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Original Article

Use of Amniotic Fluid Lactate Concentration in Prediction of Dysfunctional Labour at the University College Hospital, Ibadan, Nigeria

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Abstract

Introduction: Dysfunctional labour is a common indication for instrumental vaginal delivery or cesarean section. Raised myometrial lactate level following prolonged uterine activities has been shown to cause inhibition of contractions (poor or uncoordinated) and lack of progress or dysfunctional labour. Therefore, determining the amniotic fluid lactate concentration (AFLC) in labour may be a potential biochemical marker for labour dystocia and a good predictor of labour outcome. **Methodology:** We recruited booked, consenting parturients in active phase of labour into a cross-sectional study between September 2014 and March 2015. Amniotic fluid samples were taken twice – at initial vaginal examination or during artificial rupture of membranes and at delivery while the AFLC was determined using a primed lactate meter. **Results:** The main outcome measure was the mean AFLC. Of the 113 parturients with mean age of 30.49 ± 4.37 years, the overall mean AFLC was 18.94 ± 4.84 mmol/L while 10 (8.8%) had dysfunctional labour. Mean AFLC for parturients who had vaginal delivery was 18.76 ± 4.90mmol/L and 17.42 ± 5.26 mmol/L at first and second samplings while for those who had cesarean deliveries, mean AFLCs were 20.80 ± 2.75 and 18.24 ± 3.59 at the two samplings respectively. The cut–off for AFLC that best discriminated between normal and dysfunctional labour was 19.80 mmol/L. **Conclusion:** High levels of AFLC may play a role in predicting dysfunctional labour among pregnant women in labour.

Keywords: Amniotic Fluid Lactate; Cesarean Section; Dysfunctional Labour; Spontaneous Vaginal Delivery.

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Introduction

Dysfunctional labour or lack of progress in labour has been defined as slow or arrest of progress manifesting as cervical dilatation below 1cm per hour or failure of descent of the presenting part or both. It varies between 4% – 20% (1) and is a common indication for instrumental vaginal delivery (IVD) or cesarean section (CS).

The uterine muscles contract in rhythmic fashion in labour and, like any other muscle, produce lactate following prolonged activity. A raised lactate level in the myometrium has been shown to cause inhibition of contractions (poor or uncoordinated) and lack of progress or dysfunctional labour (2–7).

It is possible to predict this myometrial inhibition by measuring the amniotic fluid lactate concentration (AFLC) (8). An increased AFLC indicates that the myometrium is exhausted and further augmentation of labour with oxytocin is unlikely to improve the probability of spontaneous vaginal delivery (SVD) (9).

Therefore, measurement of AFLC in labour may be a biochemical marker for labour dystocia and a good predictor of labour outcome (1). This will help reduce the number of CS in women who may not need it and hasten decision-making in those with a difficult labour, thereby limiting complications from prolonged labour.

A pilot study by Hall et al in Sweden using The Lactate Pro™ 2 (LT-1730) on blood samples of parturients showed that the machine can reliably measure, in 15 seconds, the AFLC after spontaneous or artificial rupture of membranes (SROM or ARM) (10). The cost efficiency, potential use in remote settings and its versatility were also demonstrated as it can be used to determine fetal scalp and umbilical cord lactate concentrations. It was thus hypothesized that a high lactate concentration in the uterine muscles as reflected by a high AFLC may be associated with dysfunctional labour.

Materials and Methods

This was a cross-sectional study conducted at the Labour Ward Complex, University College Hospital (LWC, UCH), Ibadan, Nigeria. It involved consented, booked pregnant women presenting in established labour between September 2014 and March 2015, and assessed to be fit for vaginal delivery. The inclusion criteria included low-risk, singleton, and cephalic presenting pregnancies at term (37 – 41 weeks). Ethical approval was obtained from the University of Ibadan/University College Hospital, (UI/UCH) Ethics Committee. The study center is a tertiary health institution with approximately 1000 beds although the LWC is 20 bedded.

Amniotic fluid samples were taken on two occasions by the resident doctor in charge of the LWC. The first sample was taken during the active phase of labour when ARM was done or during vaginal examination on arrival in labour ward (if membranes had ruptured spontaneously) while the second sample was taken at the time of delivery of the baby. A 2ml needle-less syringe placed at the introitus during the amniotomy, or vaginal examination was used to aspirate less than 0.5 ml of amniotic fluid for the lactate meter. AFLC was estimated by applying the collected amniotic fluid directly to the primed Lactate Pro™ 2 LT-1730 (ARKRAY Inc., Kyoto City, Japan) test strip.

The Lactate Pro™ 2 LT-1730 is a small hand-held meter for measuring lactate concentrations in blood at the point of care. Its test strips use the lactate oxidase enzyme electrode method, and it measures concentrations between 0.5 and 25.0mmol/L. Each test result is displayed within 15 seconds. The test of reliability in amniotic fluid showed minimal measurement error with a coefficient of variation of 1.7 – 3.0% (10). The meter had a memory capacity for 330 results, is auto calibrated and requires no chip coding. Hall et al, in their study, had established that contaminating substances such as blood, meconium, obstetric cream/solutions or glove lubricants did not alter amniotic fluid lactate results (10).

The parturient, midwives and doctors were blinded to the results, so as not to influence the decision-making process. The time of sampling and AFLCs were recorded in the parturients' dated and coded proforma.

The main outcome measure was the mean AFLC. Data analysis was done with IBM SPSS version 20.0, (IBM Corp., Armonk, USA). Associations were determined with the use of chi-square test statistic while logistic regression was used to further investigate the associations between the dependent variables such as normal labour and independent variables such as AFLCs. Odds ratios as well as 95% confidence intervals were presented. In addition, the independent student t-test was used to compare means between the group that had CS and the one that had SVD. The AFLCs were tested for normality using the KS test ($p< 0.05$). Hence, median was used as the cut-off to determine high and low AFLCs. All analyses were carried out at the 5% level of significance.

Results

One hundred and thirteen eligible women were recruited to participate in the study. Their mean age was 30.49 ± 4.37 years while the modal parity was 1 (range 0 - 6). Majority of the women, 78 (69.0%) had previous delivery and 111 (98.2%) were married. Their socio-demographic characteristics are presented in Table 1.

Table I: Socio-demographic Characteristics of Participants

Variable	Frequency (n=113)	Percentage (%)
Age (years)		
≤ 20	1	0.9
21-30	63	55.7
31-40	48	42.5
≥ 41	1	0.9
Mean ± SD 30.49 ± 4.37		
Educational level		
None	1	0.9
Primary	1	0.9
Secondary	30	26.5
Tertiary	81	71.7
Occupation		
Management cadres	39	34.5
Technologists/Technicians	13	11.5
Artisans/Office support works	51	45.2
Students	10	8.8
Marital Status		
Single	1	0.9
Co-habiting	1	0.9
Married	111	98.2
Tribe		
Yoruba	101	89.4
Hausa/Fulani	1	0.9
Igbo	8	7.1
Others	3	2.6
Religion		
Christianity	66	58.4
Islam	47	41.6
Parity		
0	35	31.0
1-3	72	63.7
≥ 4	6	5.3
Modal parity 1		
Gestational age (weeks)		
$37^{+0} – 38^{+6}$	46	40.7
$39^{+0} – 40^{+6}$	50	44.3
≥ 41	17	15.0
Mean ± SD 38.97 ± 1.35		
Mode of delivery		
SVD	103	91.2
Cesarean delivery	10	8.8
Cervical dilatation at first sampling (cm)		
4 - 5	33	29.2
6 – 10	80	70.8

Table 1 also shows the mean gestational age at delivery, 38.97 ± 1.35 weeks. Eighty (70.8%) of the women had the first sampling at cervical dilatation of ≥6 cm and 103 women (91.2%) had SVD. At 4 – 5 cm cervical dilatations, the mean AFLC was 20.00 ± 3.24 mmol/L compared to 18.50 ± 5.31 mmol/L for those whose samples were taken at ≥6 cm cervical dilatation (p=0.07).

Table II: Comparison of Mean AFLC Between SVD and CS at the First and Second Samplings

Variable	Mode of delivery		t-test	p-value
	SVD	CD		
AFLC (Mean ± SD; mmol/L)				
At first sampling	18.76 ± 4.90	20.80 ± 2.75	2.05	0.06
At second sampling	17.42 ± 5.26	18.24 ± 3.59	13.08	0.52

Table III: Comparison of the mean AFLCs at first sampling with cervical dilatation and mode of delivery

Mode of delivery	AFLC (Mean±SD; mmol/L)	t-test	p-value
Cervical Dilatation 4 – 5 cm			
Caesarean delivery	20.15 ± 2.48		
SVD	19.97 ± 3.43	0.15	0.88
Cervical Dilatation ≥6 cm			
Caesarean delivery	20.70 ± 2.92		
SVD	18.24 ± 5.31	0.78	0.44

Table IV: Association between selected maternal characteristics and dysfunctional labour

Variable	Dysfunctional Labour		Chi square	p-value
	Yes (%)	No (%)		
Parity				
Nullipara	6 (17.1)	29 (82.9)	4.32	0.04
Parity ≥1	4 (5.1)	74 (94.9)		
Age (years)				
< 26	2 (15.4)	11 (84.6)	3.19	0.36
26 - 30	6 (11.8)	45 (88.2)		
31 - 35	2 (6.5)	29 (93.5)		
>35	0.0	18 (100.0)		
Gestational age (wks)				
$37^{+0} – 38^{+6}$	4 (8.7)	42 (91.3)		
$39^{+0} – 40^{+6}$	1 (2.0)	49 (98.0)	9.74	< 0.001
≥ 41	5 (29.4)	12 (70.6)		

In Table 2, women with dysfunctional labour who had CS had an apparently higher mean AFLC at first sampling (≥4 cm cervical dilatation) compared to women with SVD (20.80 ± 2.75 mmol/L versus 18.76 ±

4.96 mmol/L) (p=0.06). However, women with dysfunctional labour who had CS, had a higher mean AFLC at second sampling compared to women who had SVD: 18.24 ± 3.59 mmol/L versus 17.42 ± 5.26 mmol/L (which is statistically not significant; p=0.52).

Table V: Association Between AFLC and Type of Labour

Variable	Labour		Odds Ratio	P – value
	Dysfunctional (%)	Normal (%)		
AFLC at first sampling (mmol/L)				
<19.80	3 (5.5)	52 (94.5)	2.34 (95% CI	0.22
≥19.80	7 (12.1)	51 (87.9)	= 0.58 – 9.71)	

Table VI: Association between augmentation of labour and mode of delivery in patients with high AFLC (≥19.80mmol/L).

Variable	Mode of delivery		Odds Ratio	P– value
	Caesarean delivery (%)	SVD (%)		
Augmentation				
Yes	6 (85.7)	25 (49.1)	6.24 (95% CI =	0.07
No	1 (14.3)	26 (50.9)	0.70 – 55.59)	

Overall, the mean AFLC was 18.94 ± 4.84 mmol/L and of 33 (29.2%) women who had their first sampling at cervical dilatations 4 – 5 cm, 27 (81.8%) had SVD with mean AFLC of 19.97 ± 3.43 mmol/L while 6 (18.2%) had CS with mean AFLC of 20.15 ± 2.48 mmol/L (p=0.88; Table 3). However, the risk of CS due to dysfunctional labour was significantly higher in women who were admitted at cervical dilatation of 4 – 5 cm than in those that were admitted at cervical dilatation of ≥6 cm (OR = 2.29, p=0.007, 95% CI = 1.26 – 4.17). In consideration of selected maternal characteristics such as age, parity and gestational age, only parity (X^2 = 4.32, p=0.04) and gestational age (X^2 = 9.74, p<0.0001) were significantly associated with dysfunctional labour (Table 4). Moreover, nulliparous women (17.1%) had an increased risk of dysfunctional labour when compared to women with previous parous experiences (5.1%) (OR = 3.83, p=0.049, 95% CI = 1.01 – 14.56). Gestational age (≥41 weeks) was also significantly associated with dysfunctional labour requiring CS (OR = 7.58, p=0.0001, 95% CI = 0.86 – 17.16).

Using the median value of 19.80 mmol/L as cut-off, 58 (51.3%) women had AFLCs ≥19.80 mmol/L while 55 (48.7%) had AFLCs <19.80 mmol/L when cervical dilatation was ≥4 cm. Of the former, 12.1% (7/58) had CS due to dysfunctional labour and 5.5% (3/55) women in the other group had CS due to dysfunctional labour (p=0.22) (Table 5).

Among the 58 women with high AFLCs (≥19.80mmol/L), 31 (53.4%) had augmentation of labour. Women who had high AFLCs (≥19.80mmol/L) had a similar risk of CS following augmentation than women who had high AFLCs (≥19.80mmol/L) without augmentation (OR=6.24, 95% CI = 0.70 – 55.59, p=0.10), as shown in Table 6.

Discussion

Dysfunctional labour is a common obstetric problem worldwide and currently, there are no accurate methods for making predictions, early in labour, of parturients that will progress to SVD or those that will require CS on account of the dystocia. The purpose of a screening test for dysfunctional labour will be to identify it early and so reduce unnecessary interventions in a normally progressing labour. This study was prompted by the need for such improved screening methods and decision-making tools which will complement the partograph in the early diagnosis of dysfunctional labour.

In this study, the prevalence of dysfunctional labour requiring CS was 8.8% as compared to 57.4% reported by Wiberg-Itzel et al at the General South Hospital, Stockholm, where a large proportion of the studied population were nulliparous women (9). The low incidence for CS noted in our study may be because majority of the women had had previous parous experiences and arrived at the hospital with cervical dilatations ≥6 cm, which had been previously reported to favor SVD (11). Our study was also able to establish that parturients who attained cervical dilatation ≥6 cm are more likely to have SVD. Some of the suggested reasons for arriving at the hospital with advanced cervical dilatation included: aversion for repeated vaginal examinations due to discomfort, pain, and embarrassment (12-13) and to avoid CS due to assumed poor progress in labour frequently made by doctors (14-15). Logically, women who had spontaneously progressed to 6 cm at home are less likely to be experiencing dysfunctional labour.

This study also confirmed that parity and gestational age were significantly related to dysfunctional labour. Nulliparous women had 3 times the risk of having dysfunctional labour compared with women with previous childbirths, whereas women at gestational ages

≥41 weeks had 7 times those of lesser term gestational ages.

The high level of AFLC in this study is similar that of Wiberg-Itzel et al, where one-third of all the women had a high AFLC at first sampling. However, it is much higher than in other studies averaging 10.0 mmol/L (9). This is not surprising as van der Merwe et al had demonstrated in two different studies conducted among black and white men and women; that black populations have greater lactate release from their subcutaneous adipose tissue compared to the white population (16-17). Due to the dearth of knowledge in this research area, future studies are required to explain this wide variation.

It was noted that there was a reduction in the AFLC with advancement of cervical dilatation. This has equally been confirmed by previous studies which showed that lactate exchange is a dynamic process, with uptake and release between cells at rest and during exercise occurring concurrently (18-19). During prolonged exercise, the muscles that originally produced lactate at the onset of exercise may reverse it to net lactate uptake. The conclusion from these studies implied that lactate is a useful metabolic intermediate which can be exchanged rapidly between tissue compartments and can also be used as a substrate in aerobic conditions (18-19).

It was observed that when the first sampling was taken at cervical dilatation of 4 – 5 cm, the women who had dysfunctional labour and subsequent CS had a higher mean AFLC compared to those among the cohort who had SVD. This signifies those women who came into the labour ward complex at cervical dilatation of 4 – 5 cm had more than twice the risk of CS due to dysfunctional labour compared to women who came in at higher cervical dilatations. This may suggest that a high AFLC at these former cervical dilatations was associated with dysfunctional labour and probably be used in routine obstetric practice for screening at this early stage of labour. This is supported by the recommendation of Zhang et al (11) and Nguyen et al (20) that the active phase of labour be changed from 4 cm to 6 cm. They both found out that the rate of cervical dilatation accelerated faster after 6 cm and that progress from 4 cm to 6 cm was slower than previously described. It was concluded that by allowing labour to continue for a longer period before 6 cm of cervical dilatation, there may be a reduction in the rate of intra-partum and subsequent repeat CS.

The median value of the AFLCs was used to determine high and low concentrations and this was found to best discriminate between dysfunctional and normal labour. Even though statistically non-significant but clinically relevant; it was observed that values ≥19.80 mmol/L were associated with more than twice the risk of CS due to dysfunctional labour in our environment. This implied that high AFLCs may actually be used to forecast labour outcome.

This study has also shown that high AFLC is strongly associated with dysfunctional labour which may require urgent caesarean delivery rather than augmentation of labour. Women who had high AFLCs and augmentation had an increased risk of CS due to dysfunctional labour than women who had high AFLCs without augmentation.

Our study had the limitation of the study population having a high proportion of women with previous parous experience which favor SVD, compared to previous studies (9) where there was a high proportion of nulliparous women who had CS. Samples for AFLC estimations were taken on two occasions as compared to previous studies (9) where samples were taken on several occasions, at least hourly prior to delivery.

We therefore recommend larger studies with more frequent sampling in our environment to determine the usefulness of this screening method.

Conflict of interest

The authors have no conflict of interest.

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