New Rapid Test for Antepartum Assessment of Fetal Well-being

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Abstract : *Maternal perception of sound-provoked fetal movement test was studied on 2115 occasions in 1740 women with obstetric or medical antenatal risk factors after 26 weeks gestation. The response was compared with a nonstress test (NST) performed immediately after a three-second vibroacoustic stimulation with an electronic artificial larynx. A positive response to sound stimulation, recorded as a fetal movement by the mother, occurred on 2095 occasions (99.1%) and was accompanied by a reactive NST on 2071 occasions; giving a specificity of 99.7% and a negative predictive value of 98.8%. An inconclusive or negative response to sound (0.9%) had a sensitivity of 38.4% and a positive predictive value for a nonreactive NST of 75.0%. Results of sound-provoked fetal movement test and NST, performed within a week of delivery, in 1732 women were compared with fetal outcome. The maternal perception of sound-provoked fetal movement test had better specificity (99.5% vs 98.4%), positive predictive value (65.0% vs 35.0%) for poor fetal outcome than the NST, although its sensitivity (48.1% vs 51.8%) and negative predictive value (99.1% vs 99.2%) were slightly lower. However, the accuracy of this new rapid test for predicting fetal outcome is higher than the NST (98.8% vs 97.7%). Maternal perception of sound-provoked fetal movement test may suffice as an inexpensive and simple method of evaluating antepartum fetal well-being in risk situations. (Thai J Obstet Gynaecol 1992;4: 77-84.)*

Key words : fetal well-being, antepartum assessment, vibroacoustic stimulation, maternal perception, fetal movement

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, fetal movement counting and nonstress tests (NST) are the common initial tests performed to assess fetal health. However, fetal movement charts are not very reliable and the NST is not widely performed especially in district hospitals or primary health care centres due to the cost of the machines.

Therefore, a new method which is simple and inexpensive to evaluate fetal well-being should be sought.

Fetal ability to respond to sound vibration has long been recognized and vibroacoustic stimulation of the fetus with an electronic artificial larynx has gained considerable attention[1-5]. Ultrasound studies have shown that fetal response to sound stimulation is analogous to the newborn startle reflex. The startle reaction includes blink response, head aversion, arm movements and leg extension and is mostly felt by the mother as a pronounced fetal kick or movement[6]. It has been suggested that assessment of this generalized paroxysmal fetal reaction could be a way to assess fetal neurological status[7]. Therefore, maternal perception of sound-provoked fetal movements might be used to assess fetal well-being.

The aim of this prospective study was to assess the reliability and possible applications of this test in high risk pregnancies. Maternal perception of sound-provoked fetal movement test was compared with the NST and with fetal outcome.

Materials and Methods

Maternal perception of sound-provoked fetal movement test was studied at the Department of Obstetrics and Gynaecology, Chulalongkorn University Hospital, Thailand, from April 1990 to March 1992. All patients with obstetric or medical antenatal risk factors after 26 weeks gestation, needing objective assessment of fetal well-being by NST, were recruited. Informed written consents were obtained after explanation of the test procedure to the patients. All patients knew that they were supposed to feel fetal movements during stimulation.

The vibroacoustic stimulation test was performed immediately before a conventional NST.

Vibroacoustic stimulation

The test procedure was as follows. The patient was placed in a semireclining position. An electronic artificial larynx (EAL Model 146, Corometric Medical System, Connecticut, USA) was placed on the maternal abdomen over the position of the fetal head and vibroacoustic stimulation was applied for 3 seconds. An average of sound pressure levels of this device at 1 metre in air is 82dB with the fundamental frequency of 80 Hz and the harmonics range of 20-9000 Hz. A kick or fetal movement immediately following the vibroacoustic stimulation was considered a positive response (a normal test). If the patient did not feel any movements within 5 seconds, stimulation was repeated twice within 30 seconds. Fetal movements occuring 5 seconds or more after application of the stimulus were construed as spontaneous and not considered a normal test. If the woman did not feel fetal movements or was not sure, the test was considered negative or nonresponsive (an

abnormal test).

The test result was tabulated before the NST was performed.

The NST was performed immediately after the vibroacoustic stimulation with Fetal Monitor FM 4L (Sonic Aid, Chichester, UK) or Fetal monitor 145 (Corometrics, Connecticut, USA).

The NST was assessed by one of the authors (YT) without any knowledge of the result of the vibroacoustic stimulation test.

The NST was considered normal or reactive if 2 episodes of fetal heart rate accelerations of 15 beats above the baseline lasting for more than 15 seconds occurred in a 20 minutes window of the NST. If this criteria of reactive NST was not achieved, the NST was continued for another 20 minutes. The NST was considered abnormal or nonreactive if criteria for reactive could not be elicited even after extension of the test period to 40 minutes. Further obstetric management was based on the clinical situation and other investigation findings.

Results of the maternal perception of sound-provoked fetal movement test were related to results of the NST and both tests were related to perinatal outcome. Perinatal outcome was considered poor when there was perinatal death, a 5-minute Apgar score of less than 7, heavily meconium-stained amniotic fluid or admission to the neonatal intensive care unit.

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

Results

During the study period 1740 high risk patients were recruited. Table 1 shows the antenatal risk factors in these patients. Of the total population 0.2% were 26-32 weeks, 8.3% were 33-37 weeks, 79.3% were 38-41 weeks, and the remaining 12.2% were over 42 weeks. Vibroacoustic stimulation and NST were performed on 2115 occasions in the study groups. On 20 occasions (0.9%) the response to sound was negative. Table 2 shows results of the maternal perception of sound-provoked fetal movement tests and the NSTs. Of the 2095 mothers who felt fetal movement, 2071 (98.8%) had a reactive NST, whereas, 24 (1.2%) had a nonreactive NST. Of the 20 mothers who felt no fetal movement, 15 (75.0%) had nonreactive NSTs. Sensitivity, specificity,

Table 1 Antepartum risk factors

Risk factors	No. of patients	%
Poor weight gain	548	31.5
Reduced fetal movements	293	16.8
Postterm (≥ 42 wk)	206	11.8
Pre-eclampsia	145	8.3
Suspected growth retardation	89	5.2
Antepartum hemorrhage	31	1.8
Others (poor obstetric history, diabetes, postdate, etc.)	428	24.6
Total	1740	100

positive predictive value and negative predictive value of the maternal perception of sound-provoked fetal movement tests compared to the NSTs are shown in Table 2. The accuracy of this test compared to the NST was 98.6%.

From the study population, 1732 patients had both tests performed within a week of delivery. Fetal outcome of these women was compared with the results of maternal perception of sound-provoked fetal movement tests and NSTs. Twenty-seven fetuses were considered poor outcome namely, 9 perinatal deaths, 14 with heavily meconium-stained amniotic fluid, 2 cases of fetal distress in labour, and 2 cases admitted to the neonatal intensive care unit. Table 3 shows the results of maternal perception of sound-provoked fetal movement tests in relation to fetal outcome. Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the maternal

Table 2 Results of paired maternal perception of sound-provoked fetal movement (SPFM) tests and nonstress tests (NSTs)

Result of SPFM	No.	Result of NSTs	
		Reactive	Non-reactive
Positive	2095	2071	24
Negative	20	5	15

Sensitivity 38.4%, Negative predictive value 98.8%,
Specificity 99.7%, Accuracy 98.6%,
Positive predictive value 75.0%.

Table 3 Results of maternal perception of sound-provoked fetal movement (SPFM) tests performed within a week of delivery in relation to fetal outcomes

Result of SPFM	No.	Fetal outcomes	
		Poor	Good
Positive	1712	14	1698
Negative	20	13	7

Sensitivity 48.1%, Negative predictive value 99.1%,
Specificity 99.5%, Accuracy 98.8%,
Positive predictive value 65.0%.

Table 4 Results of nonstress tests (NSTs) performed within a week of delivery in relation to fetal outcomes

Result of NSTs	No.	Fetal outcomes	
		Poor	Good
Non-reactive	40	14	26
Reactive	1692	13	1679

Sensitivity 51.8%, Negative predictive value 99.2%,
Specificity 98.4%, Accuracy 97.7%,
Positive predictive value 35.0%.

Table 5 Outcome of patients who had no maternal perception of sound-provoked fetal movements and a non-reactive nonstress test

Case	Antenatal risk factors	GA (wk)	Mode of delivery	BW (g)	Final outcomes
1	Reduced fetal movements	26	NVD	1450	Hydrops, stillbirth
2	Pre-eclampsia	35	C/S	1200	Trisomy 18, NND
3	Suspected IUGR	35	NVD	1900	Trisomy 18, NND
4	Reduced fetal movements	36	NVD	2000	Trisomy 18, NND
5	Reduced fetal movements	41	C/S	2450	IUGR, alive and well
6	Postterm	42	F/E	2630	Alive and well
7	Poor weight gain	41	C/S	3150	Alive and well
8	Reduced fetal movement	41	C/S	3300	Heavily meconium, alive and well
9	Suspected IUGR	39	C/S	1810	IUGR, alive and well
10	Postterm	42	C/S	3000	Alive and well
11	Chronic ITP	35	C/S	2200	NND
12	Suspected IUGR	36	NVD	1300	NND
13	Suspected IUGR	38	NVD	1800	NND, Trisomy 18
14	Suspected IUGR	36	NVD	1500	NND
15	Suspected IUGR	36	C/S	900	NND

GA = Gestational age, BW = Birth weight, NVD = Normal vaginal delivery, C/S = Caesarean section, NND = Neonatal death, IUGR = Intrauterine growth retardation, ITP = Immune thrombocytopenia.

perception of sound-provoked fetal movement test to predict poor fetal outcome were 48.1%, 99.5%, 65.0%, 99.1%, and 98.8%, respectively.

Table 4 compares fetal outcome in patients with reactive and nonreactive NSTs. The sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of the conventional NST to predict poor fetal outcome were 51.8%, 98.4%, 35.0%, 99.2%, and 97.75%, respectively.

Table 5 provides details of fetal outcome in 15 cases when there was no maternal perception of sound-provoked fetal movement and a nonreactive NST. The results were poor with one stillbirth of a hydrops infant and 8 neonatal deaths (4 were aneuploid infants). Of the 6 survivors, 5 (cases 5, 7, 8, 9, 10) had ominous NSTs with clinical suspicion of fetal compromise necessitating emergency caesarean section; two (cases 5, 9) were growth retarded fetuses. Case 6 had a nonreactive NST with oligohydramnios; induced labour resulted in vaginal delivery of an infant in good condition.

Discussion

Fetal abiliy to respond consistently to vibroacoustic stimulation with movements has been documented previously[2, 4-6]. Gelman et al[2] have reported increases in the number of fetal body movements in response to sound stimulation. A fetal eye-blink response to vibroacoustic stimulation was demonstrated by Birnholz and Benacerraf[8]. Divon et al[7] studied the fetal startle reflex at EAL stimulation and suggested that assessment of this generalized paroxysmal fetal reaction could be a way to assess fetal neurological status. The startle response involves marked movement of both trunk and limbs and is a more vigorous movement than a spontaneous fetal movement. Therefore, it can be more easily recognized by the mother, giving a high perception rate as in our study and in 2 previous reports[9, 10]. It is possible that, unlike healthy fetuses, compromised fetuses might not react to vibroacoustic stimulation with startle movements. If that is so, then a positive response to sound stimulation could obviate the need for an NST. Our study found that maternal perception of sound-provoked fetal movement, when correlated with the NST, has high specificity and negative predictive value which means that when fetal movements are felt, NST is almost always reactive.

When both tests were compared for fetal outcome, the NST has slightly better sensitivity to identify fetuses who are in jeopardy than maternal perception of sound-provoked fetal movement test. However, both tests have high specificity and negative predictive value. This finding implies that whenever the mother feels fetal movements during sound stimulation, the fetus is usually in good health. When movements are not felt, other standard tests should be performed, i.e. NST or biophysical pro-

file. Therefore, maternal perception of the sound-provoked fetal movement test may serve as a first line screening test before requesting the NST.

The NST with the adjunctive use of fetal acoustic stimulation to reduce the number of nonreactive test has become an accepted investigation for antepartum fetal health[3]. Arulkumaran et al[10] found a low incidence of nonreactive NST (3.4%) after application of the stimulation once or twice and suggested that the nonreactive NST rate can be reduced further by an appropriately timed third stimulus. Because of growing concern for fetal health, more tests are being requested, with more demands on time and personnel, and greater cost in performing the test.

According to our study, we suggest that if the mother feels no fetal movements during the stimulus and the NST is nonreactive, structural abnormalities and chromosomal abnormality in the fetus should be ruled out.

The advantages of maternal perception of the sound-provoked fetal movement test are 1) highly economical, 2) little expertise needed to interpret the results, 3) considerable reduction in time, 4) better predictability of fetal health than fetal heart rate auscultation, and 5) can be performed anywhere even by the mother. The guideline using maternal perception of sound-provoked fetal movement test for assessment of fetal health in a primary health care setting where NST is not available is proposed. In an antenatal clinic when a high risk pregnancy is identified, the mother should be referred to a tertiary care centre or monitoring of the fetal health continued by using daily fetal movement chart and maternal perception of sound-provoked fetal movement test every second or third day. If the mother does not feel fetal movements during the stimulation, she should be referred.

The safety of vibroacoustic stimulation has been questioned. Two studies looked into the problem of hearing loss following in utero exposure to acoustic stimulation. One tested 40 babies 1-2 days of age[11] and the other tested 465 children at the age of 4 years[12]. Neither have shown any evidence of auditory damage. There is no attenuation of the sound produced by the devices when sound pressure level is measured in utero using a hydrophone[13]. The lack of damage must be due to the short duration of exposure during the fetal acoustic stimulation test or to reduced ciliary movement due to acoustic impedance of the amniotic fluid. It is known that cochlea ciliriary damage is less in chick embryos exposed to noise compared to hatched chicks[14]. Therefore, it would seem that the potential clinical benefit outweighs any theoretic risk currently associated with the technique.

In conclusion, maternal perception of the sound-provoked fetal movement test is a simple and inexpensive method for evaluating fetal well-being. An obvious disadvantage

is the lack of objective recording. Like the NST, this test seems to be a good predictor of fetal health, but the absence of maternal perception of fetal movement does not always indicate fetal compromise, further evaluation is needed. This test may be used as a first line screening test in busy antenatal clinics before requesting the NST. In addition, this clinical application may be helpful for assessment of fetal health at risk, in primary health care settings.

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