ORIGINAL ARTICLE

Influence of second stage of labor duration on umbilical artery lactate levels in uncomplicated multiparous women

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Aim: We examined the relationship between second stage of labor duration and umbilical artery lactate levels in uncomplicated multiparous women.

Methods: This was a retrospective study of 789 healthy multiparous women with no history of caesarean section and singleton pregnancy, who had a vaginal delivery after 37 weeks' gestation at our institutes between August 2015 and March 2017. As controls, 1,082 uncomplicated nulliparous women who gave birth during the same period were also examined.

Results: The average umbilical artery lactate level increased with increasing second stage of labor duration ($p < 0.05$) in multiparous women. Multiparous women with a second stage of labor duration of 0–60 min had a significantly lower average lactate level compared to nulliparous women ($p < 0.05$), while those with a second stage of labor duration of 121–180 min had a significantly higher average lactate level compared to nulliparous women ($p < 0.05$).

Conclusion: A prolonged second stage of labor duration was associated with increased umbilical artery lactate levels.

Introduction

Lactate in umbilical cord blood is a more reliable marker for fetal asphyxia, and a better predictor of neonates with low Apgar scores, than umbilical cord acid-base status.^{1–3)} Testing of umbilical cord blood lactate levels has been suggested to provide a highly specific means of diagnosing fetal distress. Lactate and pH values serve as parameters to distinguish between asphyxiated and normal neonates, with the former having a higher discriminating power.²⁾ Indeed, to assess fetal well-being during labor, fetal scalp blood lactate estimation can be performed more successfully than pH estimation.³⁾

The influence of a prolonged second stage of labor (hereafter, prolonged second stage) on the fetus remains controversial. Some reported that a prolonged second stage was an independent predictor of adverse neonatal outcomes such as acidemia,^{4–6)} while others found it to be no serious disadvantage to the fetus.^{7–9)} In our earlier small-scale study, a second stage of labor duration of <3

hours did not influence fetal umbilical cord acid-base status, lactate status, or oxidative status in uncomplicated nulliparous women.⁹⁾

Although second stage of labor duration has been reported to be shorter in multiparous women than in nulliparous women,¹⁰⁾ how this impacts obstetric outcomes has not been clarified. Against this backdrop, we examined the relationship between second stage of labor duration and lactate levels in umbilical arterial blood as a reflection of fetal acidosis in uncomplicated multiparous women.

Methods

The protocol of this study was approved by the Ethics Committee of Nippon Medical School. Informed consent regarding the use of a database for retrospective analysis was obtained from all subjects.

The present retrospective study targeted 810 healthy multiparous women with no history of caesarean section

Table 1. Demographic data

	Nulliparous women			Multiparous women		
Second stage of labor duration (min)	0–60	61–120	121–180	0–60	61–120	121–180
Number of patients	624 (58)	319 (29)	139 (13)	745 (94)*	32 (4)*	12 (2)*
Maternal age (years)	32.7 ± 4.8	33.6 ± 4.9	33.5 ± 5.2	34.8 ± 4.9	35.8 ± 4.5	35.0 ± 4.9
Gestational age (weeks)	39.1 ± 1.0	39.0 ± 1.2	39.3 ± 1.1	39.0 ± 1.0	39.1 ± 1.1	39.2 ± 1.1
Neonatal birth weight (g)	3,012 ± 190	3,048 ± 212	3,098 ± 210	3,105 ± 221	3,168 ± 198	3,245 ± 180
First stage of labor duration (h)	9.58 ± 4.4	10.12 ± 4.6	8.95 ± 4.9	4.55 ± 2.1*	5.98 ± 1.9*	8.12 ± 4.3

Data are presented as number (%) or average ± SD.

* $P < 0.05$ vs. nulliparous women

and singleton pregnancy, who had a vaginal delivery after 37 weeks' gestation at hospitals affiliated with Nippon Medical School between August 2015 and March 2017. None of the patients underwent epidural anesthesia for painless delivery. Oxytocin was administered as appropriate for those with weak labor pains according to the Guideline for Obstetrical Practice in Japan 2014.¹¹⁾ We examined each item of umbilical arterial blood gas analysis, as well as multiple items of clinical parameters including parity (nulliparous or multiparous), maternal age, neonatal birth weight, Apgar scores at 1 and 5 minutes, and first- and second-stage of labor durations.

Of the 810 women, 21 (2.6%) underwent cesarean section due to non-reassuring fetal status and/or arrest of labor during the first or second stage of labor, and the remaining 789 who delivered vaginally were classified into three groups according to second stage of labor duration: 0–60 min ($n = 745$, 94%), 61–120 min ($n = 32$, 4%), and 121–180 min ($n = 12$, 2%). As controls, 1,082 uncomplicated nulliparous women who delivered vaginally after 37 weeks' gestation during the same period were also classified/examined in a similar manner. In addition to the influence of second-stage labor duration on obstetric outcomes, we also examined the effect of an extremely short second stage of labor and instrumental delivery, such as forceps/vacuum extraction deliveries, on umbilical artery lactate levels in multiparous women.

Data are expressed as mean ± SD or number (%). SPSS Statistics software version 20 (IBM Corp., Armonk, NY, USA) was used for statistical analyses. Statistical comparisons between the 2 groups were performed using the unpaired t test or Welch's t test for continuous variables and χ^2 or Fisher's exact test for categorical variables. One-way analysis of variance was used. $P < 0.05$ was considered statistically significant.

Results

Demographic data of the study population are shown in Table 1. The proportion of women with a second stage of labor duration of 0–60 min was 94% in multiparous women, which was significantly higher compared to

nulliparous women (vs. 58%, $p < 0.05$). On the other hand, the proportion of those with a second stage of labor duration of 121–180 min was significantly lower in multiparous women compared to nulliparous women (2% vs. 13%, $p < 0.05$).

The average maternal age and neonatal birth weight were significantly higher in multiparous women compared to nulliparous women. The average first stage of labor duration was significantly shorter in multiparous women with second stage of labor durations of 0–60 and 61–120 min compared to nulliparous women ($p < 0.05$). However, no significant difference was observed in first stage of labor duration between multiparous women with a second stage of labor duration of 121–180 min and nulliparous women.

Delivery modes and obstetric outcomes of the study population are shown in Table 2. The rate of instrumental delivery in nulliparous women was significantly higher than that in multiparous women ($p < 0.05$). In multiparous women, the average umbilical artery lactate level increased with increasing second stage of labor duration ($p < 0.05$). There were no significant differences in Apgar scores or umbilical arterial PO_2 , PCO_2 , or pH levels between nulliparous and multiparous women. However, the average umbilical artery lactate level was significantly lower in multiparous women with a second stage of labor duration of 0–60 min, and significantly higher in multiparous women with a second stage of labor duration of 121–180 min, compared to nulliparous women ($p < 0.05$ for both).

Table 3 shows the distribution of umbilical artery lactate levels in three groups of multiparous women with a second stage of labor duration of 0–60 min (i.e., 0–15, 16–30, and 31–60 min). Umbilical artery lactate levels were significantly higher in those with a duration of 31–60 min compared to those with a duration of 0–30 min ($p < 0.05$).

In cases of instrumental delivery, umbilical artery lactate levels were significantly higher compared to normal delivery in multiparous women with second stage of labor durations of 0–60 and 61–180 min (0–60 min: 4.49 ± 1.4 vs. 3.70 ± 1.0 mmol/L, $p < 0.01$; 61–180 min: 6.75 ± 1.4 vs. 5.22 ± 1.2 mmol/L, $p < 0.01$).

Table 2. Delivery modes and obstetric outcomes

	Nulliparous women			Multiparous women		
Second stage of labor duration (min)	0–60	61–120	121–180	0–60	61–120	121–180
Number of patients	624 (58)	319 (29)	139 (13)	745 (94)	32 (4)	12 (2)
Delivery mode						
Normal	520 (83)	244 (76)	84 (60)	713 (96)	29 (91)	9 (75)
Forceps/vacuum extraction	104 (17)	75 (24)	55 (40)	32 (4)*	3 (9)*	3 (25)*
1-min Apgar score	8.8 ± 0.3	8.9 ± 0.3	8.8 ± 0.3	9.0 ± 0.2	9.1 ± 0.3	8.9 ± 0.4
5-min Apgar score	9.6 ± 0.3	9.7 ± 0.3	9.5 ± 0.3	9.6 ± 0.3	9.6 ± 0.3	9.5 ± 0.3
Umbilical arterial blood gases						
PCO ₂ (mmHg)	19.7 ± 4.0	19.5 ± 3.5	20.1 ± 4.3	19.6 ± 3.8	20.3 ± 4.1	19.8 ± 4.2
PO ₂ (mmHg)	44.5 ± 4.1	45.7 ± 4.3	46.8 ± 4.6	46.2 ± 4.4	44.8 ± 3.5	45.6 ± 3.9
pH	7.28 ± 0.09	7.32 ± 0.06	7.34 ± 0.08	7.33 ± 0.06	7.29 ± 0.07	7.30 ± 0.06
Lactate (mmol/L)	4.68 ± 1.1	4.79 ± 0.9	4.64 ± 1.2	3.77 ± 1.0*	4.98 ± 1.1 [#]	5.44 ± 1.3 [#]

Data are presented as number (%) or average ± SD.

* $P < 0.05$ vs. nulliparous women.

[#] $P < 0.05$ vs. a duration of 0–60 min.

Table 3. Distribution of umbilical artery lactate levels in three groups of multiparous women with a second stage of labor duration of 0–60 min.

Second stage of labor duration (min)	0–15	16–30	31–60
Number of patients	382 (51)	256 (34)	107 (15)
Umbilical arterial blood gases			
PCO ₂ (mmHg)	19.2 ± 3.5	19.9 ± 4.0	20.1 ± 3.8
PO ₂ (mmHg)	46.5 ± 4.5	45.9 ± 4.4	45.7 ± 3.8
pH	7.31 ± 0.07	7.34 ± 0.06	7.30 ± 0.08
Lactate (mmol/L)	3.48 ± 1.0*	3.79 ± 1.0*	4.45 ± 1.0

Data are presented as number (%) or average ± SD.

* $P < 0.05$ vs. a duration of 31–60 min.

Discussion

The present study showed that most multiparous women delivered within 60 min during the second stage of labor, with no increase in umbilical artery lactate levels compared to nulliparous women. However, when the second stage of labor duration exceeded 121 min, umbilical artery lactate levels increased significantly.

The influence of second stage of labor duration on obstetric outcomes has been widely studied, with inconsistent results.^{4–9,12–14} Some earlier studies have suggested that a prolonged second stage leads to increased adverse outcomes in multiparous women and is thus an independent risk factor for adverse maternal and neonatal outcomes.^{12,13} Chen et al.¹³ reported that a second stage of labor duration of ≥ 3 hours in multiparous women was associated with increased risks of instrumental delivery, peripartum morbidity, and undesirable neonatal outcomes. On the other hand, in nulliparous women, second stage of labor duration was not associated with adverse neonatal outcomes.^{13,14} In

the present study, there were no differences in neonatal outcomes between nulliparous women and multiparous women with a second stage of labor duration of ≤ 3 hours; however, a similar tendency was observed in umbilical artery lactate levels.

Second stage of labor duration is defined as the time from complete dilatation of the cervix until delivery based on the first notation of a fully dilated cervix. Since multiparous women tend to have a softer vaginal canal wall than nulliparous women, they are considered likely to have a smoother progression of the second stage of labor. In women who have experienced vaginal delivery, whose bodies have acclimated to childbirth, the second stage of labor may only require a brief trial. In the present study, the proportion of multiparous women with a second stage of labor duration of ≤ 60 min was 94%, which was significantly higher compared to that of nulliparous women. In addition, the average lactate level was significantly lower, and first stage of labor duration significantly shorter, in multiparous women than in nulliparous women. These findings suggest that fetuses

with smooth delivery from multiparous women are less stressed than those from nulliparous women with the same duration. Furthermore, based on our results, women with a second-stage labor duration of ≤ 30 min are expected to maintain sufficiently low levels of umbilical cord blood lactate in multiparous delivery.

On the other hand, the average lactate level was significantly higher in multiparous women with a second stage of labor duration of 121–180 min compared to nulliparous women. The reason for this is unclear. The small sample size may partly explain this finding, as the proportion of women with a second stage of labor duration of 121–180 min was only 2%. However, it is also possible that multiparous women with a prolonged second stage have a risk of increased lactate levels. In other words, multiparous women without any delivery-related complications should achieve a vaginal delivery within 120 min of the second stage of labor. Several factors may influence second-stage of labor duration, including fetal factors such as fetal size and position, as well as maternal factors such as pelvis shape, magnitude of labor pain, complications (e.g., hypertension, diabetes), age, and history of previous deliveries.¹⁵⁾

Direct stress to the fetus may also elevate umbilical artery lactate levels, as lactate is a metabolic product of the glycolysis cycle in the feto-placental circulation. For example, high lactate levels in amniotic fluid have been reported to be associated with dystocia requiring instrumental or operative delivery.¹⁶⁾ The results of the present study support this, although the sample size was too small to examine whether lactate is a useful clinical factor for identifying labor dystocia. Umbilical artery lactate levels have also been reported to correlate with maternal blood lactate levels influenced by the intensity of labor pain.^{17,18)} These findings suggest that elevated umbilical artery lactate levels may be caused by fetal stress, and can be influenced by high maternal lactate levels due to maternal muscular effort related to labor. Physicians should pay attention to maternal-fetal conditions when evaluating the neonatal state based on lactate levels. That said, since the present study did not examine maternal blood lactate levels, a large-scale study will be needed to examine potential maternal factors.

In conclusion, a prolonged second stage was associated with increased umbilical artery lactate levels, which may be affected by fetal and/or maternal conditions. A further study is warranted.

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Conflict of interest statement

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

References

1. Hamed HO. Intrapartum fetal asphyxia: study of umbilical cord blood lactate in relation to fetal heart rate patterns. *Arch Gynecol Obstet.* 2013; 287: 1067–1073.
2. Jurek W, Szymczakiewicz-Multanowska AM, Jurek G. Umbilical artery lactate level as a marker of the neonatal clinical condition—preliminary results (in Polish). *Przegl Lek.* 2001; 58: 1052–1054.
3. East CE, Leader LR, Sheehan P, Henshall NE, Colditz PB. Intrapartum fetal scalp lactate sampling for fetal assessment in the presence of a non-reassuring fetal heart rate trace. *Cochrane Database Syst Rev.* 2010; (3): CD006174.
4. Altman M, Sandström A, Petersson G, Frisell T, Cnattingius S, Stephansson O. Prolonged second stage of labor is associated with low Apgar score. *Eur J Epidemiol.* 2015; 30: 1209–1215.
5. Li WH, Zhang HY, Ling Y, Jin S. Effect of prolonged second stage of labor on maternal and neonatal outcomes. *Asian Pac J Trop Med.* 2011; 4: 409–411.
6. Hagelin A, Leyon J. The effect of labor on the acid-base status of the newborn. *Acta Obstet Gynecol Scand.* 1998; 77: 841–844.
7. Laughon SK, Berghella V, Reddy UM, Sundaram R, Lu Z, Hoffman MK. Neonatal and maternal outcomes with prolonged second stage of labor. *Obstet Gynecol.* 2014; 124: 57–67.
8. Janni W, Schiessl B, Peschers U, et al. The prognostic impact of a prolonged second stage of labor on maternal and fetal outcome. *Acta Obstet Gynecol Scand.* 2002; 81: 214–221.
9. Suzuki S, Okudaira S. Influence of the duration of the second stage of labor on fetal pH levels and oxidative status in uncomplicated pregnancies. *J Matern Fetal Neonatal Med.* 2004; 15: 100–103.
10. Ashwal E, Livne MY, Benichou JIC, et al. Contemporary patterns of labor in nulliparous and multiparous women. *Am J Obstet Gynecol.* 2020 ;222: 267.e1–9.
11. Minakami H, Maeda T, Fujii T, et al. Guidelines for obstetrical practice in Japan: Japan Society of Obstetrics and Gynecology (JSOG) and Japan Association of Obstetricians and Gynecologists (JAOG) 2014 edition. *J Obstet Gynaecol Res.* 2014; 40: 1469–1499.
12. Wang L, Wang H, Jia L, Qing W, Li F, Zhou J. The impact of stage of labor on adverse maternal and neonatal outcomes in multiparous women: a retrospective cohort study. *BMC Pregnancy Childbirth.* 2020; 20: 596.
13. Cheng YW, Hopkins LM, Laros Jr RK, Caughey AB. Duration of the second stage of labor in multiparous women: maternal and neonatal outcomes. *Am J Obstet Gynecol.* 2007; 196: 585.e1–6.
14. Cheng YW, Hopkins LM, Caughey AB. How long is too long: Does a prolonged second stage of labor in nulliparous women affect maternal and neonatal outcomes? *Am J Obstet Gynecol.* 2004; 191: 933–938.
15. Hutchison J, Mahdy H, Hutchison J. Stages of labor. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021. <https://pubmed.ncbi.nlm.nih.gov/31335010/> (March 10, 2021)
16. Wiberg-Itzel E, Pettersson H, Cnattingius S, Nordström L. Association between lactate concentration in amniotic fluid and

- dysfunctional labor. *Acta Obstet Gynecol Scand.* 2008; 87: 924–928.
17. Tajiri O, Nagano K, Okada Y, Sakamoto M, Sugihara H, Yamanaka I. Blood lactate levels in the umbilical cord artery and maternal artery during cesarean section –comparison of elective and emergency cases- (in Japanese). *J Jpn Clin Anesth.* 2000; 20: 309–314.
 18. Kalinkov D, Schachinger H, Buchholz R. Theoretical and practical significance of parallel assays of serum lactic acid, pH and blood gases in mothers and neonates at birth. *J Perinat Med.* 1980; 8: 134–141.