

## Fetal heart rate monitoring – principles and interpretation of cardiotocography

This article was originally published as *Anaesthesia Tutorial of the Week 294 (2013)*

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### CARDIOTOGRAPHY

The CTG monitor records the fetal heart rate (FHR) either from a transducer placed on the woman's abdomen or an electrode placed on the fetal scalp. An additional transducer placed on the woman's abdomen simultaneously records uterine muscle contraction. These variables are plotted graphically so that variations in FHR can be viewed over time and interpreted in the context of the contractile state of the uterus (Figure 1).

### INDICATIONS FOR CONTINUOUS CTG MONITORING

Intermittent auscultation of the FHR is recommended for women considered at low risk of complications during labour. The UK National Institute of Health and Clinical Excellence (NICE) make recommendations for continuous CTG monitoring which include:<sup>1</sup>

1. Meconium staining of liquor
2. Maternal pyrexia – defined as 38.0°C or 37.5°C on two occasions two hours apart
3. The use of oxytocin for labour augmentation
4. Fresh bleeding developing in labour
5. At the woman's request
6. Abnormal FHR detected during intermittent auscultation:
  - FHR <110 beats per minute (bpm)
  - FHR >160 bpm
  - Any decelerations after a contraction
7. Women receiving regional anaesthesia/analgesia. Continuous electronic fetal monitoring is recommended for at least 30 minutes during establishment of regional analgesia and after administration of a further bolus of local anaesthetic agent. In most UK centres, continuous CTG monitoring is performed after the insertion of a labour epidural.

### CHARACTERISTICS OF THE CTG

A combination of several abnormalities increases the likelihood of fetal distress.

Suspicious or abnormal features include:

- Baseline FHR outside normal range of 110 – 160 beats per minute (bpm)
- Baseline variability <5 bpm
- Reduced or absent accelerations
- Presence of decelerations.

#### Baseline rate

The normal baseline fetal heart rate is defined as 110 – 160 bpm. Fetal bradycardia is a baseline rate of <110 bpm. Fetal tachycardia is a baseline rate of >160 bpm.

Many fetal baseline bradycardias have no identifiable cause but may occur as a result of:

- Cord compression and acute fetal hypoxia
- Post-maturity (> 40 weeks gestation)
- Congenital heart abnormality.

Fetal tachycardia is associated with:

- Excessive fetal movement or uterine stimulation
- Maternal stress or anxiety
- Maternal pyrexia
- Fetal infection
- Chronic hypoxia
- Prematurity (<32 weeks gestation).

#### Fetal heart rate variability

Variability refers to the normal beat to beat changes in FHR. Normal variability is between 5-15 bpm. Variability can be measured by analysing a 1-minute portion of the CTG trace and assessing the difference between the highest and lowest rates during that period. Variability can be defined as:

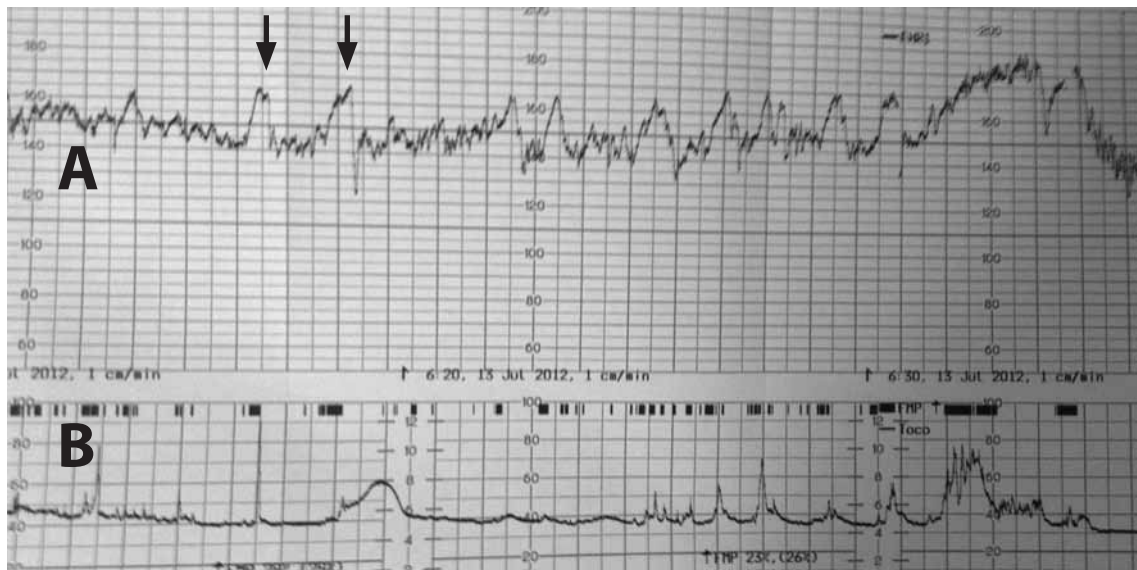
### Summary

Continuous electronic fetal monitoring is commonly performed by cardiotocography (CTG). The CTG monitor records both fetal heart rate (cardio) and maternal uterine contractions (toco). An understanding of the principles of CTG monitoring and a systematic approach to CTG analysis may enable anaesthetists to better appreciate why obstetricians make specific clinical decisions. This understanding may aid communication and timely delivery especially when the fetus is considered at high risk.

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**Figure 1.** Normal CTG with fetal heart rate uppermost (A) and the tocogram, showing uterine contractions below (B). The fetal heart rate is within the normal range and has normal baseline variability. The arrows demonstrate healthy fetal heart rate accelerations.

Normal	5-15 bpm
Increased	>15 bpm
Decreased	<5 bpm
Absent	<2 bpm

Fetal hypoxia may cause absent, increased or decreased variability. Other causes of decreased variability include normal fetal sleep-wake pattern, prematurity and following maternal administration of certain drugs including opioids.

### Accelerations (Figure 2)

Accelerations are periodic, transient increases in FHR, defined as an increase in FHR >15 bpm for more than 15 seconds. When

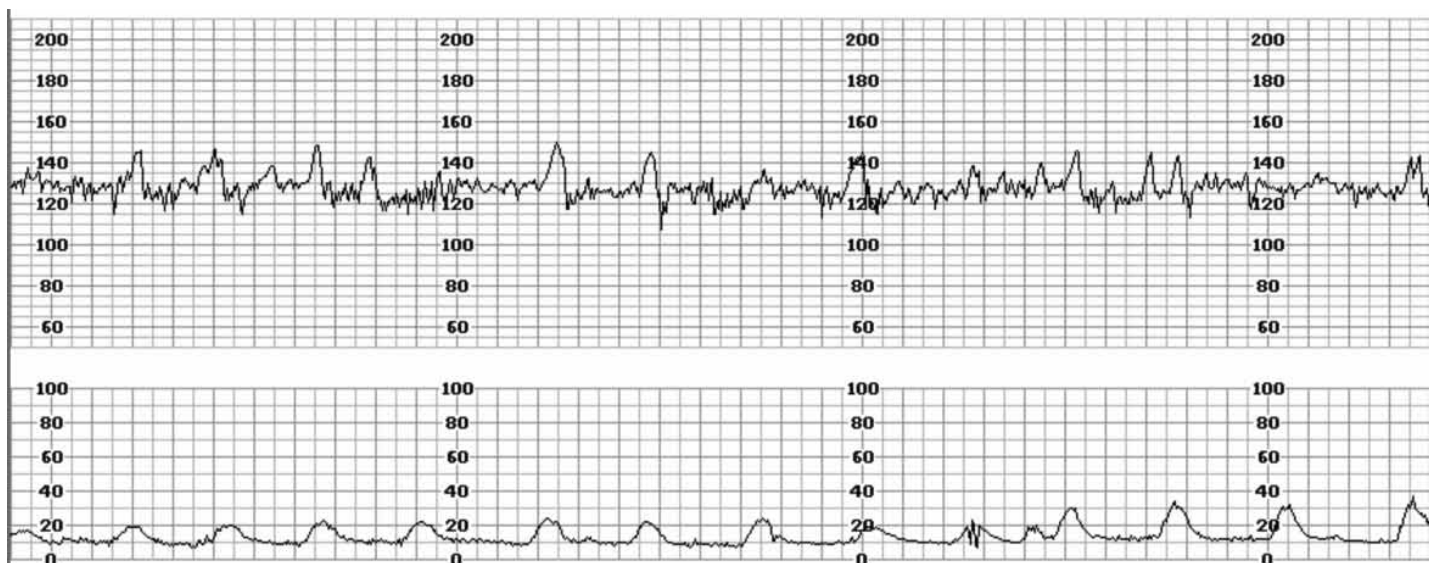
accelerations are present, the CTG is said to be reactive. Accelerations are often associated with fetal activity and are considered an indication that the fetus is healthy.

### Decelerations

Decelerations are periodic, transient decreases in FHR, usually associated with uterine contractions. They can be subdivided into four main types by their shape and timing in relation to uterine contractions. Uterine contractions must be monitored adequately in order for a deceleration to be correctly classified.

Decelerations may be:

- Early
- Late



**Figure 2.** CTG demonstrating fetal heart rate accelerations

- Variable
- Prolonged.

**Early decelerations (Figure 3)**

Early decelerations tend to occur with each contraction and are uniform in shape. Early FHR decelerations appear as a mirror image of the uterine contraction trace. The onset of the deceleration occurs at the onset of the contraction and the baseline FHR recovers by the end of the contraction. The FHR usually does not fall by more than 40 bpm during an early deceleration.

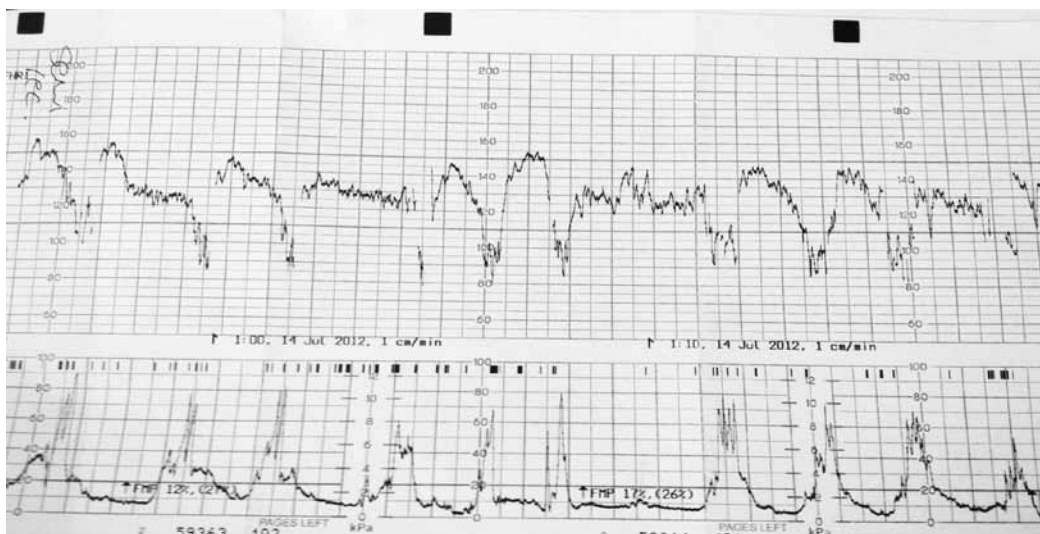
Early decelerations are caused by compression of the fetal head during a contraction. They are often relieved by changing maternal

posture and are a normal finding in the second stage of labour. They are not associated with a poor fetal outcome.

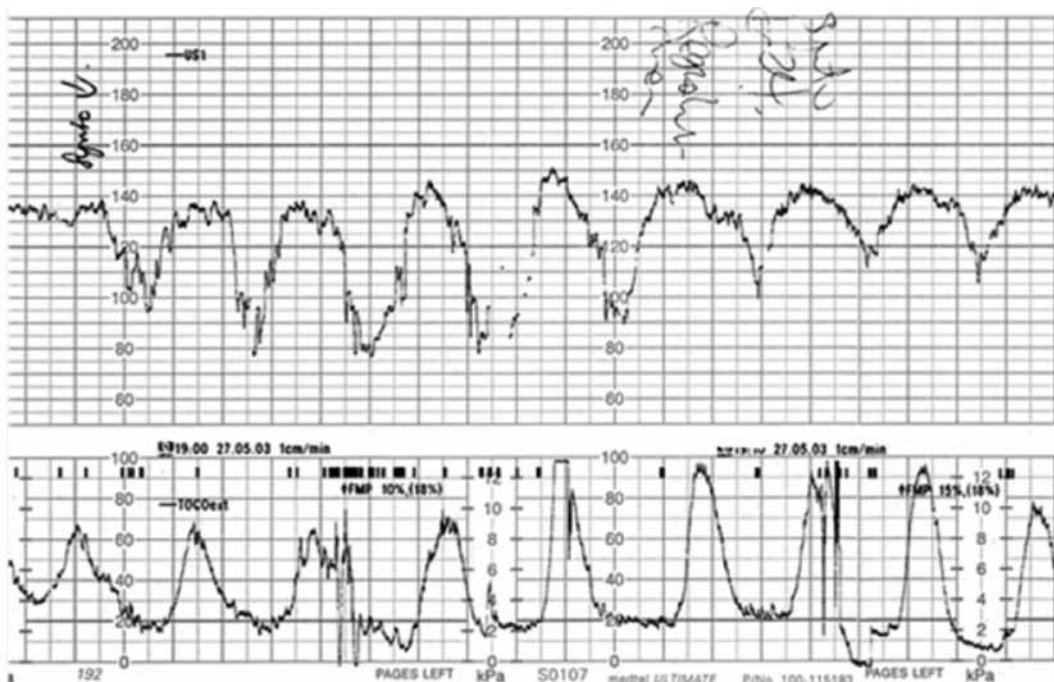
**Late decelerations (Figure 4)**

Late decelerations are uniform in shape on the CTG, but unlike early decelerations start after the peak of the uterine contraction. A deceleration in which the lowest point occurs more than 15 seconds after the peak of the uterine contraction is defined as a late deceleration. They are often associated with a decrease in the variability of the baseline FHR.

Late decelerations are associated with decreased uterine blood flow and can occur as a result of:



**Figure 3.** CTG demonstrating early decelerations. Note the onset of the deceleration occurs with the onset of the uterine contraction



**Figure 4.** CTG demonstrating late decelerations resulting from cord compression

- Hypoxia
- Placental abruption
- Cord compression / prolapse
- Excessive uterine activity
- Maternal hypotension / hypovolaemia.

**Variable decelerations (Figure 5)**

Variable decelerations describe FHR decelerations that are both variable in timing and size. They may be accompanied by increased variability of the FHR. They are caused by compression of the umbilical cord and may reflect fetal hypoxia.

**Prolonged decelerations/ bradycardia (Figure 6)**

A deceleration with a reduction in FHR of greater than 30 bpm that lasts for at least 2 minutes is termed a prolonged deceleration. They are caused by a decrease in oxygen transfer to the fetus, so can arise as a consequence of a wide variety of disorders including:

- Maternal hypotension
- Umbilical cord compression
- Uterine hypertonia.

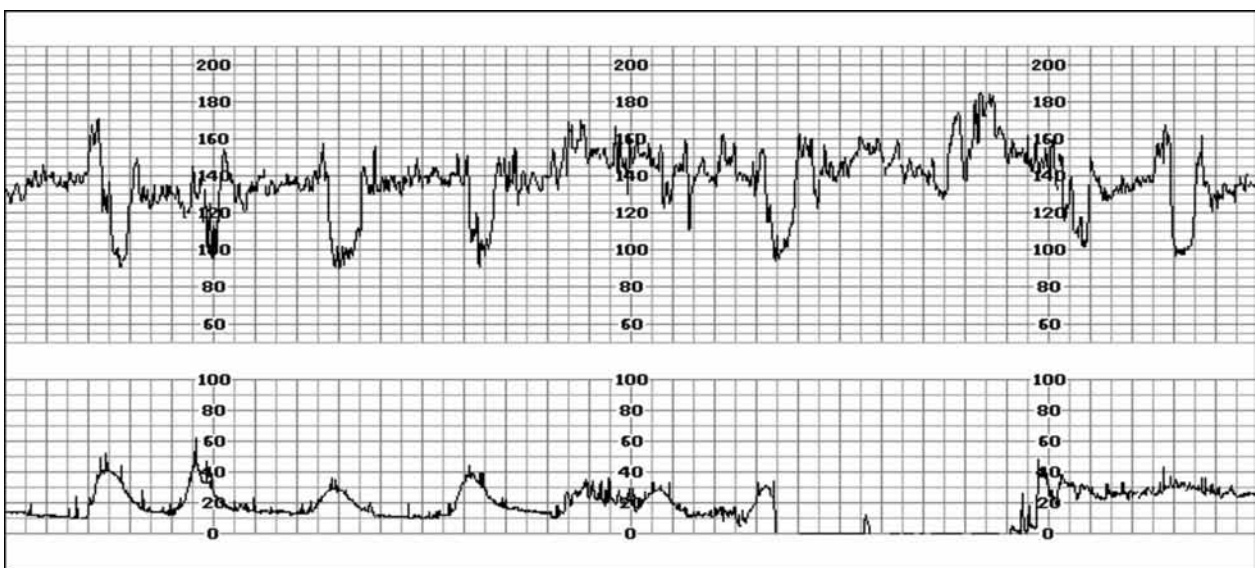


Figure 5. CTG demonstrating variable decelerations

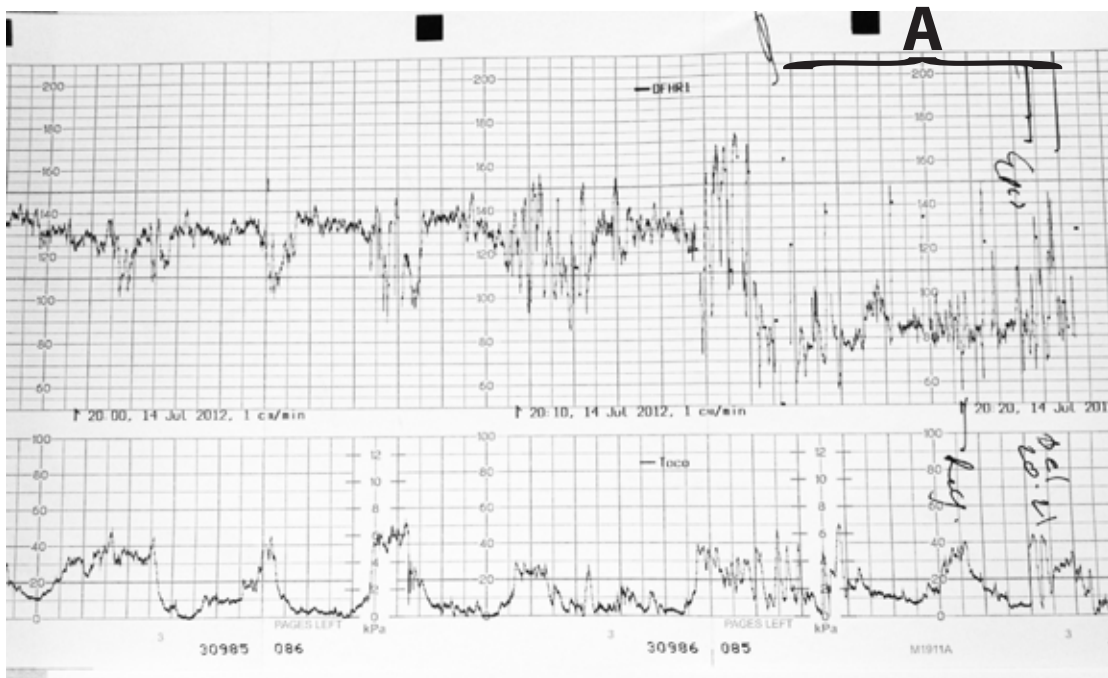


Figure 6. Prolonged deceleration/bradycardia (A - bracketed) representing fetal distress

**Table 1. Categorisation of CTG**

	<b>Reassuring</b>	<b>Non-reassuring</b>	<b>Abnormal</b>	
<b>Baseline rate (bpm)</b>	110 - 160	100 - 109 161 - 180	<100 >180	Comments:-
<b>Variability (bpm)</b>	5bpm or more	<5 for 40 min or more but < 90 min	<5 for 90min or more	Comments:-
<b>Accelerations</b>	Present	None	Comments:-	
<b>Decelerations</b>	None	Early Variable Single prolonged deceleration up to 3 min	Atypical variable Late Single prolonged deceleration > 3 min	Comments:-
<b>Opinion</b>	<b>Normal CTG</b> (All four features reassuring)	<b>Suspicious CTG</b> (One non-reassuring feature)	<b>Pathological CTG</b> (two or more non-reassuring or one or more abnormal features)	
<b>Dilatation</b>		Comments:-	<b>Contractions</b>	<b>.....:10</b>
<b>Action</b>				
Date	Signature			
Time	Status			

### CTG CATEGORISATION

Following CTG analysis, the findings can be used to categorise the CTG as: normal, suspicious or pathological. Many UK maternity units have adapted recommendations from NICE to produce a sticker (below) that is placed in the records of the labouring woman to assist her on-going management.

### FETAL SCALP ELECTRODE

A fetal scalp electrode is a device that is attached to the skin of the presenting part (most commonly the scalp) of the fetus to assess the fetal heart rate pattern when external monitoring cannot be used or when the quality of external monitoring is poor (e.g. maternal obesity). It provides a more accurate and consistent transmission of the fetal heart rate than external monitoring because external factors such as movement do not affect it.

### FETAL BLOOD SAMPLING

Fetal blood sampling (FBS) involves taking a small sample of blood from the presenting part of the fetus during labour. FBS is advised in the presence of a pathological CTG unless there is clear evidence of severe fetal compromise. If fetal compromise is evident, (e.g. prolonged deceleration of greater than 2 minutes duration), FBS should not be undertaken and the baby should be delivered urgently. Other contraindications to FBS include:

- Maternal infection (such as HIV, hepatitis, herpes simplex virus)
- Fetal bleeding disorders
- Prematurity (<34/40).

### INTRAUTERINE FETAL RESUSCITATION

If CTG monitoring indicates serious fetal compromise, or FBS result is abnormal, a decision to deliver, often by emergency caesarean section, should be made. A number of manoeuvres can be performed

**Table 2. Classification of fetal blood sampling (FBS) results<sup>1</sup>**

FBS result (pH)	Classification	Recommended subsequent action
≥ 7.25	normal	Repeat within 1 hour if FHR trace remains pathological or sooner if further abnormalities
7.21 – 7.24	borderline	Repeat within 30 minutes if FHR trace remains pathological or sooner if further abnormalities
≤ 7.2	abnormal	Seek obstetric advice, delivery is indicated

to improve fetal oxygenation before delivery.<sup>2</sup> These manoeuvres may be performed with continuous CTG monitoring and if successful may reduce the urgency to deliver allowing time to provide neuraxial anaesthesia. Steps in intrauterine resuscitation can be remembered by the acronym SPOILT:

- Syntocinon off
- Position full left lateral
- Oxygen
- I.V. – infusion of crystalloid fluid
- Low blood pressure – if present give i.v. vasopressor
- Tocolysis - terbutaline 250mcg sc (a  $\beta_2$ -agonist) or GTN (2 x 400mcg puffs sublingual)

### REFERENCES

1. Guideline CG55, National Institute for Health and Clinical Excellence, September 2007. Intrapartum care: management and delivery of care to women in labour. Available at: <http://guidance.nice.org.uk/CG55>
2. Thurlow JA, Kinsella SM. Intrauterine resuscitation: active management of fetal distress. *Int J Obstet Anesth* 2002; **11**: 105-16.