonatal condition at birth was equal in the 3 groups. As expected, more children in the medical induction group were referred to the pediatrician after delivery. Probably because of the increased cesarean delivery rate, more newborns in both induction groups needed oxygen administration and were more often admitted to the neonatal ward. Several authors reported increased need for neonatal resuscitation, admission to neonatal intensive care, and use of phototherapy.[8,10] Compared with the spontaneous onset group, more women in both induction groups needed a blood transfusion, and their hospital stay was 1 day longer.

In summary, the present study emphasizes that both medical and elective induction of labor in nulliparous women at term with a single fetus in cephalic presentation is associated with an increased risk of cesarean delivery, predominantly related to an unfavorable Bishop score. Whereas induction for medical indications is often inevitable, induction for elective reasons should be discouraged in the case of an unripe Bishop score. This is especially true for older women (≥ 30 years), those with a high BMI (≥ 31), and those with an estimated birth weight of 3,500 g or higher. The combination of several risk factors leads to a considerably increased risk of cesarean delivery, which is associated with increased need for blood transfusion and more frequent neonatal care. In addition, the hospital stay is longer.

Awareness of these results by nulliparous women and their obstetricians should convince them not to start an elective induction in case of an unfavorable Bishop score and to wait patiently for a spontaneous onset. This is also of utmost importance to reduce the ongoing rise of cesarean delivery rates.

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Received June 9, 2004. Received in revised form October 28, 2004. Accepted November 4, 2004.