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Original Research

The Effect of Induction of Labor on Second Stage Duration in Nulliparous Women, before and after the ACOG and SMFM Change in Guidelines

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Abstract

Background: To examine the effect of induction of labor (IOL) on the length of second stage of labor in nulliparous, compared to spontaneous labor while considering the change in the Obstetricians and Gynecologists and the Society for Maternal Fetal Medicine (ACOG & SMFM) guidelines. **Methods**: A retrospective study of nulliparous women who delivered vaginally at a single center (2011–2017). Second stage duration was compared between women with IOL to those who went into spontaneous labor, in the pre and post-guideline periods. **Results**: The study included 5222 nulliparous women. Women who had an IOL had more epidural analgesia and prolonged second stage of labor than those who went into spontaneous labor (95.2% *vs.* 71.9%, $p < 0.0001$ and 6.1% *vs.* 1%, $p < 0.0001$, respectively). Second-stage was longer in the IOL group, in pre-guidelines (mean duration 69 min *vs.* 151 min, $p < 0.001$), and in the post-guidelines period (mean duration 69 min *vs.* 146 min, $p < 0.001$), even after controlling for epidural analgesia. **Conclusions**: In one academic center the second-stage duration in nulliparous women who go through IOL, is longer than women who go into labor spontaneously in both the time frame before and after national changes in the definition of the second stage duration.

Keywords: induction; second stage; nulliparous; cesarean delivery

1. Introduction

There is conflicting evidence as to whether induction of labor (IOL) has an effect on adverse outcome of labor [1]. Some observational studies have suggested that IOL increases the risk of adverse outcomes including; postpartum hemorrhage, operative deliveries, and cesarean deliveries [2,3]. However, other studies have demonstrated a decreased rate of cesarean delivery following IOL in postdates pregnancies [4–6]. Less is known regarding IOL in other populations. Although IOL is believed to increase the duration of second stage of labor, few studies have directly addressed this issue.

In 2014, the American College of Obstetricians and Gynecologists (ACOG) and the Society for Maternal Fetal Medicine (SMFM) published an Obstetric Care Consensus statement for prevention of primary cesarean delivery in women without acute indications [7,8], based on data from the Consortium on Safe Labor. This consortium found that contemporary first and second stages of labor progresses at a substantially slower rate than historically proposed [9,10]. According to the ACOG and SMFM recommendations, an additional hour was added to the second stage of labor before it should be considered prolonged. The goal of second-stage management is to maximize the chances of a vaginal delivery while minimizing risks of maternal and fetal adverse outcomes. However, recent studies found considerable controversy over these recommendations and suggest caution before their adoption, since they may be accompanied by significant increases in maternal and neonatal morbidity [11–13].

It has been found that certain maternal factors such as parity and epidural use appear to alter the mean duration of and increase adverse outcomes in, the second stage [14,15]. Therefore, when making decisions about the management of the second stage, it is important to understand how obstetric interventions such as IOL might affect duration and associated adverse outcome of the second stage.

Nulliparous women undergoing IOL are with increased risk for cesarean delivery (CD) when compared to patients who go into labor spontaneously [16–19]. The reason for this remains unclear; perhaps women with IOL might be diagnosed with arrest of dilation prematurely or be more likely to truly arrest labor [20].

Our study sought to compare the length of the second stage and mode of delivery in nulliparous women who reached full dilation after induced or spontaneous onset of labor. The data will be stratified for before and after the change in the ACOG and SMFM guidelines regarding the management of the second stage duration.

2. Methods

This was a 6-year retrospective cohort study of all nulliparous women with term pregnancies (37–41 weeks of gestation) at a single, university-affiliated medical center, between January 2011 and December 2017, who reached full cervical dilatation (10 cm).

Women were included if they were nulliparous, their gestational age was at least 37 0/7 weeks at admission to the labor and delivery unit and carried a singleton pregnancy in a vertex presentation.

Exclusion criteria included multiparity, multifetal gestation, preterm birth, post-term pregnancy (42 0/7 weeks and above), known fetal genetic or chromosomal abnormalities, planned cesarean delivery, cesarean delivery prior reaching the second stage of labor, or any other contraindication for a vaginal delivery. Data was collected from the institution birth registry and a review of the electronic medical records, and from the individual patient medical files.

Second stage duration was compared between women with IOL to those who went into spontaneous labor. Length of the second stage was calculated as the number of minutes from the first cervical examination that revealed full dilation until delivery. We defined a prolonged second stage according to American College of Obstetricians and Gynecologists (ACOG's) guidelines [7,8]. Between January 2011 and March 2014 a prolonged second stage was defined as more than 120 minutes for nulliparous women, with an addition of one hour permitted for the presence of epidural analgesia [21]. This definition was updated at the end of March 2014 according to the new guidelines of the ACOG and SMFM, with an addition of one hour to each group [7,8]. Consequently, in March 2014, we changed our departmental policy. We added an additional hour to the second stage of labor; the definition of the second-stage arrest of labor was 3 hours in nulliparous women; with the addition of 1 hour for women with epidural analgesia. All health care professionals agreed to adhere to these new recommendations. Applying a washout period of one year from January 2014 to December 2014 for data collection to confirm physician compliance with the new guidelines, we compared the duration of the second stage before and after the year 2014: pre-guidelines (January/2011–December/2013) *vs*. post-guidelines (January/2015–December/2017). The washout period of one year from June 2013 to May 2014 was excluded. This is a nested study with our published study regarding the effect of the change of guidelines on the rate of CD and vacuum assisted deliveries [16] using the same database.

Induction of labor was done by several methods according to the Bishop Score at admission including: oxytocin (Cantrell Drug Company, Little Rock, AR, USA), prostaglandin E2 (pfizer, New York, NY, USA), artificial rupture of membranes (AROM), double balloon catheter, or the use of combined methods. Oxytocin was administered via intravenous (IV) access with volumetric pump while recording dose in milliunit/minute. Prostaglandin E2-was given Per Vaginal (PV), 1 mg inserted high into the posterior fornix with reassessment every 6 hours. Double balloon catheter (DBD) was Inflate balloon catheters with sterile water or 0.9% sodium chloride, 80 mL each balloon, with reassessment after 12 hours.

Statistical Analysis

SPSS version 25.0 (IBM Corporation, Chicago, IL, USA) was used for the data analysis. Descriptive statistics including mean, standard deviation (SD), median and percentiles were provided where appropriate. Differences between the two groups (no IOL *vs*. IOL) in the quantitative parameters were calculated by independent sample *t*-tests. For comparison of categorical parameters, we used Fisher's exact tests. The Kaplan-Meier method was used to calculate the time to event (delivery) between induced and spontaneous labor. A multivariate linear regression model was conducted to evaluate for the second stage duration while adjusting for several independent confounding variables (IOL, maternal age, use of epidural, smoking status, and birth weight). $p < 0.05$ was consider as significant. The study was approved by the local research committee (#0010-22-BNZ). Because the generated data set contained no patient identification information, all women received standard care and the data was retrospectively collected the study was exempt from informed consent requirements.

3. Results

Out of 11,464 deliveries during the study period, 5222 (45.5%) were eligible for analysis, of which 1873 (35.8%) women went into labor spontaneously and 3349 (64.2%) women went through IOL (Fig. 1).

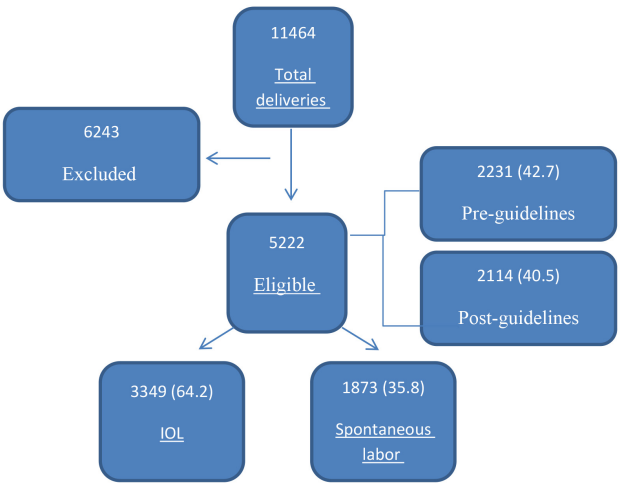

Fig. 1. Flow charts of patients included in the study. Data are presented in n (%). IOL, induction of labor.

Table 1. Baseline characteristics of the two groups.

Characteristic (%)	IOL group	No IOL group	*p* value
	n = 3349	n = 1873	
Maternal age (years)	28 (25–31)	27 (21–30)	<0.0001
Gestational age at delivery (weeks)	39.1 (40–40.8)	39.0 (39.7–40)	<0.0001
Epidural analgesia	3188 (95.2)	1347 (71.9)	<0.0001
Alcohol abuse	0 (0)	1 (0.1)	0.36
Heavy smoker	60 (2.1)	39 (2.4)	0.53
Hypertensive disorder	7 (0.2)	1 (0.1)	0.27
Gestational diabetes	4 (0.1)	0 (0)	0.30
Birth weight (gram)	3295 ± 415	3228 ± 389	<0.0001

Data are presented in median (IQR: interquartile range) or n (%). IOL, induction of labor.

The pre-guidelines period included 2231 deliveries and the post-guidelines included 2114 deliveries (Fig. 1).

The baseline characteristics of each group are presented in Table 1. Women who had an IOL were more likely to have epidural analgesia than those who went into spontaneous labor (95.2% *vs*. 71.9%, $p < 0.0001$). There were no other clinically significant differences in the baseline characteristics between women with and without IOL, though women in the IOL group were older (28 *vs*. 27 years, $p < 0.001$), delivered earlier at term (39 *vs*. 39.1 weeks, $p < 0.001$), infants with higher birth weight (3295 *vs*. 3228 grams, $p < 0.001$) (Table 1).

The rate of prolonged second stage in the entire study population was 16.1%. The IOL group women were more likely to have prolonged second stage than those who went into spontaneous labor in the whole study group (18% *vs*. 4.8%, $p < 0.0001$). That was true regardless the use of epidural anesthesia (mean duration of the second stage was 148 min in the IOL group compared to 69 min in the control group, $p < 0.0001$). They were also more likely to deliver by CD and vacuum-assisted delivery (VAD) (11.7% *vs*. 3.4%, $p < 0.0001$ and 25.4% *vs*. 11.5%, $p < 0.0001$, respectively) (Tables 2a and 2b).

Table 2a. Rate of prolonged second stage and delivery mode in the two groups (pre-guidelines period).

	IOL group	No IOL group	*p* value
	n = 1326	n = 905	
Prolonged second stage n (%)	438 (33)	76 (8.4)	$p < 0.0001$
VAD n (%)	331 (25.0)	85 (9.4)	$p < 0.0001$
CD n (%)	147 (11.1)	23 (2.5)	$p < 0.0001$

IOL, induction of labor; VAD, vacuum assisted delivery; CD, cesarean delivery.

In a sub-analysis of the two groups (IOL *vs*. spontaneous labor) we compared rates of prolonged second stage of labor, CD and VAD in the pre- and post-guidelines periods, after excluding a washout period of one year from June 2013 to May 2014. There were increase rate of prolonged second stage of labor in the IOL group in both periods of time; in the pre-guidelines period (33% *vs*. 8.4%, $p < 0.0001$) and in the post-guidelines period (11.5% *vs*. 2.2%, $p < 0.0001$) (Tables 2a and 2b). In addition, there were higher rates of CD and VAD in the IOL group in both periods; in the pre-guidelines era (11.1% *vs*. 2.5%, $p < 0.0001$ and 25% *vs*. 9.4%, $p < 0.0001$, respectively) and in the post-guidelines period (12.6% *vs*. 5.1%, $p < 0.0001$ and 26.7% *vs*. 13.6%, $p < 0.0001$, respectively) (Tables 2a and 2b).

Table 2b. Rate of prolonged second stage and delivery mode in the two groups (post-guidelines period).

	IOL group	No IOL group	*p* value
	n = 1473	n = 641	
Prolonged second stage n (%)	170 (11.5)	14 (2.2)	$p < 0.0001$
VAD n (%)	394 (26.7)	87 (13.6)	$p < 0.0001$
CD n (%)	185 (12.6)	33 (5.1)	$p < 0.0001$

IOL, induction of labor; VAD, vacuum assisted delivery; CD, cesarean delivery.

Fig. 2 uses Kaplan-Meier analyses to compare second stage duration in induced compared with spontaneous labor in the entire study population (log-rank $p < 0.001$). While assessing second stage duration, before and after the change in the ACOG and SMFM guidelines, we found a longer second-stage duration in the IOL group compared to women who went into labor spontaneously in pre-guidelines (mean duration 151 min *vs*. 69 min, $p < 0.001$), and in the post-guidelines period (mean duration 146 min *vs*. 69 min, $p < 0.001$)

A multivariate linear regression model was conducted for the association of IOL with prolonged second stage while adjusting for several independent variables including: maternal age, birth weight, smoking status and use of epidural; IOL increased the rate of prolonged second stage (2.34, 95% confidence interval (CI) (1.91–2.88), $p < 0.001$) (Table 3).

Table 3. Multiple regression analysis of factors associated with prolonged second stage.

	p value	Odds ratio	95% confidence interval for odds ratio	
			Lower	Upper
Maternal age	$p = 0.051$	1.023	1.000	1.047
Epidural analgesia	$p < 0.0001$	4.57	3.48	6.00
Induction of labor	$p < 0.0001$	2.34	1.91	2.88
Birth weight <2500	$p < 0.0001$	0.315	0.18	0.56
Birth weight >4000	0.22	1.46	0.79	2.70
Smoking status	0.98	1.00	0.49	2.08

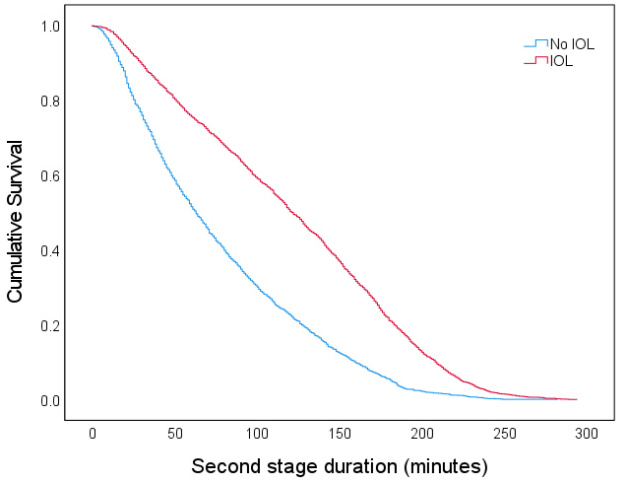

Fig. 2. Kaplan-Meier analyses to compare second stage duration in induced compared with spontaneous labor in the whole study population (log-rank $p < 0.001$).

4. Discussion

The aim of the current study was to assess the effect of induction of labor on the duration of the second stage, in nulliparous women. We also evaluated these results before and after the change in the ACOG/SMFM guidelines. The main results of our study demonstrated that IOL was associated with longer second stage duration when compared to women who went into spontaneous labor. This difference was more than 60 minutes longer. That was true for the entire study group, and when analyzing the results separately for the different time periods; before and after guidelines change of protocol. This study demonstrated that even after permitting an additional hour with IOL the risk of CD and vacuum assisted vaginal delivery remains increased.

The normal ranges generated from Friedman's data in the 1950s, which were developed from a small group of women who had a spontaneous onset of labor, served for many years for the evaluation of labor progression [22]. Subsequent studies questioned their appropriateness and reassessed a slower labor curve for nulliparous women [20,23–25]. In March 2014, the ACOG and the SMFM published an Obstetric Care Consensus for safe prevention of primary cesarean delivery [7,8], with an addition of one hour to the duration of the second stage of labor. This data indicated that it is critical to allow adequate time for normal second stages of labor unless expeditious delivery was indicated [9]. Our study aimed to evaluate the effect of IOL mainly on second stage duration, and to analyze this effect before and after the prolongation of the second stage according to these guidelines. We found that IOL was associated with longer second stage duration in nulliparous women, for the totality of the study period irrelevant of pre or post the change in guidelines.

Older studies found that there was no difference in the duration of the second stage of labor after induction in nulliparous and multiparous [10,26–30]. The differences in our findings are likely not attributable to the fact that the current study considers the most recent changes in modern labor interventions including the changes in the ACOG/SMFM guidelines regarding the progression of labor. Particularly given the fact that this would not explain our results pre-guidelines changes which were also longer than in spontaneous labor. Why this difference occurred is hard to explain when compared to other studies. Perhaps in the past physicians were more aggressive with management in the second stage opting for cesarean sections after shorter durations that currently occur.

Additional findings in our study were increased rates of CD and VAD among women who were induced. These findings are in line with previous studies [17,18,27–31]. Vahratian *et al.* [27] found that the increased risk for CD was mainly in induced nulliparous with unfavorable cervix, because of arrest of labor. However, this was not the cause of the finding in our study because all women had reached the second stage. Hoffman MK *et al.* [29] found higher rates of CD in induced multiparous women with and without cervical ripening than in women with spontaneous onset of labor; in contrast, our study included only nulliparous.

It has already been hypothesized that rates of CD may be higher in different indications for IOL rather than the induction itself [19]. Even though the data on indications for induction in the current study is missing, the common indication for induction of labor in our center includes non-reassuring fetal heart rate, suspected macrosomia, pregnancy-induced hypertension, gestational diabetes mellitus, and pre-eclampsia. Earlier studies found higher rates of CD for induced women with no known reason for induction and when induction was performed due to post-

term alone [31,32] than in women with spontaneous onset of labor. An inherent bias in the data may be that women who underwent IOL may have had pregnancies with greater risk or complications favoring CD and operative vaginal delivery. We attempted to mitigate this bias by controlling for background disease like Gestational diabetes mellites (GDM) or hypertension. However, it should be acknowledged that there were very few cases of these complications from our young healthy nulliparous study group. We had only 7 cases of hypertension (HTN) and 4 cases of GDM.

Another hypothesis is that higher rate of CD and VAD in the induced women could be attributed to the prolongation of the second stage. This was revealed in previous studies regarding nulliparous [28,33,34]. Our study is the first to assess this association after the change in guidelines in nulliparous. There is a recent large study that aimed to evaluate the impact of the duration of the stage of labor on delivery outcomes in multiparous women, after the change in guidelines and found that a longer duration of the second stage is an independent risk factor of adverse maternal and neonatal [35]. Moreover, we found in our recently published study, an increase in CD rate performed at the second stage of labor after adding on hour following implementation of the new guidelines, even after controlling for IOL [13]. Our findings are new and of clinical importance to further understand the process of labor and to manage the second stage of labor on the expected duration and complications during the second stage after induction.

Study Strengths and Weaknesses

The main limitation of our study is its retrospective nature in a single institution which may mask undetected bias. Details of the labor course such as the timing of the epidural, duration of pushing, and reason for IOL were not available. Moreover, other neonatal, demographic data and indications for CD were missing. Nevertheless, our study represents a large series addressing the effect of induction of labor on the duration of the second stage, particularly in nulliparous women even after the change in the ACOG and SMFM guidelines.

5. Conclusions

In one academic center the second-stage duration in nulliparous women who go through IOL, is longer than women who go into labor spontaneously in both the time frame before and after national changes in the definition of the second stage duration. As rates of induction continue to rise, this information may be useful to physicians who counsel and manage patients in the second stage of labor.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

EKP—Protocol/project development, Data collection and management, Data analysis, Manuscript writing/editing; MHD—Manuscript conceptualization, Manuscript writing/editing; HM—Data collection, Data analysis; DV—Manuscript conceptualization, Manuscript writing/editing and the guaranteeing author. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work to take public responsibility for appropriate portions of the content and agreed to be accountable for all aspects of the work in ensuring that questions related to its accuracy or integrity.

Ethics Approval and Consent to Participate

The study was approved by the local research committee (#0010-22-BNZ). Because the data set contained no patient identification information and all women received standard care, the study was exempt from informed consent requirements.

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Conflict of Interest

The authors declare no conflict of interest. Michael H. Dahan is serving as Editor-in-Chief and one of the Guest editors of this journal. We declare that Michael H. Dahan had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Ugo Indraccolo.

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