Short Fetal Acoustic Stimulation Test for Rapid Antepartum Assessment of Fetal Well-Being

YUEN TANNIRANDORN, M.D.*,
VERAPOL KITTIPIBUL, M.D.*

Abstract

Short fetal acoustic stimulation test (FAST) was prospectively studied in 604 high risk pregnancies after 28 weeks of gestation. Fetal heart rates were recorded 3 minutes before and 5 minutes after fetal acoustic stimulation. The results of the tests performed within a week of delivery were compared with perinatal outcomes. Reactive response to short FAST occurred in 597 cases (98.8%) while nonreactive response was found in 7 cases (1.2%). Nine fetuses were considered poor outcomes. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of short FAST to predict poor fetal outcomes were 66.7, 99.8, 85.7, 99.5, and 99.3 per cent, respectively.

Short FAST has high specificity, negative predictive value and accuracy for prediction of poor perinatal outcome. This rapid test should be used as a screening method for antepartum assessment of fetal well-being in a busy antenatal clinic.

Key word : Fetal Acoustic Stimulation, Antepartum Assessment, Fetal Well-Being

Ability to evaluate fetal condition is of major importance to those who provide health care for pregnant women. Several testing methods are presently used in antepartum assessment of fetal well-being. In Thailand, nonstress test (NST) is the initial test performed to assess fetal health[1]. It takes about 20 – 40 minutes to finish the test, this is partly due to the sleeping state of the fetus[2]. Fetal acoustic stimulation test (FAST) has been used for antepartum fetal evaluation[1,3,4]. Its major purpose is to reduce the test time by changing the fetal behavioral state from sleep to wakefulness and converting a nonreactive test to a reactive one[4]. However, the standard FAST test also takes at least

* Department of Obstetrics and Gynecology, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

20 minutes to perform. In a busy antenatal clinic without a sufficient number of fetal monitors and personnel, applicable technique to monitor fetal health should be searched for.

The aim of this prospective study was to evaluate the clinical usefulness of 5 minutes fetal heart rate response after acoustic stimulation (short FAST) for rapid antepartum assessment of fetal well-being.

MATERIAL AND METHOD

A total of 604 high risk pregnancies after the 28th week of gestation were recruited into the study at the Department of Obstetrics and Gynecology, Faculty of Medicine, Chulalongkorn University. Informed consents were obtained after explanation of the test procedure to the patients.

The patient was placed on a bed in a semi-recumbent position. A doppler fetal heart rate (FHR) transducer (Corometrics 145, Corometric Medical System, Connecticut, U.S.A.) was applied to the abdomen and adjusted for the best signal. The fetal heart rates were recorded for 3 minutes. Then, acoustic stimulation of the fetus was performed with a fetal acoustic stimulator (EAL model 146, Corometric Medical System, Connecticut, U.S.A.). The FHR was recorded for another 5 minutes. If no acceleration of the FHR was noted within 30 seconds, an additional pulse was administered to a maximum of 3 pulses, each 30 seconds apart.

The short FAST result was interpreted as a reactive response (normal) or a nonreactive response (abnormal). A reactive response was defined as one or more accelerations of the FHR ≥ 15 beats/min from the baseline persisting for 15 seconds. A nonreactive response was defined as failure to elicit a qualifying acceleration after any of 3 separate stimuli and for 5 minutes after the last stimulus. The test was performed weekly until delivery. The short FAST tracings were assessed by one of the authors (YT) without knowledge of the perinatal outcome. Further obstetric management was based on the clinical situation and other investigatory findings without knowledge of the short FAST result.

All short FAST performed within a week of delivery were related to perinatal outcome. Perinatal outcome was considered poor when there was perinatal death, intrapartum fetal distress, a five minute Apgar score of less than 7, thick meconium-stained amniotic fluid or admission to the neonatal intensive care unit.

Table 1. Antenatal risk factors.

Risk factors	No. of patients	Per cent
Poor weight gain	379	62.7
Reduced fetal movement	144	23.8
Suspected growth retardation	47	7.8
Postterm	46	7.6
Hypertensive disorders	40	6.6
Premature labor	20	3.3
Dibetes Mellitus	17	2.8
Placenta previa	6	1.0
Others	167	26.8
Total	604	100

Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the test were calculated.

RESULTS

Of the 604 cases, 0.5 per cent were 28-32 weeks, 2.8 per cent were 33-36 weeks, 75.7 per cent were 37-40 weeks, and the remaining 21 per cent were over 41 weeks. Table 1 shows the antenatal risk factors in these patients.

Reactive response to short FAST occurred in 597 cases (98.8%) while nonreactive response was found in 7 cases (1.2%).

Nine fetuses were considered poor perinatal outcomes namely, 7 with thick meconium-stained amniotic fluid and 2 cases admitted to the neonatal intensive care unit, one of which finally died from pneumonia. Table 2 shows details of the poor perinatal outcomes.

Table 3 shows the results of short FAST performed within a week of delivery in relation to perinatal outcome. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of short FAST to predict poor perinatal outcome were 66.7, 99.8, 85.7, 99.5, and 99.3 per cent, respectively.

DISCUSSION

The goal of antepartum fetal surveillance is to identify the fetus at increased risk of asphyxia. Various methods have been used to assess fetal well-being[1]. However, the noninvasive techniques are fetal movement counting, nonstress test (NST) and fetal biophysical profiles[1,5]. Fetal movement count has low sensitivity and poor predictive value

Table 2. Details of poor perinatal outcomes.

Case	Antenatal risk factors	GA (wk)	Short FAST	Mode of delivery	BW (g)	Final outcome
1	Hypertensive disorders	40	NR	C/S	2,880	Thick meconium, A/W
2	Postterm	42	NR	C/S	3,620	Thick meconium, A/W
3	Poor weight gained	39	NR	F/E	3,630	Thick meconium, A/W
4	Poor weight gained	41	NR	C/S	2,350	Thick meconium, Apgar 5 min < 7, NICU, A/W
5	Postterm	42	NR	C/S	4,030	Thick meconium, A/W
6	Reduced fetal movement	35	NR	NVD	1,740	Thick meconium, Apgar 5 min < 7, NICU, NND
7	Postterm	42	R	C/S	3,500	Thick meconium, A/W
8	Reduced fetal movement	39	R	NVD	3,550	Thick meconium, A/W
9	Poor weight gained	39	R	C/S	2,650	Thick meconium, A/W

GA = gestational age,   BW = birth weight,   NR = nonreactive
R   = reactive,   C/S = Cesarean section,   F/E = forceps extraction
NVD = normal vaginal delivery, A/W = alive and well
NND = neonatal death,   NICU = neonatal intensive care unit

Table 3. Results of short FAST performed within a week of delivery in relation to perinatal outcomes.

Results of short FAST	No.	Perinatal outcomes	
		Poor	Good
Nonreactive	7	6	1
Reactive	597	3	594

Sensitivity 66.7 per cent
Specificity 99.8 per cent
Positive predictive value 85.7 per cent
Negative predictive value 99.5 per cent
Accuracy 99.3 per cent

for positive test[1]. The explanation may be due to several factors affecting the ability to perceive or count fetal movements. This includes diurnal or other periodic variations in fetal activity, maternal attention span, maternal activity, the speed and intensity of fetal movements, placental position and drugs[1]. Even though the nonstress test is easily performed, the false positive is high and the positive predictive value is low[2,3]. This may be due to the time frame of performing the test. A nonreactive test is defined as the failure to qualify as a reactive pattern during two consecutive 20-minute windows, or a total of 40 minutes. Extension of the test to 120 minutes usually reduces the incidence of nonreactive patterns by 50 per cent[2]. Therefore, it is time consuming. Fetal biophysical profile

scoring can be used only in a referring center such as in a university hospital. This test requires monitoring of the fetal breathing movements, gross body movement, fetal tone, qualitative amniotic fluid volume and fetal heart rate[5]. Therefore, it is not a screening test for fetal well-being, it is rather a confirmatory test.

Fetal ability to respond consistently to vibroacoustic stimulation with movements and heart rate accelerations has been documented previously[1,3,6-8]. The adjunctive use of fetal acoustic stimulation with FHR tracing (fetal acoustic stimulation test) has been used increasingly for antepartum fetal evaluation[1,3,4,7]. Its major purpose is to reduce the testing time by changing the fetal behavioral state from sleep to wakefulness and converting a nonreactive NST into a reactive one[7]. The use of vibroacoustic stimulation significantly increases the baseline FHR as well as the number of FHR accelerations and fetal movements. We have previously reported the conventional FAST to perinatal outcome. The sensitivity, specificity, positive predictive value, negative predictive value and accuracy of the test for predicting poor perinatal outcomes are 76.5, 98.6, 76.5, 98.5 and 97.3 per cent, respectively. However, it takes about 20 – 30 minutes to finish the test. Therefore, the aim of this study was to evaluate the clinical usefulness of 5 minutes FHR response after vibroacoustic stimulation which we called short FAST. In our study we found that short FAST has high specificity (99.8%),

high positive predictive value (85.7%), high negative predictive value (99.5%) and high accuracy (99.3%). The sensitivity of short FAST is acceptable (66.7%) when compared to the conventional NST (sensitivity 51.8%) from our previous report. Therefore, this rapid fetal test should be used as a screening method for assessment of fetal health in a busy antenatal clinic.

The safety of fetal acoustic stimulation has been previously reported. Two studies looked into the problem of hearing loss following *in utero* exposure to acoustic stimulation[9,10]. The investigators concluded that acoustic stimulation, as applied in clinical practice, did not endanger hearing or neurological development in exposed infants.

In conclusion, weekly short FAST appears to provide a reliable screening test for rapid antepartum assessment of fetal well-being. A reactive short FAST does not appear to warrant additional fetal testing.

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การใช้เสียงกระตุ้นทารกในครรภ์อย่างสั้น เพื่อการประเมินสุขภาพของทารกในระยะก่อนคลอด

เยื้อน ตันนิรันดร, พ.บ.*, วีรพล กิตติพิบูลย์, พ.บ.*

ผู้วิจัยได้ทำการศึกษาการใช้เสียงกระตุ้นทารกในครรภ์อย่างสั้น ในสตรีตั้งครรภ์เสี่ยงสูง 604 ราย ที่มีอายุครรภ์ตั้งแต่ 28 สัปดาห์ ได้ทำการบันทึกอัตราการเต้นของหัวใจทารกเป็นเวลา 3 นาทีแล้วกระตุ้นทารกในครรภ์ด้วยกล่องเสียงเทียม และดูการตอบสนองของอัตราการเต้นของหัวใจทารกภายในเวลา 5 นาที ผลลัพธ์ของการตรวจสอบภายใน 1 สัปดาห์ก่อนคลอดจะนำมาเปรียบเทียบกับผลลัพธ์ของทารกที่คลอด ผลการศึกษาพบว่า มีทารกในครรภ์ที่ตอบสนองต่อการกระตุ้นด้วยเสียงปกติ 597 คน (ร้อยละ 98.8) และตอบสนองผิดปกติ 7 คน (ร้อยละ 1.2) มีทารก 9 รายที่มีผลลัพธ์หลังคลอดไม่ดี ผลการทดสอบในการทำนายสุขภาพที่ไม่ดีของทารกในครรภ์ก่อนคลอดพบว่า มีค่าความไวของการทดสอบเท่ากับร้อยละ 66.7 มีค่าความจำเพาะเท่ากับร้อยละ 99.8 มีความสามารถในการทำนายเมื่อเป็นโรคจริงเท่ากับร้อยละ 85.7 มีความสามารถในการทำนายเมื่อไม่เป็นโรคจริงเท่ากับร้อยละ 99.5 และมีความถูกต้องเท่ากับร้อยละ 99.3

การใช้เสียงกระตุ้นทารกในครรภ์อย่างสั้นพบว่ามีความจำเพาะ ความสามารถในการทำนายเมื่อไม่เป็นโรคจริงและความถูกต้องสูง ในการทำนายสุขภาพที่ไม่ดีของทารก การตรวจสอบนี้สามารถนำมาใช้ในการตรวจกรองสุขภาพของทารกในครรภ์ก่อนคลอด ในสถานที่ฝากครรภ์ที่มีคนมารับบริการเป็นจำนวนมาก

คำสำคัญ : การใช้เสียงกระตุ้นทารกในครรภ์, การประเมินทารกก่อนคลอด, สุขภาพของทารกในครรภ์

* ภาควิชาสูติศาสตร์–นรีเวชวิทยา, คณะแพทยศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย, กรุงเทพ ฯ 10330