

Fetal scalp stimulation tests to improve the value of an admission cardiotocograph

Kumarapperuma K.A.U.S^a, Goonewardene I.M.R^b

Abstract

Introduction: An admission cardiotocograph (CTG) in a woman in early labour can lead to unnecessary interventions without improving neonatal outcomes

Objective: To assess fetal scalp stimulation as a complementary test to improve the value of an admission CTG.

Method: Women (n = 243) with uncomplicated singleton pregnancies with a cephalic presentation at >37 weeks gestation, in early labour or with induction of labour (IOL) had a CTG for ten minutes followed by a fetal scalp Digital Stimulation Test (DST) for 15 seconds during the routine vaginal examination, and the CTG was continued for another five minutes. If fetal heart rate (FHR) acceleration were absent after DST (DST negative), an Allis Clamp was applied to the fetal scalp and the CTG was continued for another five minutes. FHR accelerations indicated a positive test result. The initial CTG and the results of DST and application of Allis Clamp were compared with the five-minute APGAR score of the neonate.

Results: Of the 243 women, 107 (44%) had a negative DST but this number decreased to 27 (11%) after additional Allis clamping of the fetal scalp. The addition of the fetal scalp stimulation tests (FSST) markedly increased the specificity of the CTG in predicting neonatal hypoxia from 58% (95% CI 51.3-64.6%) to 96.4% (95% CI 93-98.5%). After the addition of FSST, the likelihood ratio of the presence of FHR accelerations in excluding neonatal hypoxia was 22.1 (95% CI 10.8-45.4) while the likelihood ratio of the absence of FHR accelerations in predicting neonatal hypoxia was 0.22 (95% CI 0.1-0.52)

Conclusion: When FHR accelerations are absent in the admission CTG, FSST complement it by helping to rule out fetuses probably not having hypoxia during early labour or IOL, and enables the identification of fetuses who would require close monitoring.

(THMG) for both antenatal and early intra partum fetal monitoring for several years [7, 8].

The Digital Stimulation Test (DST) is easy to carry out during the vaginal examination by gently stroking the fetal scalp for 15 seconds [5, 6]. It is non invasive, and no sophisticated instruments are required. Allis clamping is non traumatic pinching of the scalp with the Allis clamp for 15 seconds. Vigorous stroking and /or Allis clamping for longer durations should be avoided as it could lead to fetal vagal stimulation leading to bradycardia. With both these tests the non hypoxic fetus usually reacts to the stimulation with fetal heart rate (FHR) accelerations. Although the absence of accelerations *per se* does not indicate possible underlying fetal hypoxia, the occurrence of FHR accelerations would indicate that fetal hypoxia is unlikely although it is not possible to completely exclude it. Furthermore the occurrence of FHR accelerations would also enable shortening the duration of the CTG on the other hand, the absence of FHR accelerations following fetal scalp stimulation tests

(FSST) would suggest the need for close monitoring of the fetus [3-6]. A meta-analysis of intra partum fetal stimulation tests have shown that, as the likelihood ratios of negative tests are very low, these tests are useful in ruling out fetal acidemia when FHR accelerations are not seen in the CTG [3]. Of the FSST described, the DST was found to have the highest likelihood ratio for a positive test and the lowest likelihood ratio for a negative test, with Allis clamping of fetal scalp being the second best among the FSST [3]

The aim of this study was to determine the effectiveness of the admission CTG combined with FSST during early labour or induction of labour (IOL) to predict or rule out possible underlying fetal hypoxia. This would be helpful in planning further intra partum monitoring.

INTRODUCTION

In low risk women who are admitted in labour, a routine admission cardiotocograph (CTG) is not recommended as it leads to unnecessary interventions without improving neonatal outcomes. This is because a CTG *per se* is

not a good method of fetal monitoring as it has poor specificity with significant false positive rates [1]. Therefore the addition of a complementary test such as fetal scalp blood sampling is used in well-resourced settings [2]. However fetal scalp blood sampling is not feasible in many centers. Fetal stimulation tests such as the Fetal Acoustic Stimulation Test (FAST), fetal scalp Digital Stimulation Test (DST), application of an Allis Clamp to the scalp and fetal scalp puncture have also been shown to improve the value of the CTG by improving its specificity [3-6]. The FAST has been used effectively in the Academic Obstetrics and Gynaecology unit of the Teaching Hospital Mahamodara, Galle

^aActing Consultant Obstetrician and Gynaecologist, Base Hospital, Udugama

^bProfessor of Obstetrics and Gynaecology, Department of Obstetrics and Gynaecology, Faculty of Medicine, Galle

Correspondence: Surange Kumarapperuma
E mail - udayasurange@gmail.com

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METHOD

The study was carried out at the Academic Obstetrics and Gynaecology unit of the Teaching Hospital Mahamodara, Galle (THMG) from 31 August 2010 to 31 March 2011. Ethical approval was obtained from the Ethical Review Committee of the Faculty of Medicine, University of Ruhuna and the Director of the THMG. Informed written consent was obtained from all the participants (n=243).

Women with singleton uncomplicated pregnancies with a vertex presentation who established spontaneous onset of labour (SOL) defined as painful uterine contractions occurring at intervals of three minutes or less and a cervical os dilated to three centimeters or more and women who had IOL with a cervical os dilated to three centimeters or more, were recruited for the study. Women with pre labour rupture of membranes and those who had or developed fever during labour were excluded. A previous study carried out in the unit had demonstrated that the addition of the FAST to the CTG in the early intra partum period had a specificity of 97% and a sensitivity of 100% in predicting an APGAR of < 7 in neonates at delivery, which was found in 8% of low risk women^[8]. Expecting the specificity and sensitivity of the scalp stimulation tests in predicting an APGAR of < 7 in the neonate at delivery to be approximately 95% each, and to detect neonatal hypoxia (APGAR < 7) of 6% or more, with a precision of 5% with a 95% confidence level, the minimum sample size was calculated to be 228 using the sensitivity and 275 using the specificity^[9]. Therefore It was decided to recruit a minimum of 228 and a maximum of 275 subjects for the study.

The CTG was started using a SONICAID™ CTG recorder and ten minutes later, having checked whether accelerations of FHR had occurred, all of the subjects recruited for the study had amniotomy. Then the DST was carried out under sterile conditions with a finger, in between the uterine contractions, by massaging the fetal scalp gently for 15 seconds. The CTG was continued for another five minutes and the presence or absence of accelerations was documented. If no accelerations were observed, an Allis Clamp was applied to the fetal scalp, under sterile conditions for 15 seconds and the CTG was continued for another five minutes. Neither DST nor Allis clamping

was included in the routine management of SOL or IOL in the unit at the time of the study. Therefore, without considering the results of DST or DST and application of an Allis clamp, all the mothers were allowed to progress in labour with either intermittent auscultation of FHR with the Pinnard fetal stethoscope only, or with additional intermittent CTGs as per routine practice, depending on the case. If fetal distress was detected, appropriate management was under taken according to management guidelines in the unit. The mode of delivery and 5 minutes APGAR score of the babies were documented. Five minute APGAR <7 was considered to indicate possible underlying fetal hypoxia. The data was stored confidentially in an online computer database and analyzed using SPSS version 17 and Epi Info version 3.4.3.

RESULTS

The mean age of the study population (n= 243) was 27.5 yrs (95% CI = 26.9 – 28.1) with a range of 18 - 37 years. Of the 243 subjects 56% were primigravidae

Out of the 243 patients 224 (92%) delivered babies with APGAR of ≥ 7 . Of the 107 women who had a no FHR accelerations in the admission CTG, 57 (53%) had FHR accelerations after the DST (Table 1).

Of the 50 women who had no FHR accelerations in the admission CTGs following DST, and therefore had Allis clamping of the fetal scalp, in 27 (54%), FHR accelerations were observed after the application of the Allis clamp. The 15 women who continued to have no FHR accelerations in the admission CTG, even after DST and Allis clamping of the fetal scalp, delivered babies with APGAR < 7

Of the 224 women who delivered babies with APGAR ≥ 7 , eight (3.6%) had no in FHR accelerations in the CTG after FSST. Of the 19 women who delivered babies with APGAR < 7, four had FHR accelerations in the CTG after FSST. (Table 2)

Of the 35 women who had meconium at amniotomy, 11 underwent subsequent emergency caesarean section (CS) for intra partum fetal distress detected by a subsequent CTG, and two of their neonates had APGAR < 7 and were admitted to the SCBU for observation. One of them had accelerations following

FSST (Table 3).

Out of the 19 neonates who had APGAR < 7, meconium stained liquor was detected in 10 at delivery, two of whom had had meconium at amniotomy while the other eight had *de novo* meconium. Two of these neonates had had FHR accelerations following FSST (Table 4). No peripartum deaths were observed

The specificity and the PPV of the admission CTG in predicting an APGAR < 7 increased from 58% to 96 %, and 12% to 65% respectively after the addition of the FSST (Table 5)

DISCUSSION

The absence of FHR accelerations following FSST markedly increased the likelihood of the occurrence of APGAR < 7 in the neonate and therefore the combination of the CTG with FSST would enable the identification of fetuses who would require close monitoring. Studies done in the United States of America have shown that the DST could have a 100% sensitivity and negative predictive value in predicting intra partum hypoxia^[5,6]. In those studies hypoxia was confirmed by fetal scalp pH (pH < 7.2) which was carried out immediately after the DST. In a previous study conducted in the same unit, the FAST carried in the early intra-partum period demonstrated a sensitivity of 100% and no false negatives (FHR accelerations) in the fetuses who had a neonatal APGAR < 7^[8].

The likely hood ratio of a negative DST in the meta-analysis was comparable to the likely hood ratio of a negative DST in our study. Although the likely hood ratio of a positive DST was only 5 (95% CI 3.5-7.4) in our study where as it was 15.68 (95% CI 3.22-76.24) in the meta-analysis, the combined FSST in our study had a likelihood ratio of a negative test of 0.22 (95% CI 0.1- 0.52) which is comparable with the results of the DST in the meta-analysis and the likelihood ratio of a positive test of 22.1 (95% CI 10.8-45.4), was better than the results of the DST in the meta- analysis (15.68, 95% CI 3.22-76.24) [3] (Table 6).

Compared to the APGAR score which is subjective and liable to inter and intra observer variations, the umbilical cord pH at delivery would have been a more reliable assessment of underlying fetal hypoxia. However facilities for estimation

of cord blood pH was not available in the unit during the period of study. It is also important to note that in the current study, four out of the 19 fetuses who had a neonatal APGAR < 7 demonstrated FHR accelerations following FSST. This is probably due to the fact that the FSST was carried out in early SOL or at IOL, and subsequent intra partum hypoxia can occur due to other reasons including oxytocin infusions and these could lead to a low APGAR at birth. In spite of these limitations, the addition of FSST would not only increase the value of an admission CTG, but could also reduce the duration of the CTG especially in settings with limited resource

CONCLUSION

When FHR accelerations are absent in the admission CTG, fetal scalp stimulation tests complement it by increasing its specificity and helping to rule out possible fetal hypoxia during early labour or IOL. Therefore the combination of the CTG with FSST would increase the value of an admission CTG and enable the identification of fetuses who would require close monitoring.

CONFLICTS OF INTEREST

The authors have no conflicts of interest

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Table 1 Admission Cardiotocograph with Scalp Digital Stimulation Test and APGAR Score (n = 243)

	Admission CTG Before DST		Admission CTG After DST		Total
	No FHR Accelerations	FHR Accelerations	No FHR Accelerations	FHR Accelerations	
APGAR \geq 7	94	130	35	189	224
APGAR < 7	13	06	15	04	19
Total	107	136	50	193	243

CTG = Cardiotocograph; DST = Digital Stimulation Test; FHR = Fetal Heart Rate

Table 2. Fetal scalp stimulation and APGAR score (n = 243)

	Admission CTG after FSST*		Total
	No FHR Accelerations	FHR Accelerations	
APGAR \geq 7	8	216	224
APGAR < 7	15	4	19
Total	23	220	243

CTG = Cardiotocograph

FHR = Fetal Heart Rate

*FSST = Fetal scalp stimulation tests included the Digital Stimulation Test (DST) combined with Allis clamping if the DST did not result in FHR accelerations.

Table 3 Analysis of women with meconium stained liquor at amniotomy (n = 35)

	Admission CTG after FSST*		Total
	No FHR Accelerations	FHR Accelerations	
APGAR \geq 7	1	32	33
APGAR <7	1	1	2
Total	2	33	35

CTG = Cardiotocograph; FSST = Fetal Scalp Stimulation Test; FHR = Fetal Heart Rate

Table 4 Analysis of neonates with APGAR<7 at delivery (n =19)

	Admission CTG after FSST*		Total
	No FHR Accelerations	FHR Accelerations	
Meconium present At delivery	8	2	10
Meconium absent At delivery	7	2	9
Total	15	4	19

CTG = Cardiotocograph; FSST = Fetal Scalp Stimulation Test ; FHR = Fetal Heart Rate

Table 5. Ability of cardiotocography before and after fetal scalp stimulation tests to predict neonatal asphyxia (APGAR < 7) (n=243)

	Admission CTG (n=243)	Admission CTG after FSST* (n=243)	Difference (95% CI) p
Sensitivity (95% CI)	68.4 % (43.5-87.4%)	79% (54.4-94%)	10.6% (2.9-19%) 0.0061
Specificity (95% CI)	58% (51.3-64.6%)	96.4% (93.1-98.5%)	38.4% (30.9-44.8%) <0.0001
Positive Predictive Value (95% CI)	12.2% (6.6-19.9%)	65.2% (42.7-83.6%)	53% (45.2-60.1%) <0.0001
Negative Predictive Value (95% CI)	95.6% (90.6-98.4%)	98.1% (95.4-99.5%)	2.5% (-0.6-6.8%) 0.072
Likelihood Ratio of a Positive Test (95% CI)	1.6 (1.2-2.3)	22.1 (10.8-45.4)	
Likelihood Ratio of a Negative Test (95% CI)	0.54 (0.3-1.1)	0.22 (0.1-0.52)	
Prevalence (95% CI)	7.8 (4.8 – 11.9)	7.8 (4.8 – 11.9)	

CTG = Cardiotocograph

DST = Digital Stimulation Test

*FSST = Fetal scalp stimulation tests included DST combined with Allis clamping if DST did not result in fetal heart rate accelerations:
95% CI = 95% Confidence Interval

Table 6. Likelihood Ratios of Fetal scalp stimulation tests

	Likelihood Ratio of a positive test(95% CI)	Likelihood Ratio of a negative test(95% CI)
Allis clamp[3]	10.4 (1.47-73.61)	0.10 (0.01-0.68)
DST[3]	15.68 (3.22-76.24)	0.06 (0.01-0.31)
DST current study	5 (3.5-7.4)	0.25 (0.1-0.6)
Allis clamp +DST current study	22.1 (10.8-45.4)	0.22 (0.1-0.52)

DST = Digital Stimulation Test