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REVIEW ARTICLE

Labor Admission Test

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ABSTRACT

Labor admission test (LAT) is performed at the onset of labor to establish fetal well-being in low-risk pregnancies and identify those fetuses who either may be hypoxic, needing delivery or at risk of developing hypoxia during labor so that additional measures of fetal surveillance can be instituted to prevent adverse outcomes. We searched the literature in Medline, Cochrane Library and PubMed using the words—cardiotocograph, cardiotocogram, nonstress test, vibroacoustic stimulus (VAS), amniotic fluid index (AFI), Doppler, labor admission test, labor admission cardiotocography (CTG) and reviewed four randomized controlled trials (RCTs) and three systematic reviews to summarize the current evidence regarding use of LAT. Although the existing RCTs and systematic reviews do not favor admission testing, we have critically reviewed the methodology used in some of these major studies. There is a need for robust RCTs with adequate sample size to evaluate the effectiveness of LAT. In clinical practice, while a normal admission CTG reassures the mother and the clinician about the health of the baby, an admission CTG with nonreassuring FHR pattern leads to careful review which may reveal a growth restricted or compromised fetus before onset of active labor when the risk of fetal hypoxia is higher with increasing frequency and duration of uterine contractions. Like in other obstetric interventions, the woman should be offered the choice of LAT after providing appropriate information and her informed decision should be respected.

Keywords: Labor admission test, Admission CTG.

WHAT IS LABOR ADMISSION TEST?

Labor admission test (LAT) is a test of fetal well-being that is performed when a woman with a low-risk pregnancy is admitted in labor. Its aim is to assess fetal well-being at the onset of labor and identify those fetuses that may be already hypoxic or may not withstand the stress of uterine contractions which can expose them to hypoxia in labor. Such fetuses may then be delivered or subjected to additional tests of fetal surveillance like continuous CTG (cardiotocography) throughout labor in order to prevent adverse outcomes. An admission CTG and 'intelligent' auscultation are the two commonest forms of admission tests carried out in modern obstetrics. We searched the literature in Medline, Cochrane Library and the PubMed using the words—cardiotocograph, cardiotocogram, nonstress test, vibroacoustic stimulus (VAS), amniotic fluid index (AFI), Doppler, labor admission test, labor admission CTG and reviewed four randomized controlled trials and three systematic reviews to summarize current evidence on the use of LAT.

HISTORY

Electronic fetal monitoring/CTG was introduced with the aim of reducing perinatal mortality and morbidity like cerebral palsy. Since its introduction in 1960s, the intrapartum and the admission use of the electronic fetal monitoring increased rapidly in well-resourced countries. The effectiveness of continuous CTG in labor was evaluated in a Cochrane systematic review in 2006 which included 12 randomized and quasi-randomized controlled trials (over 37,000 women).[1] The study found that continuous cardiotocography during labor was associated with a reduction in neonatal seizures, but no significant differences were noted in cerebral palsy, infant mortality or other standard measures of neonatal well-being. There was an increase in cesarean sections and instrumental vaginal births with the use of CTG. The authors suggested that the real challenge was how best to convey this uncertainty to women to enable them to make an informed choice without compromising the normality of labor.

Most clinical guidelines that subsequently emerged recommended continuous CTG in labor for women at high risk and intermittent auscultation for those considered at low risk.[2] The clinician was often faced with the challenge of adequate identification of women at high risk in labor. There is no such thing as 'no risk' in obstetrics. There is 'low risk' and 'high risk', with a common phenomenon being a change in risk with time from the former to the latter.[3] Fetal morbidity and mortality are greater in high-risk women, such as those with prolonged pregnancy, intrauterine growth restriction, hypertension, diabetes or other risk factors. However, it is interesting to note that in pregnancies that proceeded to term,

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morbidity and mortality due to intrapartum events occurred with similar frequency in those categorized as low risk compared with high risk based on traditional classification[4,5] suggesting that some of the high-risk cases may have been missed during antenatal assessments.

LAT was originally designed as a preliminary assessment of women with low-risk pregnancies at the onset of labor so that those with nonreassuring fetal heart rate (FHR) pattern could be subjected to additional tests of fetal surveillance or delivered depending on the severity of fetal jeopardy. It often meant that women with abnormal LAT were classified as high risk and then monitored with continuous CTG throughout labor. Thus, LAT could be utilized as a screening tool in early labor to detect compromised fetuses on admission and select the women who may benefit with continuous CTG during labor.

FORMS OF ADMISSION TEST

History and Clinical Examination

On admission to the labor ward, detailed history should be obtained to recognize any known risk factors to detect pregnancies at highrisk. History of reduced fetal movements is important. General examination should include—estimation of body mass index (BMI), blood pressure, temperature and signs of anemia. Thorough abdominal examination needs to be carried out including symphysial-fundal height (SFH) measurement, assessment of fetal lie, presentation, station of presenting part and nature of contractions. After 20 weeks of pregnancy, SFH corresponds to gestational age in cm +/– 2 cm up to 36 weeks and +/– 3 cm after 36 weeks. A reduced SFH may indicate a small fetus who may be suffering from chronic hypoxia and such a fetus is more likely to develop an abnormal heart rate pattern before and particularly in labor.[3] Although clinical estimation of fetal size and liquor volume may be subjective, it may be valuable in cases of significant IUGR or macrosomia to undertake additional investigations, such as ultrasonography and to anticipate and prepare for complications during labor. Vaginal examination should include assessment of cervical dilatation, effacement, status of membranes and color of liquor, station of the presenting part as well as any malpresentation and caput/molding of head if in advanced labor.

Auscultation

When performing an admission test with auscultation alone a Doppler device is preferable to Pinard's or stethoscope. The mother should be asked about fetal movements and a baseline FHR recorded. An attempt should then be made to feel the fetal movements per abdomen and look for any fetal heart rate accelerations associated with these movements. If there are uterine contractions, presence or absence of any obvious decelerations immediately after the contractions should be noted and an attempt made to estimate the depth and duration of deceleration, and whether it recurs with the next few contractions with the mother on her left lateral.

Feeling of fetal movements associated with FHR accelerations and no decelerations soon after a contraction should reassure the mother and the healthcare professional of good fetal health. Subsequent observations should be—auscultation of FHR soon after contraction every 15 minutes for 1 minute in the first stage of labor and every 5 minutes or after every alternate contraction in the second stage.[2]

Admission CTG

The labor admission CTG comprises of a CTG trace of 20 to 30 minutes duration carried out on admission to the maternity ward. Most admission tests last 15 to 30 minutes. However, a normal trace that shows two accelerations and no decelerations with two contractions within 5 to 10 minutes should not be monitored unduly. If the test is attempted when the fetus is in quiescent/sleep phase, it will need to be continued until the fetus reawakens and a reassuring FHR pattern emerges. In clinical practice, an admission CTG with nonreassuring fetal heart rate pattern may often lead to careful review of the case which may reveal a growth restricted or compromised fetus before onset of active labor when the risk of fetal hypoxia is higher with increasing frequency and duration of uterine contractions.

Advantages of Admission CTG Overauscultation

A crucial advantage of the admission CTG is the ability to assess all parameters of fetal heart rate including baseline variability. Presence of accelerations, normal baseline heart rate, variability more than 5 bpm and absence of any decelerations are features of a normal reassuring CTG (Fig. 1). Although auscultation may provide the baseline fetal heart rate and indicate presence of accelerations/decelerations—baseline variability is not audible to the unaided ear and quantification/description of type of decelerations may be difficult.

The admission CTG being a visual test can make parents as well as clinicians feel reassured that the fetus is not at risk of hypoxia at the time of admission and is unlikely to develop hypoxia in the next few hours.

Interpretation of Admission CTG

A normal admission CTG in a mother who on history and examination is low-risk assures a healthy fetus for the next

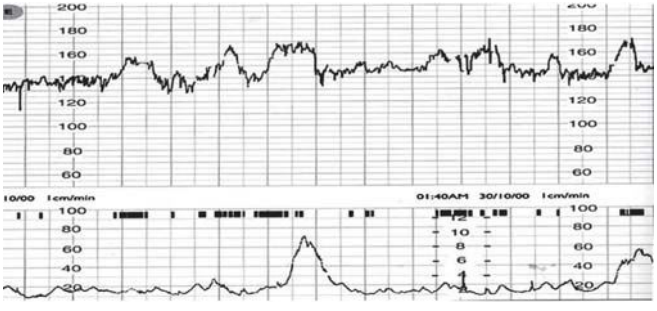

Fig. 1: Reactive CTG with normal baseline heart rate (110-160 bpm), two accelerations in 15 minutes, normal baseline variability and no decelerations with contractions

3 to 4 hours unless an acute obstetric event supervenes, such as—placental abruption, cord prolapse, injudicious oxytocic use or incorrect application of instrument.[3] If the admission test is normal and reactive, a gradually developing hypoxia will be reflected by no acceleration, repeated decelerations and gradually rising baseline rate. Furthermore, it is known that if a well-grown fetus with clear amniotic fluid and a reactive CTG trace starts to develop an abnormal FHR pattern, it takes some time with these FHR changes before acidosis develops. A study estimated that in situations with abnormal FHR pattern—for 50% of the babies to become acidotic took 115 minutes with repeated late decelerations, 145 minutes with repeated variable decelerations and 185 minutes with a flat trace.[6] Fetuses with a reactive admission test will show following features prior to or becoming hypoxic—all will exhibit decelerations (100%), almost all will have reduced baseline variability (93%) and baseline tachycardia (93%) (Fig. 2).[7] On the other hand, if the admission test is nonreactive, the development of further abnormal features with progress of labor are variable and subtle; this is difficult to recognize by intermittent auscultation (Fig. 3).[3] This is because there might be preexisting hypoxic damage and the fetus is unable to respond. It is important to bear in mind that a hypoxic fetus can have a normal baseline rate and shallow decelerations of less than 15 bpm in a non-reactive trace when the baseline variability is below 5 bpm (Fig. 3). Such a fetus may not withstand the stress of uterine contractions and runs the risk of death within a few hours of admission. An anemic fetus (due to fetomaternal hemorrhage) will manifest with a sinusoidal trace which may not be picked up on auscultation alone as the baseline rate may well be within normal limits (Fig. 4).

EVIDENCE FOR THE USE OF LAT

Prospective Studies

A large blinded prospective study of admission CTG was conducted in 1041 low-risk women where the trace was analyzed after the delivery of the fetus which was monitored by intermittent auscultation.[8] The test was reactive in 94.3% and in this group fetal distress (cesarean section, forceps for distress, Apgar score less than 7 at 5 minutes) occurred in 1.3%. Ten patients (1.0%) had ominous tests; four of these had fetal distress and one of these fetuses died *in utero* 3 hours after admission, during which time stethoscopic auscultation failed to detect the fetal compromise. It was concluded that the admission test can detect fetal distress already present at admission and unnecessary delay in intervention could be avoided in such a case. The test seemed to have some predictive values for the fetal well-being for the next few hours of labor following the test.

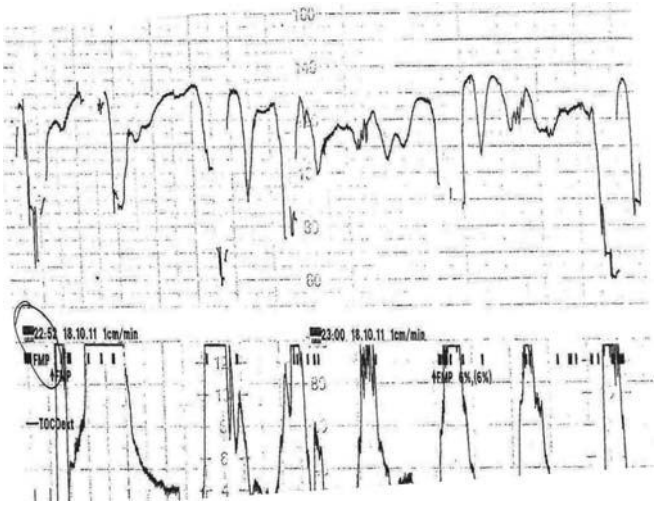

Fig. 2: CTG trace with markedly reduced baseline variability and atypical variable decelerations

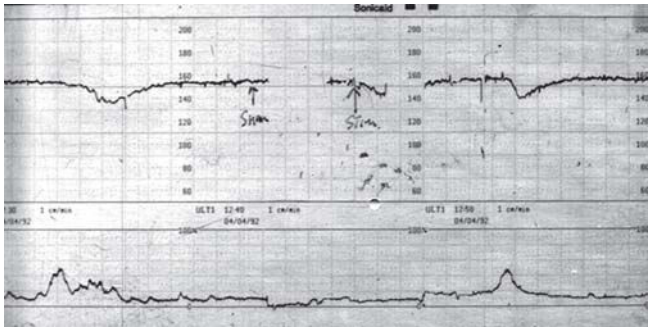

Fig. 3: Admission CTG with markedly reduced baseline variability and shallow decelerations that may be difficult to identify on auscultation. These cases do not show the rise in baseline FHR with hypoxia but the FHR may suddenly collapse with terminal

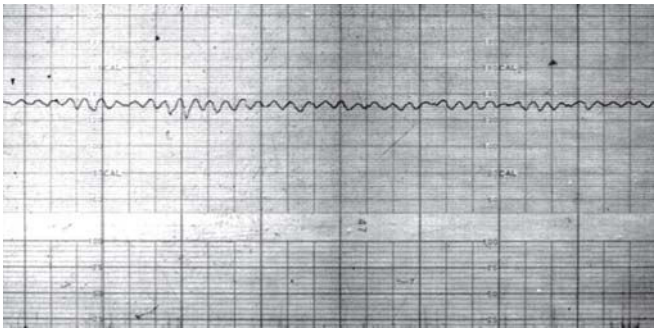

Fig. 4: CTG with sinusoidal FHR trace

Another study performed fetal heart tracing on cardiotocogram for 30 minutes in 500 women on admission in labor and contraction-mediated responses were recorded. Subjects were also stratified into high or low-risk groups based on antenatal factors. Seventy-seven out of 500 labor cases (36 out of 433 cases with reactive, 16 out of 37 with suspicious and 25 out of 30 cases with ominous LATs) manifested fetal distress. Eighty-two percent of antenatal high-risk and 89% of low-risk pregnancies showed reactive LATs. The LAT was found to have high specificity (93%) and negative predictive value (91%). However, the sensitivity and positive predictive values were lower (53% and 61% respectively). Patients with no antenatal risk factors did not develop fetal distress till 6 hours after reactive LAT.[9]

A systematic review in 2005 which included 11 observational studies besides three randomized controlled trials (RCTs) found that the prognostic value of LAT from the observational studies for several major maternal and neonatal outcomes was generally poor.[10]

A Norwegian study was conducted to explore what information and knowledge the labor admission test is perceived to provide and what meaning the test carries in the daily work of practicing midwives using in-depth interviews of 12 practicing midwives.[11] The findings suggested that the midwives found conflicting interests within themselves, or between themselves and others when using the labor admission test. It was concluded that the labor admission traces could be difficult to interpret, especially for newly qualified midwives. Some midwives thought that a labor admission trace could protect them in case of litigation. The hierarchy of power in the labor ward influenced the use and interpretation of the labor admission test. Some midwives also felt their professional identity threatened and that midwives in general were losing their traditional skills because of the increasing use of obstetric technology.

EVIDENCE FOR USE OF ADMISSION CTG FROM RANDOMIZED CONTROLLED TRIALS (RCTs) AND SYSTEMATIC REVIEWS

Randomized Controlled Trials

1. An RCT conducted in Dublin aimed to compare the effect on neonatal outcome of admission cardiotocography *vs* intermittent auscultation of the fetal heart rate.[12] A total of 8580 women admitted to the delivery ward of a Dublin teaching hospital who were at low risk of fetal distress in labor were randomly assigned admission cardiotocography (20 minutes) or intermittent auscultation only (with continuous cardiotocography only if clinically indicated). The authors reported an increase in the use of continuous cardiotocography (1.39; 1.33-1.45) and fetal blood sampling (1.30; 1.14-1.47) with admission cardiotocography. There were no significant differences in the rates of cesarean delivery (1.13; 0.92-1.40), instrumental delivery (1.03; 0.92-1.16) or episiotomy (1.06; 0.99-1.13). Other indices of neonatal morbidity also showed no differences. It was concluded that routine use of cardiotocography for 20 minutes on admission to the delivery ward does not improve neonatal outcome.

   There are three significant issues that need to be considered regarding the conclusions of this study and its applicability to the general obstetric population. First, the observation of no significant increase in operative delivery could have been because of liberal use of fetal blood sampling. Second, this study was performed at Dublin National Maternity Hospital where labor in nulliparous women was managed actively. Among other things, the amniotomy was performed upon admission (mean cervical dilatation at rupture of membranes was less than 2 cm) and only those with clear amniotic fluid were included in the study. Clear amniotic fluid in itself would have served as an admission test. Early amniotomy is not a norm in most labor wards and may be associated with a nonsignificant trend toward increase in the risk of a cesarean section. Third, the high rates of continuous CTG and a higher incidence of fetal blood sampling (FBS) may have been because in this study 32% of admission CTGs were considered suspicious or abnormal—an unexpectedly high percentage in early labor in women with clear amniotic fluid. This may signify the limitation of 20 minutes for LAT if it was done in the quiet epoch of the CTG.
2. Mires et al conducted an RCT to compare the effect of admission cardiotocography and Doppler auscultation of the fetal heart on neonatal outcome and levels of obstetric intervention in a low-risk obstetric population.[13] A total of 2367 women were randomized to receive either cardiotocography or Doppler auscultation of the fetal heart when they were admitted in spontaneous uncomplicated labor. The primary outcome measure was umbilical arterial metabolic acidosis. There were no significant differences in the incidence of metabolic acidosis or any other measure of neonatal outcome among women who remained at low risk when they were admitted in labor. However, compared with women who received Doppler auscultation, women who had admission cardiotocography were significantly more likely to have continuous fetal heart rate monitoring in labor (odds ratio 1.49, 95% confidence interval 1.26 to 1.76), augmentation of labor (1.26, 1.02 to 1.56), epidural analgesia (1.33, 1.10 to 1.61) and operative delivery (1.36, 1.12 to 1.65). The conclusion of the trial was compared with Doppler auscultation of the fetal heart, admission cardiotocography does not benefit neonatal outcome in low-risk women.
3. Another RCT from Glasgow attempted to test the hypothesis that the use of admission electronic fetal monitoring (EFM) for healthy low-risk pregnant women (n = 312) in spontaneous labor would result in an increase in continuous EFM when compared to women who have had no admission EFM.[14] This trial found no statistically significant differences between the groups for use of continuous monitoring or any of the obstetric interventions studied. The authors concluded that the use of admission EFM did not in itself lead to a cascade of intervention.

Systematic Reviews

1. A systematic review was performed to assess the effectiveness of the labor admission test in preventing adverse outcomes, compared with auscultation only, and to assess the test's prognostic value in predicting adverse outcomes.[10] It included the above three randomized controlled trials including 11259 women and 11 observational studies including 5831 women. It was found that women randomized to the labor admission test were more likely to

have minor obstetric interventions like epidural analgesia (RR 1.2, 95% CI 1.1-1.4), continuous electronic fetal monitoring (RR 1.3, 95% CI 1.2-1.5) and fetal blood sampling (RR 1.3, 95% CI 1.1-1.5) compared with women randomized to auscultation on admission. There were trends toward more operative deliveries, operative deliveries for fetal distress and cesarean sections among the women randomized to the labor admission test, although these differences did not reach statistical significance. There were no significant differences in augmentation of labor between the two groups, or in any of the neonatal outcomes. From the observational studies, prognostic value for various outcomes was found to be generally poor. The authors concluded that there is no evidence supporting that the labor admission test is beneficial in low-risk women.

The high proportion of labor admission tests considered abnormal by Impey et al[12] and Mires et al[13] may be the reason that so many women in the intervention group had continuous electronic fetal monitoring which then led to increased obstetric interventions. The authors pointed out that in low-risk women, serious adverse outcomes occur infrequently and that their meta-analysis may be underpowered to detect differences in these outcomes.

2. Another systematic review published in 2007 was performed with the aim to determine whether intrapartum admission CTG in women at low obstetric risk can improve neonatal outcome (in terms of Apgar score) and whether it is associated with an increase in the incidence of instrumental delivery and cesarean section.[15] The same three RCTs were included. The pooled relative risk for having an Apgar score less than 7 points at 5 minutes after delivery was higher in the admission CTG group (RR 1.35, 95% CI 0.85-2.13) but it was not statistically significant. The pooled relative risks for having a cesarean section delivery (RR 1.2 95% CI 1.00-1.41) and an instrumental delivery (RR 1.1 95% CI 1.00-1.18) were both higher in the admission CTG group. Both these were statistically significant. The reviewers concluded that intrapartum admission cardiotocography in women at low obstetric risk increases the risk of cesarean section and instrumental delivery. In addition, there is no evidence for neonatal benefit in terms of Apgar score at 5 minutes after delivery. However, the authors suggested that a larger sample size would be needed in order to answer this important question.

GUIDELINES

NICE guidance (based on the systematic review by Blix et al[10]) presently does not recommend the use of admission cardiotocography in low-risk pregnancy in any birth setting.[2]

CARDIOTOCOGRAPHY AND VIBROACOUSTIC STIMULATION (CTG AND VAS)

A study investigated fetal heart rate reactions to the fetal acoustic stimulation in 952 women in early labor.[16] All had cephalic presentations (greater than 33 weeks of gestation) and were screened with a 15 minutes fetal heart rate recording (admission test) before the sound stimulation was applied. Three different types of responses were observed: Type I, an accelerative response; type II, a biphasic response with acceleration(s) followed by a deceleration; type III, no response or a prolonged deceleration (greater than 60 beats/min and greater than 60 seconds). A type I response was recorded in 98.0% of the women after a reactive admission test result, in 90.2% after an equivocal admission test result, and in 42.9% after an ominous admission test result. Fetal distress in labor occurred in these three groups is 2.0, 22.2 and 35.7% of cases respectively. The risk for fetal distress was high after an ominous admission test and a type III response on the fetal acoustic stimulation test (75.0%). It was suggested that the fetal acoustic stimulation test might be of value in labor and give additional information about fetal well-being in patients previously screened by the admission test. Testing time can be shortened after an equivocal admission test.

Another prospective study involving 210 women which evaluated the efficacy of VAS and modified fetal biophysical profile (mFBP) for early intrapartum fetal assessment and prediction of adverse perinatal outcomes reported a high accuracy of VAS/mFBP for early intrapartum fetal assessment (diagnostic values for perinatal morbidity—sensitivity 66.7%, specificity 99.0%, positive predictive value 80% and negative predictive value 98%).[17]

DOPPLER STUDIES

The main drawback of use of Doppler studies as a screening tool in early labor is the need for ultrasound equipment and expertise. Umbilical artery Doppler velocimetry has been used as an admission test but shown to be a poor predictor of fetal distress in labor in low-risk population. A large study of 1092 women showed Doppler at admission to be of little value in the presence of normal CTG. In those cases with a suspicious admission CTG, normal Doppler velocimetry was associated with less operative deliveries for fetal distress, better Apgar scores and less need for assisted ventilation or admission to neonatal intensive care unit.[18]

AMNIOTIC FLUID INDEX (AFI)

Perinatal mortality and morbidity are increased in the presence of reduced amniotic fluid volume at delivery. Measurement of amniotic fluid volume in early labor has been considered an admission CTG to triage a fetus to a high-risk or low-risk status in early labor. In a study of 120 women in early labor,[19] it was found that ultrasound measurement of the vertical depth of two amniotic fluid pockets could be easily and rapidly performed by medical and midwifery staff and that the results were easily reproducible. Depth of two pools > 3 cm was highly sensitive and predictive when used as a predictor of the absence of significant fetal distress in the first stage of labor.

In another study of 1092 singleton pregnancies,[20] a four quadrant AFI < 5 in early labor was associated with higher operative delivery rates for fetal distress, low Apgar scores and more infants needing assisted ventilations.

Reduced liquor volume may often be a sign of incipient hypoxia. As labor progresses, the stress of uterine contractions and cord compression may lead to development of hypoxia and acidosis.

A Cochrane Database systematic review published in 2011[21] reviewed evidence on the benefits of admission tests other than cardiotocography in preventing adverse perinatal outcomes. The objective was to assess the effectiveness of admission tests other than cardiotocography in preventing adverse perinatal outcomes. The reviewers included one study involving 883 women [comparison of sonographic assessment of amniotic fluid index (AFI) on admission *vs* no sonographic assessment of AFI on admission]. The incidence of cesarean section for fetal distress in the intervention group (29 of 447) was significantly higher than those of controls (14 of 436) [risk ratio (RR) 2.02; 95% confidence interval (CI) 1.08 to 3.77]. The incidence of Apgar score less than 7 at 5 minutes in the intervention group (10 of 447) was not significantly different from controls (7 of 436) (RR 1.39, 95% CI 0.54 to 3.63). The incidence of artificial rupture of membranes and use of oxytocin for augmentation of labor in the intervention group (213 of 447) was significantly higher than controls (132 of 436) (RR 1.57; 95% CI 1.32 to 1.87). The incidence of neonatal NICU admission in the intervention group (35 of 447) was not significantly different from the controls (33 of 436) (RR 1.03; 95% CI 0.66 to 1.63). The authors did not find enough evidence to support the use of amniotic fluid index as admission test.

CONCLUSION

LAT is aimed at identifying fetuses of low-risk women who are unlikely to cope with the stress of labor and become hypoxic. While a suspicious or abnormal LAT should prompt continuous CTG, a normal admission test reassures the parents and the clinician about good health of the fetus and may permit the attending health professional to encourage mobilization, alternative delivery positions, use of water immersion and water birth with greater confidence.

An admission CTG with nonreassuring fetal heart rate pattern may often lead to careful review which may reveal a growth-restricted or compromised fetus before onset of active labor which may have been missed in the antenatal period. It is also important to remember that a fetus who is already hypoxic or anemic at the onset of labor may have a normal baseline heart rate but will show additional signs like reduced baseline variability with shallow decelerations or sinusoidal pattern. Reduced baseline variability is a feature not audible to the unaided ear on auscultation and such a finding may be easily missed leading to adverse outcomes.

Bulk of the evidence regarding use of LAT in low-risk women stems from the three RCTs performed to date. NICE guidelines do not recommend routine use of admission CTG in low-risk pregnancies based on the findings of the systematic review incorporating these three RCTs. However, a critical appraisal of the RCTs suggests that the biggest study by case numbers that may have influenced the meta-analysis of the systematic review had a preselection criteria of clear amniotic fluid at early cervical dilatation (mean <2 cm). Additional advantage was the one to one midwifery care in their unit, that permits FHR auscultation every 15 minutes in the first stage and every 5 minutes in the second stage of labor. Such facilities may not be available in other settings. Hence, appropriate randomized controlled trials of LAT with adequate sample size are required to obtain definitive answers. Absence of robust evidence does not equate lack of effectiveness.

The parents should be given a choice, as in every matter, after providing them with relevant information about LAT and their final decision should be respected. EFM should be used appropriately to serve best its original purpose for which it was introduced—to identify fetuses at risk in labor so as to take appropriate steps to prevent adverse outcomes.

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