Is it Time for UK Obstetricians to Accept Fetal Scalp Lactate as an Alternative to Scalp pH?

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1. Background

Since the introduction of cardiotocography (CTG) to monitor the fetus in labour, obstetricians have attempted to reduce its false-positive rate and therefore unnecessary intervention. The method used primarily is fetal blood sampling (FBS) to estimate fetal pH. To date, only one trial has compared the use of continuous CTG monitoring with or without fetal scalp blood sampling and its effect on the rate of caesarean section. In the group with scalp blood sampling, the total caesarean section rate was reduced from 18% to 11% and caesarean section indicated by fetal distress from 7% to 3%, when fetal scalp blood sampling was allowed. However, as only some 230 patients were included in each group, the study did not have power to show significance. A Cochrane meta-analysis in 2013 looked at continuous fetal heart rate monitoring versus intermittent auscultation. Using a subgroup analysis between trials allowing scalp blood sampling for pH or not, they found significantly less neonatal acidosis but more instrumental deliveries in trials allowing scalp blood analysis. They concluded that access to fetal scalp blood sampling did not influence prespecified outcomes such as perinatal mortality or caesarean section. However, this was an indirect analysis between studies with different populations and likely different management guidelines.

An alternative method of establishing fetal condition in labour, fetal scalp lactate, has been introduced into obstetric practice in Sweden, France and Australia, but not the UK. The advantage claimed for lactate over pH is that sampling is easier to perform, yields results more often, can be performed at the bedside and is a better predictor of long-term neonatal condition. Since December 2014, lactate has been recommended by the National Institute for Health and Care Excellence, provided that trained staff and the relevant equipment are available.

This paper will review the evidence supporting fetal scalp pH as a predictor of short- and long-term fetal outcome and then review the evidence for fetal scalp lactate. It will discuss the Australian and Scandinavian experience with fetal lactate and offer an opinion on the implications for UK practice.

2. Fetal pH

Originally introduced by Saling in 1967, fetal scalp sampling was the first technique used to assess the fetal condition directly during the intrapartum period. In the original work by Saling, pH was equilibrated to a $P_{CO_2}$ of 40 mmHg to eliminate the influence of respiratory acidaemia: i.e. to evaluate the metabolic acidaemia. For unknown reasons, the use of this equilibration disappeared over the years, probably due to the more complex laboratory work needed before analysis. Trials in the 1960s and 1970s suggested improvement in clinical outcomes when fetal scalp sampling to assess fetal pH was used. This supposition was based on the premise that a lower than normal fetal pH is associated with short- and long-term neonatal morbidity.

The strength of the association between low pH and morbidity is, however, beginning to be questioned. When neurological outcomes were compared in a cohort of babies with an umbilical cord pH ranging from 7.03–7.56, no significant difference was found. A relationship between low pH and poorer long-term neurological outcome has been shown in a recent meta-analysis. However, the relationship was thought ‘most substantial’ only in those babies with a pH of 7 or below. In another recent observational study of over 51,000 deliveries, it was found that in babies with a cord pH above 7.00 the association with neonatal morbidity was weak. Even for those babies with a cord pH below 7.00, the absolute risk of encephalopathy with seizures (and/or death) was only 2.95%. As one of its conclusions, this paper stated that the use of pH as a trigger for intervention to prevent poor long-term
neurological outcome, using current thresholds, will fail to prevent most adverse outcomes and at the
cost of high rates of intervention.9

Obtaining a fetal scalp sample for pH has been shown to take a significant amount of time and to be
prone to failure. Tuffnell10 and Westgren11 found it to be a task which took approximately 20 minutes and
failed in up to 20% of the attempts.

3. Lactate physiology and measurement

In recent years, lactate has been shown to be a good predictor of adverse outcome in many areas of
medicine. It is regularly used for the evaluation of the critically ill patient, both among adults and
neonates. Lactate has also been tested to triage emergency patients with good results and included in
diagnostic criteria for severe septicaemia. The mechanism of interest is not only tissue hypoxia but also
tissue perfusion.12–14

In the early years of fetal lactate studies, there was debate about whether the source of lactate measured
in the fetus was maternal or fetal. Initially, the source was thought to be maternal skeletal muscles.15
However, investigation over several years led to the conclusion that the fetus was the primary source of
lactate measured in the fetal scalp and a marker of its increasing dependence on anaerobic metabolism
in cases of intrapartum fetal hypoxia, as labour progresses.16 Lactate is a metabolite produced during
glucose metabolism as a result of tissue hypoxia.17

The pH of blood within the fetal circulation is reduced by higher than normal levels of either carbonic
acid (resulting from dissolved carbon dioxide) or lactic acid. Carbon dioxide levels rise when the
fetus is unable to rid itself of carbon dioxide produced as a result of normal metabolism: for example,
during a period of umbilical cord compression. Lactic acid production occurs when the fetus receives
oxygen concentrations less than those required to maintain aerobic respiration, forcing a switch to
anaerobic respiration. Lactate levels in the subcutaneous tissues have been shown to increase before
pH decreases in the hypoxic process and therefore serve as an earlier marker.18 This is explained by
the buffering capacity within the tissue which can ‘mop up’ the hydrogen ions, maintaining pH. With
continued production of hydrogen ions (associated with prolonged hypoxia), this capacity decreases,
the concentration of H+ increases and pH falls.

Fetal lactate estimation has long been recognised as an alternative method of establishing the
presence of fetal metabolic acidaemia. Lactate as an indicator of prenatal oxygen deprivation has
been known since the 1960s.19 The ability to measure fetal lactate in blood from the fetal scalp during
labour has been reported since the 1970s.19–22 Fetal scalp blood lactate collected during labour and
in umbilical artery blood at delivery has been shown to predict depressed newborns better than pH
and/or base deficit.23–25

Previously, lactate assays required 150–200 microlitres of blood from the fetal scalp during labour and
1 ml of blood if taken after delivery from umbilical vein or artery. It is now possible to measure lactate ‘at
the bedside’ using an electrochemical microvolume device which requires a smaller fetal scalp sample
of up to 5 microlitres of blood from the fetal scalp.26 This technique employs the same sampling method
as fetal pH but has a much lower failure rate.27 This is primarily due to the much smaller volume of
blood required. In addition, the test is performed at the bedside with no need to leave the labour room.
It has to be emphasised that different lactate devices are available. They measure lactate levels and are
calibrated differently, measuring lactate in different blood compartments (plasma, haemolysed blood
or whole blood with intact erythrocytes). These facts influence the actual lactate level obtained which
is likely to differ between devices used.28 Several lactate sensors have been evaluated and have shown
coefficients of variation of less than 4%.29
4. Lactate versus pH

Fetal scalp blood lactate has been shown to be superior in predicting hypoxic ischaemic encephalopathy (HIE), with a sensitivity of 67% and a specificity of 93% in predicting moderate to severe HIE versus 49% and 93% respectively for pH. This has been supported by a more recent study showing cord blood lactate as a better predictor of low Apgar scores and HIE.

Women’s experience of FBS during labour was examined as a pain score in a labour ward using both lactate and pH analyses. They found the procedure to be acceptable for most women. The median pain score was 3.5 out of 10.

During labour, the aim is to identify fetuses at risk for severe adverse outcome to be able to intervene before damage has occurred: i.e. to prevent and not predict adverse outcomes. In the observational data by Kruger et al., the optimal cut-off value to predict an Apgar score of less than 4 at 5 minutes was 6.0 mmol/l. The corresponding value for moderate/severe HIE was 6.5 mmol/l. To be able to prevent these conditions, a cut-off value leading to intervention has to be set lower than these values. They therefore chose the 75th centile for scalp blood lactate (4.8 mmol/l) and 25th centile for pH (7.21) in this high-risk group of labours. This lactate value (4.8 mmol/l) was then suggested as the threshold for intervention as it was close to the recommended value for scalp pH of 7.20 and below the predictive values quoted above.

A suggested clinical guideline for scalp blood determination and management is as follows:

<table>
<thead>
<tr>
<th>Lactate value (mmol/l)</th>
<th>Description</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 4.2</td>
<td>Normal</td>
<td>Continue labour</td>
</tr>
<tr>
<td>4.2–4.8</td>
<td>Preacidemia</td>
<td>Repeat FBS between 20 and 30 minutes later</td>
</tr>
<tr>
<td>&gt; 4.8</td>
<td>Acidaemia</td>
<td>Consider delivery</td>
</tr>
</tbody>
</table>

Recently, a large randomised controlled trial compared the use of fetal scalp lactate versus scalp pH to manage the fetus during labour with nonreassuring CTG. This demonstrated comparable results showing a similar level of acidaemia at birth: 3.2% in the lactate arm and 3.6% in the pH arm. As threshold values (centiles) for intervention were set at the same level, intervention rates were expected to be similar regardless as to whether lactate or pH was used. Similar intervention rates were also found in the trial.

A Cochrane meta-analysis has compared analysis of lactate and pH in fetal scalp blood during labour and found no differences in fetal/neonatal outcome or operative interventions but a significantly higher success rate with lactate compared with pH (risk ratio 1.10; 95% CI 1.08–1.12). Only two trials are included in this meta-analysis and some 90% of the cases in this analysis emerge from the randomised controlled trial by Wiberg-Itzel et al. However, in a recently published large observational study, where the above clinical guidelines were used, the FBS frequency was 11% and out of these 9% were acidaemic (greater than 4.8 mmol/l). This implies that only 1% of all deliveries had an FBS lactate indicating operative/instrumental delivery.

It has to be emphasised that FBS is useful in cases showing progressive deterioration of the CTG trace. In cases with bradycardia, FBS has no place. If fetal heart rate is not recovering, delivery has to be expedited regardless of analysis results. If it recovers, observation for at least 20 minutes is recommended as transient acidaemia is likely shortly after a bradycardic event. In obstetric ‘catastrophies’, for example, placental abruption, cord prolapse and uterine rupture, there is no place for FBS.

5. Swedish and Australian experience

Many large obstetric units in Australia recommend either pH or lactate to investigate cases of suspected intrapartum acidemia; indeed some have moved exclusively to using lactate. The latest Royal Australian and New Zealand College of Obstetricians and Gynaecologists guideline on intrapartum fetal surveillance recommends the use of scalp lactate rather than pH measurement because it is ‘an easier and more affordable adjunct to electronic fetal monitoring for some units’. Lactate is used as an adjunct to electronic fetal monitoring in 41 out of 46 Swedish obstetric units.

6. Opinion

Fetal lactate estimation in labour, from a fetal scalp sample using the latest bedside techniques, has been shown to be quicker and easier to perform and to yield results more often. To date, it has not been accepted into routine practice within the UK, although it is used in Sweden and Australia. Lactate deserves to be seen as at least equivalent to fetal pH when investigating the fetus with suspicious or pathological CTG in labour, as theoretically lactate is a better indicator of adverse outcome compared to pH and/or base deficit.

References


