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CLINICAL ARTICLE

Cumulative oxytocin dose during induction of labor according to maternal body mass index

Kristina Roloff [a], Sheppard Peng [b], Luis Sanchez-Ramos [c], Guillermo J. Valenzuela [a,*]

[a] Division of Maternal and Fetal Medicine, Department of Women's Health, Arrowhead Regional Medical Center, Colton, CA, USA
[b] Manatee Memorial Hospital, Bradenton, FL, USA
[c] Department of Obstetrics and Gynecology, University of Florida College of Medicine, Jacksonville, FL, USA

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ABSTRACT

Objective: To determine the cumulative oxytocin dose needed to achieve vaginal delivery among obese and non-obese women. *Methods:* A retrospective study was undertaken of women with singleton, term (≥37 weeks) pregnancies who delivered at an institution in California, USA, between May 1 and July 31, 2012. Women were deemed to be obese when their body mass index (BMI; calculated as weight in kilograms divided by the square of height in meters) was 30 or above. Cumulative oxytocin doses were calculated for women who achieved vaginal delivery. *Results:* Overall, 413 women were included. Among 357 women for whom BMI data were available, 204 (57.1%) were obese. Vaginal delivery was achieved in 379 women. Among women who received augmentation after spontaneous labor onset, obese women trended towards more cumulative oxytocin (minimum: 24.7 ± 100.5 mU among women with a BMI of 18.50–24.99; maximum: 1580.5 ± 2530.5 mU among women with a BMI of 35.00–39.99; $P = 0.086$). Women who underwent induction of labor required significantly more oxytocin with increasing BMI class ($P < 0.001$), despite no difference in length of labor. *Conclusion:* Obese women required a larger cumulative oxytocin dose to achieve vaginal birth during labor induction, but not during augmentation of labor. The physiology of spontaneous labor could supersede or influence the metabolic derangement facing obese patients undergoing induction of labor.

1. Introduction

Obesity is a risk factor for cesarean delivery: with increasing weight, the odds of a cesarean delivery can more than double [1–3]. Contemporary analyses suggest that a protracted first stage of labor is more common among obese women than among women of a normal weight, and that the second stage of labor progresses more slowly [4–8]. The average progress during labor in obese women can be interpreted as a labor arrest disorder, which is one of the major contributing indications for preventable primary cesarean in the USA [9–11].

The reasons behind the slower progress in labor among obese women remain unknown. Increasing evidence suggests that a complex interplay of hormonal modulators produced in adipose tissue could inhibit myometrial contractility [12–14]. In vitro studies also suggest that oxytocin receptor expression and/or function is affected by body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters) and that oxytocin response is somehow blunted by obesity [15]. Indeed, treatment of protracted labor with oxytocin has been shown to be less effective in obese patients [16].

The objective of the present study was to assess the cumulative oxytocin dose needed to achieve vaginal delivery among obese and non-obese women after spontaneous onset of labor or labor induction. The low primary cesarean delivery rate in the study center makes for an ideal setting to study the cumulative oxytocin dose required for vaginal birth.

2. Materials and methods

A retrospective study was undertaken of women who delivered at Arrowhead Regional Medical Center (ARMC), Colton, CA, USA, between May 1 and July 31, 2012. The ARMC performs approximately 2500 deliveries annually and serves as a tertiary referral center for complicated pregnancies within the County of San Bernardino, CA. Viable singleton pregnancies at term (37–42 weeks) with cephalic presentation were included. Women with a previous cesarean delivery, multiple pregnancy, or abnormal placentation, and those undergoing primary cesarean delivery for maternal or fetal indications that would contraindicate vaginal delivery (i.e. breech) were excluded. The study was conducted with the approval of the ARMC Institutional Review Board. Informed consent was not required or obtained because of the retrospective nature of the study.

* Corresponding author at: Division of Maternal and Fetal Medicine, Department of Women's Health, Arrowhead Regional Medical Center, 400 N Pepper Avenue, Colton, CA 92324, USA. Tel.: +1 909 580 3470; fax: +1 909 580 3289.
E-mail address: valenzuelag@armc.sbcounty.gov (G.J. Valenzuela).

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Charts were reviewed and the following data were retrieved: BMI at time of delivery, method of delivery, use of oxytocin (as augmentation [among women with spontaneous onset of labor] compared with induction), age, gravidity, parity, gestational age, birth weight, Apgar score, umbilical cord arterial pH, cervical examination at time of admission, maternal medical comorbidities, indication for induction, and cumulative oxytocin dose. BMI was calculated based on delivery weight and height, as pre-pregnancy weight is performed by recall and subject to a greater degree of bias. Pregnancies were classified as high risk when the mother had one or more significant comorbid condition that could increase the odds of cesarean delivery, including diabetes (gestational or pre-existing), intrauterine growth restriction, hypertension, pre-eclampsia, anemia (hemoglobin <100 g/L), asthma, use of illicit substances, infections with herpes simplex virus, heart disease, hospitalization during pregnancy, lupus, seizure disorder, advanced maternal age (age 35 years or greater at time of delivery), or other maternal or fetal condition. The WHO International Classification of Obesity was used to define five BMI classes: normal weight (18.50–24.99), pre-obese (25.00–29.99), obesity class I (30.00–34.99), obesity class II (35.00–39.99), and obesity class III (≥40.00). Spontaneous labor was defined by regular uterine contractions with cervical dilation of 3 cm or more on digital examination, irrespective of effacement, or documented cervical change in the presence of uterine contractions if cervical dilation was less than 3 cm.

Oxytocin augmentation was started under the direction of the on-call attending physician if inadequate contractions were present (<4 contractions in a 10-minute period or <200 Montevideo units [MVU]) with a lack of cervical dilation or fetal descent, after the onset of spontaneous labor. The ARMC standard practice in patients with an arrest of labor follows evaluation of estimated fetal weight and clinical pelvimetry, placement of internal monitors if not contraindicated, and oxytocin infusion to treat inadequate contractions, aiming for 200–250 MVU. Thus, for labor augmentation, oxytocin was started at a rate of 1–2 mU per minute and increased by 1–2 mU per minute every 20–30 minutes. For labor induction, cervical ripening was performed at the discretion of the attending physician using 25–50 μg misoprostol by oral or vaginal route every 4–6 hours, transcervical Foley bulb ripening, oxytocin according to the labor augmentation titration schedule, or through a sequential combination of methods. Oxytocin was started following cervical ripening at the discretion of the attending physician. A minimum of 4 hours since misoprostol administration was required before oxytocin initiation. If transcervical ripening was used, oxytocin administration was started after expulsion of the catheter.

Comparisons were made between four subgroups within the cohort, defined as: BMI below 30, spontaneous labor; BMI of 30 or above, spontaneous labor; BMI below 30, induction of labor; and BMI of 30 or above, induction of labor. Perinatal characteristics between the four groups were compared using the Student *t* test and χ^2 test as appropriate. The Levene test for equality of variances was used to determine use of the *t* test for equal or unequal variances. The Fisher exact test was used to compare the frequency of high-risk pregnancies, and use of oxytocin among induced patients.

Cumulative oxytocin doses were compared in augmented patients and in those who underwent induction of labor on the basis of BMI class using univariate ANOVA testing. One outlier, with a BMI of 36.2, was excluded from the analysis because the cumulative oxytocin dose was extremely high (675,000 mU). Least-square difference testing was used to compare the five BMI classes. Only women who achieved vaginal delivery were included in the analysis of cumulative oxytocin dose, because cesarean delivery for either failure to progress or category 2/3 fetal heart rate tracing interrupted the exposure and falsely decreased the cumulative doses.

Initial cervical examinations were also compared for the four groups using a modification of the Bishop score. Position and consistency were not reliably recorded in the medical record; therefore, dilation, effacement, and station were used to create a score ranging from 0 to a maximum of 9.

The duration of labor was determined to assess whether any increased oxytocin dose was due to a longer labor, and therefore a longer duration of exposure to oxytocin alone, rather than an increased need for oxytocin. The first and second stages of labor were considered to be from 6–10 cm dilation and from 10 cm to delivery, respectively. The total time for active labor was defined as the sum of the first and second stages, or the time from 6 cm to delivery. The duration of labor was compared for the first, second, and active stages for each BMI class, on the basis of the onset of labor (spontaneous or induction), using a univariate ANOVA test.

All analyses were performed using SPSS version 22.0.0.0 (IBM, Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

3. Results

In total, 413 women were included. Among these women, 265 (64.2%) were admitted with spontaneous labor and 148 (35.8%) underwent labor induction. A primary cesarean delivery was performed in 34 (8.2%) women. Oxytocin was administered to 262 (63.4%) women. Primary cesarean delivery was more frequent among women who received oxytocin (31 [11.8%] of 262) than among those who did not receive oxytocin (3 [2.0%] of 151; $P = 0.002$).

Overall, 204 (57.1%) of 357 women for whom BMI was available were obese (Table 1). Cesarean delivery was more common among obese women (21 [10.3%] of 204) than among women with a BMI below 30 (10 [6.5%] of 153), although the difference was not significant

Table 1
Demographic and perinatal characteristics of all included women.[a]

Characteristics	Value (n = 413)
Age, y	25.24 ± 6.19
Gravidity	2.74 ± 1.85
Parity	1.25 ± 1.48
Ethnic origin[b]	
White	30 (9.6)
Hispanic	236 (75.6)
Black	29 (9.3)
Asian	6 (1.9)
Other	11 (3.5)
Length of pregnancy, wk	39.4 ± 1.2
BMI	32.12 ± 6.76
High-risk pregnancy	266 (64.4)
WHO obesity class[c]	
Normal	39 (10.9)
Pre-obese	114 (31.9)
Obese, class I	100 (28.0)
Obese, class II	65 (18.2)
Obese, class III	39 (10.9)
Admission cervix examination	
Cervix dilation	2.79 ± 1.91
Cervix effacement	67.05 ± 25.86
Fetal station	−1.5 ± 0.9
Bishop score (modified)	5.27 ± 1.84
Oxytocin	
No	151 (36.6)
Yes	262 (63.4)
Type of delivery	
Spontaneous vaginal	360 (87.2)
Operative vaginal	19 (4.6)
Cesarean	34 (8.2)
Neonatal characteristics	
Birth weight, g	3332 ± 419
5-minute Apgar score	8.92 ± 0.36
Umbilical artery pH	7.26 ± 0.07

Abbreviation: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters).
[a] Values are given as mean ± SD or number (percentage).
[b] n = 312.
[c] n = 357.

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