

Intrapartum fetal monitoring

Intrapartum fetal monitoring^[1] is a set of methods used to prevent fetal hypoxia in an attempt to prevent the consequences of hypoxia (hypoxic-ischemic encephalopathy, fetal death). The goal is to distinguish **unaltered fetuses**, altered fetuses with **a preserved ability to compensate** (increased blood flow, change in metabolism) and altered fetuses that **are no longer capable of compensation**.

 For more information see *Fetal Hypoxia*.

Currently, mainly three different methods are used: **cardiotocography (CTG)**, **fetal ECG (ST-analysis, STAN)** and **fetal pulse oximetry (FPO)**. **Saling's method of determining blood gases** from a drop of blood taken from child's head is rarely used.

Cardiotocography

Cardiotocography (CTG)^[1] is a method of **fetal monitoring** using the simultaneous recording of fetal heart rate (*cardiotachogram*) and uterine contractions (*tocogram*). Modern devices enable a third signal modality in the form of recording fetal movements. The method is based on the fact that **hypoxic changes affect the hemodynamics of the fetus** and changes in the uteroplacental circulation will be manifested by a change in the frequency of fetal echoes^[1].

Independent CTG diagnosis is in agreement with the diagnosis of hypoxia of the newborn after birth in 50-60%^[1]. The simultaneous use of CTG and STAN will reduce the incidence of metabolic acidosis by 60% and the number of operations for fetal distress by 25%^[1].

Physiology of uterine contraction

The basal tone of the uterus is around **10 mmHg**. At a pressure exceeding 20 mmHg, the venous flow through the uterus stops. At a pressure exceeding 60 mmHg, the arterial flow through the uterus stops (physiologically, the part of contraction lasting approx. 20 s). A healthy fetus has compensatory mechanisms (increase in flow, change in metabolism). However, if the refractory phases between contractions are not long enough, the contractions are arrhythmic, the contraction frequency is too high, the contractions are too long, or the basal tone itself is elevated above 20 mmHg, the fetal compensatory mechanisms are exhausted. Thus, an unaltered fetus gradually becomes an altered fetus and later an altered fetus incapable of compensation.

Tocogram

It is measured either by an external sensor, which mechanically measures the circumference of the abdomen, or by an internal one, which can be used to directly measure intrauterine pressure. Only the internal sensor can be accurately calibrated, but this is only used for research purposes. Only an external sensor is used clinically, whose absolute pressure values are indicative only.

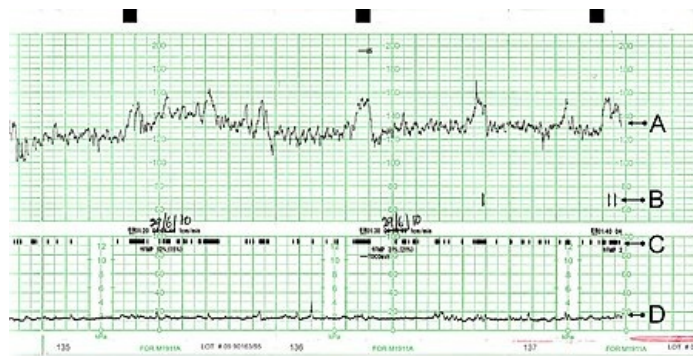
The length, intensity and frequency of uterine contractions can be estimated on the tocogram. As a guideline, the ideal contraction frequency is **4-6/10 min**. It is important for the evaluation of medium-term phenomena in the cardiotachogram.

Cardiotachogram

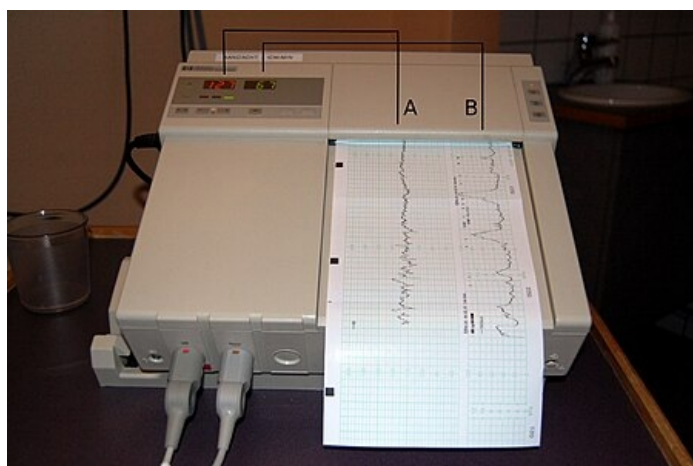
The recording method is Doppler ultrasonography. It is possible to use an external or internal probe (*Hono's scalp electrode*), which is used if the external one slips.

We distinguish between **long-term**, **medium-term** and **short-term** phenomena.

Long-term phenomena



Physiological CTG: A – Heart rate; B – Movements felt by the mother (push of a button); C – Fetal movements; D – Uterine contractions



Schematic explanation of cardiotocography: heart rate (A) is calculated from fetal heart sounds determined by ultrasound, and uterine contractions are measured by a pressure transducer (B). These numbers are represented on a time scale with the help of a running piece of paper, producing a graphical representation.

It is about determining the **basal rate**, it is a stable heart rate during a period of 5-10 minutes, from which medium- and short-term phenomena deviate.

Normal basal rate(**normocardia**) is 110-150/min. Mild tachycardia is a rate of 150-170/min, severe is over 170/min. At a frequency above 180/min, this is almost clear hypoxemia. Mild bradycardia is a basal rate of 100-110/min, severe bradycardia is below 100/min and sometimes a very heavy rate below 90/min is distinguished, which - if it cannot be reversed otherwise - is an indication for acute or peracute termination of pregnancy.

Medium-term phenomena

We distinguish accelerations and decelerations. **Accelerations** are transient increases in frequency of 15/min from basal rate lasting longer than 15 s. **Sporadic accelerations** are a natural fetal catecholamine response to movements or to acoustic or mechanical stimuli. **Periodic accelerations** are accelerations occurring simultaneously with at least three successive contractions. Their shape is described (round, steep,...).

Decelerations are transient decreases in fetal heart rate with an amplitude exceeding 15/min longer than 10 s. **Sporadic decelerations** (DIP 0) are not dependent on contractions, they are spiked, usually shorter than 30 s. They are usually a reaction to vagus irritation. If they are **prolonged**, it may be a decrease in uteroplacental flow as a result of aortocaval compression syndrome, large blood loss or shock. **Periodic decelerations** are dependent on uterine contractions and can be either **early** (DIP 1), **late** (DIP 2), or **variable**. Early periodic decelerations(**DIP 1**) have a peak directly opposite the peak of the uterine contraction in the tocogram. The cause may be compression of the fetal head or umbilical cord complication. If there are 1-3 of them within 20 minutes, the CTG record is evaluated as suspicious, if 4 or more, then as pathological. Late periodic decelerations(**DIP 2**) have a phase shift of 20-60 s relative to the peak of the contraction in the tocogram. They are the result of uteroplacental insufficiency and when they occur, the CTG record is clearly pathological.

Short-term phenomena

There are deviations of the fetal heart action from the basal frequency of less than 15 s. With an amplitude of 10-25/min, they are in the so-called **undulatory zone**. The amplitude of 5-10/min is a **narrowed undulatory band**, which is caused by the attenuation of the fetal circulation, mostly by fetal sleep or pharmacologically induced attenuation. An amplitude of less than 5/min is referred to as a **silent band**. It is caused by fetal hypoxia. Termination of pregnancy is indicated after exclusion of sleep and pharmacological fetal depression. Deflections with an amplitude higher than 25/min are referred to as a **saltator band**. They are mostly caused by the umbilical cord complication, which the fetus tries to compensate for. Like a **sinusoidal oscillation** refers to variable short-term phenomena with an amplitude of 5-15/min changing their amplitude in a time period longer than 20 min according to the course of the sinusoid. They are a sign of chronic fetal hypoxia often caused by anemia (Rh incompatibility,...).

Evaluation

The CTG record is evaluated by an obstetrician and can be threefold (grades 1, 2 and 3, or the letters F, S and P):

1. physiological recording (**F**),
2. suspicious record (**S**),
3. pathological record (**P**).

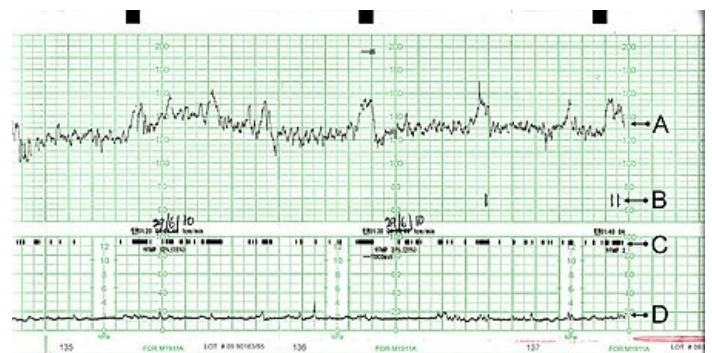
Method of monitoring

CTG is performed both before and during labor. It can be monitored either **intermittently** or **continuously**. Indications for continuous recording are: suspicious or pathological NST, meconium turbidity of amniotic fluid, prematurity, IUGR, maternal hypertension, previous cesarean delivery, epidural analgesia (due to a certain risk of maternal hypotension and subsequent fetal hypoxia), basal rate abnormality in CTG, oligohydramnios, postmaturity, suspicious CTG recording, application of oxytocin or prostaglandins, internal diseases of the mother (diabetes mellitus,...), infection, chorioamnitis, during the 2nd stage of labor ^[1].

Fetal ECG - ST analysis

Fetal ECG analysis (FEKG) or *ST-analysis*(**STAN**) ^[1] is a fetal monitoring method based on **the ability of the myocardium to respond to hypoxia**.

During hypoxia, catecholamines are flushed out, β -receptors are activated. Due to the increased metabolic demands in the myocardium, anaerobic glycogenolysis occurs, lactate is produced and hyperkalemia develops. The resulting change in the cell membrane potential of the myocardial cells is manifested as **ST depression**. Hypoxemia, combined with additional stress, causes a further flush of adrenaline, increasing contractile activity that requires further glycogenolysis, which is manifested by an **increase in the T wave**. During



A typical CTG output for a woman not in labour. A: Fetal heartbeat
B: Indicator showing movements felt by mother (caused by pressing a button) C: Fetal movement D: Uterine contractions

- KREJČÍ, Vratislav. *Cardiotocography, disorders of uterine activity, fetal hypoxia* [lecture for subject Gynecology and Obstetrics pre-state internship, specialization General Medicine, 1st Faculty of Medicine Charles University in Prague]. Prague. 17.2.2013.

Recommended literature

- MĚCHUROVÁ, Alena. *Cardiotocography : minimum for practice*. 1. edition. Prague : Maxdorf, 2012. 183 pp. ISBN 978-80-7345-274-2.