Interaction between Maternal Obesity and Bishop Score in Predicting Successful Induction of Labor in Term, Nulliparous Patients

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Abstract

Objective Determine the Bishop score most predictive of induction of labor (IOL) success for different maternal weight groups.

Study Design Retrospective cohort study. Prospectively collected database utilized to determine the optimum Bishop score within each prepregnancy body mass index (BMI) category of term, nulliparous patients undergoing IOL.

Results For the total group ($n = 696$), Bishop score ≥ 5 was most predictive of success (75% versus 56%, $p < 0.0001$). Within each BMI category, Bishop score ≥ 5 remained most predictive: normal weight (79% versus 64%, $p < 0.01$); overweight (72% versus 58%, $p = 0.03$); and obese (73% versus 45%, $p < 0.0001$). Overall, nonobese patients had more success than obese patients (70% versus 59%, $p < 0.01$). The nonobese group had more success than the obese group when the Bishop score was <3 (57% versus 39%, $p < 0.05$) but not when it was ≥ 3 (72% versus 65%, $p = 0.1$). Also, there was a higher fraction of patients with Bishop score <3 in the obese group compared with the nonobese group (25% versus 14%, $p < 0.001$).

Conclusion The optimum Bishop score for predicting successful IOL in nulliparous patients was 5 regardless of BMI class. The higher IOL failure rate observed in obese women was associated with lower starting Bishop scores and was compounded by higher failure rates in obese women with Bishop scores <3.

Keywords
- BMI
- Bishop
- induction
- nulliparous

Maternal obesity is an epidemic in the United States; in the 2004 National Health and Nutrition Examination Survey, 33% of adult American women were classified as obese.[1] This has important implications for the practice of obstetrics because obesity is associated with several pregnancy complications including failed induction of labor (IOL), increased cesarean section rate and increased postoperative wound infections and blood loss.[2–8] These complications increase with increased maternal prepregnancy body mass index (BMI).[9,10] Also, overweight and obese patients are more likely to have preexisting medical problems such as hypertension and diabetes[4,11] as well as pregnancy-specific conditions to include gestational hypertension, preeclampsia, and gestational diabetes.[2,5,9] Because most of these conditions are also indications for IOL, obese patients may be more likely to start the delivery process with a cervix that is less favorable than their nonobese counterparts.

The most widely used system for evaluating cervical ripeness for IOL was developed by Dr. Edward Bishop in 1964. Bishop assigned individual scores of 0 to 3 in each of

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five categories based on the cervical examination (dilatation, effacement, station, consistency, and position) and found that a total Bishop score of 9 or more was associated with a zero rate of failed inductions in parous patients.[12] A more recent study found a 31.5% cesarean section rate for IOL with Bishop score <5 versus a cesarean section rate of 18.1% when the Bishop score was ≥5 ($p < 0.001$).[13] Another investigator had similar findings but with a Bishop score of ≥4 as the cutoff.[14] None of these studies controlled for maternal BMI. Of note, not all studies have found the Bishop score to be predictive of successful labor induction.[15]

Although obesity and low Bishop score are both associated with failed IOL, it is unknown whether the two act independently or synergistically. Most of the studies on obesity and cesarean section have not controlled for the patient's cervical exam on admission. In one small case control study that looked at both maternal BMI and cervical examination, both factors were significant contributors to an increased cesarean section rate. In that study, only cervical dilatation was considered (versus the full Bishop score) and the interaction between these two factors was not investigated.[16] Therefore, the objective of this study was to determine the Bishop score that most accurately predicted induction success in nulliparous patients within each maternal prepregnancy weight group, as well as any factors responsible for the differences observed. We limited our study to nulliparous patients because the data regarding Bishop score and increased cesarean rate are more consistently associated with unlabored uteri.[14]

Methods

This study was approved by the Institutional Review Board at Madigan Army Medical Center. This was a retrospective cohort study of 696 nulliparous patients undergoing IOL at term (37 to 42 weeks' gestation) between 2006 and 2010. The study inclusion criteria were nulliparous patients 18 to 50 years old with BMI ≥18.5 and singleton pregnancy undergoing IOL at 37 to 42 weeks' gestation. Exclusion criteria were previous uterine surgery, intrauterine fetal demise, noncephalic fetal presentation, and ruptured membranes or labor at time of admission. Also, patients were excluded from the study if their BMI data at the start of pregnancy or Bishop score on admission was not available.

We divided our study population into groups according to BMI at the time of their first prenatal visit: normal weight ($25 > \text{BMI} \geq 18.5$), overweight ($30 > \text{BMI} \geq 25$), obese ($35 > \text{BMI} \geq 30$) and morbidly obese ($\text{BMI} \geq 35$). For each patient, estimated gestational age, indication for IOL, preinduction five component Bishop score, height and prepregnancy weight, patient demographics, estimated fetal weight, birth weight, and mode of delivery were recorded. The Bishop score was based on the initial cervical examination performed by the midwife, resident, or attending physician that admitted the patient for labor induction. This data were collected utilizing our institution's electronic medical record system, which documents all patient encounters including antenatal visits, admission history, and physicals, delivery notes, and newborn exams. All nulliparous patients who underwent IOL during the study period and who met inclusion criteria were analyzed. The optimum Bishop score for predicting successful IOL was calculated for our entire study population and separately for each BMI group. For the purpose of this study, we defined successful IOL as vaginal or operative vaginal delivery. Cesarean section for any reason after beginning the induction process was classified as an induction failure. During the study period, our providers considered the active phase of labor to commence with regular uterine contractions and a cervical dilatation of 4 cm or more. Our center follows American College of Obstetricians and Gynecologists guidelines for labor management.[17]

Multivariate logistic regression was performed to determine independent factors associated with IOL success in our study population. SPSS 14.0 software (SPSS Inc., Chicago, IL) and Open Epi Version 2.3.1 (Open Source Epidemiologic Statistics for Public Health, Emory University) were utilized in this study. Statistical tests used included two sided Student *t* test for continuous data and chi-square and Fisher exact tests for discreet data. Block entry was used for the logistic regression.

Results

A total of 9777 women delivered during the study period and 4385 (45%) of them were nulliparous. Of these 4385 patients, 783 met the inclusion criteria. Of these 783, BMI at the start of pregnancy and Bishop score at start of induction were available for 696 (89%) of them. For the 696 nulliparous patients studied, the rate of successful IOL was 67%. In the total study group ($n = 696$), a Bishop score of ≥5 compared with <5 had the best predictive value for successful IOL (75% versus 56%, chi-square = 27.3, $p < 0.0001$). Within each BMI category, a Bishop score of ≥5 compared with <5 remained most predictive, as shown in ►**Table 1** and ►**Fig. 1**. Compared with the obese group ($\text{BMI} \geq 30$, $n = 198$), the nonobese group ($\text{BMI} < 30$, $n = 498$) had a higher rate of successful induction (70% versus 59%, $p < 0.01$).

When these groups were subdivided further, we did not observe differences in rates of successful IOL. Specifically, IOL success between the normal weight group ($18.5 \leq \text{BMI} < 25$, $n = 276$) and overweight group ($30 > \text{BMI} \geq 25$, $n = 222$) was not statistically significant (73% versus 66%, $p = 0.1$). The difference between the mildly obese ($35 > \text{BMI} \geq 30$, $n = 125$) and morbidly obese groups ($\text{BMI} \geq 35$, $n = 73$) was not statistically significant either (58% versus 60%, $p = 0.7$). Therefore, we limited further analysis to comparisons between obese and nonobese groups only.

Compared with nonobese patients, the obese patients had lower rates of successful IOL for Bishop scores <3 (57% versus 39%, $p < 0.05$) but not for Bishop scores ≥3 (72% versus 65%, $p = 0.1$). In addition, a higher proportion of patients had Bishop scores <3 in the obese group compared with the nonobese group (25% versus 14%, $p < 0.001$; ►**Figs. 2** and **3**). Of the independent risk factors for IOL failure identified with our logistic regression, only maternal age (24.6 versus 23.4, $p = 0.001$), maternal prepregnancy weight (210.0 versus 145.6, $p < 0.0001$), and Bishop score (4.5 versus 5.0,

Table 1 Optimal Bishop Score within Different BMI Categories

BMI Category	Bishop Score	IOL Success	Statistics[a]
Normal (BMI < 25), $n = 276$; IOL success = 73%	≥ 1 versus < 1	73% versus 63%	$\chi^2 = 0.4$, $p = 0.5$
	≥ 2 versus < 2	73% versus 67%	$\chi^2 = 0.3$, $p = 0.6$
	≥ 3 versus < 3	75% versus 59%	$\chi^2 = 5.0$, $p = 0.03$
	≥ 4 versus < 4	77% versus 62%	$\chi^2 = 5.8$, $p = 0.02$
	≥ 5 versus < 5	79% versus 64%	$\chi^2 = 7.6$, $p = 0.006$
	≥ 6 versus < 6	81% versus 67%	$\chi^2 = 6.5$, $p = 0.01$
	≥ 7 versus < 7	83% versus 70%	$\chi^2 = 4.8$, $p = 0.03$
	≥ 8 versus < 8	90% versus 70%	$\chi^2 = 6.6$, $p = 0.01$
	≥ 9 versus < 9	93% versus 72%	$\chi^2 = 3.0$, $p = 0.08$
Overweight ($30 >$ BMI ≥ 25), $n = 222$, IOL success = 66%	≥ 1 versus < 1	66% versus 0%	$\chi^2 = 2.0$, $p = 0.2$
	≥ 2 versus < 2	67% versus 58%	$\chi^2 = 0.4$, $p = 0.6$
	≥ 3 versus < 3	68% versus 54%	$\chi^2 = 2.0$, $p = 0.2$
	≥ 4 versus < 4	70% versus 57%	$\chi^2 = 3.0$, $p = 0.08$
	≥ 5 versus < 5	72% versus 58%	$\chi^2 = 4.8$, $p = 0.03$
	≥ 6 versus < 6	74% versus 61%	$\chi^2 = 3.8$, $p = 0.05$
	≥ 7 versus < 7	72% versus 64%	$\chi^2 = 1.1$, $p = 0.3$
	≥ 8 versus < 8	77% versus 65%	$\chi^2 = 1.5$, $p = 0.2$
	≥ 9 versus < 9	80% versus 66%	$\chi^2 = 0.9$, $p = 0.4$
Obese (BMI ≥ 30), $n = 198$, IOL success = 59%	≥ 1 versus < 1	59% versus 50%	$\chi^2 = 0.3$, $p = 0.6$
	≥ 2 versus < 2	60% versus 50%	$\chi^2 = 0.9$, $p = 0.3$
	≥ 3 versus < 3	65% versus 39%	$\chi^2 = 10.5$, $p = 0.001$
	≥ 4 versus < 4	69% versus 41%	$\chi^2 = 14.4$, $p = 0.0002$
	≥ 5 versus < 5	73% versus 45%	$\chi^2 = 15.4$, $p < 0.0001$
	≥ 6 versus < 6	72% versus 52%	$\chi^2 = 7.8$, $p = 0.005$
	≥ 7 versus < 7	72% versus 54%	$\chi^2 = 4.8$, $p = 0.03$
	≥ 8 versus < 8	73% versus 57%	$\chi^2 = 2.0$, $p = 0.2$
	≥ 9 versus < 9	75% versus 58%	$\chi^2 = 1.4$, $p = 0.2$
Total group ($n = 696$), IOL success = 678%	≥ 1 versus < 1	67% versus 56%	$\chi^2 = 1.0$, $p = 0.3$
	≥ 2 versus < 2	68% versus 57%	$\chi^2 = 2.6$, $p = -0.1$
	≥ 3 versus < 3	70% versus 50%	$\chi^2 = 18.9$, $p < 0.0001$
	≥ 4 versus < 4	72% versus 53%	$\chi^2 = 23.4$, $p < 0.0001$
	≥ 5 versus < 5	75% versus 56%	$\chi^2 = 27.3$, $p < 0.0001$
	≥ 6 versus < 6	76% versus 60%	$\chi^2 = 19.2$ $p < 0.0001$
	≥ 7 versus < 7	76% versus 64%	$\chi^2 = 9.6$, $p = 0.002$
	≥ 8 versus < 8	82% versus 65%	$\chi^2 = 10.0$, $p = 0.002$
	≥ 9 versus < 9	83% versus 66%	$\chi^2 = 4.7$, $p = 0.03$

BMI, body mass index; IOL, induction of labor.
[a]*p* value (two-tailed chi-squre).

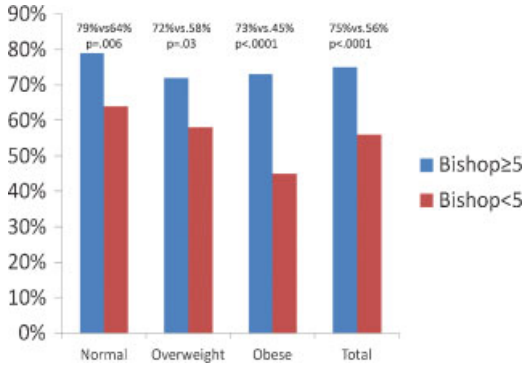

Figure 1 Induction success by maternal body mass index.

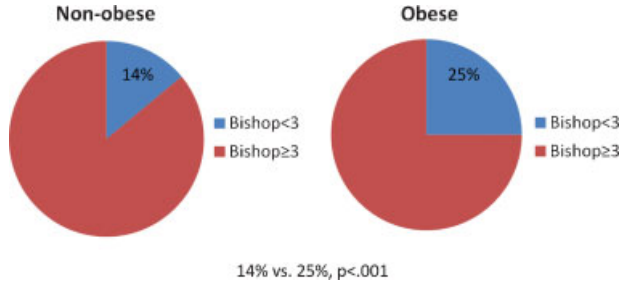

Figure 3 Proportion of Bishop scores < 3 by maternal body mass index.

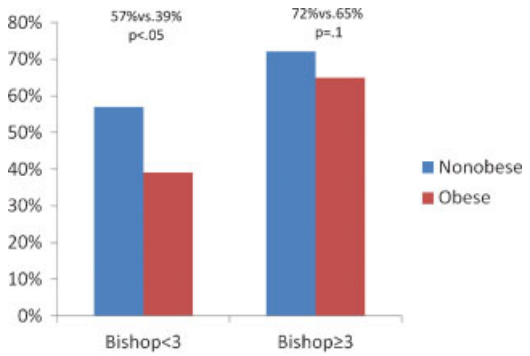

Figure 2 Induction success with very low Bishop scores.

$p = 0.02$) were significantly different between obese and nonobese groups. Birth weight, maternal height, and induction for nonreassuring fetal monitoring were significant factors but were not statistically different between the two groups. Maternal demographics are displayed in ►**Table 2**. Intrapartum complications and neonatal outcomes are shown in ►**Table 3**. Indications for cesarean section are listed in ►**Table 4**.

In summary, the optimum Bishop score for predicting successful IOL in nulliparous patients was 5 regardless of BMI class. The higher IOL failure rate observed in obese women was associated with lower starting Bishop scores and was compounded by higher failure rates in obese women

Table 2 Maternal Demographics

Variable	Nonobese (30 > BMI ≥ 18.5), $n = 498$	Obese (BMI ≥ 30), $n = 198$	p Value
Age (y)	23.4 ± 4.3	24.6 ± 4.5	0.001
Height (in.)	64.6 ± 2.6	64.8 ± 3.0	NS
Weight[a] (lb.)	145.6 ± 21.8	210.0 ± 35.1	<0.0001
BMI[b] (kg/m^2)	24.5 ± 3.1	5.1 ± 4.7	<0.0000001
Bishop score[c]	5.0 ± 2.1	4.5 ± 2.5	0.02
EGA[d]	39.7 ± 1.3	39.5 ± 1.2	NS
Indication for IOL			
IUGR[e]	20 (4.0)	2 (1.0)	NS
NRFM[f]	68 (13.7)	17 (8.6)	NS
Hypertension[g]	221 (44.4)	127 (64.1)	<0.00001
Diabetes mellitus	17 (3.4)	18 (9.1)	<0.01
Post-dates[h]	98 (19.7)	23 (11.6)	<0.05
Other	74 (14.9)	11 (5.5)	<0.001

Data are *n* (%) or mean ± standard deviation unless otherwise specified.BMI, body mass index; EGA, estimated gestational age; IOL, induction of labor; IUGR, intrauterine growth restriction; NFRM, nonreassuring fetal monitoring
[a]Maternal weight at first prenatal visit before 12^{+6} weeks' gestation.
[b]BMI at first prenatal visit before 12^{+6} weeks' gestation.
[c]Five-part Bishop score on admission for IOL.
[d]At time of IOL.
[e]Estimated fetal weight <10th% for EGA.
[f]Based on nonstress test, biophysical profile, and/or low amniotic fluid index.
[g]Chronic hypertension, gestational hypertension, or preeclampsia.
[h]EGA ≥41^{+0} weeks.

Table 3 Intrapartum and Neonatal Outcomes

Variable	Nonobese (30 > BMI ≥ 18.5), *n* = 498	Obese (BMI ≥ 30), *n* = 198	*p* Value
Chorioamnionitis	25 (5.0)	32 (16.2)	<0.00001
PPH	3 (0.6)	2 (1.0)	NS
Shoulder dystocia	6 (1.2)	7 (3.5)	NS
3rd/4th degree laceration	4 (0.8)	3 (1.5)	NS
Birth weight (g)	3414 ± 493	3445 ± 477	NS
1 min Apgar	7.8 ± 1.4	7.7 ± 1.5	NS
5 min Apgar	8.9 ± 0.42	8.8 ± 0.46	NS
NICU	27 (5.4)	16 (8.1)	NS

Data are *n* (%) or mean ± standard deviation. BMI, body mass index; NICU, admission to neonatal intensive care unit; NS, not significant; PPH, postpartum hemorrhage.

Table 4 Indications for Cesarean Section

Indication	Nonobese (30 > BMI ≥ 18.5), *n* = 150	Obese (BMI ≥ 30), *n* = 81	*p* Value
NRFM	54 (36.0)	21 (25.9)	NS
Arrest of dilatation	53 (35.3)	40 (49.4)	NS
Arrest of descent	27 (18.0)	13 (16.0)	NS
Failed induction[a]	9 (6.0)	4 (4.9)	NS
Other	7 (4.6)	3 (3.7)	NS

Data are *n* (%). BMI, body mass index; NRFM, nonreassuring fetal monitoring; NS, not significant.
[a]Failed to enter the active phase of labor.

with Bishop scores <3. The obese patients were also older, which was an independent risk factor for failed induction.

Discussion

In our total study population, nulliparous patients undergoing IOL with a Bishop score ≥5 had the most favorable outcomes, consistent with the findings in previous studies.[13,14] Our observation of higher IOL failure rates in heavier patients is also consistent with prior investigations.[8–10,18–20] Therefore, it was surprising that the optimum Bishop score for predicting successful induction was the same regardless of maternal BMI. That is, the higher induction failure rates associated with increased maternal weight did not translate into different optimal Bishop scores for different maternal weight classes.

Our findings highlight two potential problems for nulliparous patients who are obese and undergoing IOL. First, among the subgroup of patients starting induction with the most unfavorable Bishop scores (0 to 2), obese patients had higher failure rates than nonobese patients. Second, a higher proportion of obese patients started induction with these very unfavorable Bishop scores. It is possible that these two factors act synergistically against obese patients undergoing IOL. Several investigators have observed a longer first stage of labor in heavier patients.[21,22] This phenomenon could increase the incidence of cesarean section for arrest of dilatation in obese patients; however, our study was not powered to measure such a difference. Although our findings suggest that outcomes could be improved by delaying induction in nulliparous obese patients until they achieve more favorable cervical examinations (Bishop score >2), a randomized trial would be needed to answer this question for certain. Other strategies proposed to reduce the cesarean section rate include: requiring at least 12 hours of oxytocin administration after membrane rupture before deeming labor induction a failure in the latent phase[23]; changing the cervical dilatation used to diagnose the start of the active phase from 4 cm to 6 cm[24]; and increasing the length of time allotted for cervical change in the active phase from 2 hours to 4 hours.[25] Again, randomized testing is required to determine if any of these algorithms would decrease the cesarean section rate without unduly increasing maternal or neonatal morbidity in obese patients. For now, obese patients with the most unfavorable cervical examinations could be more accurately counseled about their risk for induction failure.

The principle weakness of our study was its retrospective design, which made it vulnerable to bias and prevented drawing any conclusions of causality. In addition, a uniform method of induction was not used. The principle strength of our study was its use of a comprehensive database, populated prospectively at the time of patient admission. As a result, recall bias was not an issue and provider behavior was not influenced by expected or desired study outcome.

Note

The views expressed in this study are those of the authors and are not to be construed as official or reflecting the views of the Department of the Army or the Department of Defense.

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