

Comparison of fetal heart rate in different populations: role of computerized non-stress test

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ABSTRACT — OBJECTIVE: Previous studies demonstrated that fetuses of black women were more likely to show non-reactive non-stress test (NST), either in baseline conditions or during vibratory-acoustic stimulation. The aim of the present study is to apply a computerized Non Stress Test (NST) to compare fetuses of black and Caucasian women.

PATIENTS AND METHODS: 114 pregnant women at term who referred to the Safe Motherhood Clinic for the antenatal routine evaluation were considered eligible for a prospective, case-control study. For every black woman, Italian born and Maghreb coming women at similar gestational week (+/- 1 week), were enrolled. Each woman was submitted to computerized NST for 60 minutes. A multiparametric analysis including spectral parameters from autoregressive models and nonlinear algorithms (approximate entropy) was also applied.

RESULTS: The fetal heart rate of fetuses of black women significantly differed in comparison to the others: they showed lower episodes of large accelerations and higher values of approximate entropy. However, the acid-base status did not differ between groups, thus excluding that fetuses of black women were more likely to experience intra-partum distress.

CONCLUSIONS: Antenatal fetal heart rate differences among different population should be considered in the non-stress

test evaluation. In particular as far as the black women are concerned, further developments in ante-partum fetal algorithms are needed in order to avoid a wrong interpretation of NST features.

KEYWORDS

Computerized non stress test, Ethnic differences, Black women.

INTRODUCTION

Previous investigations^{1,2} demonstrated that black women carried fetuses more likely to show a non reactive non-stress test (NST) defined as the presence of less than two accelerations in 20 minutes, either in baseline conditions or during vibratory-acoustic stimulation. Such results were confirmed by further large retrospective study³. Later on, Johnson et al⁴ demonstrated that black fetuses also showed a higher baseline fetal heart rate (FHR) in comparison with Caucasian population although such difference did not correlate with behavioral states abnormalities^{5,6}. Moreover, by using a computerized NST analysis, Ogueh et al⁷ confirmed that not only numbers of accelerations but also baseline FHR were affected by ethnicity. Differences in baseline FHR values were also found between fetuses from mothers with Japanese and United States origin⁸. The aim of the present study is to compare ante-partum computerized NST analysis between black and Caucasian fetuses from Italian and Maghreb women.

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PATIENTS AND METHODS

From September 2003 to November 2004, 114 pregnant women routinely referred to the Safe Motherhood Clinic for the antenatal evaluation were considered eligible for a case-control, prospective study. For any black women, Caucasian women with Italian and Maghreb origin with similar age (± 2 years) and similar gestational week (± 1 week) were enrolled. The protocol was approved by the Institutional Review Board.

Inclusion criteria: singleton pregnancy, gestational age ranging between 38-41 weeks, uneventful pregnancy, regular Amniotic Fluid Index (AFI) ranging between 8-18 cm accordingly to Phelan classification⁹.

Black women referred for the 95% to Bantu ethnic origin. They were first immigrant having parents and grandparents of African origin living in Nigeria and Ghana. The women of Maghreb origin were from Tunisia (9 cases) and Morocco (21 cases). Exclusion criteria: fetal malformations or chromosome abnormalities, maternal diseases, drug assumption with the exception of iron or folic acid supplementation.

After obtaining written consent to participate in the study, each woman was submitted to ante-partum computerized NST through a Hewlett-Packard 8040 cardiotocograph equipped with a wide range external ultrasound transducer and a transabdominal tocodynamometer (HP-2CTG, Hewlett-Packard Division, Italy). All the recordings were performed in the morning between 10-12 a.m., for 60 minutes, with the women in a comfortable, semi-recumbent position. The traditional parameters considered for the study were: fetal heart rate (FHR), number of large accelerations (LA) defined as FHR variations above the baseline of amplitude greater than 15 beats per minute (bpm) for at least 15s, number of small accelerations (SA) defined as FHR variations above the baseline of amplitude greater than 10 bpm for at least 12.5s, oscillations bandwidth around the baseline expressed in bpm (DELTA bpm) (expression of the differences between the minimum and maximum value of FHR for each minute), long term variability evaluated with the long term irregularity index (LTI), short term variability (STV) evaluated every 60s and defined as average of successive 2.5-s

pulse intervals epochal differences, number of decelerations (DEC) defined as number of FHR variations below the baseline of amplitude greater than 20 bpm for at least 30 s or greater than 10 bpm for at least 60s¹⁰⁻¹³.

The multiparametric FHR analysis including spectral parameters from autoregressive models and nonlinear algorithms (approximate entropy) was also applied. The approximate entropy (ApEn) quantifies the amount of regularity in data; higher values are expression of greater randomness in heart rate pulses. It was calculated using sequential epochs of 2.5 s with a window length of 2 epochs and a filtering level of 2 bpm according to the formula of Pincus et al¹⁴. The spectral analysis provides quantitative measurements of the activity performed by the atrioventricular sinus node, which controls the physiologic variability of the heartbeats and represents the expression of a sympathetic/vagal balance. Each FHR interval of sufficient quality was submitted to the spectral analysis and, in the FHR spectrum, 3 component were identified: 1- the low frequency (LF: 0.03-0.15 HZ) correlated to baroreceptor of neural sympathetic/parasympathetic activity; 2- high-frequency (HF:0.5-1 Hz) correlated to fetal breathing modulated by parasympathetic activity; 3- the median frequency (MF:0.15-0.5 Hz) correlated to fetal movements and maternal breathing. The ratio LF/HF+MF, which quantifies the autonomic balance between neural control mechanism from different origin, was also calculated¹⁵⁻¹⁷.

RESULTS

No differences were observed between black and Caucasian women as far as maternal age (30.3 \pm 4.9 vs. 29.4 \pm 4.1 vs. 29.7 \pm 5 years) and gestational age at inclusion (39.2 \pm 1.4 vs. 39.2 \pm 1.3 vs. 39.3 \pm 1.2 weeks). Nulliparity differed between groups being higher in Italian women (76.3% vs. 19% vs. 24%; $p < 0.01$).

The final analysis was made on 102 patients because 12 patients dropped out: 1 woman was excluded in black group for mild hypertension onset and 13 in Caucasian group for low compliance toward the study.

Black fetuses showed lower episodes of large accelerations (Table I) and also a different pattern of approximate entropy (Table II).

Table I. The baseline computerized NST parameters. Values are expressed as Mean \pm Standard Deviation (M \pm SD). A p -value less than 0.05 indicates a significant value.

	Bantu Women (N°37)	Italian Women (N°35)	Maghreb Women (N°30)	$p <$
Fetal Heart Rate (bpm)	137.8 \pm 8.8	136.2 \pm 8.9	137.2 \pm 6.2	N.S.
Short Term Variability (bpm)	6.0 \pm 2.1	6.6 \pm 1.7	6.7 \pm 1.6	N.S.
Long Term Irregularity (bpm)	21.2 \pm 5.8	22.10 \pm 4.8	21.8 \pm 4.2	N.S.
Delta	38.5 \pm 8.9	41.8 \pm 8.8	41.7 \pm 6.5	N.S.
Irregularity Index	0.8 \pm 0.4	0.8 \pm 0.4	0.8 \pm 0.4	N.S.
Large Accelerations (n°)	8.8 \pm 8.7	15.0 \pm 7.7	12.5 \pm 7.5	0.002
Small Accelerations (n°)	5.3 \pm 3.6	4.9 \pm 2.3	5.7 \pm 4.2	N.S.
LA/SA Ratio	2.3 \pm 4.0	4.0 \pm 3.5	3.7 \pm 5.4	N.S.

Table II. Approximate entropy and the spectral analysis of the fetal heart rate. Data are expressed as mean±standard deviation (M±SD). A *p*-value less than 0.05 indicates a significant value.

	Bantu Women (N°37)	Italian Women (N°35)	Maghreb Women (N°30)	<i>p</i> <
Approximate Entropy	1.4±0.2	1.3±0.6	1.39±0.1	0.05
Low Frequency (LF)	77.5±6.3	79.5±13.2	80.7±3.8	N.S.
High Frequency (HF)	7.2±3.8	5.7±3.9	6.3±2.6	N.S.
LF/HF+MF Ratio	3.1±1.5	4.5±2.3	3.83±1.83	N.S.

Gestational age at delivery, birth weight and arterial blood cord values does not differ between groups. However, black women showed a higher rate of caesarean sections in comparison with both Italian and Maghreb women (40% vs. 25.7% vs. 15.4%; *p*<0.02).

CONCLUSIONS

The ante-partum computerized NST analysis showed that black fetuses were characterized by a lower number of large acceleration. These findings agree with previously published data based on visual NST interpretation⁷. Moreover, also the LA/SA ratio, whose reduction by term has been reported to correlate with a negative prognostic outcome¹⁸, showed a trend to be lower in such fetuses. The evaluation of the approximate entropy disagrees with these data. Indeed, they were characterized by higher values of approximate entropy considered a good predictive value; whereas acidosis seems to be correlated to lower values^{19,20}.

Thus, the present data seem partly support the notion that fetuses of black women showed a non-re-assuring NST in respect to others. Moreover, the acid-base status in spontaneously delivered newborns did not differ between groups, thus excluding that they are more likely to experience intra-partum distress.

Considering that normal gestational length is shorter in black and Asian compared with Caucasian women, it has been suggested that term pregnancy could be considered prolonged in such groups²¹. Therefore, we could hypothesize that the NST values found could be correlated to a condition of prolonged pregnancy rather than true distress.

The present study is limited by the small sample size investigated, which does not allow to address the issue of prognostic value of ante-partum NST.

Anyway, antenatal fetal heart rate differences among different populations should be considered, in particular as far as the fetuses of black women are concerned in order to avoid a wrong interpretation of NST that could contribute to a high incidence of emergent caesarean section^{22,23} occurring in such population.

CONFLICTS OF INTEREST:

The Authors declare that there are no conflicts of interest

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