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Original Article

Contemporary second stage labor patterns in Taiwanese women with normal neonatal outcomes

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ABSTRACT

Objective: To compare the duration of second stage labor among modern Taiwanese women who achieved vaginal delivery without adverse neonatal outcomes and women who delivered during the early 1990s.

Materials and methods: Data were collected from women who underwent spontaneous labor and vaginally delivered cephalic singleton fetuses with normal neonatal outcomes at the Taipei Chang Gung Memorial Hospital, Taipei, Taiwan from 1991–1995 (Cohort 1, $n = 10{,}721$) and 2010–2014 (Cohort 2, $n = 3734$). We calculated the median duration and 95th percentiles of second stage labor. The women were stratified according to analgesia and parity. Multiple linear regression analysis was used to determine the association between the maternal/pregnancy characteristics and second stage labor duration.

Results: The median second stage labor duration was significantly longer for Cohort 2 than for Cohort 1. For nulliparous women, the 95th percentile second stage labor thresholds were 255 minutes and 152 minutes (Cohort 2) and 165 minutes and 107 minutes (Cohort 1) for women with and without epidural analgesia, respectively. For multiparous women, the 95th percentile second stage labor thresholds were 136 minutes and 43 minutes (Cohort 2) and 125 minutes and 39 minutes (Cohort 1) for women with and without epidural analgesia, respectively. Birth weight, maternal age at delivery, and time period (2010–2014 vs. 1991–1995) were significant factors associated with the duration of second stage labor.

Conclusion: Modern Taiwanese women who achieved vaginal delivery without adverse neonatal outcomes experienced longer second stage labors than women 25 years ago. The 95th percentile thresholds differed between nulliparous and multiparous women with and without epidural analgesia.

Introduction

Recent studies from the USA have reported prolonged labor duration for contemporary women with spontaneous labor onset and normal neonatal outcomes compared to women in past decades [1–4]. This trend is more prominent during the second stage of labor in women who receive intrapartum epidural analgesia [1,3]. Nevertheless, it is not clear whether a similar change will be found in women of different ethnicities or other regions of the world. Moreover, explanations for the increased duration of labor are still unclear. Changes in obstetric characteristics, such as increasing maternal age, maternal and fetal body sizes, and weight gain during pregnancy as well as the increased prevalence of obesity and gestational diabetes mellitus (GDM), may play a role [1,2,5–9]. However, the association between these factors and the prolonged duration of labor has not been extensively examined.

A computerized obstetric database was established at Taipei Chang Gung Memorial Hospital, Taipei, Taiwan in July 1990. The database includes maternal demographic characteristics, medical and obstetric histories, and information regarding the course of the index pregnancy and perinatal outcomes [10,11]. The data were collected by trained personnel through daily abstracts from medical and delivery records, and audits of these data were routinely performed during departmental meetings. By 2014, the database had

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collected data from >70,000 deliveries. Thus, we studied changes in the duration of second stage labor over the past 25 years.

This study compared the duration of second stage labor in Taiwanese women who achieved vaginal deliveries without adverse neonatal outcomes during the periods of 1991–1995 and 2010–2014. We also determined whether changes in maternal and pregnancy characteristics were associated with an increased duration of second stage labor.

Materials and methods

A retrospective cohort study was conducted among all cephalic, live, singleton births to women who delivered at the Taipei Chang Gung Memorial Hospital between 1991 and 2014. The study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (No. 104-4606B); the review board also determined that informed consent was not required because of the retrospective study design and patient anonymization.

We analyzed all deliveries during the periods of 1991–1995 ($n = 20{,}096$) and 2010–2014 ($n = 9286$). We excluded pregnancies complicated by multiple gestations ($n = 999$), preterm birth (<37 complete weeks, $n = 2310$), post-term pregnancy (>42 complete weeks, $n = 157$), and stillbirths ($n = 12$). Women with cesarean deliveries ($n = 9744$) or vaginal deliveries after prior cesarean deliveries ($n = 88$), nonvertex presentations ($n = 20$), and induced labors ($n = 1121$) were also excluded. Furthermore, we excluded neonates with congenital anomalies (structural or chromosomal, $n = 76$), a 5-minute Apgar score < 7 ($n = 17$), and neonatal intensive care unit admission ($n = 383$). Overall, a total of 14,455 deliveries were selected in the present analysis, including 10,721 women from 1991–1995 (defined as Cohort 1) and 3734 women from 2010 to 2014 (defined as Cohort 2). Figure 1 depicts the sample selection process.

In this hospital, all deliveries were performed by the attending physicians or senior residents with the supervision of an attending physician. Epidural analgesia was offered to all parturients during labor if there were no contraindications [11]. The procedure was available upon request, regardless of cervical dilatation. The duration of second stage labor was defined as the time interval between complete cervical dilatation and delivery of the fetus. A prolonged second stage labor (>2 hours for nulliparous women or 1 hour for multiparous women, with an additional hour if epidural analgesia is used) is an indication for obstetricians to evaluate the parturient, fetus, and labor progress. However, the use of a vacuum or forceps to facilitate the delivery is not mandatory. Decisions concerning obstetrical management were made by the attending obstetricians.

Statistical analyses were performed using the SPSS software, version 20.0 (SPSS Inc., Armonk, NY, USA). We compared differences in the maternal and pregnancy characteristics between the two cohorts. Continuous variables were tested for normality using the Kolmogorov–Smirnov test. Variables were presented as mean ± standard deviation if normally distributed or medians (interquartile range) if not normally distributed. Categorical variables were calculated as n (%). Continuous parameters were compared between the two groups using Student t test or the Mann–Whitney U test when appropriate. Categorical variables were compared using the χ^2 test. A p value < 0.05 was considered significant.

To clarify the contributions of the different maternal and pregnancy characteristics to the duration of second stage labor, a multiple linear regression analysis was performed. The characteristics that differed significantly in prevalence between the two cohorts were included in the multiple linear regression analysis to control for confounding effects. A backward elimination process was used to obtain the final regression model with $p < 0.05$ as the selection criterion for stepwise procedures. Adjusted R^2 values and standardized regression coefficients were calculated to describe the fitness of the model and the association between the variables and duration of second stage labor.

Results

Table 1 shows the maternal and pregnancy characteristics of the study population. Compared to Cohort 1, the women in Cohort 2 were older (maternal age > 34 years) and had higher prepregnancy body mass index (>24.2 kg/m^2). Compared to Cohort 1, the women in Cohort 2 had higher rates of nulliparity, intrapartum epidural analgesia, conception assisted by reproductive technology, genetic amniocentesis, and GDM. However, the women in Cohort 2 had a lower rate of prior induced abortion, less weight gain during pregnancy, earlier delivery times, and a lower rate of instrument-assisted vaginal delivery than the women in Cohort 1. Additionally, the infants from Cohort 2 had lower birth weights and smaller fetal sizes compared to infants from Cohort 1. In this hospital, the total and primary cesarean delivery rates were 38.9% and 18.0% (1991–1995) and 42.4% and 25.2% (2010–2014), respectively.

We also determined the relationship between the duration of second stage labor and the time period of delivery stratified by parity (nulliparous or multiparous) and intrapartum use of epidural analgesia (with or without). As shown in Table 2, the women in Cohort 2 had a longer median second stage labor duration than the women in Cohort 1. The difference in duration ranged from 3 minutes for the multiparous women without epidural analgesia to 14 minutes for the nulliparous women without epidural analgesia. Moreover, the 95th percentile threshold differences in the duration of second stage labor were larger than the differences in the median values. In Cohort 2, the 95th percentile thresholds for second stage labor were 255 minutes and 152 minutes for nulliparous women with and without epidural analgesia, respectively. In Cohort 1, the 95th percentile thresholds were 165 minutes and 107 minutes for the nulliparous women with and without epidural analgesia, respectively. In Cohort 2, the 95th percentile thresholds for second stage labor were 136 minutes and 43 minutes for multiparous women with and without epidural analgesia, respectively. In Cohort 1, the 95th percentile thresholds for second stage labor were 125 minutes and 39 minutes for multiparous women with and without epidural analgesia, respectively. Moreover, the extent of these differences varied among the four groups: 90 minutes and 45 minutes for nulliparous women with and without epidural analgesia, respectively; and 11 minutes and 4 minutes for multiparous women with and without epidural analgesia, respectively.

Table 3 shows the results of the multiple linear regression analysis. We adjusted for confounding factors, including maternal age, prepregnancy body mass index, weight gain during pregnancy, gestational age, birth weight, fetal head circumference, fetal length, conception methods, genetic amniocentesis, prior induced abortion, and different time periods (2010–2014 vs. 1991–1995). Birth weight significantly correlated with the duration of second stage labor among all four groups. Maternal age at delivery and time period also contributed significantly to the duration of second stage labor in nulliparous women with or without epidural analgesia and in multiparous women without epidural analgesia. Weight gain during pregnancy was an additional determinant for the duration of second stage labor in nulliparous women without epidural analgesia.

Discussion

The median duration of labor is frequently used to assess the progression of a labor, and 95th percentile thresholds are commonly

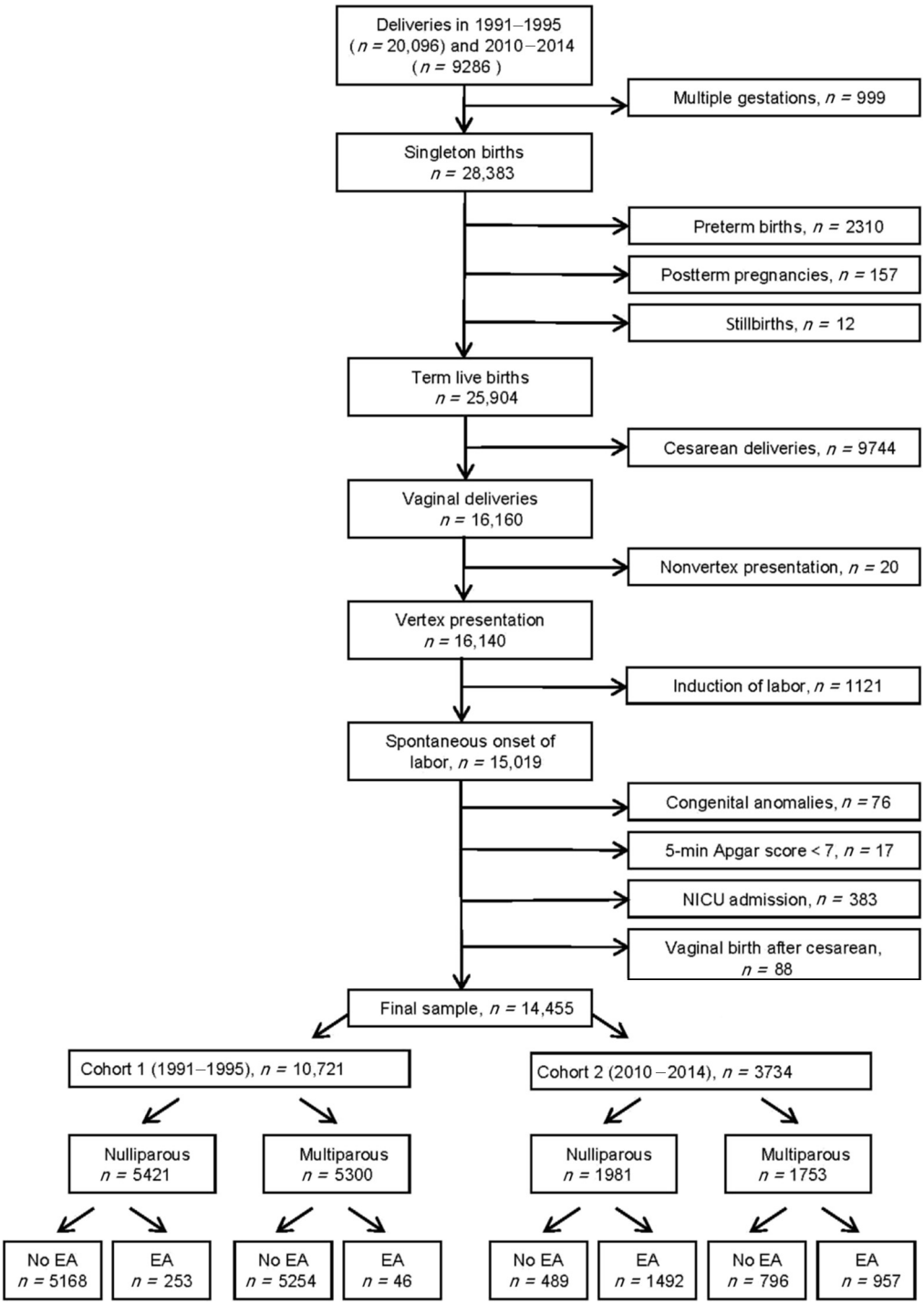

Figure 1. Diagram of patient selection. EA = epidural analgesia; NICU = neonatal intensive care unit.

used to define the extreme ends of a distribution among laboring women. Consistent with previous studies [1,2], we found that women who achieved vaginal deliveries without adverse neonatal outcomes during the 2010–2014 period had a longer second stage labor compared to the women who delivered during the 1991–1995 period. Although significant, the differences in the median durations among the four groups of women were <15 minutes. Therefore, this difference may have little clinical significance. However, the extent of this difference was more profound in the 95th percentile of second stage labor duration. Furthermore, a differential change in the 95th percentile of second stage labor duration was noted between nulliparous and multiparous women with and without epidural analgesia. The smallest increase in duration was observed in multiparous women without epidural analgesia, and the largest increase in duration was observed in nulliparous women with epidural analgesia.

In addition to the prolonged second stage of labor, the population of women in contemporary obstetrics in Taiwan has also changed compared to the early 1990s. Contemporary Taiwanese have higher rates of maternal age >34 years, prepregnancy body

Table 1
Characteristics of the study population.

	Cohort 1 (1991–1995)	Cohort 2 (2010–2014)	p^*
	n = 10,721	n = 3734	
Age (y)			
<20	66 (0.6)	14 (0.4)	0.100
20–34	9600 (89.5)	2639 (70.7)	<0.001
>34	1055 (9.8)	1081 (29.0)	<0.001
Prepregnancy BMI (kg/m^2)			
<19.8	4415 (41.2)	1483 (39.7)	0.118
19.8–24.2	5761 (53.7)	1858 (49.8)	<0.001
>24.2	545 (5.1)	393 (10.5)	<0.001
Nulliparity	5421 (50.6)	1981 (53.1)	0.009
Intrapartum epidural analgesia	299 (2.8)	2449 (65.6)	<0.001
Prior induced abortion	4583 (42.7)	1003 (26.9)	<0.001
Prior fetal death	62 (0.6)	31 (0.8)	0.119
Prior preterm birth	21 (0.2)	6 (0.2)	0.827
Conception assisted by ART	70 (0.7)	41 (1.1)	0.008
Genetic amniocentesis	57 (0.5)	1293 (34.6)	<0.001
Cigarette smoking	27 (0.3)	8 (0.2)	0.847
Overt diabetes mellitus	22 (0.2)	8 (0.2)	0.927
Gestational diabetes mellitus	332 (3.1)	396 (10.6)	<0.001
Preeclampsia	171 (1.6)	67 (1.8)	0.410
Weight gain during pregnancy (kg)	14.5 ± 4.5	13.0 ± 3.9	<0.001
Gestational age (wk)	39.1 ± 1.1	38.8 ± 1.0	<0.001
Birth weight (g)	3289 ± 351	3163 ± 343	<0.001
Fetal head circumference (cm)	33.5 ± 1.3	33.4 ± 1.2	<0.001
Fetal length (cm)	51.6 ± 2.1	50.4 ± 1.9	<0.001
Operative vaginal delivery	1120 (10.4)	157 (4.2)	<0.001
Male fetus	5550 (51.8)	1929 (51.7)	0.924

Data are presented as n (%) or mean ± SD.
*p values based on χ^2 or Student t test.
ART = artificial reproductive technology; BMI = body mass index.

Table 3
Multiple linear regression analysis results.[a]

	Duration of the second stage of labor (min)		
	Adjusted R^2	Coefficient[b]	p
Nulliparity with epidural analgesia	0.028		
Age (y)		0.112	<0.001
Birth weight (g)		0.095	<0.001
Period (2010–2014 vs. 1991–1995)		0.059	0.021
Nulliparity without epidural analgesia	0.049		
Age (y)		0.131	<0.001
Birth weight (g)		0.125	<0.001
Period (2010–2014 vs. 1991–1995)		0.113	<0.001
Weight gain during pregnancy (kg)		0.061	<0.001
Multiparity with epidural analgesia	0.008		
Birth weight (g)		0.096	0.002
Multiparity without epidural analgesia	0.009		
Age (y)		0.042	0.005
Birth weight (g)		0.086	<0.001
Period (2010–2014 vs. 1991–1995)		0.037	0.015

[a] Factors included in the regression analysis: maternal age, prepregnancy body mass index, weight gain during pregnancy, gestational age, birth weight, fetal head circumference, fetal length, conception methods, genetic amniocentesis, prior induced abortion, and time period.
[b] Standardized regression coefficient.

mass index >24.2 kg/m^2, nulliparity, intrapartum epidural analgesia administration, conception assisted by reproductive technology, genetic amniocentesis, and GDM. One strength of this study was the investigation of the association between maternal and pregnancy characteristics and the duration of second stage labor (stratified by parity and the use of epidural analgesia). After adjusting for confounding factors, birth weight, maternal age, and time period (2010–2014 vs. 1991–1995) were significant factors associated with the duration of second stage labor.

Several previous studies have shown that the duration of second stage labor increases directly with maternal age [5,6,12]. The myometrial tissues may undergo a physiologic aging process, or the myometrium may become less effective or responsive to oxytocic agents with age [13]. Alternatively, skeletal muscular strength declines with age. Decreased muscular strength contributes to a more prolonged pushing effort in older women during the second stage of labor [14]. In this study, the women in Cohort 2 were older than the women in Cohort 1 and, therefore, more likely to experience a longer second stage of labor.

In addition to maternal and pregnancy characteristics, obstetric practices also changed considerably during the study period, with more genetic amniocentesis and intrapartum epidural analgesia but fewer operative vaginal deliveries among Cohort 2 compared to Cohort 1. However, even when we limited our analysis to a select, low-risk population (vaginal delivery with spontaneous onset of labor and a normal neonatal outcome) by excluding cesarean deliveries and stratifying by parity and the use of epidural analgesia, the women in Cohort 2 were still more likely to have a longer second stage of labor than the women in Cohort 1, suggesting that other changes in obstetric practices were likely to be influential.

Increasing birth weight has been suggested to have an effect on the duration of labor. In a large cohort of contemporary laboring women, Leftwich et al [7] found that as birth weight increases, labor progression is slower. Furthermore, using data from the Collaborative Perinatal Project (deliveries in 1959–1966) and the Consortium on Safe Labor (deliveries in 2002–2008), Laughon et al [2] found that contemporary women had longer first and second stage labors and higher birth weights than women who delivered 50 years ago. In this study, birth weight was another significant factor associated with the duration of second stage labor. However, the mean birth weight of the women in Cohort 2 was lower than Cohort 1. Therefore, we could not consider birth weight as a potential factor for the increasing duration of second stage labor during the study period.

Several limitations of our study merit attention. First, our results were derived from data from an academic institution, limiting the generalizability to the broader population. Furthermore, obstetric practices differ between hospitals. Therefore, the applicability of our results to different clinical settings should be carefully evaluated. Second, the study was limited by its observational and retrospective design. One or more unmeasured confounders may have contributed to the prolonged second stage labor. Third, the higher cesarean

Table 2
Median and 95th percentile thresholds for second stage labor (stratified by delivery period).[a]

	Cohort 1 (1991–1995)		Cohort 2 (2010–2014)		P
	Median	95th percentile	Median	95th percentile	
Nulliparity with epidural analgesia	62	165	73	255	<0.001
Nulliparity without epidural analgesia	31	107	45	152	<0.001
Multiparity with epidural analgesia	17	125	27	136	<0.001
Multiparity without epidural analgesia	11	39	14	43	<0.001

[a] Data are time of labor in minutes. The p values are based on Mann–Whitney U test.

rate during the 2010–2014 period could cause an inherent selection bias from informative censoring, which probably obscures the true duration of second stage labor because intrapartum cesarean deliveries were performed according to the prevailing definition of labor arrest. This censoring may have resulted in bias toward a shorter labor, particularly at the 95th percentiles. It is likely that normal labor is even longer in contemporary obstetrics.

Currently, prolonged second stage labor is defined as >2 hours without or 3 hours with epidural analgesia in nulliparous women and 1 hour without or 2 hours with epidural analgesia for multiparous women [15]. Although we may not fully understand the causes of longer second stage labors, our results suggest that contemporary labor practices should consider the changing maternal and pregnancy characteristics in Taiwanese women. Furthermore, the duration of labor should be balanced with potential maternal and neonatal risks [16,17]. However, using current guidelines, the timing of cesarean delivery for a prolonged second stage labor should be reconsidered for otherwise normal maternal and fetal cases, particularly for nulliparous women with epidural analgesia.

Conflicts of interests

The authors have no conflicts of interest relevant to this article.

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