

Comparison of halogen light and vibroacoustic stimulation on nonreactive fetal heart rate pattern

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ABSTRACT

Background: One of the first-line assessment tools for fetal surveillance is nonstress test (NST), although it is limited by a high rate of false-nonreactive results. This study was performed to investigate if external stimulation from vibroacoustic and halogen light could help in provoking fetal responsiveness and altering NST results.

Materials and Methods: This is a clinical trial. Sampling was done from April to July 2010. One hundred pregnant women with nonreactive NST for 20 min were allocated in two groups: *Vibroacoustic stimulated NST* (VNST, $n = 50$) who received vibration from a standard fetal vibratory stimulator and *halogen light stimulated NST* (LNST, $n = 50$) who received a halogen light source for 3 and 10 sec, respectively. Results were compared together and then compared to biophysical profile (BPP) scores as a backup test. We used Mann-Whitney U test, Chi-square test, and Fisher's exact test to compare the variables in the two groups through SPSS version 14. $P < 0.05$ was considered as statistically significant.

Results: Following stimulations, 68% nonreactive subjects in halogen light stimulation group and 62% in vibroacoustic stimulation group changed to reactive patterns. Time to onset of the first acceleration (VNST: 2.17 min; LNST: 2.27 min) and the test duration (VNST: 4.91 min; LNST: 5.26 min) were the same in the two groups. In VNST 89.5% and in LNST 87.5% of nonreactivity followed by score 8 in BPP. There was no significant relation between stimulus NSTs and BPPs.

Conclusion: Vibroacoustic and light stimulation offer benefits by decreasing the incidence of nonreactive results and reducing the test time. Both halogen light stimulation and vibroacoustic stimulation are safe and efficient in fetal well-being assessment services.

Key words: Biophysical profile, fetal heart rate, fetal monitoring, halogen light stimulation, Iran, light, nonstress test, vibroacoustic stimulation, visual stimulation

INTRODUCTION

Nonstress test (NST) is usually done in high-risk pregnancies, but can be applied in all pregnancies after 32 weeks,^[1,2] and earlier from week 28.^[3]

High false-nonreactive results ranging from 75 to 99.8% are one of the limitations of this test.^[4,5] However, most of the fetuses with a nonreactive result are not in danger, but due to sleeping cycle in a normal healthy fetus,^[6] increasing time from 20 to 40 min reduces the rate of false-nonreactive results.^[4]

So far, measures to reduce such false-nonreactive results, including vibroacoustic stimulating, intake of glucose by the mother, and abdominal manipulating to awake fetus

have been followed.^[7,8] Only vibroacoustic stimulation could significantly reduce the rate of false-nonreactive results.^[9-15] Application of low-frequency vibration stimuli on term fetuses can change the fetal state within 3 min. These changes are associated with long and fast heart rate variability and strong fetal movements.^[15]

In recent years, several studies on "halogen light" as an intervention that could stimulate the fetal heart reactivity in fetus have been done.^[8,16-21] In Caridi *et al.*'s study, the earlier onset of Fetal Heart Rate (FHR) accelerations after halogen light stimulation prompted a more rapid reactive NST result. Bolnick *et al.* reported more reactive results in stimulus groups. The mean difference in time from the onset of the recorded stimulation to the first FHR accelerations, and a reactive result was shorter with either light or vibroacoustic stimulation compared with no stimulation. However, in Tanaboonyawat *et al.*'s study, no statistical difference was observed between halogen light and no stimulation group.^[8,17,19]

The purpose of these studies was to increase the FHR in less time, and thus to reduce the false nonreactivity. Halogen light makes fetuses move head and leads to an increase in FHR through crossing the abdomen and uterine tissues

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and exposing the eyes of the fetus. So far, neither negative visual side effects in fetuses nor burning and inflammation in mothers have been reported.^[17,19]

Although study reports noted the benefits of halogen light stimulation in NST, clinical trials have not yet concluded whether halogen light is more effective than vibroacoustic stimulation. The investigators aim to study vibroacoustic and halogen light stimulations on nonreactive fetal heart patterns to improve NST results through reducing the false-nonreactive results and time to reactivity.

While fetal well-being evaluation is one of the essential parts of prenatal care, the midwives' role is fully understood. Applying new approaches to pregnant women by midwives could promote maternal and fetal health.

MATERIALS AND METHODS

This study is a clinical trial with registration ID in IRCT of IRCT201011275261N1.

Sampling was done in 2010 from April to July. The study population consisted of 100 pregnant women at 32-42 weeks of gestation. Inclusion criteria were singleton and cephalic pregnancy, absence of fetal anomalies, no labor pain and vaginal bleeding, no smoking 1 h before the test, absence of recognized psychiatric disorders including psychosis and anxiety, and the presence of a nonreactive FHR tracing in 20 min (absence of two adequate FHR accelerations). Women signed the informed consent form and were allocated randomly in *vibroacoustic stimulated NST* (VNST, $n = 50$) and *halogen light stimulated NST* (LNST, $n = 50$) groups.

For all women in left lateral position, hp Hewlett Pakard Series 50A (71834 Boeblingen, Germany) at 2 cm/min speed recorded FHR tracing. In the LNST group, the investigator used the flash light of 1,000,000 candle power as a halogen light source (CE Spotlight, Yuyao Shunye Electrical Appliances Co., Ltd, Yuyao, China) purchased locally. The power was equivalent to the halogen light source (CE Spotlight, Grand Globalization Group Co. Ltd., Bangkok, Thailand) previously reported for fetal light stimulation.^[19] The light was gently placed above mother symphysis to create a 10-cm-diameter surface for 10 sec. In the VNST group, a fetal vibratory stimulator (FS-1 Fetal Stimulator, Edan Instruments, Inc., Shekou, Nanshan Shenzhen, China) set on 80 Hz of frequency was applied gently to lower abdomen on the skin above mother symphysis for 3 sec.

The investigator (a postgraduate midwifery student) recorded the time and was ready to apply the stimulus.

The same investigator marked an arrow on the tracing, signifying the onset of intervention (halogen light or vibroacoustic). From either external source, if an adequate FHR acceleration of ≥ 15 beats/min above baseline was absent for ≥ 15 seconds, the stimulus would be repeated later up to maximum three times in 5 min intervals.

Our endpoint for comparison was nonreactive pattern to reactive changes. Then, the time elapsed from the stimulation till the onset of first adequate FHR acceleration, and the time elapsed from the stimulation to reactive pattern (end of second acceleration) were recorded. The interpretation of FHR tracing was performed by the same investigators and confirmed by an obstetrician blinded to interventions. NST results in the two groups were compared to Biophysical Profile (BPP) scores as a backup test. BPP was performed by a radiologist who was blinded to the interventions, evaluating four parameters including fetal breathing, fetal movement, fetal tone, and amniotic fluid index. Each parameter had a score of two, with a total score of eight if all were normal.

Assuming 40% false nonreactivity in halogen light stimulation and 70% in vibroacoustic stimulation, we calculated a sample size of at least 43. Due to probable dropping, we considered 50 cases in each group for 80% power at 5% significance.

Statistical comparisons were made using SPSS version 14. Mann whitney U and Chi-square tests were used to compare the two groups. Results were expressed as mean \pm SD at 95% confidence interval (CI). Chi-square test and Fisher's exact test were used to compare results in the two groups and to BPP scores.

RESULTS

The investigator enrolled 100 pregnant women (out of 850 NSTs) and allocated 50 women in VNST and 50 women in LNST groups.

The two groups were identical in maternal age, gestational age, and Body Mass Index (BMI). The indications for NST were maternal diabetes (66%), previous history of complications in the present pregnancy (normal condition at the test time) (66%), and unfavorable obstetrics conditions such as fetal growth restriction, reduced fetal movements, hypertension, and so on (17%) [Table 1]. Cardiovascular and lung problems, kidney and thyroid dysfunctions, and collagen tissue disorders were considered as medical indications for NST. Only one woman in VNST was with controlled hydronephrosis who had a nonreactive VNST and BPP of score 8. There was no significant difference in testing indications in the two groups.

Figure 1 displays the steps and manner of subjects' participation through the trial.

Since the trial was conducted in one stage, no pregnancy was lost. Out of 100 stimulated tests, 62% in VNST and 68% in LNST produced reactive results. There was no significant difference in both groups.

The effect of external stimulation on FHR response is shown in Table 2. The mean time elapsed from the stimulation to the onset of the first FHR acceleration in the two groups was not significantly different (VNST: 2.17 min; LNST: 2.27 min). In either group, almost 50% reached the first

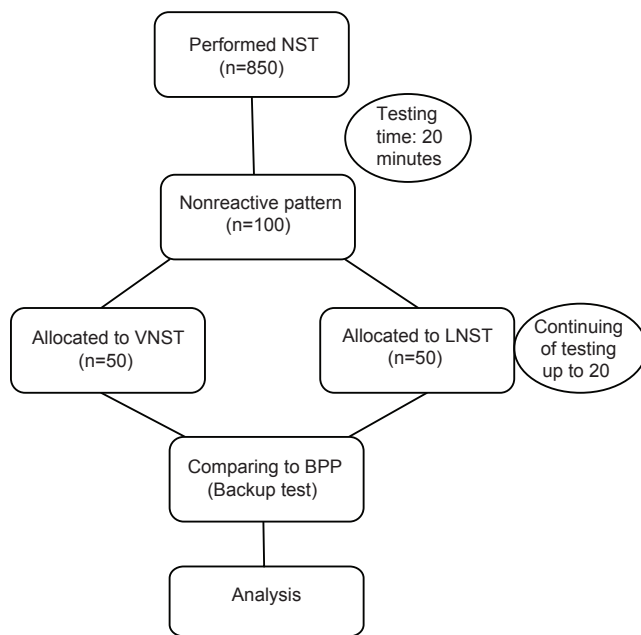


Figure 1: Steps and manner of subjects' participation through the trial. NST: Nonstress test; VNST: Vibroacoustic stimulated NST; LNST: Halogen light stimulated NST; BPP: Biophysical profile

Table 1: Indications for testing in VNST and LNST

Indications	VNST (%)	LNST (%)
Gestational diabetes	19 (38)	14 (28)
History of complications in present pregnancy (normal condition at testing)	14 (28)	19 (38)
Unfavorable obstetrics conditions	17 (34)	17 (34)

Fisher's exact test was performed ($P=0.053$); VNST: Vibroacoustic stimulated NST; LNST: Halogen light stimulated NST

Table 2: Fetal reactivity comparisons

Reactivity	VNST	LNST	P value
Reactive results	31 (62%)	34 (68%)	0.529*
Time to onset of first acceleration	2.17±2.15	2.27 (1.95)	0.498**
Time to reactive pattern	4.91±2.56	5.26±2.62	0.752***

* $\chi^2=0.392$; **Mann-Whitney U test was performed ($Z=-0.678$); ***Mann-Whitney U test was performed ($Z=-0.316$); VNST: Vibroacoustic stimulated NST; LNST: Halogen light stimulated NST

FHR acceleration in less than 2 min and 80% in 4 min. The mean time elapsed to reactive pattern (the end of second acceleration) was 4.91 min and 5.26 min in the VNST and LNST groups, respectively. In either group, most nonreactive patterns reached reactivity in 9 min (VNST: 96.8% and LNST: 88.3%). There was no significant difference between the two groups.

The results were compared to BPP in all 100 participants. About 90% of the participants gained a score of 8. Score <8 belonged to five women in VNST and four women in LNST.

In VNST, two women had a score of 4. Score 0-2 was not reported. In either group, there was no significant relation between stimulated NST results and BPP scores. In VNST 89.5% and in LNST 87.5% of nonreactivity scored 8 in BPP. In the two groups, all nonreactive patterns remained despite three times of stimulation. Repeated stimulation had no effect in changing results. There was no significant relation between stimulated NST results and either gestational age or BMI.

DISCUSSION

This is the first study focusing on the FHR responses to transabdominal halogen light stimulation, after 20 min of nonreactivity. The review of literature indicates the increasing reactive results followed by halogen light stimulation.^[8,16-21] However, altering nonreactive patterns to reactive results was the same in two different groups.

In either VNST or LNST group, the time to onset of the first acceleration was rather similarly shortened. In Bolnick *et al.*'s study, the mean time to onset of reactivity was 4.4 min in vibroacoustic group and 4.3 min in halogen light group.^[8] Similarly, Caridi *et al.* and Thanaboonyawat *et al.* reported them to be 4.1 min and 5.4 min, respectively.^[17,19] Our findings were considerably improved. Either intervention was similarly effective in reducing the time to onset of acceleration. Time to reactive pattern in Thanaboonyawat *et al.* and Caridi *et al.*'s study was 10.5 min and 5.6 min, respectively.^[17,19] The mean time to reactivity in Bolnick *et al.*'s study was 9.4 min in vibroacoustic group and 9.1 min in halogen light.^[8] Our findings are obviously less similar or the same as the previous ones.

All 35% nonreactive patterns despite three times of stimulation in 20 min remained nonreactive. In one study, repeating stimulation infrequently happened (vibroacoustic group: 3.3%, halogen light: 5%).^[8] The need for repeating stimulation may be related to the different study methods. The frequency of interventions was the same in the two groups.

We did not observe the effect of external interventions on heights and widths of FHR accelerations. No effect was

reported previously.^[8,13,14,16-21] In this study, early onset of FHR reactivity was partly related to the type of light source. Halogen light transmits more and has more power to penetrate tissue.^[20] Although NST and BPP are being performed in fetal well-being assessment, due to high false-nonreactive results reported along with reassuring BPP (score 8), there was no relation between stimulated NST results and BPP in either VNST or LNST group.

Factors such as gestational age and abdominal wall thickness may affect the fetal visual stimulation. Visual stimulation reactivity increases as the fetus grows up. Some findings noted fetuses of 37 weeks and older responded more to light stimulation.^[21] In term fetuses, test time was reduced by 2.4 min, but the difference was not significant.^[19]

Two different levels of gestational age (≥ 37 and < 37) did not affect the NST results. Lower abdominal thickness helps light transmission into uterus and increases the reactivity. Test time was reduced by 2.3 min in BMI < 27 , but the difference was not significantly different.^[19] We considered BMI and indirectly maternal abdomen thickness to see the different responses; no effect of BMI in two levels (< 25 and ≥ 25 kg/m²) was statistically seen on NST results.

With regard to depth of penetration, halogen light intensity is half of that of sunlight, and 10 sec of exposure is brief. On the other hand, light distribution in uterus and amniotic fluid reduces the level of intensity.^[17] Exposure of 10 sec duration at 10 min intervals is safe for fetuses, and no thermal injury is caused to skin. There was no side effect and no contraindication for light stimulus test.^[19] In Bolnick's study, no thermal injury was seen through use of a mild light source. In none of the cases, FHR deceleration was reported and Apgar score was at least 8 in the fifth minute. Red reflex eye and hearing tests were normal in all neonates before discharge.^[8] We did not face any FHR instability and fetal bradycardia. In addition, there was no complication in the participants during a week after stimulus test.

CONCLUSION

This study is the first one to investigate the halogen light stimulation on 20-min nonreactive patterns. All NSTs were performed by the same investigator. We did not have a control group to see how results alter only by passing time. We do not know if the fetal eye positions could affect the fetal responsiveness to light; however, conditions were the same for all participants. Similar findings in comparing vibroacoustic and halogen light stimulation suggest halogen

light stimulation approach can help as conventional NST complementary in fetal well-being evaluation as well as vibroacoustic stimulation. Applying vibroacoustic and halogen light stimulation, which are achievable, could be efficient and worthy upon midwives' decision and mothers' preference.

ACKNOWLEDGMENT

This study was funded by Tehran University of Medical Sciences. The authors would like to thank all participants who trusted and were involved in this study.

REFERENCES

1. Kliegman RM, Behrman RE, Jenson HB, Stanton BF. Nelson Textbook of Pediatrics, 96.2-Fetal Distress, (18th ed). Saunders, an Imprint of Elsevier. 2011: Available from: <http://www.mdconsult.com/books/page.do?eid=4-u1.0-B978-1-4377-0755-7.00090-7-sc0015> and isbn=978-1-4377-0755-7 and sid=1372916832 and uniqId=376673885-17#4-u1.0-B978-1-4377-0755-7.00090-7-sc0015, [Last retrieved on 2012 Sep 07].
2. Rakel RE. Textbook of Family Medicine, 8th ed. Saunders, an Imprint of Elsevier; 2011. Available from: <http://www.mdconsult.com/books/page.do?eid=4-u1.0-B978-1-4377-1160-8.10021-1-s0285> and isbn=978-1-4377-1160-8 and sid=1372915226 and uniqId=376673885-7#4-u1.0-B978-1-4377-1160-8.10021-1-s0285. [Last retrieved on 2012 Sep 07].
3. Cunningham FG, Leveno KJ, Bloom SL, Hauth JC, Rose DJ, Spong CY. Williams Obstetrics. 23rd ed. USA: McGraw Hill Medical; 2010. p. 334-48.
4. Gobbe S, Neibyl J, Simpson J. Obstetrics: Normal and problem pregnancies. Biophysical profile technique of fetal evaluation, assessment of fetal well being. 6th ed. Churchill Livingstone, an Imprint of Elsevier; 2012. Available from: <http://www.mdconsult.com/books/page.do?eid=4-u1.0-B978-1-4377-1935-2.00031-4-s0130> and isbn=978-1-4377-1935-2 and sid=1372913339 and uniqId=376673885-4#4-u1.0-B978-1-4377-1935-2.00031-4-s0130 [Last retrieved on 2012 Sep 07].
5. Modarres M, Mir Mohammad A, Haghani H, Arami R, Rahnama P. The conformity of BPP and vibroacoustic stimulation results in fetal non reactive non stress test. J Tehran Univ Med Sci 2006;64:46-54.
6. Lin C, Vassal B, Mittendorf R. Is antepartum vibro acoustic stimulation an effective predictor of fetal acidosis? J Prenat Med 2002;29:506-12.
7. Alus M, Okumus H, Mete S, Guklu S. The effect of different maternal positions on non- stress test. J Clin Nurs 2007;16:562-8.
8. Bolnick J, Garcia G, Fletcher B, Rayburn W. Cross-over trial of fetal heart rate response to halogen light and vibroacoustic stimulation. J Matern Fetal Neonatal Med 2006;19:214-9.
9. Miller D. External stimuli. Clin Obstet Gynecol 2002;45:1054-62.
10. van Heteren CF, Boekkooi PF, Jongsma HW, Nijhuis JG. Fetal habituation to vibroacoustic stimulation in relation to fetal states and fetal heart rate parameters. Early Hum Dev 2001;61:135-45.
11. Turitz AL, Bastek JA, Mary D, Sammel MD, Parry S, Schwartz N. Can vibroacoustic stimulation improve the efficiency of a tertiary care antenatal testing unit? J Matern

- Fetal Neonatal Med 2012;25:2645-50.
12. Kenner C, Lubbe W. Fetal stimulation-a preventative therapy. *Newborn Infant Nurs Rev* 2007;7:227-30.
 13. Pinette MG, Blackstone J, Wax JR, Cartin A. Using fetal acoustic stimulation to shorten the biophysical profile. *J Clin Ultrasound* 2005;33:223-5.
 14. Papadopoulos VG, Decavalas GO, Kondakis XG, Beratis NG. Vibroacoustic stimulation in abnormal biophysical profile: Verification of facilitation of fetal well-being. *Early Hum Dev* 2007;83:191-7.
 15. López Ramón Y Cajal C. Response of the foetal pupil to vibro-acoustic stimulation: A foetal attention test. *Early Hum Dev* 2011;87:199-204.
 16. Kiuchi M, Nagata N, Ikeno S, Terakawa N. The relationship between the response to external light stimulation and behavioral states in the human fetus: How it differs from vibroacoustic stimulation. *Early Hum Dev* 2002;58:156-8.
 17. Caridi B, Bolnick J, Fletcher B, Rayburn W. Effect of halogen light stimulation on nonstress testing. *Am J Obstet Gynecol* 2004;190:1470-2.
 18. Wilson JD, Adams AJ, Murphy P, Eswaran H, Preissl H. Design of a light stimulator for fetal and neonatal magnetoencephalography. *Physiol Meas* 2009;30:1-10.
 19. Thanaboonyawat I, Wataganara T, Boriboonhiransarn D, Viboonchart S, Tontisirin P. Effect of halogen light in fetal stimulation for fetal well-being assessment. *J Med Assoc Thai* 2006;89:1376-80.
 20. Rayburn B, Theele D, Bolnick J, Rayburn W. Selecting an external light source for fetal biophysical testing. *J Reprod Med* 2004;49:563-5.
 21. Tatsumura M. Study on features of fetal movement and development of human fetus with use of fetal actogram. *Nihon Sanka Fujinka Gakkai Zasshi* 1991;43:864-73.

How to cite this article: Rahimikian F, Rahiminia T, Modarres M, Mehran A. Comparison of halogen light and vibroacoustic stimulation on nonreactive fetal heart rate pattern. *Iranian J Nursing Midwifery Res* 2013;18:112-6.

Source of Support: Tehran University of Medical Sciences, **Conflict of Interest:** None.