Fetal electrocardiogram: ST waveform analysis in intrapartum surveillance

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ST waveform analysis of fetal electrocardiogram (ECG) for intrapartum surveillance (STAN) is a newly introduced method for fetal surveillance. The purpose of this commentary is to assist in the proper use of fetal ECG in combination with cardiotocography (CTG) during labour. Guidelines and recommendations concerning CTG and ST waveform interpretation and classification are stated that were agreed on by the European experts on ST waveform analysis for intrapartum surveillance during a meeting in Utretch, the Netherlands in January 2007.

Prerequisites for initiation of STAN monitoring

A checklist was suggested to be used at the start of recording (Table 1). STAN calculates the initial reference baseline T/QRS using the first 20 T/QRS data recorded and resets the baseline if it becomes lower or after 3 hours of recording. A ST rise is detected when a sequence of T/QRS data are recorded, which significantly exceeds this T/QRS baseline, and an ST event is flagged by the computer. In a case of pre-existing fetal hypoxia, the ST change may have already taken place and further ST rise may not occur. Therefore, STAN recordings should start during the first stage of labour, with ideally a reassuring FHR trace.

Based on a large prospective study where acid–base values were evaluated with CTG and ECG changes, the expert group considers it acceptable to start STAN monitoring on a non-reassuring CTG trace if the previous FHR pattern includes measures to overcome user errors to reduce ambiguity and the risk of adverse outcome. This commentary outlines these recommendations.
signs of reactivity (accelerations and/or FHR variability). Abnormal FHR at the start of recording without previous FHR information requires assessment of the fetal state prior to the application of STAN, for example analysis of fetal scalp pH and/or FHR reactivity with digital or vibroacoustic stimulation. Absence of ST events in a situation with nonreassuring FHR trace from the start could be related to previous compromise in a fetus that is unable to respond with ECG changes. If additional assessment of the fetal condition in such a case is not possible, the need for intervention should be based on FHR, clinical situation and fetal blood sampling (FBS) but not on STAN information.

**Signal quality**

Fetal ECG ST analysis requires good signal quality. Continuous data (with at least one T/QRS ratio/minute) are needed to obtain reliable ST information. Gaps in the T/QRS ratios for more than 4 minutes may result in missed STAN events. This is particularly important in the presence of intermediary or abnormal FHR and during second stage when the condition of the fetus may deteriorate rapidly.

**Disconnection of ST waveform analysis**

The reference T/QRS baseline calculated previously is kept when the machine is temporarily disconnected by using the 'temporary end' function. However, ST events that may occur during the disconnected period will not be detected. Therefore, pausing a recording when the FHR is abnormal is not recommended, as significant STAN events may be missed. If the FHR has become abnormal during temporary disconnection, the situation maybe similar to starting a recording with an abnormal trace, that is there is a need to check the fetal status using FBS or stimulation tests.

**FHR classification used with STAN technology**

With the use of STAN, the FHR pattern is classified according to the International Federation of Obstetrics and Gynecology guidelines. With a combination of several intermediary observations, the FHR should be classified as abnormal (Table 2). Calling for additional expertise in assessing FHR should be considered an intervention and is as important as alleviation of the cause(s) of fetal compromise, such as stopping oxytocin infusion or repositioning of the mother.

**Table 1. ST analysis checklist at start-up**

| Before starting STAN | After start-up |
|----------------------|---------------|
| >36 + 0 gestational weeks | Normal ECG waveform with sufficient signal quality |
| Ruptured membranes | Event log message baseline determined |
| No contraindication for scalp electrode | Check for reactivity and nondeteriorating fetal state at the onset of a STAN recording, classify FHR! |
| First stage, no active or involuntary pushing at onset |

**Table 2. CTG classification**

| CTG-class | Baseline heart rate | Variability/reactivity | Decelerations |
|-----------|---------------------|------------------------|---------------|
| Normal CTG | 110–150 bpm | 5–25 bpm | Early uniform decelerations; |
|           |                     | Accelerations | Uncomplicated variable decelerations with a duration of <60 sec and loss of <60 beats |
| Intermediary CTG | 100–110 bpm | >25 bpm (saltatory pattern) | Uncomplicated variable decelerations with a duration <60 sec and loss of >60 beats |
|           | 150–170 bpm | <5 bpm for >40 minutes with absence of accelerations |
|           | Short bradycardia episode (<100 bpm for ≤3 minutes) |
| Abnormal CTG | 150–170 bpm and reduced variability | <5 bpm for >60 minutes | Complicated variable decelerations with a duration of >60 sec |
|           | >170 bpm | Sinusoidal pattern | Repeated late uniform decelerations |
|           | Persistent bradycardia (<100 bpm for >3 minutes) |
| Preterminal CTG | Total lack of variability (<2 bpm) and reactivity with or without decelerations or bradycardia |

bpm, beats per minutes.
Gradual deterioration of the FHR pattern in the absence of ST events

In rare cases, the FHR pattern may gradually change from normal to abnormal, without the appearance of ST events (see paper by Westerhuis et al. in this issue). An abnormal FHR pattern for more than 60 minutes (or earlier if the CTG deteriorates rapidly) with normal ST requires qualified assessment and checking for nondeteriorating fetal state (with a preterminal FHR pattern, intervention is always indicated, irrespective of the ST data).

Table 3. STAN simplified clinical guidelines. Intervention recommended on the basis of CTG abnormalities and ST events*

|                  | Intermediary CTG | Abnormal CTG | Preterminal CTG |
|------------------|------------------|--------------|-----------------|
| Episodic T/QRS rise | >0.15            | >0.10        | Immediate       |
| Baseline T/QRS rise | >0.10            | >0.05        | delivery        |
| Biphasic ST      | Three biphasic   | Two biphasic | ST events       |

*Biphasic ST events

Biphasic (BP) ST events should be considered in relation to the window of recording. This implies that two BP events in combination with an abnormal CTG calls for intervention. The time-span between the BP should be related to the clinical situation. Appropriate and consistent classification of the FHR patterns is still the weakest link in intrapartum monitoring, as education and training in FHR interpretation is not as widespread as the method itself.

Maternal fever

STAN is a method for detection of acute intrapartum asphyxia not fetal infections. In the presence of maternal pyrexia, even intermediary FHR changes may be regarded as significant in connection with an ST event.

Supplementary material

The following supplementary material is available for this article:

Appendix S1. Acknowledgements.

These materials are available as part of the online article from: http://www.blackwell-synergy.com/doi/abs/10.1111/j.1471-0528.2007.01479.x

(This link will take you to the article abstract).

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References

1 Westerhuis MEMH, Kwee A, van Ginkel AA, Drogtrop AP, Gyselaers WJA, Visser GHA. Limitations of ST analysis in clinical practice: three cases of intrapartum metabolic acidosis. BJOG 2007;114:1194–201.

2 Doria V, Papageorghiou AT, Gustafsson A, Ugwumadu A, Farrer K, Arulkumaran S. Review of the first 1502 cases of ECG-ST waveform analysis during labour in a teaching hospital. BJOG 2007;114:1202–7.

3 Luttkus AK, Norén H, Stupin JH, Blad S, Arulkumaran S, Erkkola R, et al. Fetal scalp pH and ST analysis of the fetal ECG as an adjunct to CTG. A multi-center, observational study. J Perinat Med 2004;32:486–94.

4 FIGO News: Roth G, Huch A, Huch R. Guidelines for the use of fetal monitoring. Int J Gynaecol Obstet 1987;25:159–67.