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OBSTETRICS

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## The Study of Correlation between Sound Provoked Test (SPT) and Nonstress Test (NST)

Wirawit Piyamongkol MD,  
Arthitaya Anantachote MD.

*Department of Obstetrics and Gynaecology, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand*

### ABSTRACT

**Objective** To correlate the sound-provoked fetal movement (SPT) detected by ultrasound with the nonstress test (NST).

**Design** Cross-sectional study.

**Setting** Maternal-Fetal Medicine Unit, Department of Obstetrics and Gynaecology, Faculty of Medicine, Chiang Mai University, Thailand.

**Subjects and methods** From 1st October 1993 to 1st January 1995, both SPT and NST were performed in the same setting in 1,017 occasions on high-risk pregnancies. The SPT test was defined as reactive (normal) when at least one fetal movement was sonographically observed and nonreactive (abnormal) when no fetal movement was detected after the sound-provoked was applied to the fetus.

**Results** It was found that SPT was an accurate test in detection of reactive NST with high specificity of 96.67%, however, the sensitivity of the test was rather low (34.14%).

**Conclusion** Objectively detected sound-provoked fetal movement may be used as a simple and rapid method of evaluating antenatal surveillance in high risk situation where an ultrasound is available.

**Key words** : sound-provoked, nonstress test, antenatal fetal surveillance

Monitoring gross fetal body movement has gained worldwide attention as a method for evaluating fetal health.<sup>(1,2)</sup> The healthy fetus may be inactive as a result of sleep state for periods of up to 60 minutes.<sup>(3)</sup> Gagnon R et al examined effects of a 5 second external vibratory acoustic stimulus on fetal breathing and gross body

movement patterns. There was a significant but delayed increase in the incidence of gross fetal body movements that persisted for 1 hour after the stimulus.<sup>(4,5)</sup> Maternal perception of sound-provoked fetal movement was also a reliable method of evaluating antenatal fetal well-being,<sup>(6-8)</sup> but there is still no objective recording.

The mother's registering of fetal activity near term was reported as 87% of motions recorded by an electromagnetic device<sup>(9)</sup> and 82% of all trunk and lower limb motions viewed sonographically.<sup>(10)</sup> There was also a positive relation between perceived fetal activity and that viewed by real-time ultrasound scanning.<sup>(11,12)</sup>

This study was conducted to correlate the sound-provoked fetal movement (SPT) detected by ultrasound to improve fetal visualization with the nonstress test (NST).

## Materials and Methods

The study was undertaken at Maternal-Fetal Medicine Unit, Department of Obstetrics and Gynaecology, Faculty of Medicine, Chiangmai University, Thailand, from 1st October 1993 to 1st January 1995. A total of 1,017 individual tests have been performed on high-risk pregnancies. We obtained informed consent after explaining the procedure of the test. Age, parity, gestational age, and indications for testing were recorded.

Both SPT and NST were performed in all cases. The patients were placed in a semi-Fowler's position. Fetal acoustic stimulation was accomplished with a single pulse of sound 3 seconds in duration applied transabdominally over or near the fetal vertex using a Corometrics Model 146 fetal acoustic stimulator, sound level 82 dB at 1 metre in air, the fundamental frequency of 80 Hz and the harmonics range of 20-9,000 Hz (Corometrics Medical Systems, Connecticut, USA), during continuous ultrasound visualization using Aloka SSD 680 by single ultrasonologist. Fetal movement resulting in visualization of the desired anatomy within 30 seconds of administering the sound pulse was considered a positive response (a normal test). If there was no fetal movement observed within 30 seconds, the stimulation was repeated up to three times. If there was still no

fetal movement observed, the test was considered negative response (an abnormal test). The NST was performed immediately after the vibroacoustic stimulation with fetal heart rate monitor 145 (Corometrics, Connecticut, USA). All the fetal heart rate tracings were interpreted blindly by one independent perinatologist, who did not have any clinical information on the result of the SPT. The NST was considered reactive if there were two or more fetal heart rate accelerations of at least 15 bpm, lasting 15 seconds, in any 20 minute period. One prolonged acceleration of the fetal heart rate of at least 15 bpm lasting more than two minutes was also interpreted as reactive. If these criteria were not met in 40 minutes of monitoring, the test was interpreted as nonreactive, and additional testing with either the contraction stress test (CST), biophysical profile (BPP), or Doppler velocimetry was further performed.

Results of sound-provoked fetal movement test detected by ultrasound would be correlated to results of the NST.

## Results

SPT and NST were performed on 1,017 occasions in 666 high-risk pregnancies. Table 1 presents the main risk factors in these patients. Of the total population 13.0% were 28-32 weeks, 58.1% were 33-37 weeks, 26.6% were 38-41 weeks, and the remaining 2.3% were  $\geq$  42 weeks. Table 2 shows the results of the sound-provoked fetal movement detected by ultrasound in relation to the results of the NST. On 59 occasions (5.8%) the response to vibroacoustic stimulation was negative. There was fetal movement detected by ultrasound in 958 occasions (94.2%); 83.4% detected with the first stimulation, 6.3% with the second, 2.9% with the third, and only 1.6% with the fourth stimulation.

**Table 1.** Main risk factors in 1,017 occasions included in the study

Risk factors	Frequency	%
Postterm	19	1.9
Suspected intrauterine growth retardation	625	61.5
Decreased fetal movement	147	14.5
Pregnancy-induced hypertension	63	6.2
Chronic hypertension	7	0.7
Diabetes mellitus	45	4.4
Heart disease	14	1.3
Others	97	9.5
Total	1,017	100.0

**Table 2.** Result of 1,017 paired sonographically observed sound-provoked fetal movement in relation to the results of nonstress test

Sonographically observed Sound-Provoked Fetal Movement	Result of Nonstress Test		Total
	Nonreactive	Reactive	
Absent	28	31	59 (5.8%)
Present	54	904	958 (94.2%)
Total	82 (8.1%)	935 (91.9%)	1,017 (100%)

Of the 958 occasions which detected the fetal movement, 904 (94.4%) had a reactive NST, whereas 54 (5.6%) had a nonreactive NST. Of the 59 occasions with absence of fetal movement, 28 (47.5%) had a nonreactive NST. Twenty-eight of the 82 nonreactive NST were predicted by absence of fetal movement in response to vibroacoustic stimulation, giving a sensitivity of 34.1%. Of 935 reactive NST, 904 were predicted by the detection of fetal movement in response to the stimulus, giving a specificity of 96.7%.

Twenty-eight of 59 occasions with absence of fetal movements had nonreactive NST, giving a predictive value of a positive (abnormal or nonreactive NST) test of 47.5%. The predictive value of negative (normal or reactive NST) test was 94.4 (904/958).

## Discussion

Recording gross fetal body movement may serve as an indirect mean of evaluating central nervous function and integrity since the coordina-

tion of whole body motion requires complex neurologic control.<sup>(1)</sup> External vibratory acoustic stimulation may provoke increased fetal activity and an associated increase in heart rate baseline. This vibratory acoustic device was helpful in increasing the likelihood of a reactive nonstress test pattern and a reduction of test time.

Attempts had been made to evaluate the value of maternal perception of sound-provoked fetal movement as a test of antenatal fetal health compared with a nonstress test, and maternal perception of sound-provoked fetal movement was found to be a method for evaluating fetal well-being.<sup>(6-8)</sup> But only 82-87% of fetal motions was reported by mother's registering.<sup>(9,10)</sup> This study was conducted to evaluate the value of sound-provoked fetal movement detected by ultrasound in an effort to improve visualization of the fetal movement.

We found that sound-provoked fetal movement visualized by ultrasound, when correlated with the NST, had high specificity (96.7%) and negative predictive value (94.8%) which meant that NST was almost always reactive when fetal movement was visualized. The results confirmed the previous reports of subjectively maternal perception of sound-provoked fetal movement.<sup>(6-8)</sup> Sensitivity, specificity, positive predictive value, and negative predictive value for sound-provoked fetal movement in each study were compared in table 3. The objectively detected sound-provoked fetal movement may be used as a simple and rapid method of evaluating fetal health in high risk pregnancies where an ultrasound is available, but the absence of detection of fetal movement does not always indicate fetal compromise.

**Table 3.** Comparison between sensitivity, specificity, positive predictive value, and negative predictive value for sound-provoked fetal movement in each studies

	Westgren <sup>(6)</sup> (subjective)	Arulkumaran <sup>(7)</sup> (subjective)	Chutiwongse <sup>(8)</sup> (subjective)	This study (objective)
Sensitivity (%)	100	76.9	35.0	34.1
Specificity (%)	89	92.8	99.6	96.7
Positive predictive value (%)	19	11.4	77.8	47.5
Negative predictive value (%)	100	99.7	97.4	94.4

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