



# Association Between Amniotic Fluid Lactate Concentration and Labor Outcome in Primiparas' Deliveries

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## Abstract

**Objectives:** Because of the higher frequency of dystocic labor in nulliparous pregnant women, a supplementary test is highly important for predicting the probability of the cesarean intervention. The aim of this study was to evaluate the correlation between the amniotic fluid lactate (AFL) level and the outcome of delivery in nulliparous term pregnant women referring with the complaint of the spontaneous rupture of membranes.

**Methods:** Nulliparous women with term pregnancies and single cephalic presentation, presenting with the spontaneous rupture of membranes and active phase of labor, were enrolled in this study. The AFL was evaluated by a portable device. In addition, the partogram curve, labor progression, and delivery method were recorded for each patient. Finally, the association between the need for cesarean delivery and the AFL level was investigated as well.

**Results:** In general, 200 nulliparous pregnant women were enrolled in this study. The mean age of women and the mean AFL were  $29.12 \pm 7.54$  years and  $7.32 \pm 3.63$  mmol/L, respectively. Among 144 patients with AFL below 10.1 mmol/L, 33 patients (22.9%) had a cesarean delivery. Further, among 56 patients with AFL above 10.1 mmol/L, 42 patients (75%) had a cesarean delivery ( $P < 0.001$ ). Eventually, an AFL level higher than 10.1 mmol/L in predicting the cesarean section had a sensitivity of 85.6% and a specificity of 82.7%.

**Conclusions:** Amniotic lactate levels  $>10.1$  mmol/L in nulliparous women with single-term pregnancy can be used as a marker for predicting cesarean delivery.

**Keywords:** Amniotic fluid lactate level, Labor, Outcome, Cesarean delivery

## Introduction

Nulliparity refers to those women who have no delivery beyond 20 weeks of pregnancy. In nulliparous women, cesarean delivery is more frequent mainly due to dysfunctional delivery. Considering the benefits of normal vaginal delivery and the significant side effects of dystocia, it is important to use effective methods for the monitoring of labor progress and early diagnosis of labor arrest resulting from myometrial fatigue. Some physiologic changes occur in pregnant women. Cardiac output increases about 50%, which helps the body to increase the blood flow of the enlarged uterus and placenta and the glomerular filtration rate in order to eliminate extra waste from the fetus. The relaxin hormone, estrogen, and progesterone are responsible for most of these physiologic changes (1). Small maternal pelvis, placenta previa, fetus bradycardia, and asphyxia are some examples of absolute indications, and prolonged labor, also known as labor secondary arrest and a history of previous cesarean section are the examples of the relative indications of cesarean section (2). Its prevalence is estimated to be up to 48% in Iran (3).

In 1970, Philpott and Castle showed the efficacy of partogram in predicting hard delivery, but it is not a

perfect indicator and has errors in the correct prediction of abnormal labor progress (4).

Hence, there is an absolute need for a supplementary modality to predict the necessity of surgical interventions.

Although the myometrium produces lactate in normal conditions, when myometrial fatigue occurs, lactate production increases as anaerobic metabolism becomes more dominant (5).

Wiberg-Itzel et al demonstrated that an amniotic fluid lactate (AFL) level  $>10.1$  mmol/l had a significant association with dystocic labor and thus suggested using AFL concentrations for the early diagnosis of dystocic labor (6).

Later, Wiberg-Itzel et al indicated that the concurrent use of AF lactate and partogram was a better predictor for cesarean delivery (7). A few studies have investigated the predictive power of AFL in predicting cesarean delivery. Nonetheless, further evaluations are needed for clinical use. Accordingly, predicting a cesarean delivery and timely preparing the operation room are useful, especially in those centers with limited facilities. Given the above-mentioned explanations, this study aimed to evaluate the correlation between the AFL level and the outcome of delivery in nulliparous term pregnant women



referring with the complaint of the spontaneous rupture of membranes.

### Materials and Methods

Overall, 200 nulliparous women with term ( $\geq 37$  weeks) pregnancy and single cephalic presentation with spontaneous and active labor (cervical dilation more than 3 cm), who experienced regular contractions and the complaint of the spontaneous rupture of membranes were included in this cross-sectional study since January 2016 until October 2018. According to our preliminary investigations, 40% of those admitted to our tertiary center had the inclusion criteria and 57% of them had undergone cesarean section, and finally, the study population was estimated as 189 patients considering a 95% confidence level and a 5% margin of error. On the other hand, the exclusion criteria were preeclampsia, diabetes mellitus, premature delivery, and intrauterine growth retardation. A fine tube connected to a 5 cc syringe was used to collect amniotic fluid from the posterior fornix of the cervix after sterile speculum insertion in the lithotomy position. If there was no enough amniotic fluid for analysis, the patient was excluded from the study. In the first hour of admission, 1 mL of amniotic fluid free of blood and meconium stain was analyzed by an Amniotic Fluid Lactate™ monitoring system (developed by ObsteCare AB) and was immediately analyzed for lactate concentrations. The AFL™ monitoring system includes a single used sensor probe and a monitoring system. The necessary analysis was done at the patients' bedside using a sample of amniotic fluid, and the results were available in 15 seconds. The lactate concentration in the amniotic fluid was measured with a variation coefficient of approximately 3% at a lactate concentration of 11 mmol/L. The device detects hydrogen peroxide which is produced by lactate oxidase (7). AFL was measured according to (7) when a patient had our inclusion criteria. In addition, patients were divided into those with an AFL  $\geq 10.1$  and AFL  $< 10.1$  according to AFL.

The caesarian section was done for maternal and fetal indications. When the pregnancy terminated because of fetal distress and meconium aspiration, the patient was excluded from the study. In the case of labor arrest or inadequate descent, oxytocin was administered up to 30 mU/min according to the progress of the delivery. Decision-making about cesarean delivery was done by the patients' corresponding physician.

Partogram curve, labor progression, delivery method, and neonatal Apgar score were recorded for each patient and then compared with the level of AFL. Patients' demographic and laboratory data were collected according to the patients' files and a questionnaire form after delivery.

### Statistical Analysis

Continuous data were presented as the mean  $\pm$  standard

deviation and the categorical data were provided as percentages. Fisher's exact and chi-square tests were used to analyze any association between the AFL level and the outcome of delivery. The analysis was performed using the SPSS software (version 21.0), and the results were considered statistically significant at  $P < 0.05$ .

### Results

The mean age of the patients was  $29.1 \pm 7.5$  years. Figure 1 shows the gestational age of pregnancies. The mean age and the gestational age of the patients with normal and abnormal partogram were  $28.75 \pm 7.04$  and  $31.13 \pm 7.39$ , ( $P = 0.637$ ), as well as  $38.07 \pm 1.01$  and  $38.19 \pm 1.28$  ( $P = 0.076$ ), respectively.

Table 1 presents patients' data according to their on-admission AFL concentrations. In general, 144 (72%) and 56 (28%) patients had AFL concentrations below 10.1 mmol/L and higher than 10.1 mmol/L, respectively. Based on the results, normal vaginal delivery was dominant in patients with AFL concentrations lower than 10.1 mmol/L. Contrary, an AFL  $> 10.1$  mmol/L had a significant association with cesarean delivery ( $P < 0.001$ ). The relative risk for cesarean delivery in patients with an AFL level of more than 10.1 mmol/L was estimated as 3.27. Thus, the AFL level had a significant association with partogram results ( $P < 0.001$ ).

Although the newborns of the low lactate group had a better Apgar score, it was not significant statistically ( $P = 0.06$ ). Eventually, an AFL level of higher than 10.1 mmol/L in predicting cesarean section had a sensitivity of 85.6% and specificity of 82.7% (Figure 2).

### Discussion

Amniotic fluid is highly important for the normal development of the fetus. It surrounds the fetus and protects him/her from trauma and prevents umbilical cord compression by providing enough space in the uterus. It also helps the gastrointestinal and pulmonary system development by its growth factors and prevents infections by its immunoglobulins (8,9). Few improvements have been made since 1970 when Philpot and Friedman showed the efficacy of partogram in predicting dystocic labor

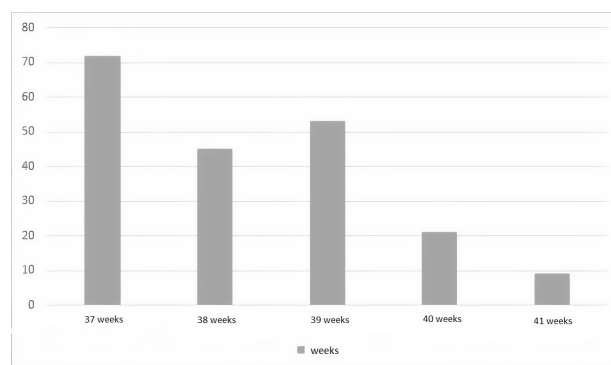
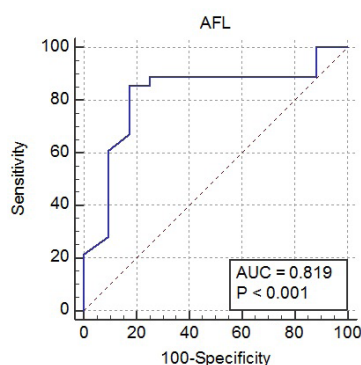


Figure 1. Pregnancy Weeks and Number of Delivery.



**Figure 2.** Receiver Operating Characteristic curve Showing a Good Association Between AFL and Cesarean Section. Note. AFL: Amniotic fluid lactate.

(10). Dystocic labor is estimated to complicate nearly 20% of all deliveries (11). On the other hand, some women with abnormal partogram will still have a normal vaginal delivery. Hence, a complementary method seems to be necessary for predicting hard delivery and timely surgical interventions. Lactate production grows in the anaerobic state when muscles receive little oxygen and perfusion (12). The current study investigated the association between AFL concentrations and the outcome of delivery in nulliparous term pregnant women presented with spontaneous delivery. The results of this study suggested that a low AFL concentration is a good predictor of normal vaginal delivery. On the other hand, high AFL concentration was associated with a higher incidence of cesarean deliveries. Similarly, Murphy et al reported that the AFL concentration above 10 mmol/L independently predicted cesarean delivery. In their investigation, the AFL level had a sensitivity of 23% and a specificity of 92% in predicting cesarean delivery (13).

Likewise, Weiberg-itzel et al demonstrated that AFL concentrations above 10.1 mmol/L could predict cesarean delivery with a sensitivity of 81% and a specificity of 83%

(14), which is in line with our findings. It seems that a better prediction of dystocic labor can be achieved through correct and sufficient amniotic fluid sample collection and sampling repetition. In their study, Wiberg-Itzel et al found a positive association between the AF lactate level and adverse neonatal outcomes (11). Chander et al also showed that lower AF lactate resulted in a better Apgar score of neonates (15).

Recently, the results of a study revealed that a high AFL is associated with hypoxia in the fetus and the mother (16). Our results also represented a lower Apgar in the neonates of those patients with a high AFL.

It seems that early intervention in cases of abnormal labor progress can prevent adverse outcomes in neonates.

When anaerobic glycolysis happens, lactate is the main produced metabolite (17). The contractions of the myometrium and reduced blood flow during contractions make hypoxic myocytes produce more lactates (18). Wray concluded that myometrial lactic acidosis can impair the normal progression of vaginal delivery. Even oxytocin administration will not be helpful in this condition (19).

Previous studies described some mechanisms to show why the elevated lactate concentration in the myometrium can prevent myometrium from effective contractions (11). Myometrial acid-base balance changes with lactate accumulations in the myometrium (20). It has been shown that the reduction of myometrial pH results in weak myometrial contractions and difficult labor (21).

$Ca^{2+}$  enters myometrium mainly via L-type  $Ca^{2+}$  channels, where the increased lactate results in decreased pH, affecting myometrial  $Ca^{2+}$  current, and eventually, leading to impaired myometrial contraction (12, 21). Some hormonal changes are associated with dystocic labor. PGF (2alpha), cortisol and 15-ketodihydro-PGF (2alpha), and sustained oestrone sulphate after parturition are associated with adverse outcomes. Thus, evaluating these factors in future studies and their association with AFL can help in a better understanding of the pathophysiology

**Table 1.** Patients' Data According to Their on-admission AFL Concentration

Variable	AFL Concentration (>10.1 mmol/L) n=56 (28%)	AFL Concentration (<10.1 mmol/L) n=144 (72%)	P Value
Weight (kg)	68.4±9.3	69.9±11.2	0.335
Height (cm)	158.9±5.6	159.4±5.1	0.562
Alanine aminotransferase	13.1±3.9	14.9±5.8	0.012
Aspartate aminotransferase	17.9±4.1	18.0±4.3	0.879
Alkaline phosphatase	139.6±36.9	137.1±38.1	0.670
Normal vaginal deliveries, No. %	14 (25%)	111 (77.1%)	<0.001
Cesarean delivery, No. %	42 (75%)	33 (22.9%)	<0.001
Abnormal partogram, No. %	50 (89.3%)	58 (40.3%)	<0.001
Apgar score	7.96±2.01	8.62±2.39	0.061
Age of women	29.18±6.37	30.28±7.96	0.087
Pregnancy weeks	38.6±1.3	38.04±1.05	0.537
Normal partogram results, No. %	6 (10.6%)	86 (59.7%)	<0.001
Oxytocin administration, No. %	30 (56)	23 (15.9)	<0.001

Note. AFL: Amniotic fluid lactate.

of adverse outcomes in dystocic deliveries.

### Limitations of Study

This study focused on analyzing the AFL on admission and after the rupture of the amniotic membrane. Better results could be obtained by more samplings and AFL analysis before the rupture of the membrane.

### Conclusions

Amniotic lactate levels >10.1 mmol/L in nulliparous women with single term pregnancy can be used as a marker for predicting cesarean delivery.

### Authors' Contribution

All authors contributed equally to the design of the manuscript, reviewing the literature, collecting the data, data analysis, editing, and submitting this manuscript. All authors approved the final manuscript and take responsibility for the integrity of the data.

### Conflict of Interests

Authors declare that they have no conflict of interests.

### Ethical Issues

This study was approved by the Ethics Committee of Urmia University of Medical Sciences by registration number 95/01/66/2519. All pregnant women agreed to participate in this study by giving their informed consent.

### Financial Support

This research received no specific grants.

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