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Intrapartum fetal heart rate patterns of trisomy 21 fetuses: A case–control study ☆,☆☆,★

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ABSTRACT

Background/Aim: To determine whether there are specific characteristic intrapartum heart rate patterns for fetuses with trisomy 21(T21).
Background study design/patients: Intrapartum fetal heart rate (FHR) tracings of T21 fetuses were compared to those of euploid fetuses in a retrospective, observational, matched, case–control study. The study group consisted of 42 fetuses with T21 and 42 matched euploid controls. Matching was designed to accommodate possible confounders. The sign test and McNemar's test were used for categorical variables. The paired t test was used for comparison between quantitative variables.
Results: Intrapartum baseline FHR of fetuses with T21 was found to be slightly decreased compared to controls (122.5 vs 129.05 beats per minute, $p = 0.028$). No differences were detected in the presence of periodic changes, or FHR variability between the groups.
Conclusion: When evaluating intrapartum FHR of fetuses with T21, decreased baseline FHR can be expected.

1. Introduction

Down syndrome is the most prevalent chromosomal abnormality and the most common genetic syndrome causing mental retardation. Its prevalence is similar worldwide, at about 1 in 800–1000 live births [1], and increases with advanced maternal age [2]. Shaare Zedek is the largest center for maternal–fetal medicine in Israel, with an average of 14,000 live births every year. The department caters to a largely Jewish Orthodox population characterized by a large proportion of women who are admitted for labor without prenatal screening for trisomy 21(T21), as well as women who choose to continue their pregnancies despite a prenatal diagnosis of T21.

The literature is inconsistent regarding the characteristics of fetal heart tracing in these fetuses. Most studies do not address intrapartum monitoring and involve only small study samples. In some studies T21 appeared to be associated with a more rapid fetal heart rate (FHR) in comparison with normal fetuses [3,4], in some cases findings varied, and in some reports the Down syndrome fetuses had slower FHR [5]. In addition, if there are differences in FHR in T21, it is unclear whether this represents a normal variant or whether it could be attributed to a stressful event. Interventions due to misinterpretation of FHR patterns, such as emergency Cesarean section or mechanically-assisted delivery, are ideally avoided; thus a more complete understanding of typical findings during intrapartum fetal monitoring in T21 may affect both fetal and maternal health.

Considering the inconsistencies, as well as the limitations of previous studies, we compared intrapartum FHR in T21 fetuses with FHR in a matched cohort of normal fetuses, with the aim of determining whether a specific pattern of intrapartum FHR in Down syndrome fetuses can be identified.

2. Methods

This is an observational, retrospective, matched case–control study. Continuous electronic fetal heart monitoring is routinely performed at our institution from admission until delivery. Electronic recordings of FHR monitoring for a series of T21 fetuses (study group) were compared with a matched set of euploid fetuses (control group). Data was collected and integrated from the computerized database of the Shaare Zedek Medical Center. The Medical Center's Institutional Review Board approved the study design and waived the requirement for informed consent (exemption p27/09).

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Fetuses with T21 from a singleton pregnancy with available fetal heart monitoring data, were included in the study; those from multiple gestations and those lacking sufficient (at least 1 h, good quality) FHR monitoring data were excluded. In cases where the mother gave birth by elective Cesarean section, and those in which immediate Cesarean section was decided on admission, FHR monitoring was insufficient to meet inclusion criteria. In all cases, T21 diagnosis was made in the neonatal period. None of the women, in either group, was known at the time of delivery to have a fetus with a structural anomaly.

Each T21 fetus was matched by a euploid fetus born in the Medical Center. Fetuses that were possible matching controls for each T21 baby were identified, and the infant with the closest delivery date was chosen. Fetuses were matched according to variables known to affect FHR tracing, including gestational age at birth (±1 week), birth weight (±100 g), use of oxytocin, and use of epidural analgesia during labor. In all cases where epidural anesthesia was used, the anesthetic agent was bupivacaine 0.5%. Tracings within 30 min after insertion of the epidural catheter and administering the initial dose of anesthesia were not used for analysis. Narcotic was not administered prior to the analyzed tracing and prostaglandins were not used for induction of labor in any birth of a trisomy 21 or euploid fetus included in this study.

External monitoring was performed using the Viridia series 50 XM monitor (Hewlett Packard, Palo Alto CA).

The dependent variables in the study were electronic fetal heart tracing characteristics in a predetermined time interval. Nomenclature and definitions of normal fetal heart and interpretation of FHR tracings were based on the American Congress of Obstetrics and Gynecology (ACOG) guidelines [6]. Baseline FHR, variability and presence of periodic changes (decelerations or accelerations), were noted for each fetus. The strip of FHR tracing analyzed was representing the first hour in the first stage of active labor (≥4 cm cervical dilatation). Variability was assessed, and the 15 consecutive minutes with the lowest variability during this hour were chosen. Baseline FHR was rounded to the closest 5 beats per minute (bpm) mark. A single board-certified physician specialist in obstetrics and gynecology with 10 years experience (RMC) interpreted all fetal heart monitoring recordings. The interpreter was blinded to fetal identity and group.

We examined baseline FHR both as a continuous and a categorical variable. The distributions of baseline FHR and variability for the T21 and euploid groups were compared. As normal baseline FHR is defined as 110–160 bpm [6], and normal variability as 6–25 bpm, we also compared the proportion of cases where the baseline FHR was below or above the thresholds of 110, 140, and 160 bpm; and where the variability was below the thresholds of 5, 7, and 10 bpm. The number of women with accelerations or decelerations in each group was also compared. Deceleration was defined as a decrease of 15 bpm or more from baseline that lasted 15 s or longer.

Medical charts of the cases and controls were reviewed for relevant antenatal and events, birth outcomes, and the existence of aneuploidy. The pediatric charts were examined to ascertain the presence of cardiac anomalies and congenital hypothyroidism.

2.1. Statistical analysis

Paired statistical methods were used for statistical analysis. The null hypothesis was that the two groups would be similar in the measured parameters. The sign test and McNemar's test were used for categorical variables. The paired t test was used for comparison between quantitative variables. All statistical tests were two-tailed. A p value of 0.05 or less was considered statistically significant. The Statistical Package for the Social Sciences (SPSS, IBM, Chicago IL) was used for statistical analysis.

3. Results

A total of 83 neonates with T21 were born in Shaare Zedek from January 2005 to December 2010. Among them, 22 were excluded from the study due to insufficient quality or duration of monitoring, 18 were excluded due to birth via elective Cesarean section or Cesarean section on admission, and one was excluded due to precipitous delivery while en route to the hospital; thus 42 neonates with T21 (study group) and 42 matched euploid fetuses (controls) were included in the analysis.

Table 1
Matching parameters for T21 (study group) and euploid (control) fetuses.

	T21 ($n = 42$)	Euploid ($n = 42$)	p
Gestation (weeks)	38.3 (27–41)	38.3 (27–41)	0.083
Birth weight (grams)	2989 (709–3917)	3024 (800–3826)	0.359
Use of oxytocin (no. of cases)	4	6	0.3
Epidural anesthesia (no. of cases)	25	23	0.5

There were no significant differences between fetuses in the T21 and control groups in gestational age at birth, birth weight, use of oxytocin, or use of anesthesia during labor (Table 1). Two T21 fetuses that were born preterm with low birth weight were matched for gestational age and birth weight, since these characteristics possibly have a greater impact on FHR pattern and were thus prioritized; however, matching for additional variables was not possible. Labor characteristics of fetuses in both groups are shown in Table 1.

FHR characteristics are summarized in Table 2. When FHR was analyzed as a continuous variable, there was a significant difference in the average baseline FHR for T21 fetuses (122.5 ± 14.2 bpm, range 100–170 bpm) versus the control group (129.1 ± 13.0 bpm, range 100–150 bpm) ($p = 0.028$). Categorical analysis of FHR found that the baseline FHR of neonates with T21 was not statistically different from the control group for either the thresholds of 110 or 140 bpm ($p = 0.727$, 0.267, respectively). Only one fetus in the T21 group had a baseline FHR greater than 160 bpm, hence this threshold was not evaluated.

Average FHR variability was 5.8 ± 2.2 bpm (range 2–10 bpm) in the T21 group versus 6.7 ± 2.8 bpm (range 2–15 bpm) in the control fetuses ($p = 0.088$). There were 12 fetuses with a mean variability of less than 7 bpm in the study group (28%) versus four in the control group (9.5%). This difference did not reach statistical significance ($p = 0.077$). Similarly, there were no significant differences between groups for threshold variability ≤5 bpm, or ≤10 bpm.

As evident from Table 2, there were also no significant differences in either accelerations or decelerations between the groups.

Within the study group 23/42 (55%) children had cardiac malformations and 3/42 (7%) had congenital hypothyroidism. There were no significant differences in average baseline FHR between fetuses with T21 and cardiac malformations (120.4 ± 15.8 bpm) to those with T21 without malformations (125.0 ± 11. bpm) ($p = 0.305$). Similarly fetuses with congenital hypothyroidism had a similar baseline (122.6 ± 14.4) to euthyroid T21 fetuses (121.6 ± 12.5) ($p = 0.917$).

4. Discussion

We aimed to determine whether the intrapartum FHR pattern of fetuses with T21 differs from that of euploid fetuses. We found that T21

Table 2
Fetal heart rate characteristics.

	T21 ($n = 42$)	Euploid ($n = 42$)	p
Mean baseline heart rate	122.5 bpm	129.1 bpm	0.028
Baseline heart rate < 110 bpm	26.2% (11)	14.3% (6)	0.267
Baseline heart rate < 140 bpm	92.9% (39)	88.1% (37)	0.727
Baseline heart rate > 160 bpm	1	0	
Mean heart rate variability	5.8 bpm	6.7 bpm	0.088
Heart rate variability < 5 bpm	28.6% (12)	23.8% (10)	0.815
Heart rate variability < 7 bpm	81% (34)	62% (26)	0.077
Heart rate variability < 10 bpm	90.5% (38)	83.3% (35)	0.508
Heart rate accelerations	81.0% (34)	88.0% (37)	0.549
Heart rate decelerations	14.3% (6)	14.3% (6)	1.00