

## Neonatal outcome in the CTG+ST group

|  |    |
|--|----|
| Perinatal deaths .....                       | 2  |
| LDG 245.....                                 | 2  |
| MAE 473 .....                                | 4  |
| Cases with metabolic acidosis.....           | 7  |
| OEB 282b.....                                | 7  |
| OEH 330.....                                 | 11 |
| OEB 239.....                                 | 13 |
| MAD 494.....                                 | 15 |
| MAE 251 .....                                | 17 |
| Cases with mild neonatal encephalopathy..... | 19 |
| MAA 293.....                                 | 19 |
| MAC 0003.....                                | 21 |
| MAC 0433.....                                | 24 |

## Perinatal deaths

### LDG 245

Date of delivery; 

#### Clinical data

Para 0, Uneventful pregnancy

spontaneous onset after 40 weeks of gestation

Meconium stained liquor

Maternal fever, 39.3°C treated with i.v. antibiotics.

Delivery by emergency CS for threatening asphyxia after 21 hrs rupture of membranes:  
at 02:46

#### Neonatal data

Female

Apgar 0-0-0

Cord artery: pH 6.68  
PCO<sub>2</sub> 7.17 kPa  
BDecf 27.1 mmol/l

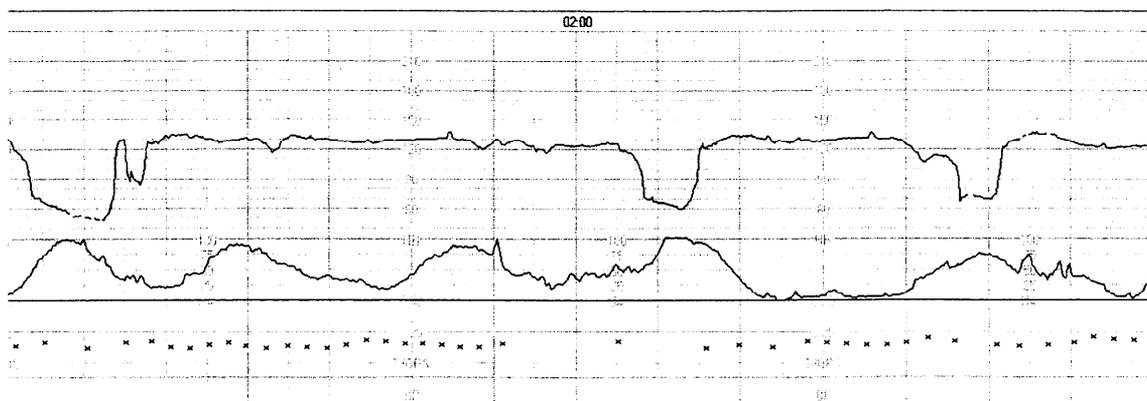
Cord vein: pH 6.95  
PCO<sub>2</sub> 5.37 kPa  
BDecf 20.7 mmol/l

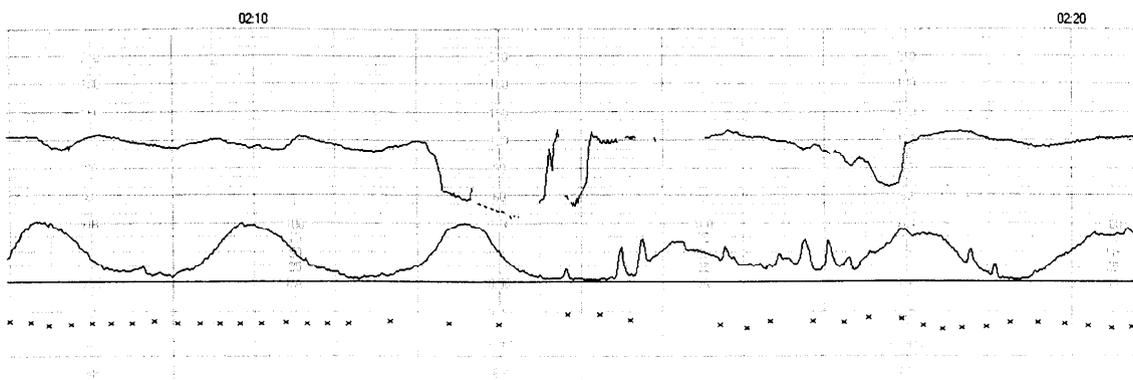
#### Neonatal outcome

A post mortem showed chorioamnionitis, no microorganisms cultured.

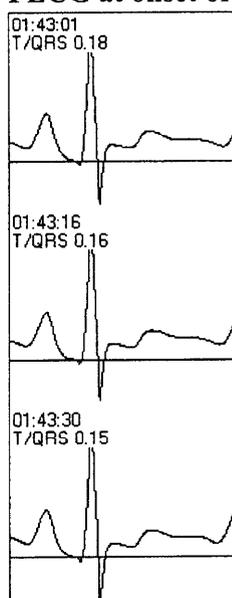
#### Assessment of the recording

Recording started 01:40 and contains 44 min, data showing a FHR with baseline of 120-130 bpm. No signs of reactivity or short term variability. No indications of ST events.

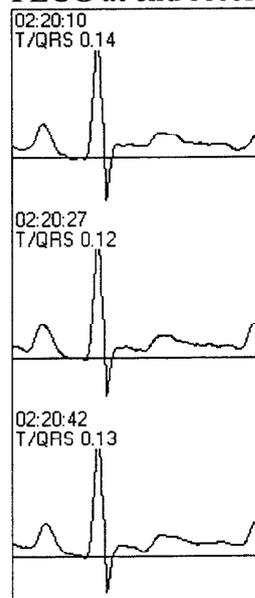




### FECG at onset of recording



### FECG at end recording



### Comments

Perinatal death associated with signs of infection with maternal fever in labour and chorioamnionitis. The CTG shows a preterminal FHR trace with lack of reactivity and variability.

On detailed analysis, the ST waveforms show a negative ST slope but an increase in T wave amplitude. Such a pattern could indicate that the myocardium had been exposed to a combination of infection and hypoxia. It appears as if the fetal ECG monitoring started late and that most resources had already been utilised. According to CTG+ST clinical guidelines intervention was required on the basis of the CTG pattern alone.

**MAE 473**Date of delivery; **Clinical data**

Para 0 with myoma uteri.  
 spontaneous onset of labour after 40 weeks of gestation  
 Clear liquor  
 Onset of active pushing: 2 at 18:50  
 Outlet ventouse at 19:44

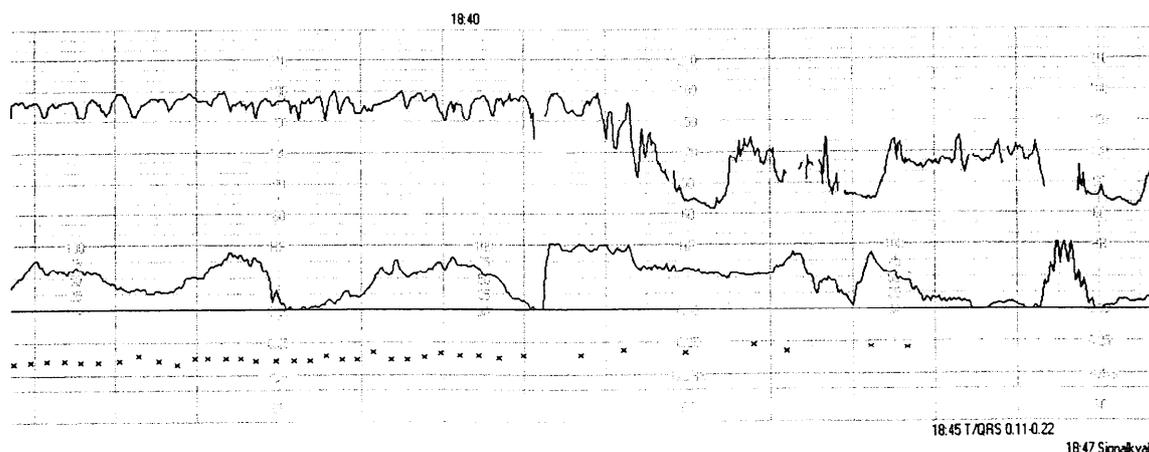
**Neonatal data**

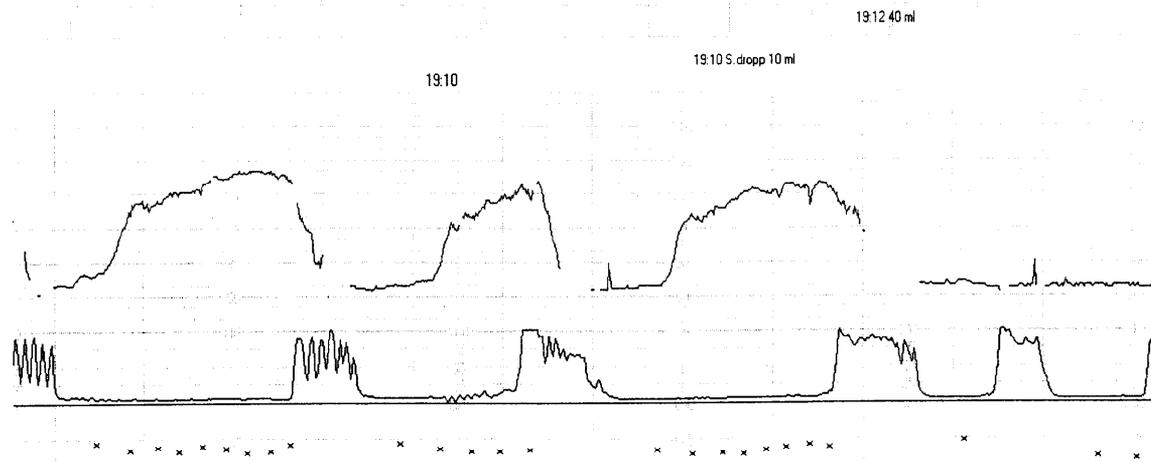
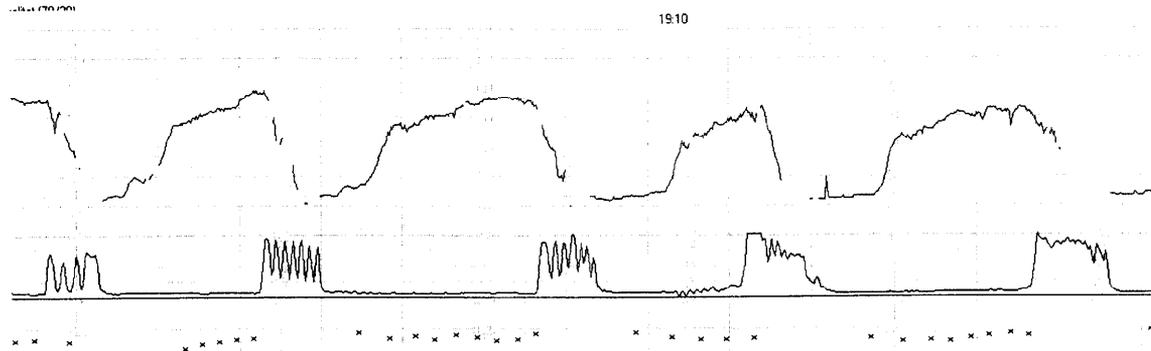
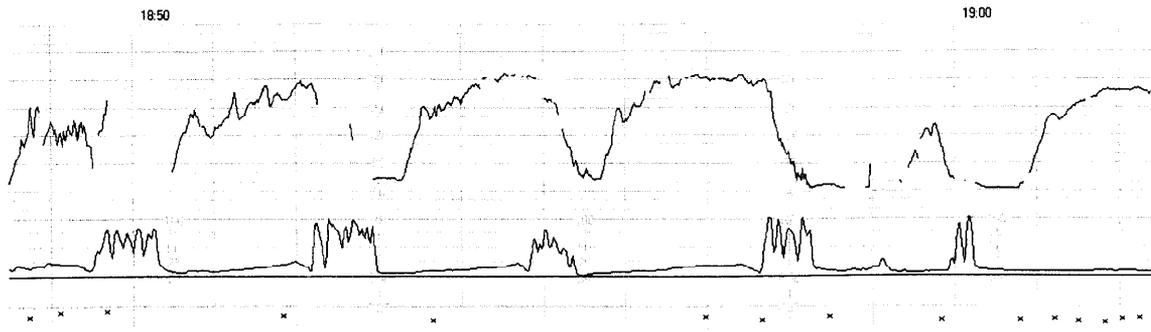
Male 3500 g  
 Apgar 0-0-0  
 Cord artery pH 6.82  
 PCO<sub>2</sub> 14.59 kPa  
 BDecf 14.5 mmol/l  
  
 Cord vein pH 7.14  
 PCO<sub>2</sub> 5.84 kPa  
 BDecf 12.4 mmol/l

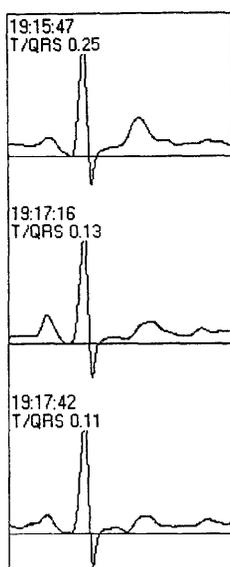
**Assessment of the recording**

Recording obtained at onset of active pushing showing a rise in T/QRS from 0.11 to 0.22. The ST log was not activated thereafter due to low signal quality with <50% of the ECG complexes found to be of sufficient quality.

Normal delivery until 18:40 when the fetus reacted with an increase in baseline FHR from 150 to 170 bpm followed by variable decelerations. At this point in time signal quality deteriorated somewhat, limiting the possibility to automatically assess ST events. The ST log identified an episodic T/QRS rise at 18:45, coinciding with the initial decelerations. This T/QRS rise became more persistent from 19:06 onwards. The bradycardia was associated with a change in the configuration of the ST with a negative slope emerging. Unfortunately, the scalp clip was disconnected at 19:20 as the vacuum extractor was applied. According to the staff, the externally recorded CTG showed a fetal heart rate of 120-160 bpm during the 23 minutes required to deliver the baby.







### Comments

Parallel changes in CTG+ST with onset of active pushing in labour. According to the CTG + ST guidelines, intervention should have been done soon after 18:45 h. The reason why the staff did not intervene during the following long period of severe pathological CTG is unknown, and the indication for the ventouse (failure to progress) is difficult to understand. The progression of ST events recorded, with ST segment showing a negative slope, with the onset of the final bradycardia indicates a myocardium exposed to very marked and persistent hypoxia. Although, the ST log has been designed only to operate when there is sufficient signal quality and ST information, this should not prevent intervention according to guidelines as visual analysis would then have to take place. The duration between onset of abrupt bradycardia most likely due to cord compression and delivery was 29 minutes. Acute hypoxia from cord compression seems to be the most likely course of intrapartum death.

## Cases with metabolic acidosis

### OEB 282b

Date of delivery; 

#### Clinical data

Para 0, 40 weeks of gestation, Normal pregnancy

Spontaneous onset of labour.

Meconium stained liquor.

FBS  at 01:55; pH 7.30 and at 02:56; pH 7.34

Active pushing started 04:50

Mid cavity ventouse at 06:01 for FTP.

#### Neonatal data

Female 3770 g

Apgar 1-3-6

Cord artery: pH 7.03  
PCO<sub>2</sub> 6.17 kPa  
BDecf 16.5 mmol/l

Cord vein: pH 7.04  
PCO<sub>2</sub> 6.38 kPa  
BDecf 15.7 mmol/l  
note same vessel – most likely cord vein.

#### Neonatal outcome

Initial resuscitation with face mask, extra O<sub>2</sub>, CPAP, cord artery catheter + buffer 30 ml.

Acid-base at 55 min of age: pH 7.04  
PCO<sub>2</sub> 3.12 kPa  
BDecf 21.5 mmol/  
Lactate 14.9 mmol/l  
Glucose 10.4 mmol/l

At 6 hrs age deteriorating respiratory functions – meconium aspiration - on ventilator + surfactant treatment.

Normal neurology Day 1

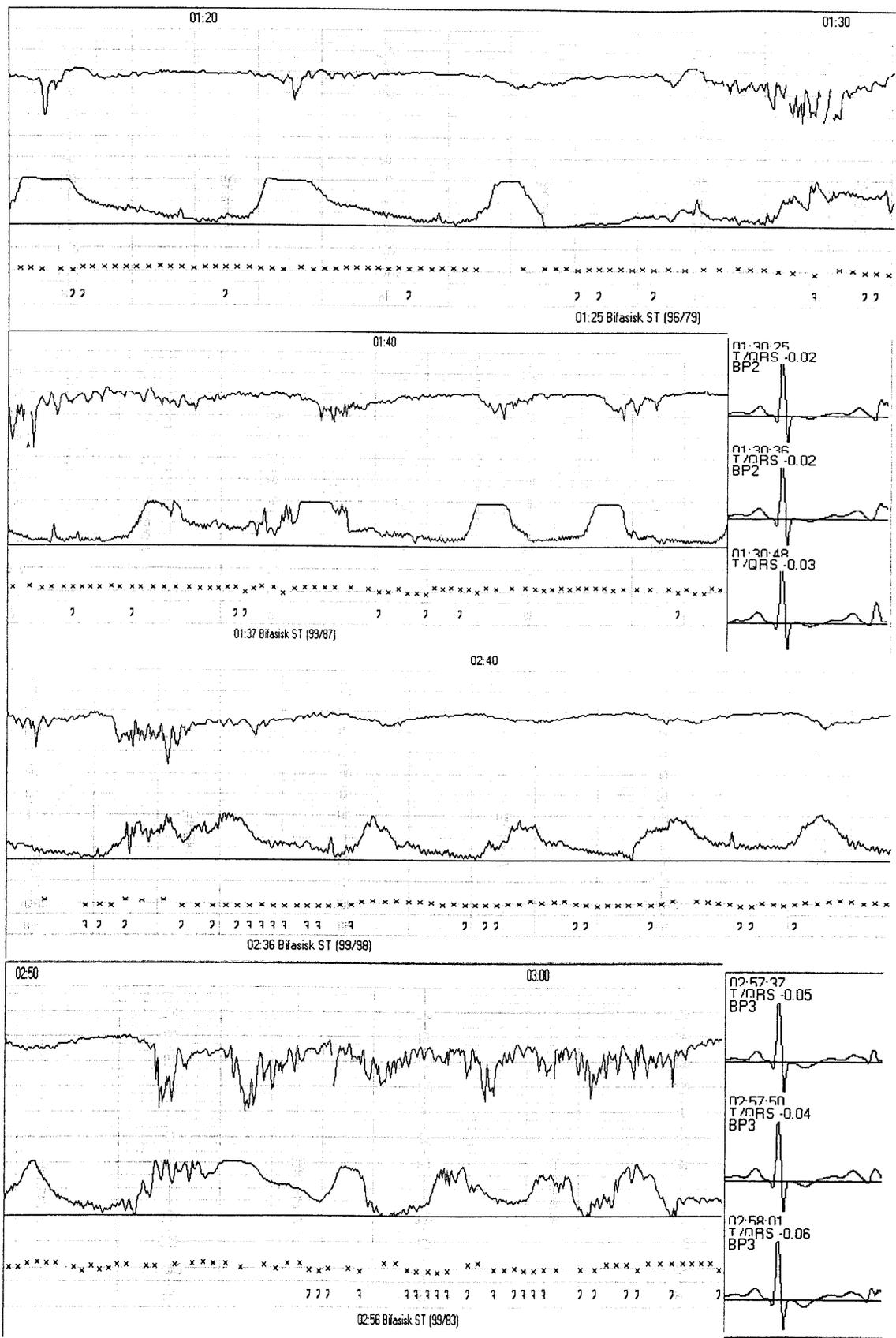
Day 3 improving, off ventilator after 3 days

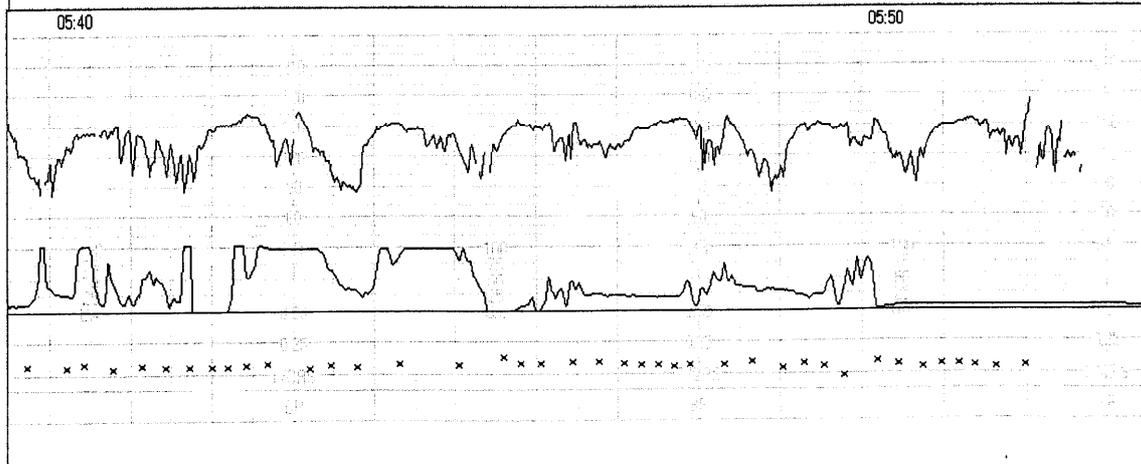
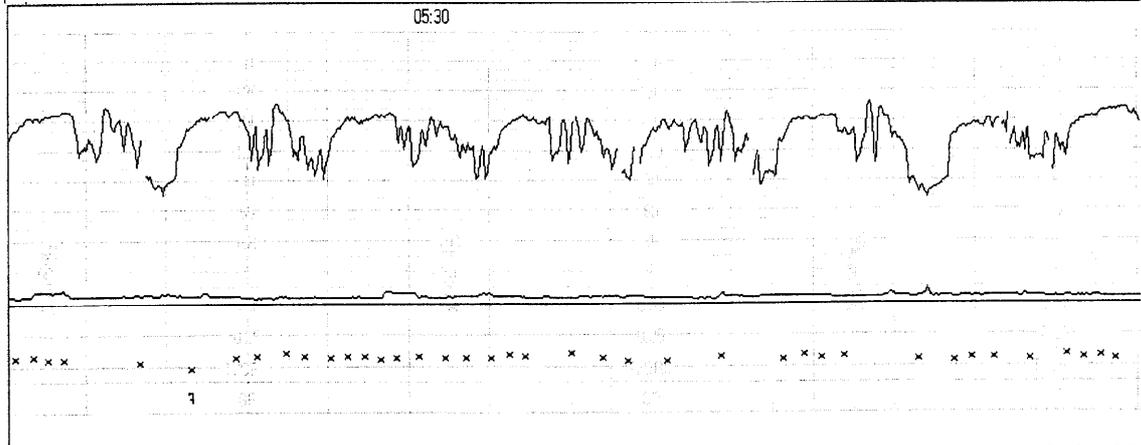
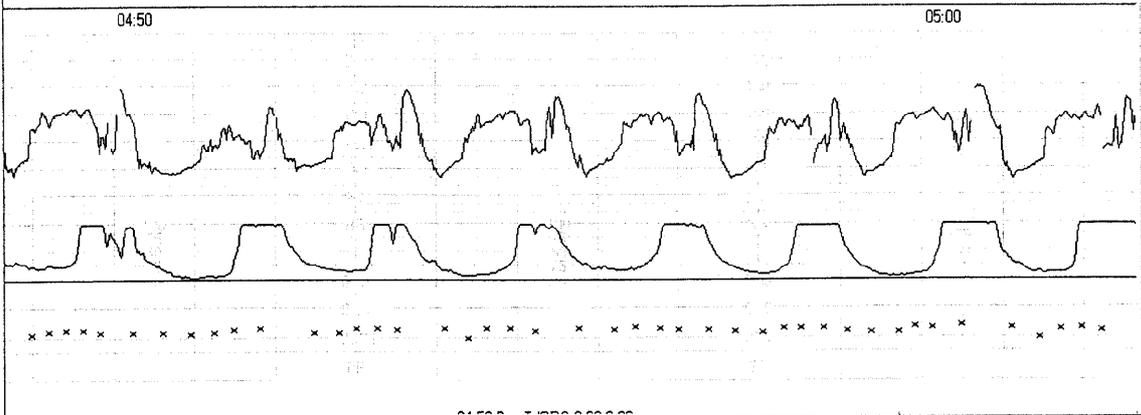
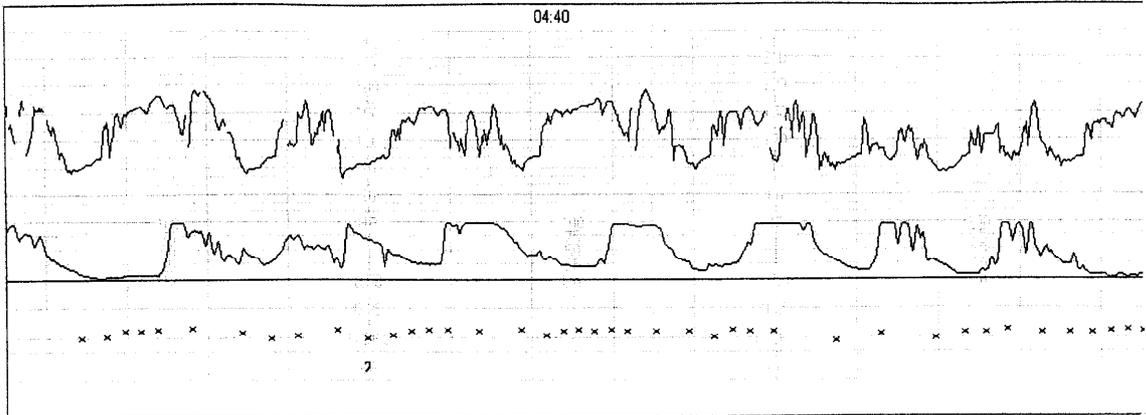
Normal neurology

Check-up 17 month of age: Everything normal.

#### Assessment of the recording

Good quality recording. Normal CTG+ST until 00:30 when baseline FHR increased to 180 bpm, from 00:50 shallow decelerations and at 01:25 first biphasic ST. This pattern continues with tachycardia, contraction induced decelerations and biphasic ST. From 04:30 marked late decelerations. At 04:40, a baseline T/QRS rise of 0.08 was noted. The recording finished at 05:52.





**Comments**

A case showing predominantly tachycardia and biphasic ST waveforms during first stage of labour. According to CTG+ST guidelines this should have been a cause of intervention. The pattern would indicate a myocardium affected by long standing factors having a negative influence on myocardial function such as hypoxia, infection or other. Two fetal blood samples at 01:55 and 02:56 showed normal scalp pH. As labour progressed into active pushing the ST log showed a baseline rise of the T/QRS ratio indicating an alarm reaction with a switch to anaerobic metabolism. This was verified from metabolic acidosis at birth with a high lactate and glucose, the latter, a sign of liver glycogenolysis.

Although a mid cavity ventouse for failure to progress took place, there was ample fetal ECG information to indicate that the fetus was affected for hours. The case illustrates the complexity adding FBS information, a blood based parameter when CTG+ST indicates abnormal reactions. According to CTG+ST guidelines, intervention should not indicate FBS. This is a case recorded during the initial part of study where the CTG+ST guidelines were not followed.

**OEH 330**Date of delivery; **Clinical data**

Para 0, 40 weeks of gestation.

Normal pregnancy, spontaneous onset of labour, clear liquor.

FBS at 10:16, pH 7.37.

Active pushing commenced at 11:15.

Mid cavity forceps 12:49 for threatening asphyxia.

**Neonatal data**

Female 3530 g

Apgar 6-8-8

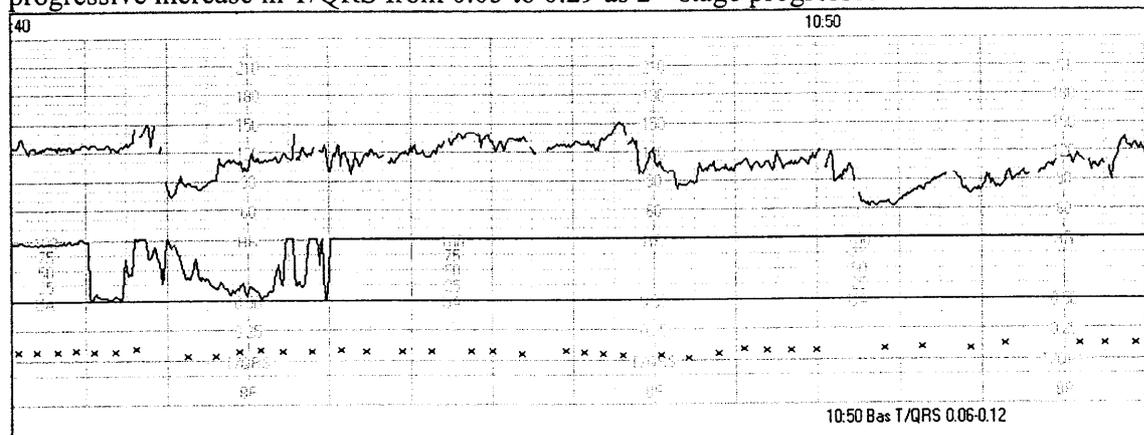
Cord artery: pH 6.88  
PCO<sub>2</sub> 11.73 kPa  
BDecf 14.9 mmol/lCord vein: pH 6.97  
PCO<sub>2</sub> 9.10 kPa  
BDecf 14.2 mmol/l**Neonatal outcome**

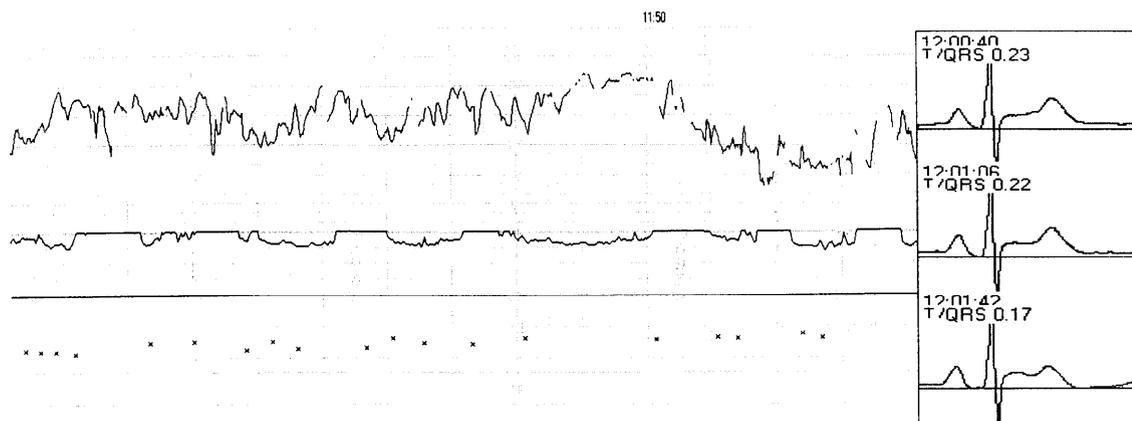
15 ml buffer was given followed by normal acid-base findings.

General observation for one day without any signs of abnormal behaviour.

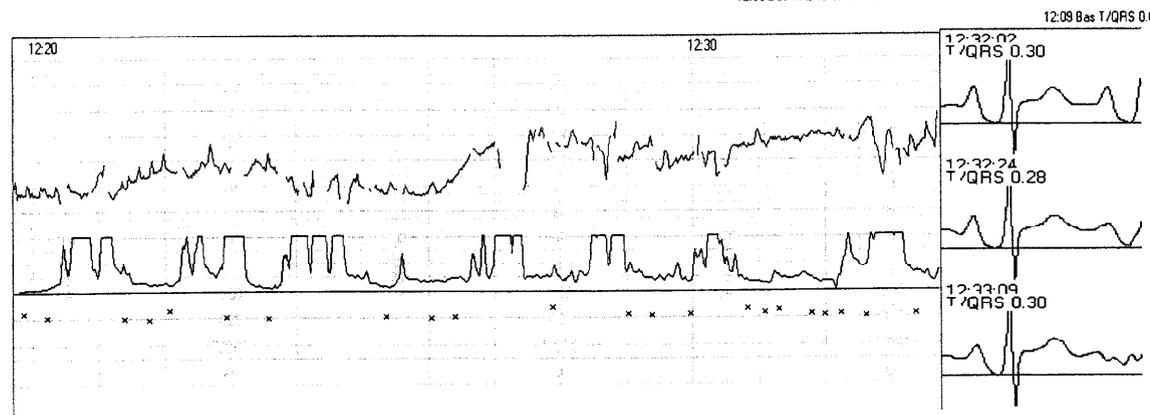
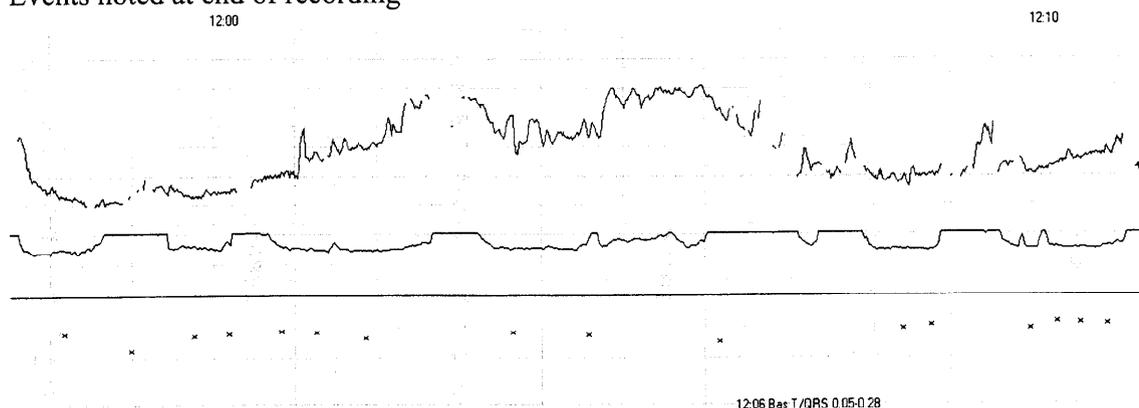
**Assessment of the recording**

Everything normal until 10:40. Bradycardia episodes with tachycardia in between, maintained short term FHR variability. First baseline T/QRS rise occurred at 10:50 followed by a progressive increase in T/QRS from 0.05 to 0.29 as 2<sup>nd</sup> stage progressed





Events noted at end of recording



**Comments**

Signs of intrapartum hypoxia with onset of 2<sup>nd</sup> stage of labour. ST events indicate a fetus responding to the stress of labour for approximately 1 hour. Cord artery and vein metabolic acidosis indicating anaerobic metabolism of some duration. Uneventful neonatal period.

CTG+ST clinical guidelines would have indicated a need for assisted delivery at 12:00. A case recorded during the initial part of study where the CTG+ST guidelines were not followed.

**OEB 239**

Date of delivery;

**Clinical data**

Para 2, pyelonephritis during pregnancy spontaneous onset of labour after 39 weeks of gestation

Clear liquor

Active pushing commenced at 10:00

Normal vaginal delivery at 10:39

**Neonatal data**

Male 3600 g

Apgar 6-8-8

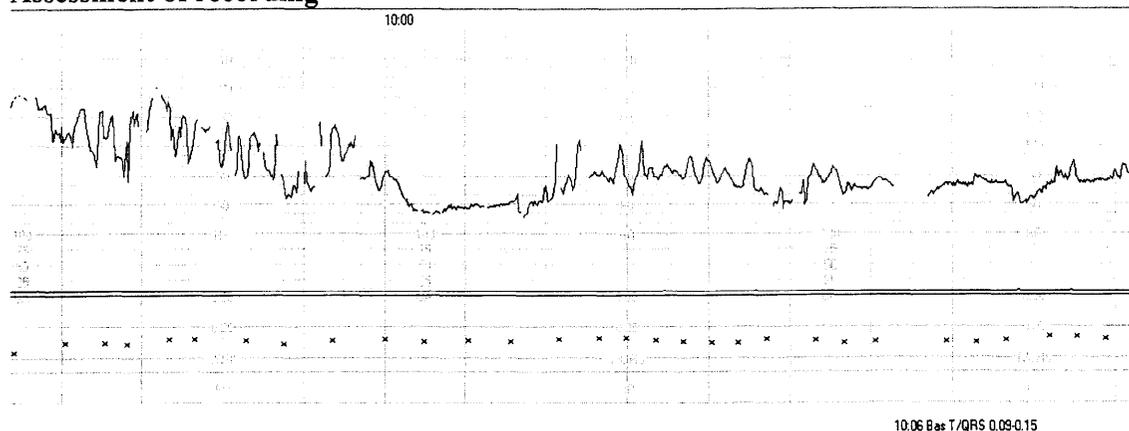
Cord artery: pH 6.87  
PCO<sub>2</sub> 12.61 kPa  
BDecf 14.3 mmol/l

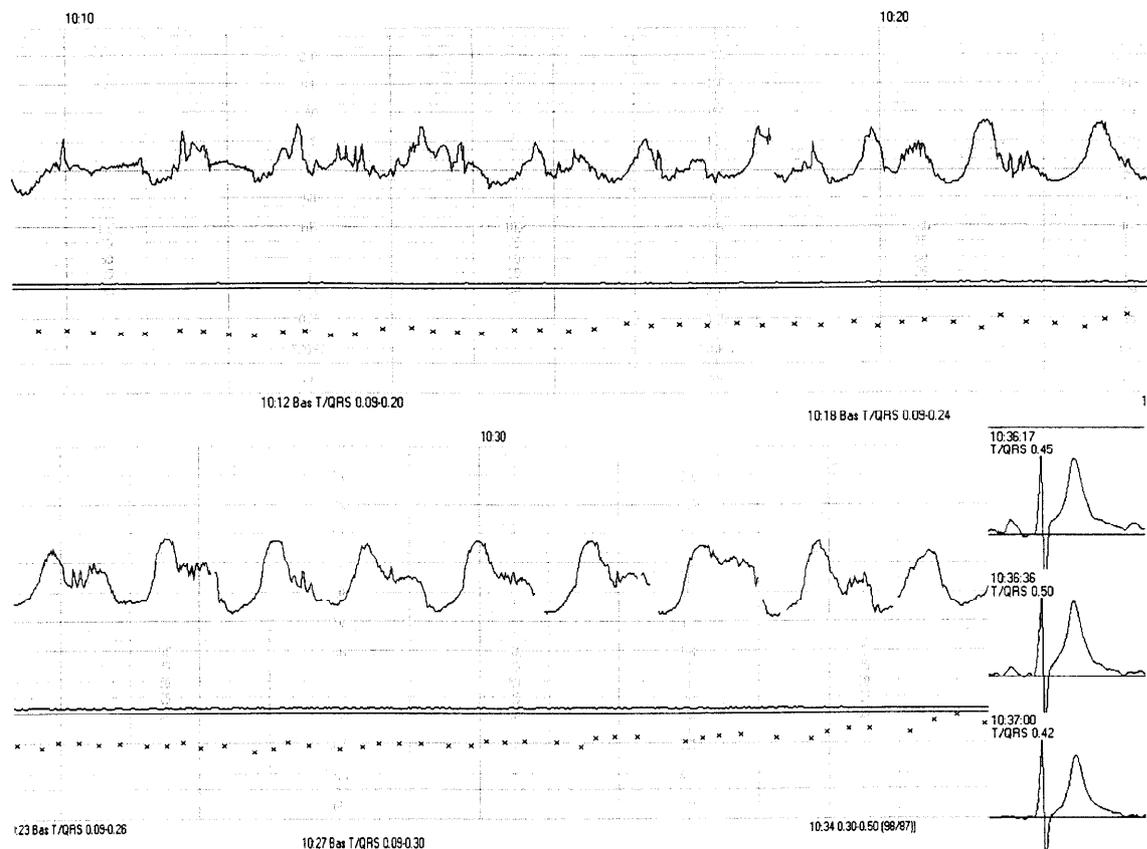
**Neonatal outcome**

Admitted to SCBU because of cyanosis, requiring 100% O<sub>2</sub>. Normal neuromuscular status.

On ultrasound, signs of cardiac malformation with transposition + VSD + coarctatio.

Operated on at 2 month of age, nothing to indicate abnormal neurology at 18 month of age.

**Assessment of recording**



Normal CTG+ST until 09:50. At this point in time with onset of active pushing, the fetus reacted with increased short term variability followed by a bradycardia and a slow recovery of baseline FHR. This event was followed by intermittent decelerations with graded loss of short-term variability. End of recording at 10:37. Note, the uterine activity sensor had been disconnected.

### Comments

CTG+ST show signs of intrapartum hypoxia emerging with onset of active pushing. Although the hypoxia lasts 40 minutes, the fetus seems to be capable of responding with a marked alarm reaction as identified by the consistent rise in T wave height, cord metabolic acidosis and adequate Apgar scores. To what extent the cardiac malformation had an influence on the cardiovascular reaction caused by the stress of labour remains subject to speculations. According to CTG+ST clinical guidelines, an assisted operative delivery should have commenced approx. 10:10.

This is a case recorded during the initial part of study where the CTG+ST guidelines were not followed.

**MAD 494**Date of delivery; **Clinical data**

Para 0, norm pregnancy, spontaneous onset of labour, clear liquor.

Onset active pushing: at 17:45

Normal vaginal delivery at 18:47

**Neonatal data**

Female 3590 g

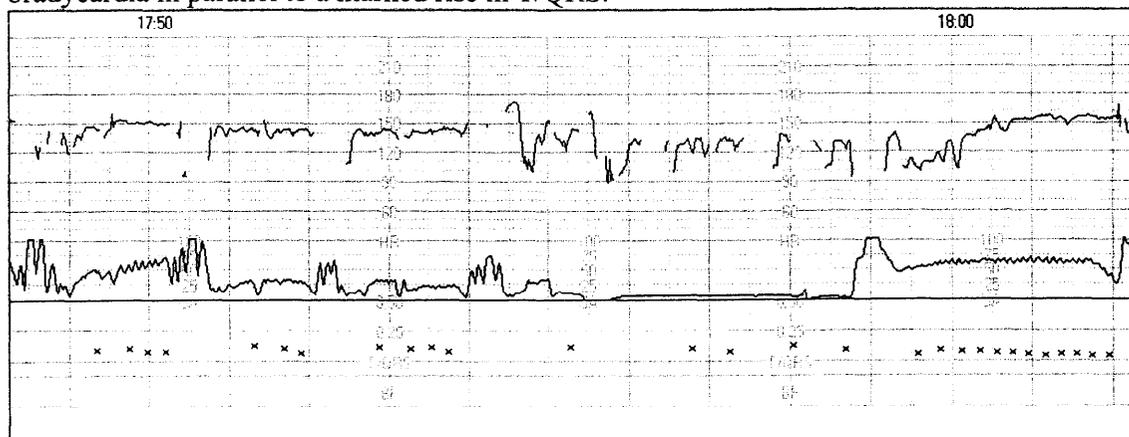
Apgar 4-9-9

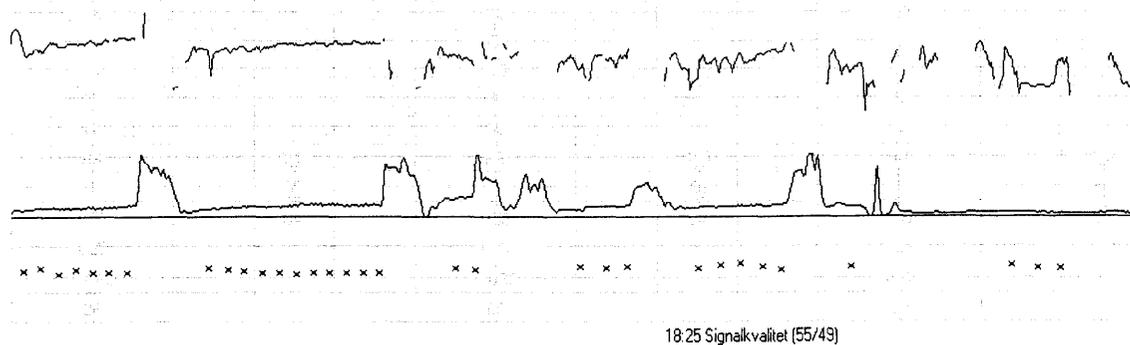
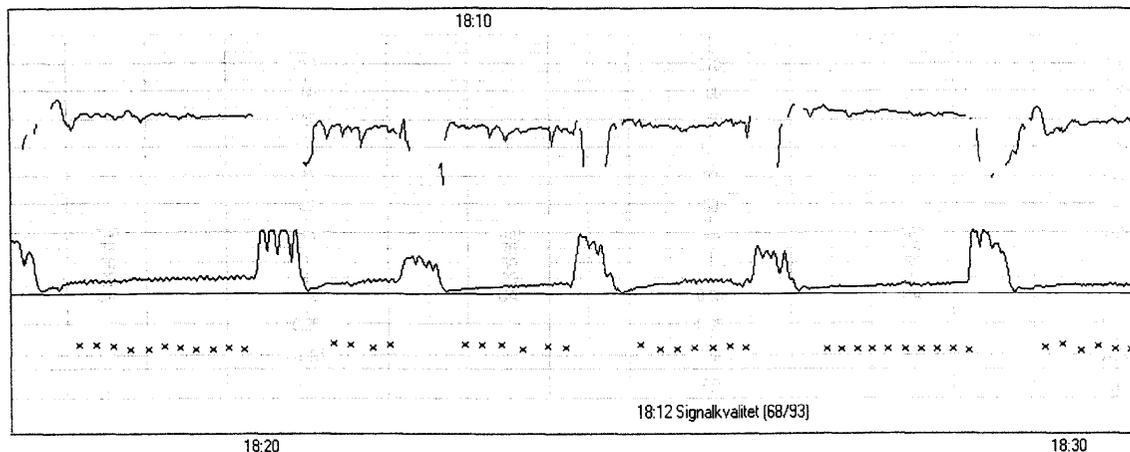
Cord artery: pH 6.98  
PCO<sub>2</sub> 9.67 kPa  
BDecf 12.8 mmol/l2<sup>nd</sup> Cord sample: pH 7.00  
PCO<sub>2</sub> 10.02 kPa  
BDecf 11.2 mmol/l**Neonatal outcome**

The baby spent the first three hours in the neonatal ward because of metabolic acidosis and administration of buffers, no clinical signs of maladaptation. On day three, tachypnea and cyanosis was noted and the diagnosis of coarctatio aorta was made.

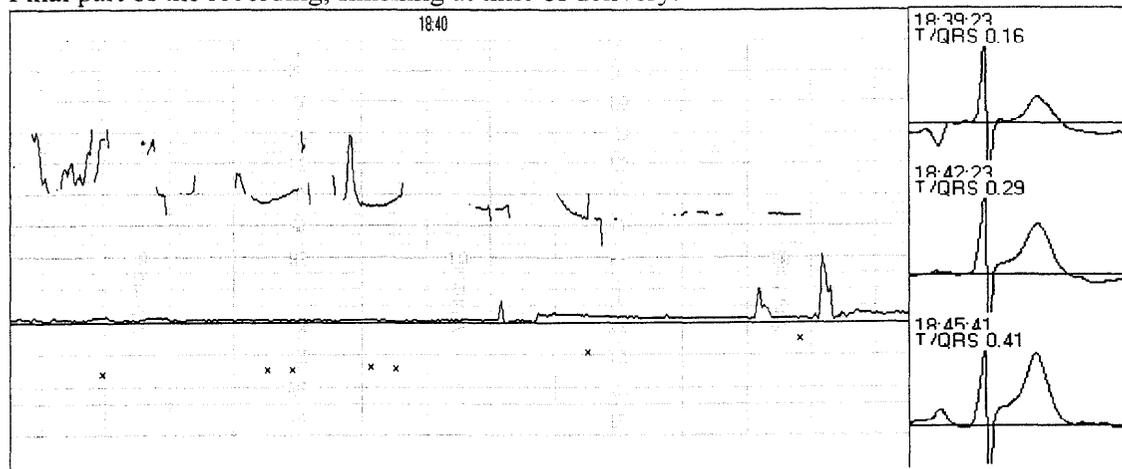
**Assessment of the recording**

Events emerging during the last 20 minutes with decelerations and end of 2<sup>nd</sup> stage, bradycardia in parallel to a marked rise in T/QRS.





Final part of the recording, finishing at time of delivery.



### Comments

CTG+ST signs of an acutely emerging hypoxia in 2<sup>nd</sup> stage of labour associated with cord artery metabolic acidosis and normal immediate neonatal adaptation.

Duration of hypoxia: approx. 10 minutes. To what extent the cardiac malformation had an influence on the cardiovascular reaction caused by the stress of labour remains subject to speculations.

**MAE 251**Date of delivery; **Clinical data**

Para 0, normal pregnancy, spontaneous onset after 38 weeks gestation  
 Clear liquor  
 32hrs of ruptured membranes and maternal fever developing during labour, treated with antibiotics.  
 Onset 2<sup>nd</sup> stage at 20:15  
 Mid cavity ventouse for threat asphyxia at 20:55

**Neonatal data**

Male 3950 g  
 Apgar 6-8-9,  
 Cord artery: pH 6.91  
 PCO<sub>2</sub> 11.13 kPa  
 BDecf 14.2 mmol/l

Cord vein: pH 7.03  
 PCO<sub>2</sub> 8.89 kPa  
 BDecf 11.6 mmol/l

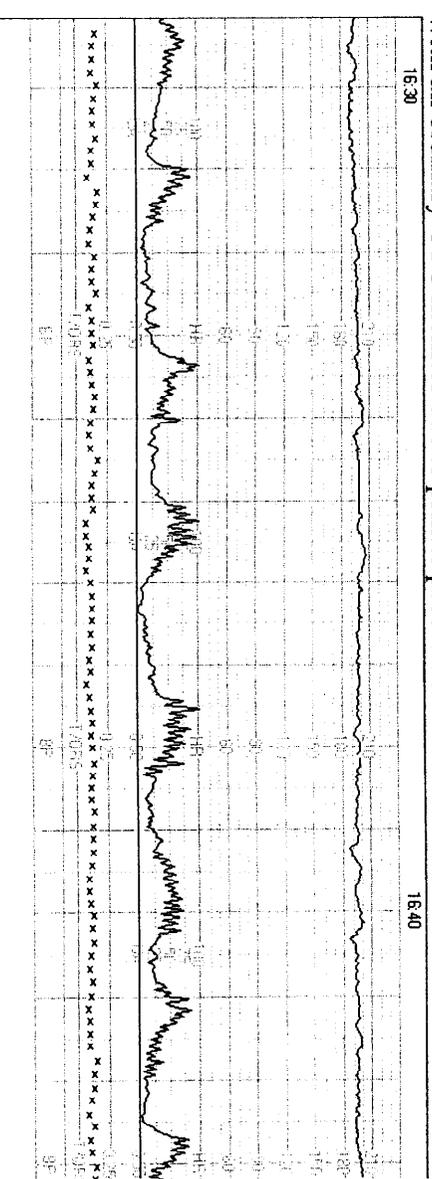
**Neonatal outcome**

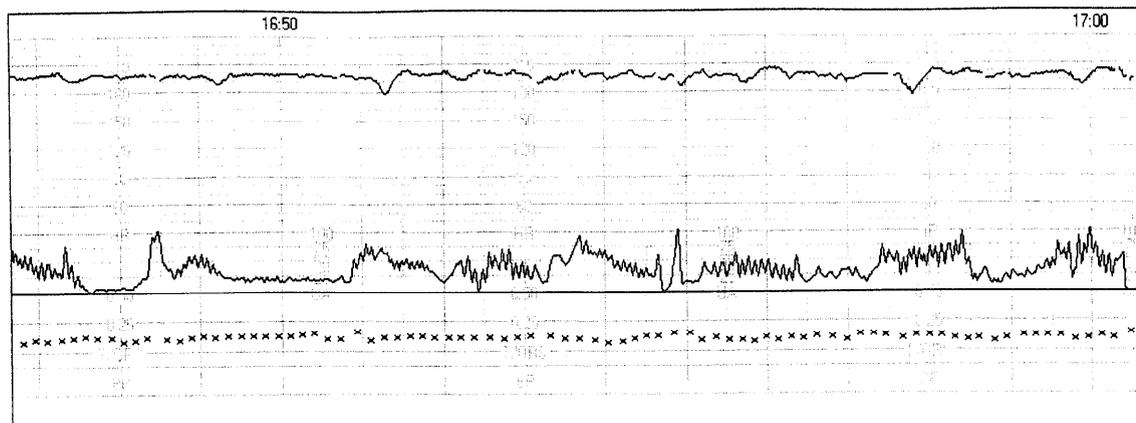
Admitted to SCBU for buffering. Negative bacterial cultures.

**Assessment of recording**

Start recording: 16:10  
 End recording: 17:00

The recording showed marked tachycardia with normal ST. The STAN monitor was replaced with an ordinary CTG monitor due to printer problems.



**Comments**

Marked tachycardia with normal ST waveforms. Obviously, impossible to know to what extent ST waveform analysis would have influenced the outcome of labour as almost four hours of labour was managed on standard CTG surveillance alone.

## Cases with mild neonatal encephalopathy

### MAA 293

Date of delivery: 

#### Clinical data

Para 1, previous CS for FTP.

Proteinuria.

Spontaneous onset of labour after 40 weeks gestation, meconium stained liquor.

Emergency CS for threatening asphyxia at 06:32

#### Neonatal data

Male 4700 g

Apgar 3-6-8

Cord artery: pH 6.91  
PCO<sub>2</sub> 13.3 kPa  
BDecf 11.2 mmol/l

Cord vein: pH 6.96  
PCO<sub>2</sub> 11.1 kPa  
BDecf 11.7 mmol/l

#### Neonatal outcome

Initial bradycardia and mask ventilation required. Initial treatment with CPAP for tachypnea. Increased CRP, treated with antibiotics. Hyper alert/jitteriness with normal neuromuscular tone. Five days in SCBU.

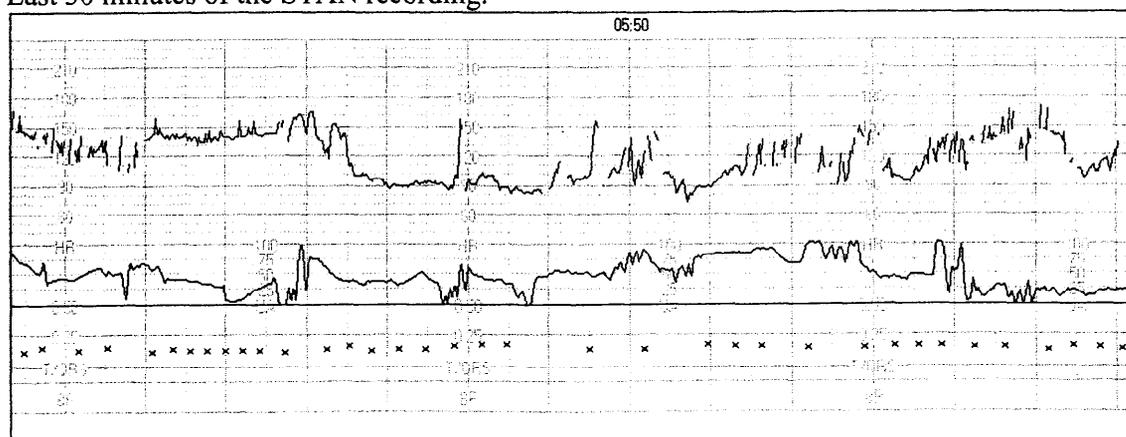
#### Assessment of the recording

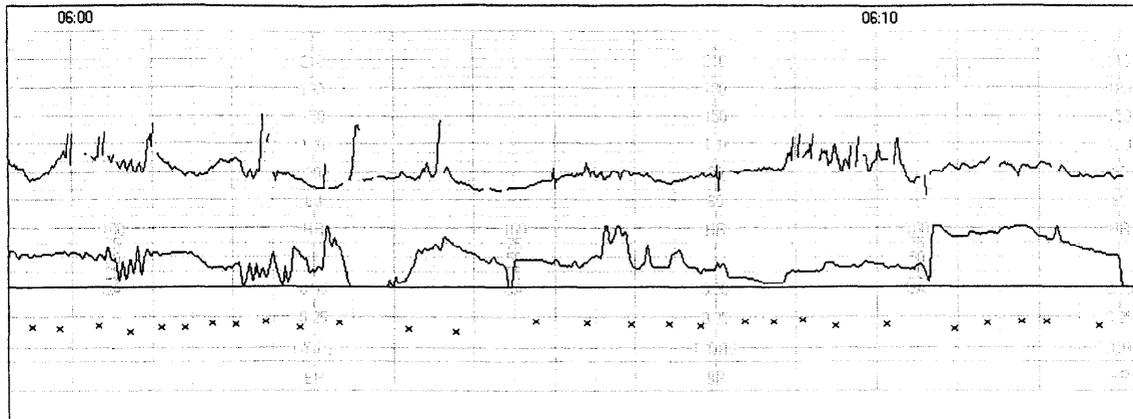
Start recording: 02:38

End recording: 06:13, i.e 19 min before delivery.

CTG+ST normal until 05:47. At this point in time decelerations occurred in parallel to a rise in baseline T/QRS from 0.15 to 0.21.

Last 30 minutes of the STAN recording.



**Comments**

Moderate hypoxia in 1<sup>st</sup> stage of labour. Parallel changes in CTG and ST waveform. The baby was moderately affected at birth with signs of pulmonary maladaptation requiring CPAP during the first hours. Biochemically, there was a rise in C-reactive protein to 60, causing antibiotic treatment. Neurological assessment showed a hyper alert baby with normal neuromuscular tone.

A case from the initial part of the trial where the protocol was not followed. There was 32 minutes from ST log statement to delivery by emergency CS.

**MAC 0003**Date of delivery; **Clinical data**

Para 0, induction after 38 weeks gestation for hypertension in pregnancy.

Clear liquor

Dihydralazin (Nepresol<sup>®</sup>) and magnesium given intravenously due to the hypertension disorder.

Three attempts were made to induce labour. The mother developed fever, was treated with antibiotics in labour and delivered by CS for failure to progress at 23:33 after 33 hours of rupture of membranes.

FBS at 19:48, pH 7.40

**Neonatal data**

Female 3380 g

Apgar 1-7-8

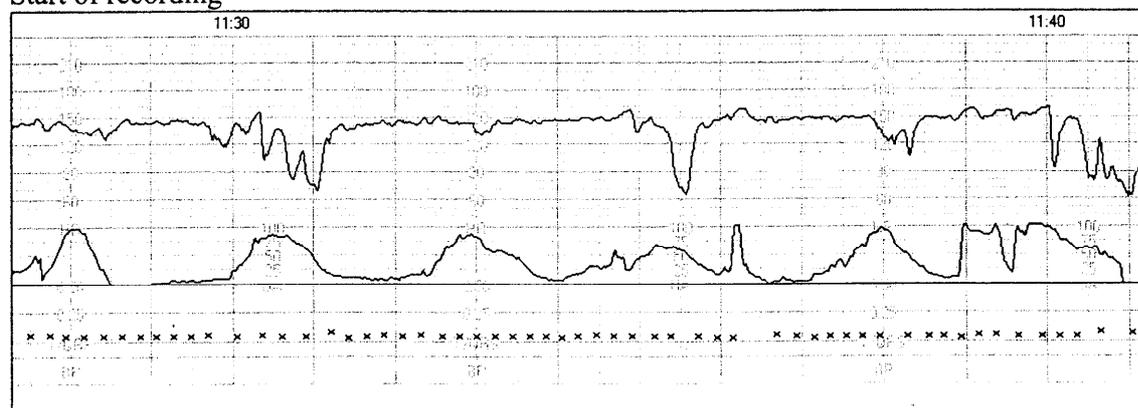
Cord vein: pH 7.40  
BDecf 3.5 mmol/l**Neonatal outcome**

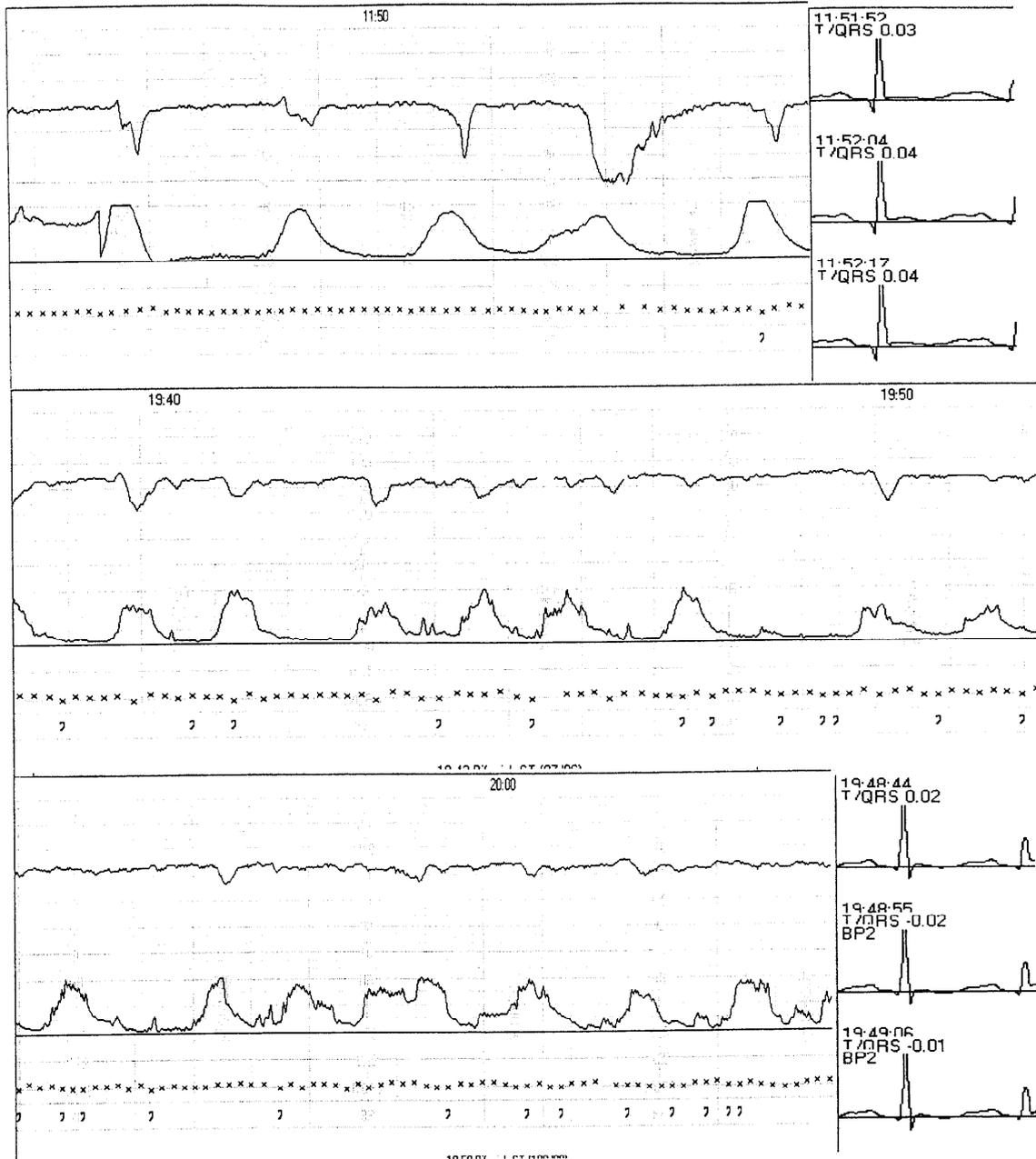
Assisted ventilation by mask for 5-6 min. Hyperexcitability during the initial two days. Lowest blood glucose 2.2 mmol/l. Enterococci in blood culture treated by antibiotics, negative CRP. Home after 5 days in SCBU.

**Assessment of the recording**

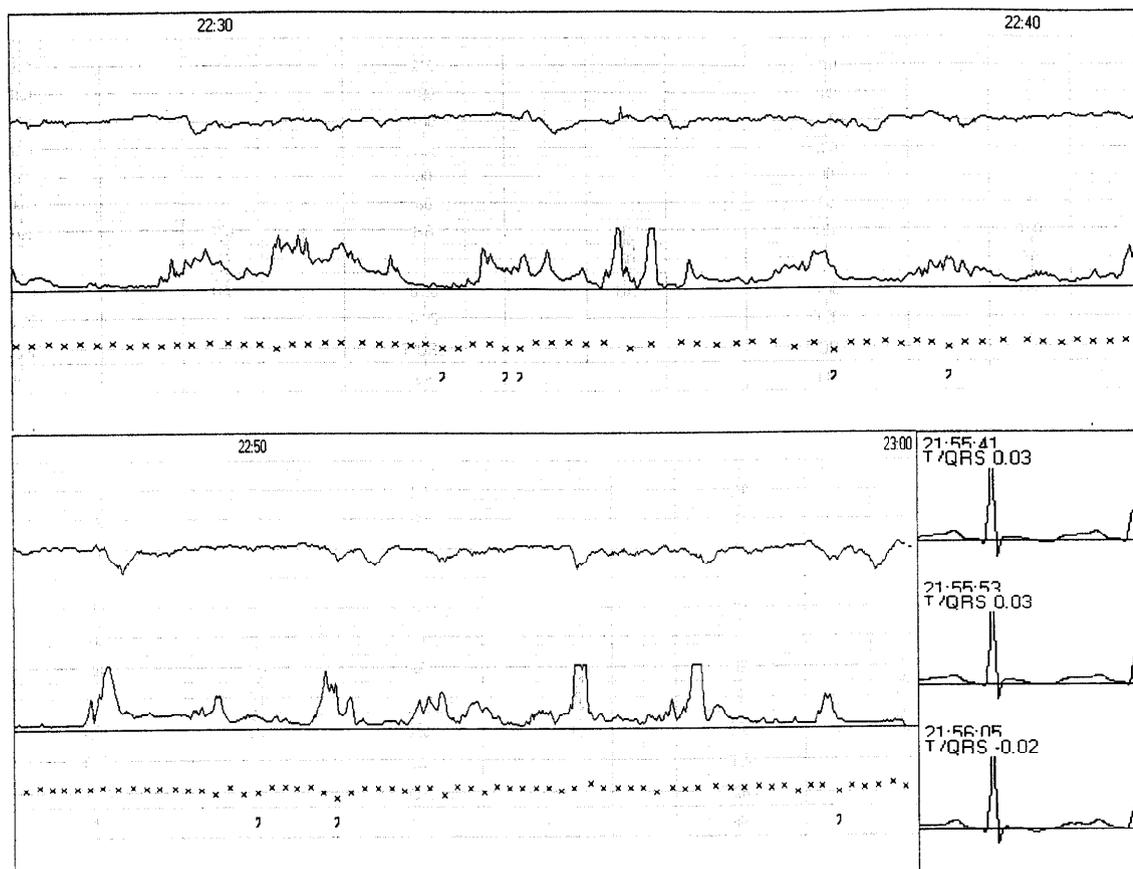
The recording started 11:20 and finished 23:00, i.e. 33 minutes before delivery.

CTG shows gradually increasing baseline FHR to 160 bpm with reduced short-term variability at approximately 19.00. FBS obtained when the first ST log statement of biphasic ST was given. The CTG and ST pattern continued throughout the recording.

**Start of recording**



End recording



### Comments

A case of prolonged rupture of membranes with maternal fever and antibiotic treatment. The CTG+ST showed tachycardia and biphasic ST developing as the fetus became affected by the infection/maternal fever. Note the appearance of ST segment changes as labour progressed. According to CTG+ST guidelines intervention should have been considered at approx. 22:00 without additional scalp-pH information. The normal cord vein acid base would preclude a long-lasting hypoxia. A case recorded during the initial part of study where the CTG+ST guidelines were not followed.

**MAC 0433**Date of delivery; **Clinical data**

Para 0, normal pregnancy, spontaneous onset of labour after 41 weeks gestation, clear liquor  
 Mid cavity ventouse for FTP, noted to be very difficult.  
 Dystocia, head and shoulders fixed during three contractions. The baby delivered at 18:58

**Neonatal data**

Female

Apgar 3-8-9

Cord artery: pH 7.10  
 PCO<sub>2</sub> 7.61 kPa  
 BDecf 10.5 mmol/l

Cord vein: pH 7.14  
 BDecf 10.0 mmol/l

**Neonatal outcome**

Ventilation by mask during the first minutes, at 5 min a sudden drop in neuromuscular tone, pale with grunting at the same time as the head circumference increased – according to the attending midwife. Drop in Haemoglobin concentration from 157 to 120 g/l during the first four hours. The baby required CPAP treatment for respiratory distress for 12 hours and a blood transfusion was undertaken. Normal Computed Tomography of the brain at seven days of age, subgaleal haematoma on ultrasound.

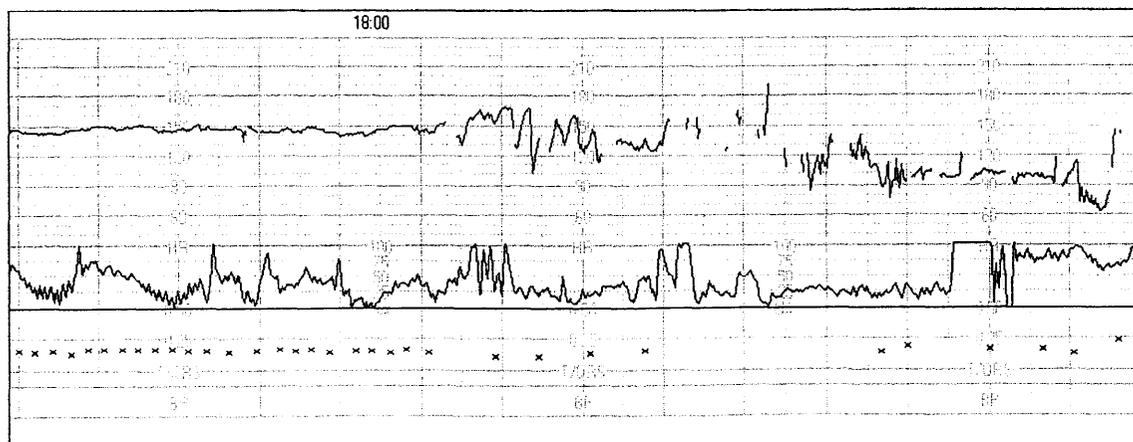
Hyperexcitability causing the diagnosis of mild neonatal encephalopathy most likely due to pain caused by the subgaleal haematoma associated with the mid cavity ventouse delivery. Discharged after 9 days.

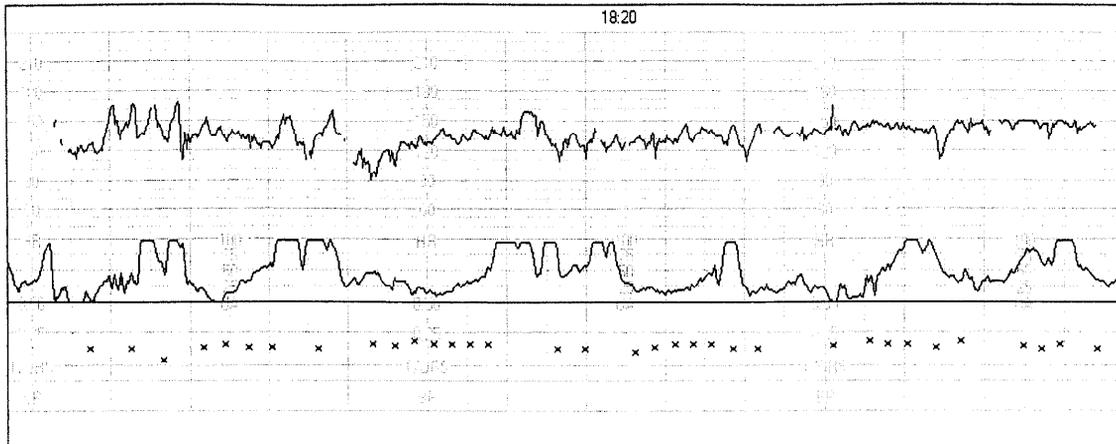
**Assessment of the recording**

Normal CTG+ST.

Start recording 07:32

End recording 18:28, i.e &gt;20 min to delivery.



**Comments**

No signs of intrapartum hypoxia. Neonatal symptoms associated with complicated mid cavity ventouse with the baby fixed during three contractions. Most likely the baby was affected by a large subgaleal haematoma causing pain.



## **Cases of metabolic acidosis in CTG group not requiring special neonatal care**

### **ST information revealed**

#### **Cases**

|               |    |
|---------------|----|
| LDB 250.....  | 2  |
| LDC 369.....  | 3  |
| LDD 297 ..... | 5  |
| LDE 272.....  | 6  |
| LDF 308 ..... | 8  |
| LDH 328 ..... | 10 |
| MAA 457 ..... | 12 |
| MAC 534 ..... | 14 |
| MAD 344 ..... | 16 |
| MAD 360 ..... | 18 |
| MAD 397 ..... | 19 |
| MAE 271.....  | 21 |
| MAE 340.....  | 24 |
| MAE 444.....  | 25 |
| MAE 491.....  | 27 |
| MAF 237 ..... | 29 |
| MAF 244.....  | 31 |
| OEF 241b..... | 32 |
| OEH 267 ..... | 34 |
| OEI 327.....  | 36 |
| OEK 384 ..... | 38 |

## **LDB 250**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour 41 weeks of gestation  
Meconium stained liquor, Epidural . Augmented labor.

Normal vaginal delivery at 01:15

### **Neonatal data**

Female: 3735 g

Apgar: 8-9-9

|              |                           |
|--------------|---------------------------|
| Cord artery: | pH 6.98                   |
|              | PCO <sub>2</sub> 10.1 kPa |
|              | BDecf 12.2 mmol/l         |
| Cord vein:   | pH 7.25                   |
|              | PCO <sub>2</sub> 4.59 kPa |
|              | BDecf 10.5 mmol/l         |

### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

No data stored.

### **Comments**

Adequate cord acid base data indicating slight metabolic acidosis in a vigorous newborn

## **LDC 369**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Meconium, epidural.

Active pushing commenced at 09:15

NVD at 09:27

### **Neonatal data**

Female: 3590 g

Apgar: 7-9-10

Cord artery:     pH 7.00  
                  PCO<sub>2</sub> 9.32 kPa  
                  BDecf 12.4 mmol/l

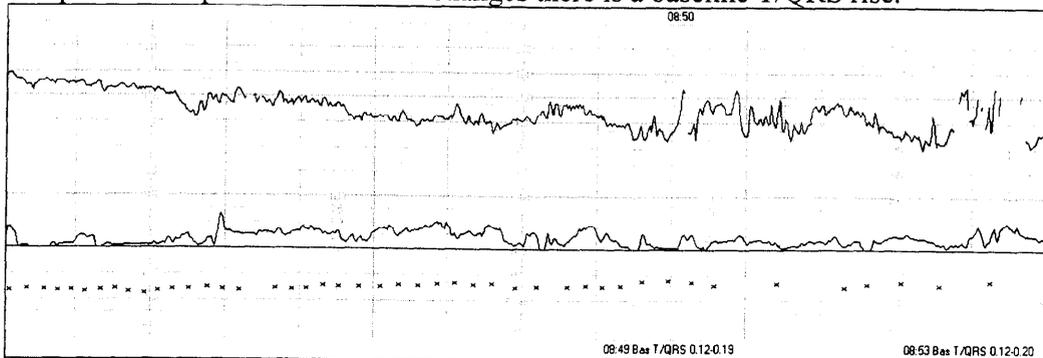
Cord vein:       pH 7.14  
                  PCO<sub>2</sub> 6.96 kPa  
                  BDecf 9.8 mmol/l

### **Neonatal outcome**

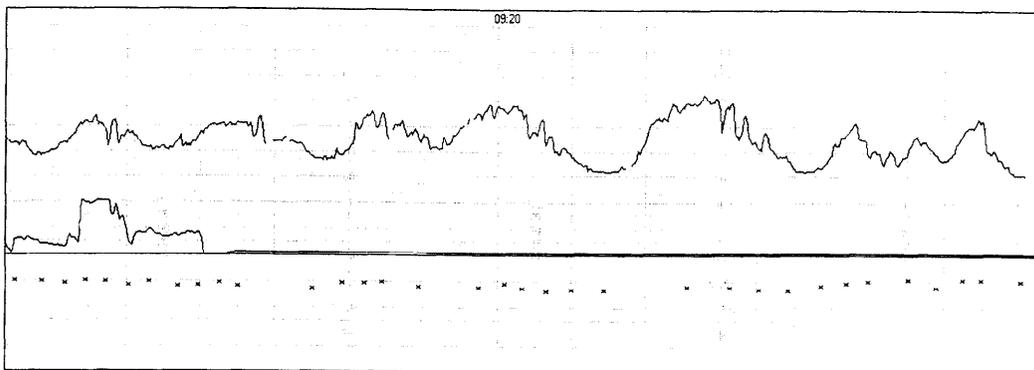
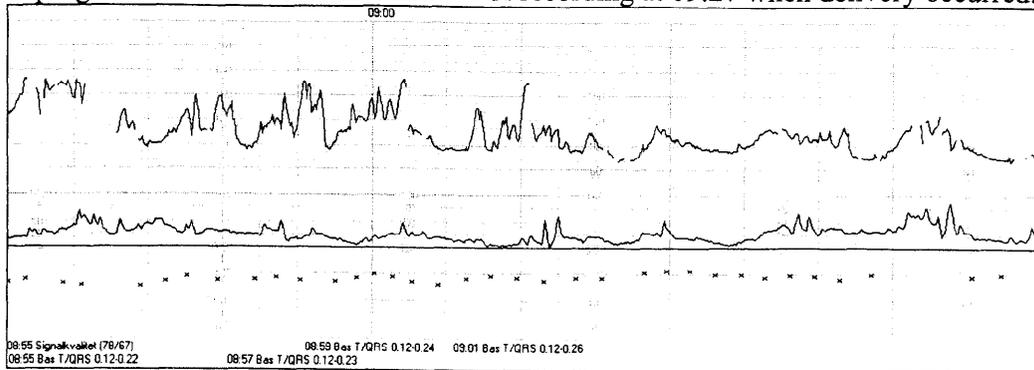
Normal neonatal outcome.

### **Assessment of recording**

Normal FHR pattern until end of 1<sup>st</sup> stage when a variable deceleration is followed by tachycardia. Thereafter the FHR pattern show repeated variable decel, some complicated. In parallel to the FHR changes there is a baseline T/QRS rise.



A progressive ST rise is noted until end of recording at 09:27 when delivery occurred.



### Comments

Hypoxia developing during 2<sup>nd</sup> stage of labor (adequately recorded cord acid-base data). CTG+ST guidelines indicated a need for delivery at 08:53.

## **LDD 297**

### **Clinical data**

Para 2. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Clear liquor, augmented labor.  
Scalp pH 7.27 at 04:00  
Active pushing commenced at 04:45  
Mid cavity vacuum for fetal distress at 04:55

### **Neonatal data**

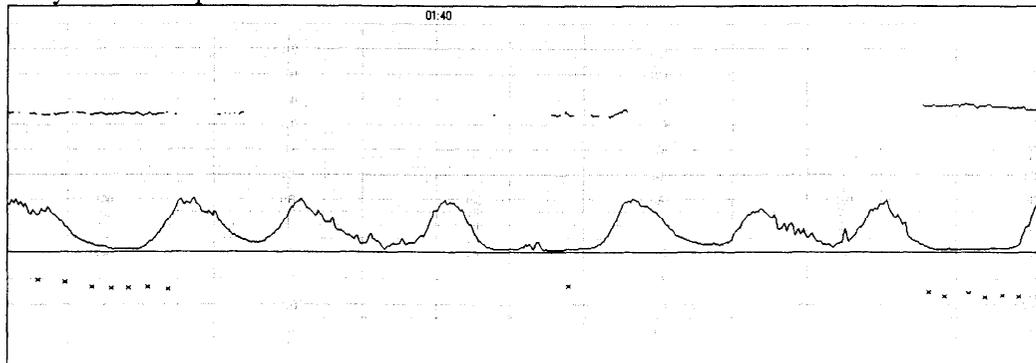
Female: 2800 g  
Apgar: 6-7-8  
Cord artery: pH 7.04  
PCO<sub>2</sub> 4.67 kPa  
BDecf 18.8 mmol/l  
Cord vein: pH 7.12  
PCO<sub>2</sub> 1.98 kPa  
BDecf 21.8 mmol/l

### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

Only a short sequence available on the STAN monitor. Disconnected at 01:48.



Fetal surveillance by standard CTG technology thereafter.

### **Comments**

A case of inadequately recorded cord acid-base with low PCO<sub>2</sub> readings causing falsely high BDecf.

## LDE 272

### Clinical data

Para 0. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Clear liquor  
Active pushing commenced at 01:00  
Outlet vacuum for failure to progress at 01:26

### Neonatal data

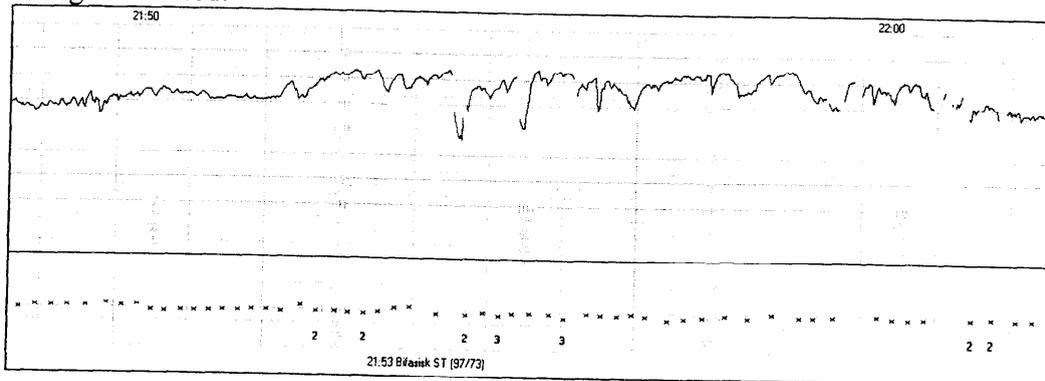
Female: 3930 g  
Apgar: 7-8-10  
Cord artery: pH 7.00  
PCO<sub>2</sub> 8.91 kPa  
BDecf 13.1 mmol/l  
Cord vein: pH 7.06  
PCO<sub>2</sub> 7.07 kPa  
BDecf 13.5 mmol/l

### Neonatal outcome

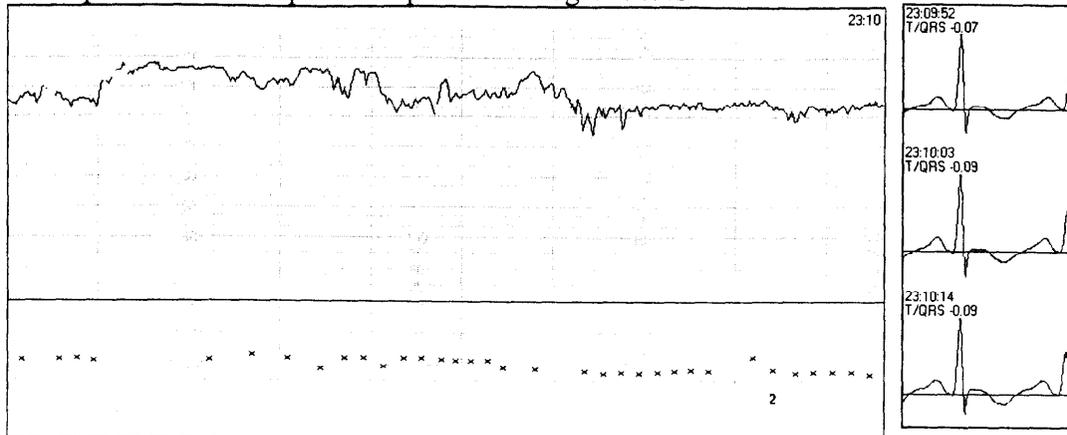
Normal neonatal outcome.

### Assessment of recording

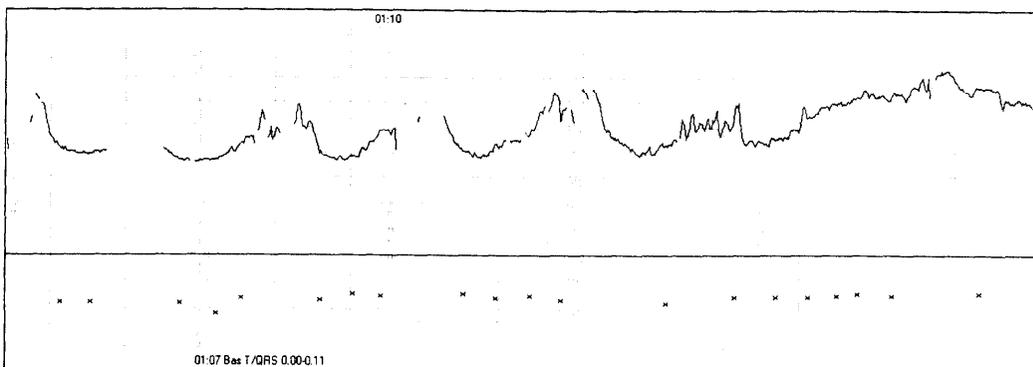
The fetus displayed periods of tachycardia as noted below. In this case biphasic ST changes occurred.



The biphasic ST developed into episodes of neg T waves



With onset of active pushing, the CTG+ST pattern changed with the appearance of bradycardia and T/QRS rise.



### Comments

CTG+ST changes showing periods of tachycardia and ST depression followed by an ST rise in conjunction with active pushing in 2nd stage of labor. This is a typical pattern of a myocardium operating under stress – unknown reason – during 1<sup>st</sup> stage. During the more marked stress in 2<sup>nd</sup> stage, the fetus is capable of responding to hypoxia with an ST rise as a sign of an alarm reaction. Clear indications to intervene with an assisted delivery at 01:06.

## **LDF 308**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Clear liquor, epidural, augmentation of labor.  
Active pushing commenced at 16:15  
Outlet vacuum for threatening asphyxia according to CTG at 17:04

### **Neonatal data**

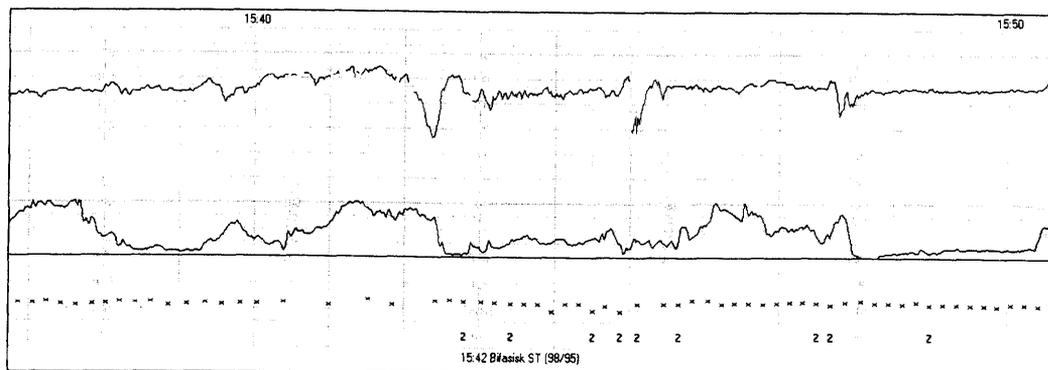
Female: 3580 g  
Apgar: 8-10-10  
Cord artery: pH 6.93  
PCO<sub>2</sub> 11.08 kPa  
BDecf 13.3 mmol/l  
Cord vein: pH 7.02  
PCO<sub>2</sub> 8.8 kPa  
BDecf 12.3 mmol/l

### **Neonatal outcome**

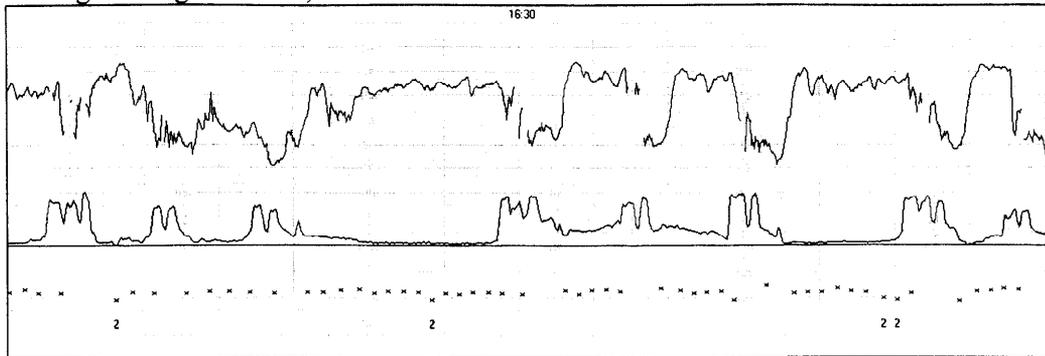
Normal neonatal outcome.

### **Assessment of recording**

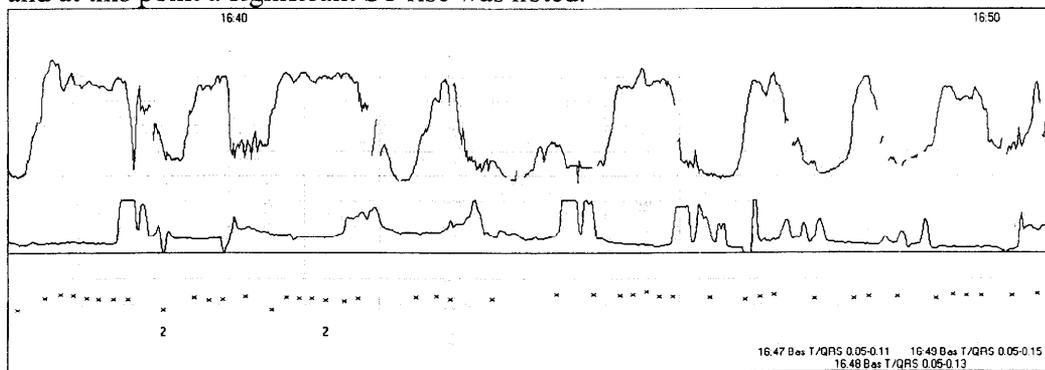
A ST event with biphasic ST was recorded with the development of a tachycardia.



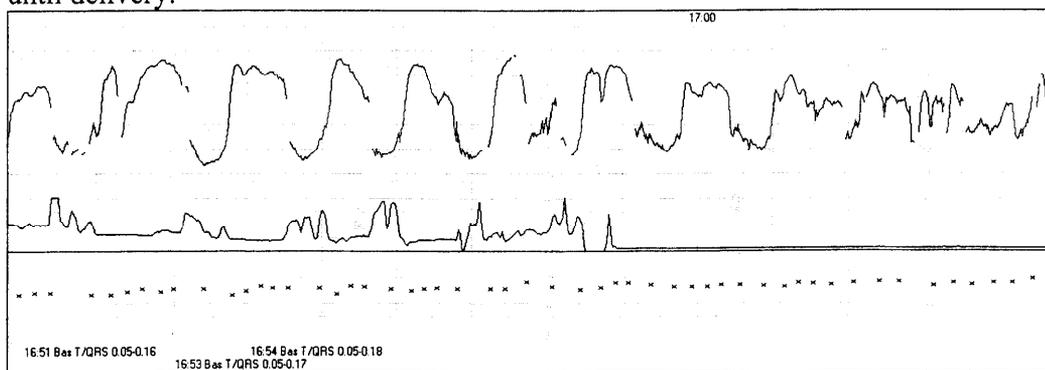
During 2<sup>nd</sup> stage of labor, decelerations started.



These developed into complicated variable decelerations with persistent tachycardia and at this point a significant ST rise was noted.



The ST changes became more marked as labor progressed. The recording continued until delivery.



## Comments

Almost identical situation to LDE 272. CTG+ST changes showing tachycardia and ST depression followed by an ST rise in conjunction with active pushing in 2<sup>nd</sup> stage of labor. This is a typical pattern of a myocardium operating under stress – unknown reason – during 1<sup>st</sup> stage. During the more marked stress in 2<sup>nd</sup> stage, the fetus is capable of responding to hypoxia with an ST rise as a sign of an alarm reaction. Clear indications to intervene with an assisted delivery at 16:47.

## LDH 328

### Clinical data

Para 0. Normal pregnancy. Spontaneous onset of labour after 38 weeks of gestation  
Meconium stained liquor. Augmented labor.  
Active pushing commenced at 03:15  
NVD at 03:53

### Neonatal data

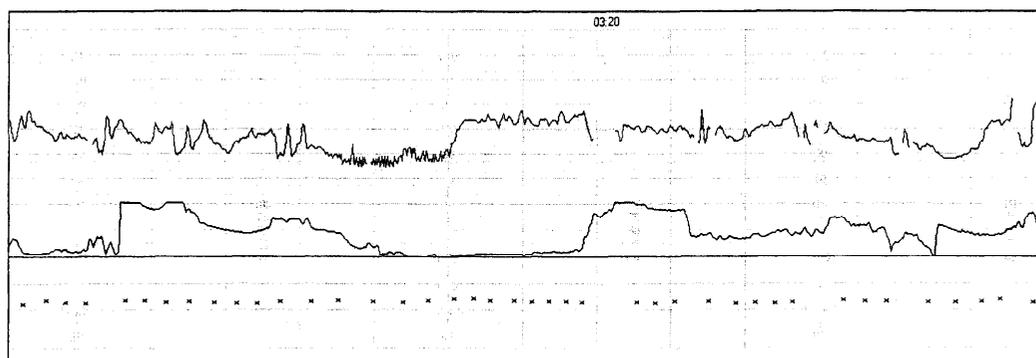
Male: 3170 g  
Apgar: 7-9-10  
Cord artery: pH 6.92  
PCO<sub>2</sub> 10.26 kPa  
BDecf 14.9 mmol/l  
Cord vein: pH 6.98  
PCO<sub>2</sub> 9.02 kPa  
BDecf 13.9 mmol/l

### Neonatal outcome

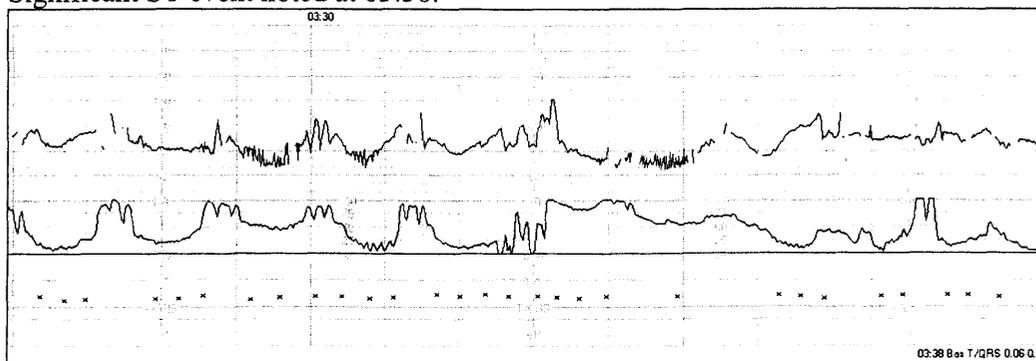
Normal neonatal outcome.

### Assessment of recording

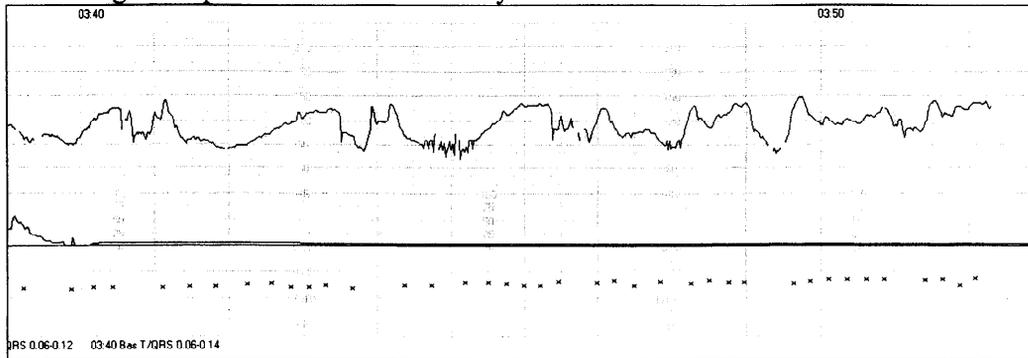
Single complicated decelerations during end 1<sup>st</sup> stage becoming more frequent as labor progressed into 2<sup>nd</sup> stage with active pushing.



Significant ST event noted at 03:38.



Becoming more pronounced until delivery 03:53.



### Comments

Significant hypoxia emerging during 2<sup>nd</sup> stage of labor. A fetus capable of responding with an alarm reaction, including metabolic acidosis and normal Apgar scores. Clear indications to intervene at 03:38.

## MAA 457

### Clinical data

Para 2. Normal pregnancy. Spontaneous onset of labour after 41 weeks of gestation  
Clear liquor  
Active pushing commenced at 15:10  
NVD at 15:15

### Neonatal data

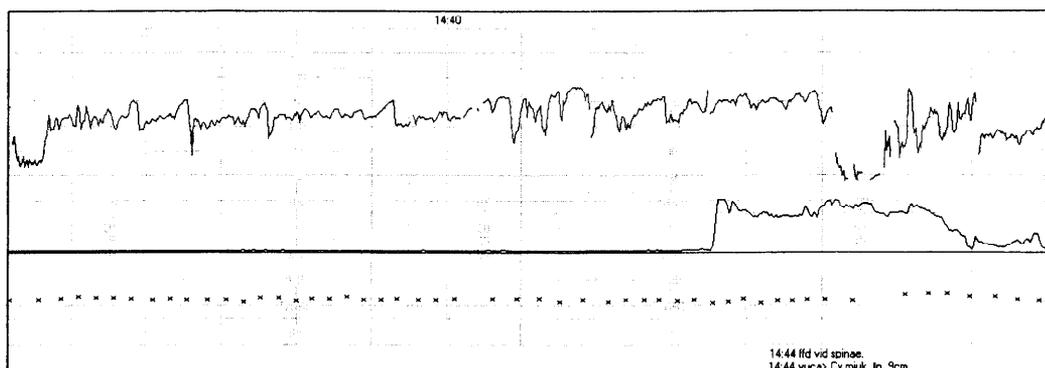
Male: 3805 g  
Apgar: 9-10-10  
Cord artery: pH 7.02  
PCO<sub>2</sub> 8.91 kPa  
BDecf 12.1 mmol/l  
Cord vein: pH 7.23  
PCO<sub>2</sub> 6.25 kPa  
BDecf 6.8mmol/l

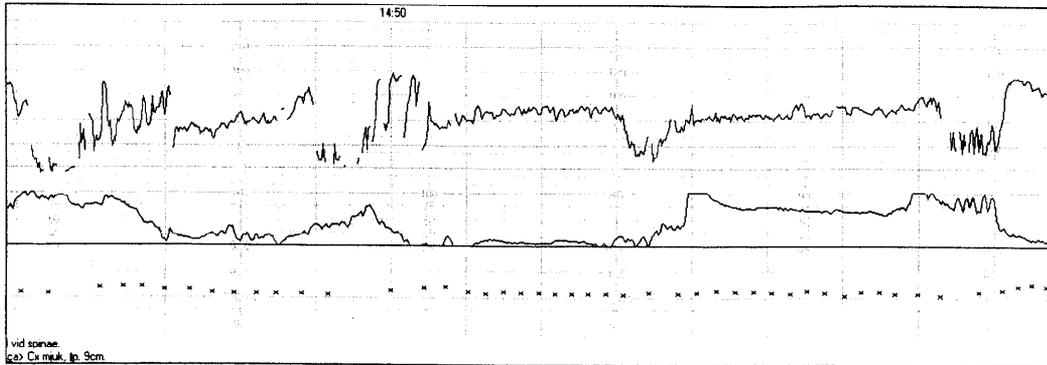
### Neonatal outcome

Normal neonatal outcome.

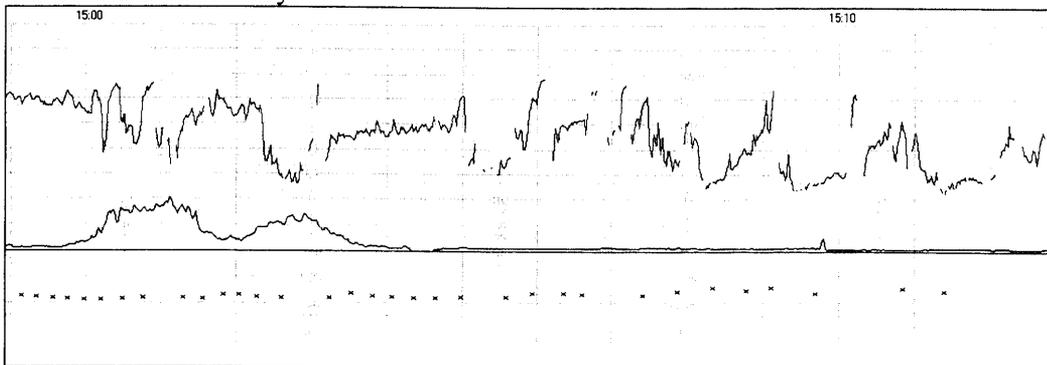
### Assessment of recording

Only some intermediary FHR changes as seen below. Note the small increase in T/QRS with the variable decelerations.





End recording finishing 2 min before delivery. Note the T/QRS rise starting 10 minutes before delivery.



## Comments

Some hypoxia during 2<sup>nd</sup> stage, accurately identified by CTG+ST. The case illustrates a fetus capable of responding and modifying its response according to the duration of cord compression and the degree of hypoxia.

## MAC 534

### Clinical data

Para 0. Normal pregnancy. Spontaneous onset of labour after 40 weeks of gestation  
Clear liquor, epidural, augmented labor.  
Active pushing commenced at 02:10  
NVD at 02:25

### Neonatal data

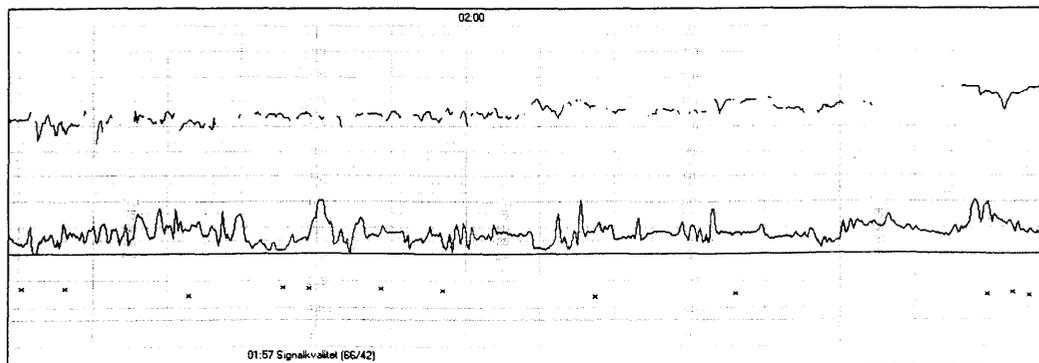
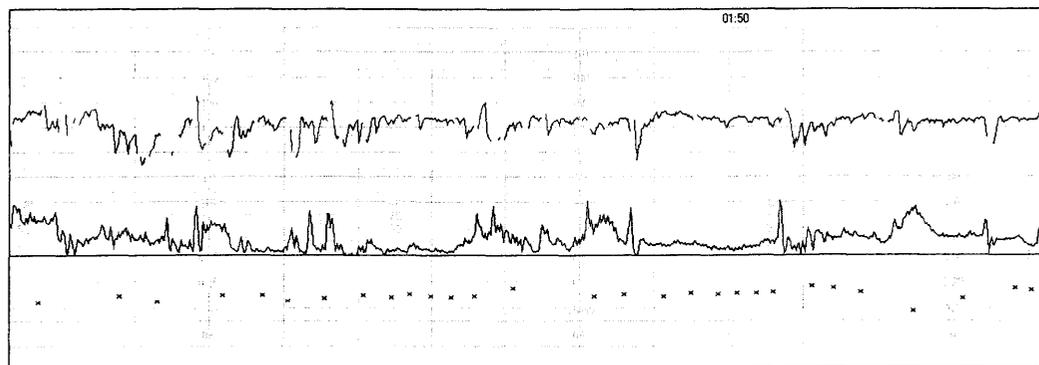
Female: 3480 g  
Apgar: 9-9-10  
Cord artery: pH 7.00  
PCO<sub>2</sub> 6.85 kPa  
BDecf 16.5 mmol/l  
Cord vein: pH 7.32  
PCO<sub>2</sub> 3.95 kPa  
BDecf 9.4mmol/l

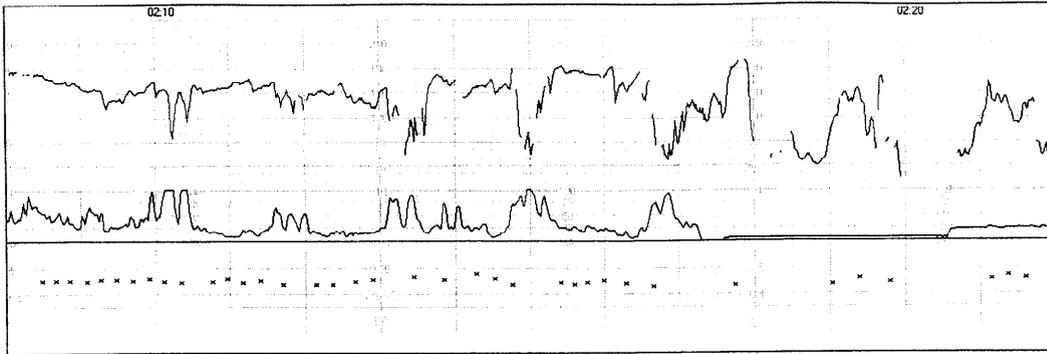
### Neonatal outcome

Normal neonatal outcome.

### Assessment of recording

Normal FHR pattern apart from some complicated variable decelerations immediately prior to delivery.





### Comments

Intermittent cord compression during the last 5-10 minutes causing no clinical problems. Cord twice around neck.

## **MAD 344**

### **Clinical data**

Para 1. Normal pregnancy. Spontaneous onset of labour after 41 weeks of gestation  
Clear liquor, epidural.  
Active pushing commenced at 14:40  
Rotational forceps for threatening asphyxia according to CTG+ST at 14:50

### **Neonatal data**

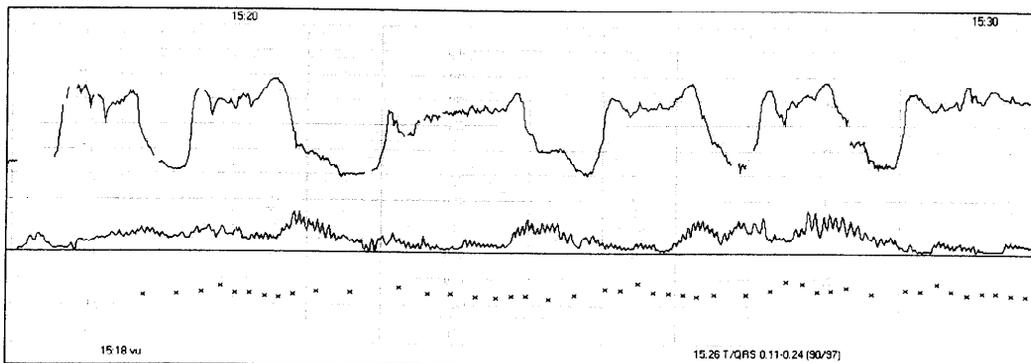
Male: 3290 g  
Apgar: 7-8-9  
Cord artery: pH 6.98  
PCO<sub>2</sub> 9.24 kPa  
BDecf 13.5 mmol/l  
Cord vein: pH 7.21  
PCO<sub>2</sub> 6.53 kPa  
BDecf 7.2 mmol/l

### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

A recording characterised by marked variable decelerations becoming complicated as labor progressed into 2<sup>nd</sup> stage. Tachycardia. Episodic T/QRS rise recorded at 15:26.



## **MAD 360**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 42 weeks of gestation  
Meconium, epidural, augmented labor.  
Active pushing commenced at 06:10  
NVD at 06:38

### **Neonatal data**

Female: 3910 g  
Apgar: 9-9-10  
Cord artery: pH 7.04  
PCO<sub>2</sub> 7.56 kPa  
BDecf 13.5 mmol/l  
Cord vein: pH 7.27  
PCO<sub>2</sub> 4.91 kPa  
BDecf 8.7 mmol/l

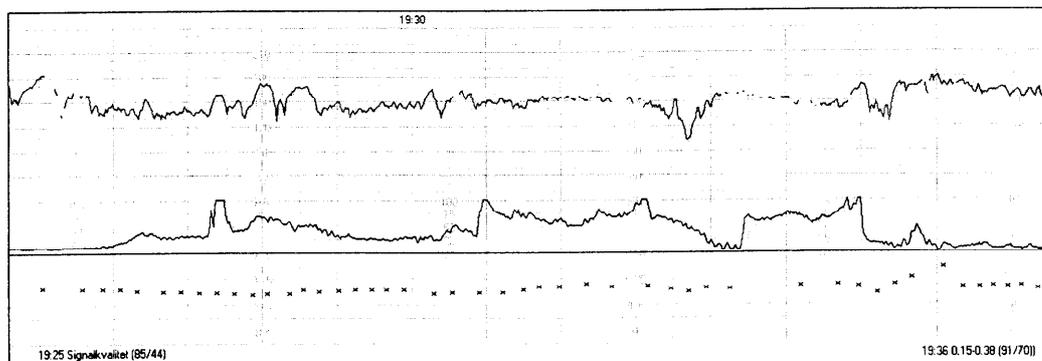
### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

A case where the STAN monitor was disconnected approx 9h before delivery.

The data available show a normal FHR pattern. One episodic T/QRS rise was noted at 19:36 illustrating the ability of the fetus to react.



## **MAD 397**

### **Clinical data**

Para 1. Normal pregnancy. Induction of labour after 43 weeks of gestation  
Clear liquor, epidural, augmented labor.  
Active pushing commenced at 23:56  
Outlet vacuum for failure to progress at 00:35

### **Neonatal data**

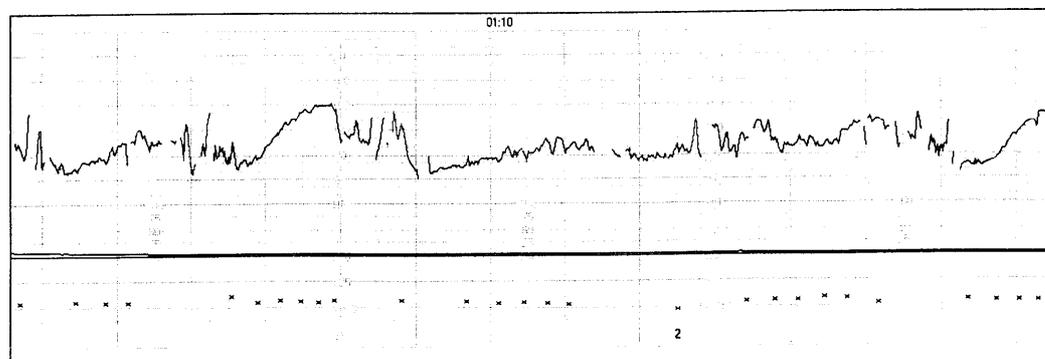
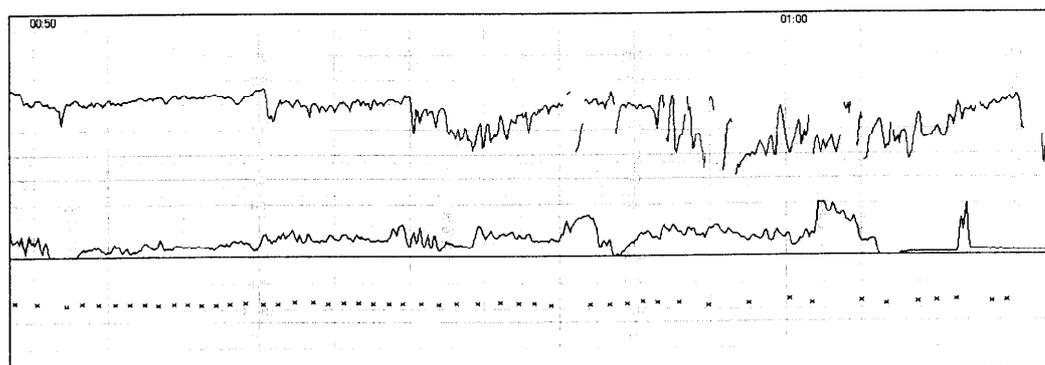
Female: 3520 g  
Apgar: 8-9-10  
Cord artery: pH 7.04  
PCO<sub>2</sub> 5.36 kPa  
BDecf 17.5 mmol/l  
Cord vein: pH 7.10  
PCO<sub>2</sub> 7.01 kPa  
BDecf 11.7 mmol/l

### **Neonatal outcome**

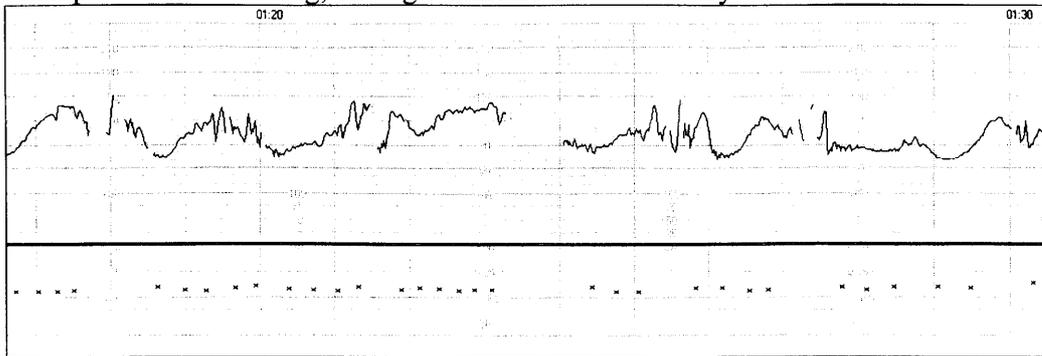
Normal neonatal outcome.

### **Assessment of recording**

Normal FHR pattern with a tendency for reduced variability in 2<sup>nd</sup> stage. Note recorder set on "winter time".



Final part of the recording, ending 5 minutes before delivery.



### Comments

Cord acid-base showing signs of late clamping and a falsely high BDecf in the cord artery. Nothing to indicate marked intrapartum hypoxia. Tendency for a T/QRS rise during the last 20 minutes, reflecting the increase in sympathetic tone.

## MAE 271

### Clinical data

Para 0. Preeclampsia. Spontaneous onset of labour after 41 weeks of gestation  
Clear liquor, augmented labor.  
Scalp-pH 7.29 at 16:33  
Active pushing commenced at 17:30  
Rotational forceps for threatening asphyxia according to CTG+ST at 17:53

### Neonatal data

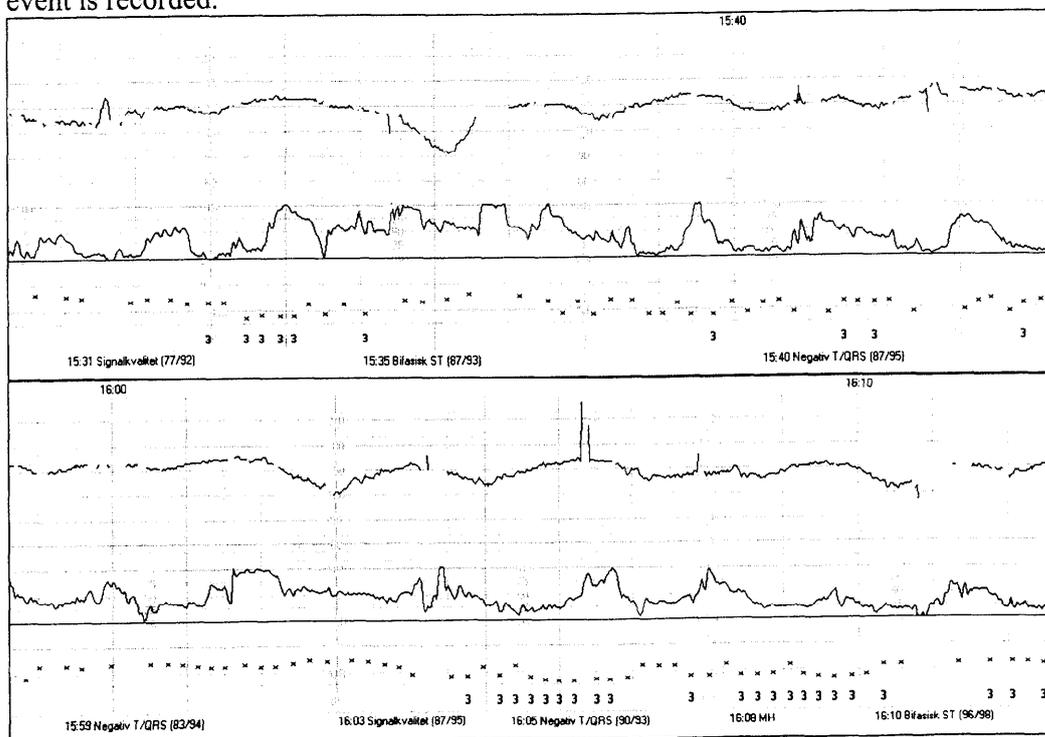
Male: 4570 g  
Apgar: 8-9-10  
Cord artery: pH 6.99  
PCO<sub>2</sub> 8.71 kPa  
BDecf 13.9 mmol/l  
Cord vein: pH 7.22  
PCO<sub>2</sub> 6.27 kPa  
BDecf 7.3 mmol/l

### Neonatal outcome

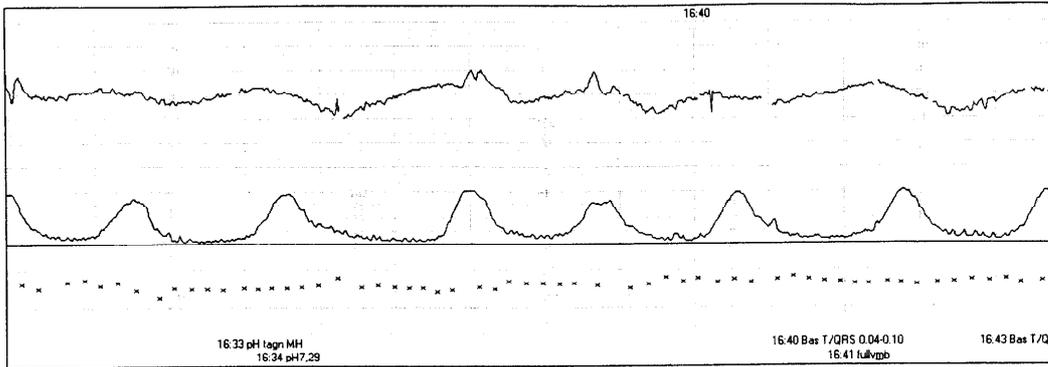
Normal neonatal outcome.

### Assessment of recording

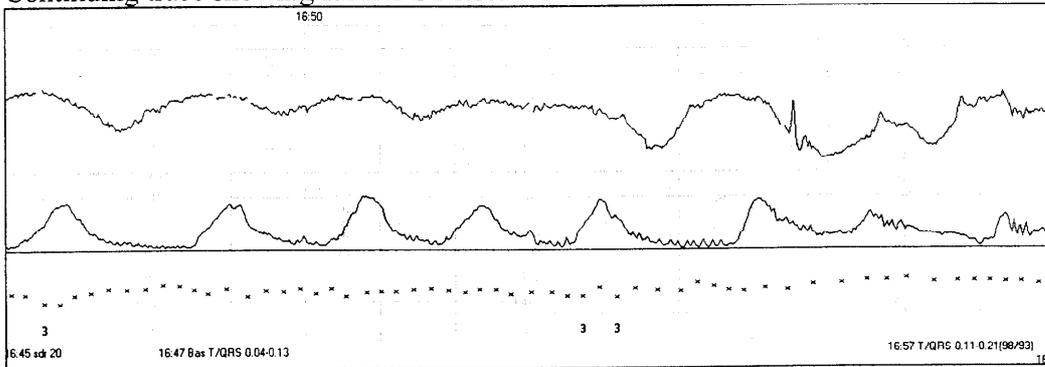
A FHR pattern that already from the beginning is non-reassuring with tachycardia and late decelerations but maintained variability. Very soon, the first Biphasic / neg T event is recorded.



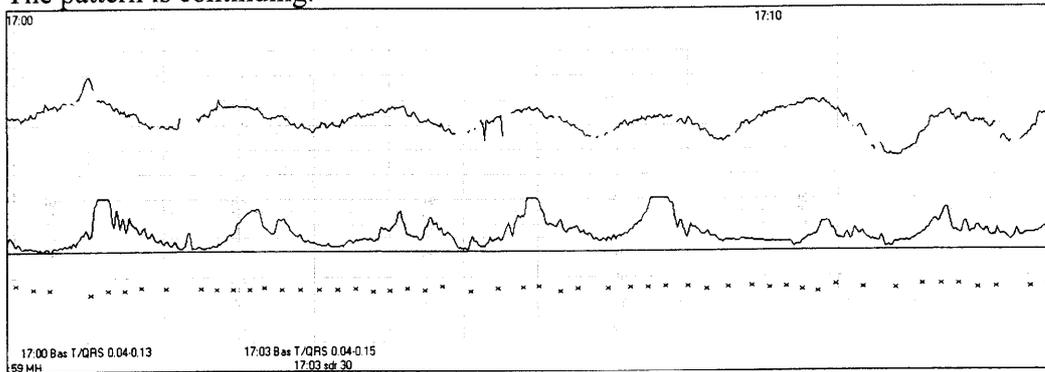
At 16:33 a scalp-pH is obtained, shortly after a baseline T/QRS rise is noted.



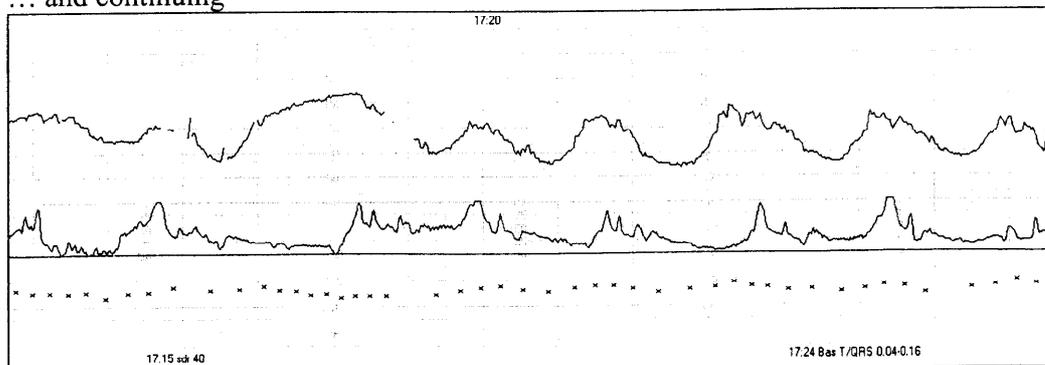
Continuing trace showing further ST rise.



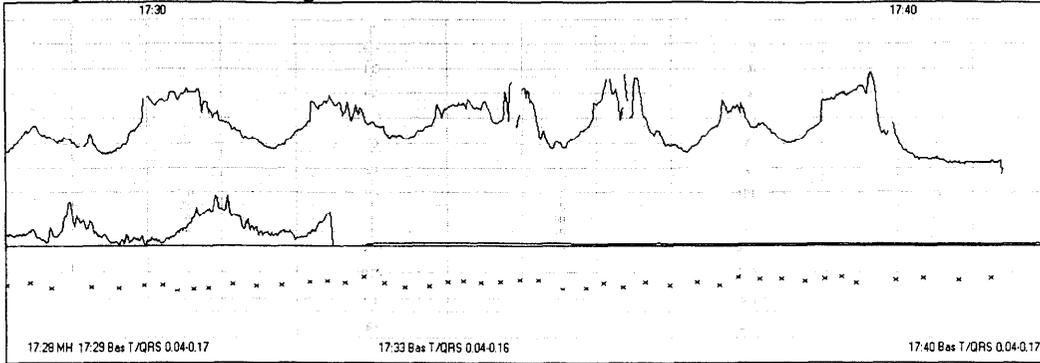
The pattern is continuing.



... and continuing



Final part of the recording, outlet vacuum for fetal distress at 17:53



### Comments

An illustration of gradually developing hypoxia in labor displaying all the fetal ECG features. Clinically, the normal scalp-pH would have provided false reassurance that the FHR pattern although abnormal, was not indicating hypoxia. The additional ST information would have alerted the clinician and according to CTG+ST guidelines an intervention would have been indicated approx 16:10.

The case also illustrates the capacity of this fetus to manage by utilizing its key resource, increase in sympatho-adrenal activity and myocardial glycogenolysis.

## **MAE 340**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Clear liquor  
Active pushing commenced at 04:15  
NVD at 04:53

### **Neonatal data**

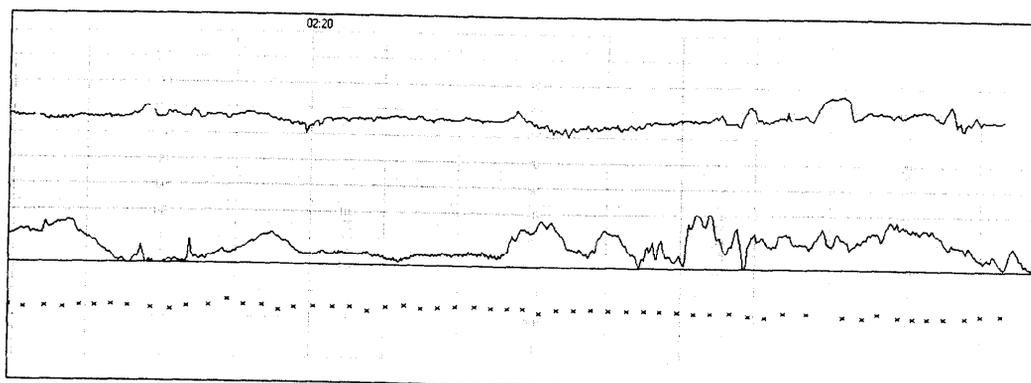
Female: 3085 g  
Apgar: 8-8-8  
Cord artery: pH 7.02  
PCO<sub>2</sub> 8.42 kPa  
BDecf 12.8 mmol/l  
Cord vein: pH 7.07  
PCO<sub>2</sub> 8.67 kPa  
BDecf 9.9 mmol/l

### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

Normal FHR pattern. Unfortunately, the STAN monitor was disconnected for unknown reason at 02:30. Delivery occurred at 04:53.



## **MAE 444**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 39 weeks of gestation  
Clear liquor, augmented labor.  
Active pushing commenced at 04:15  
NVD at 04:32

### **Neonatal data**

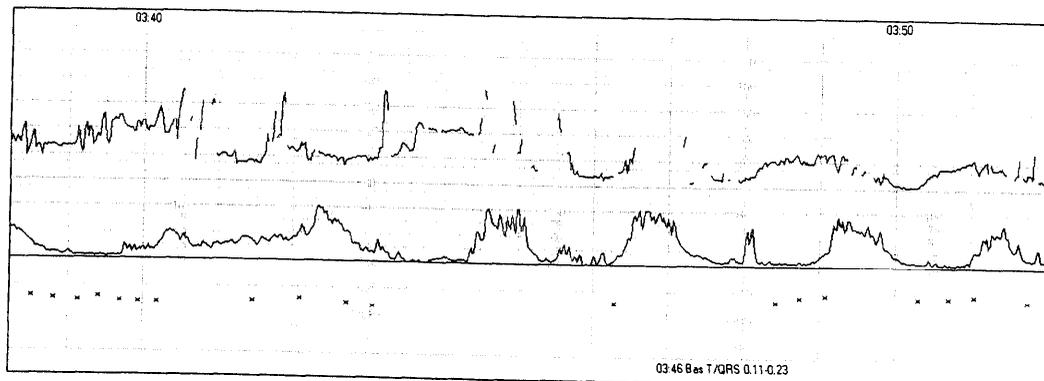
Male: 3320 g  
Apgar: 9-9-10  
Cord artery: pH 6.99  
PCO<sub>2</sub> 9.45 kPa  
BDecf 12.7 mmol/l  
Cord vein: pH 7.09  
PCO<sub>2</sub> 7.11 kPa  
BDecf 12.0 mmol/l

### **Neonatal outcome**

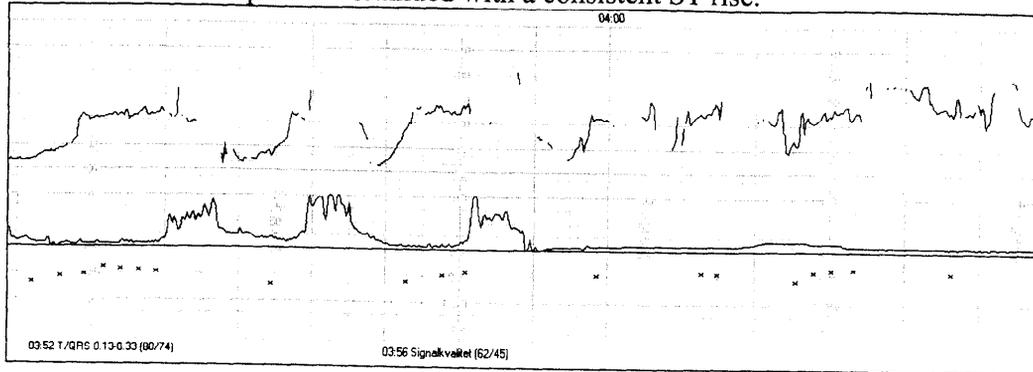
Normal neonatal outcome.

### **Assessment of recording**

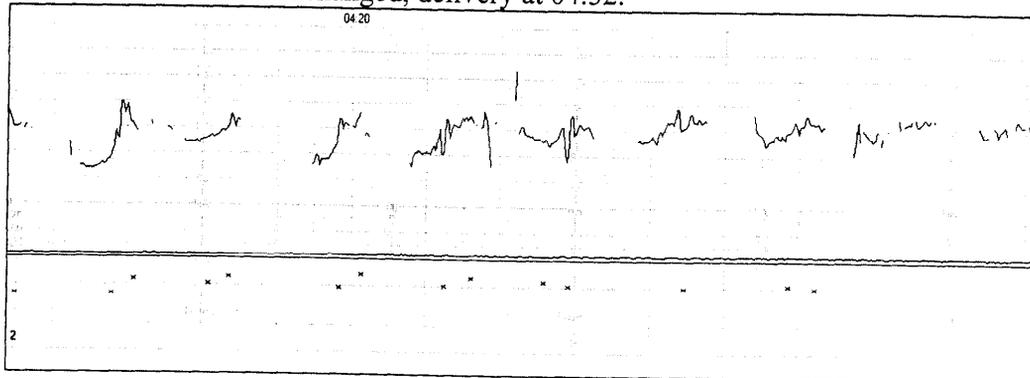
Prolonged bradycardia with a ST rise note at end 1<sup>st</sup> stage of labor.



The abnormal FHR pattern continued with a consistent ST rise.



The situation remains unchanged, delivery at 04:32.



### Comment

Hypoxia developing during the last 30 minutes of labor. The fetus is able to compensate utilising key resources. Indication to intervene according to CTG+ST guidelines at 03:52.

## MAE 491

### Clinical data

Para 0. Normal pregnancy. Onset of labour after 41 weeks of gestation

Mid cavity vacuum for failure to progress at 21:35

### Neonatal data

Male: 4115 g

Apgar: 5-8-10

Cord artery: pH 7.03  
PCO<sub>2</sub> 8.24 kPa  
BDecf 12.8 mmol/l

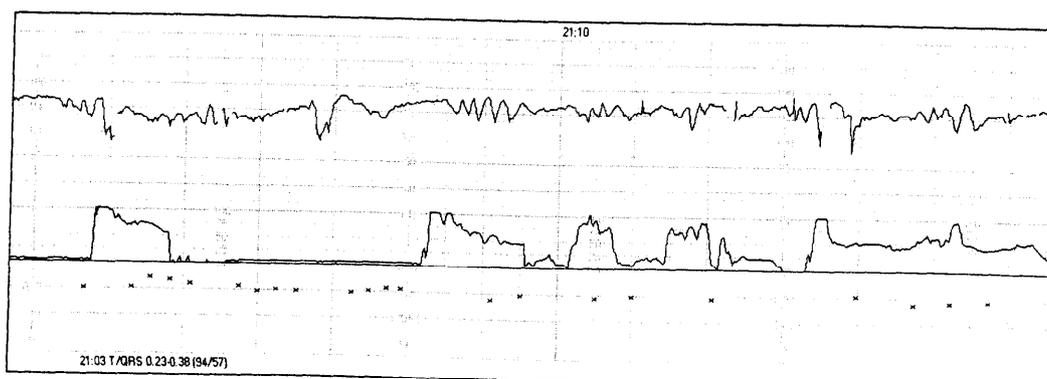
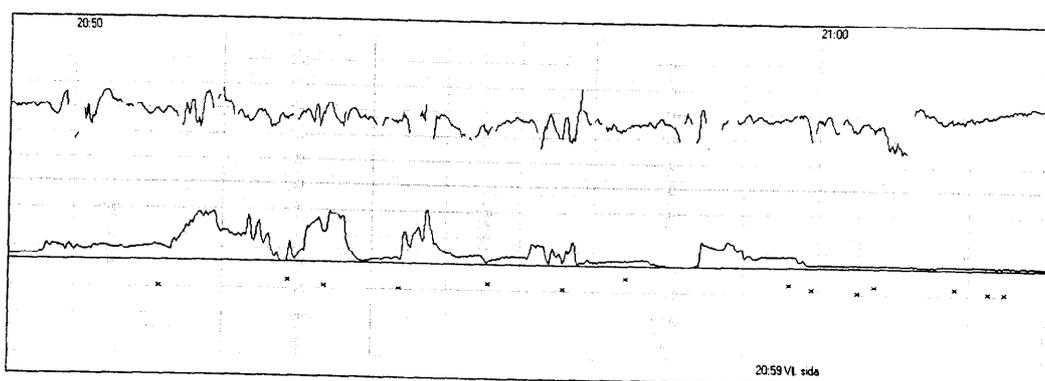
Cord vein: pH 7.25  
PCO<sub>2</sub> 5.32 kPa  
BDecf 8.5 mmol/l

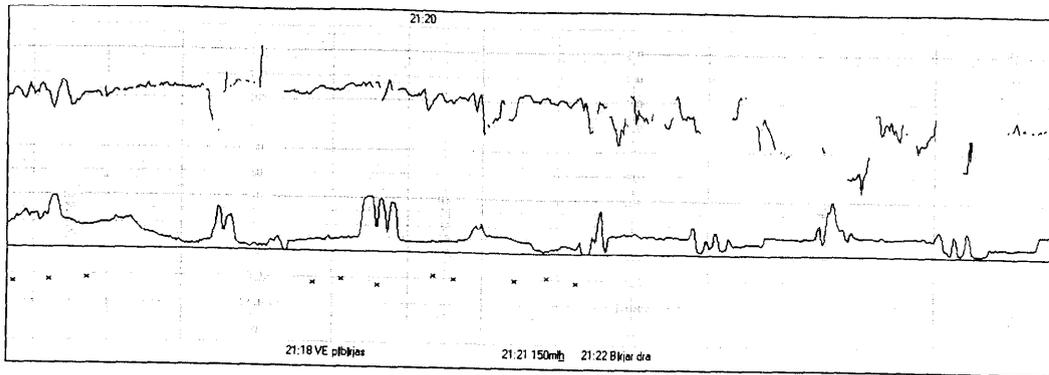
### Neonatal outcome

Normal neonatal outcome.

### Assessment of recording

Apart from some tachycardia, normal FHR pattern. ST showed an episodic event of  $>0.15$ . Thus in case of an intermediary FHR pattern (tachycardia), CTG+ST guidelines indicated a need for intervention.





**Comments**

Difficult case to assess with the data available. However, ST indicated a need for the fetus to respond to the stress of labor.

Note, this case has been excluded but there is nothing to indicate inadequate data.

## **MAF 237**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 40 weeks of gestation  
Clear liquor  
Active pushing commenced at 22:05  
NVD at 22:18

### **Neonatal data**

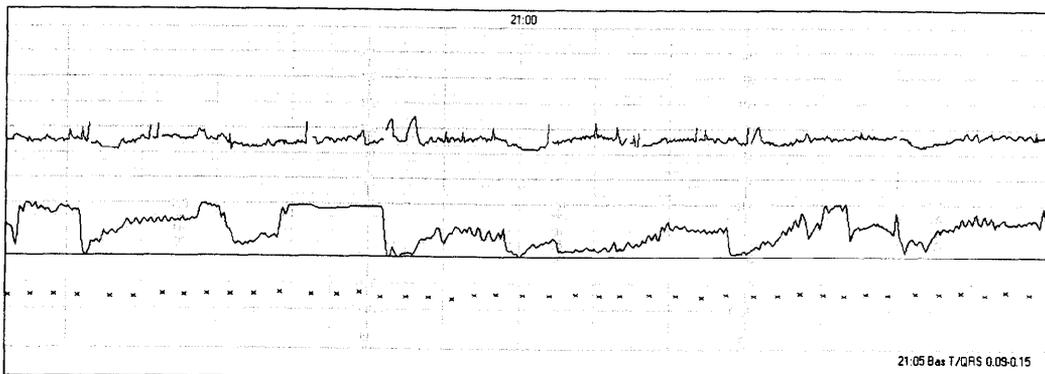
Male: 3940 g  
Apgar: 9-10-10  
Cord artery: pH 7.02  
PCO<sub>2</sub> 8.85 kPa  
BDecf 12.2 mmol/l  
Cord vein: pH 7.05  
PCO<sub>2</sub> 8.75 kPa  
BDecf 10.8 mmol/l

### **Neonatal outcome**

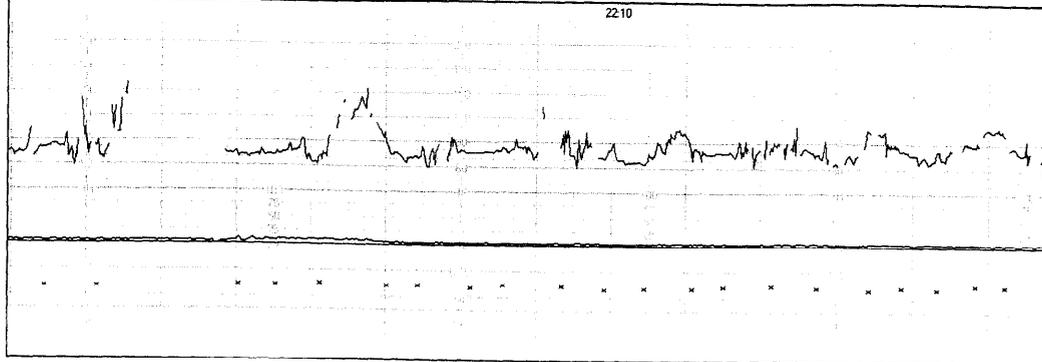
Normal neonatal outcome.

### **Assessment of recording**

Decrease in baseline FHR noted at 12:52 in parallel to a baseline T/QRS rise.



The FHR + ST pattern improved in 2<sup>nd</sup> stage, the graph showing the final recording. NVD at 22:18.



### Comments

FHR+ST changes indicating some cord blood flow reduction at end 1<sup>st</sup> stage of labor. Borderline case. The data indicate a fetus adapting to the events of labor.

## **MAF 244**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 41 weeks of gestation  
Clear liquor, augmented labor.  
Active pushing commenced at 08:00  
NVD at 10:16

### **Neonatal data**

Female: 3960 g  
Apgar: 8-10-10  
Cord artery:     pH 7.00  
                      PCO<sub>2</sub> 8.43 kPa  
                      BDecf 13.9 mmol/l  
Cord vein:        pH 7.24  
                      PCO<sub>2</sub> 5.1 kPa  
                      BDecf 9.6 mmol/l

### **Neonatal outcome**

Normal neonatal outcome.

### **Assessment of recording**

Discontinued recording. Data missing  
Inadequate recording.

## **OEF 241b**

### **Clinical data**

Para 2. Normal pregnancy. Induction of labour after 42 weeks of gestation  
Meconium, augmented labor.  
Active pushing commenced at 18:00  
NVD at 18:09

### **Neonatal data**

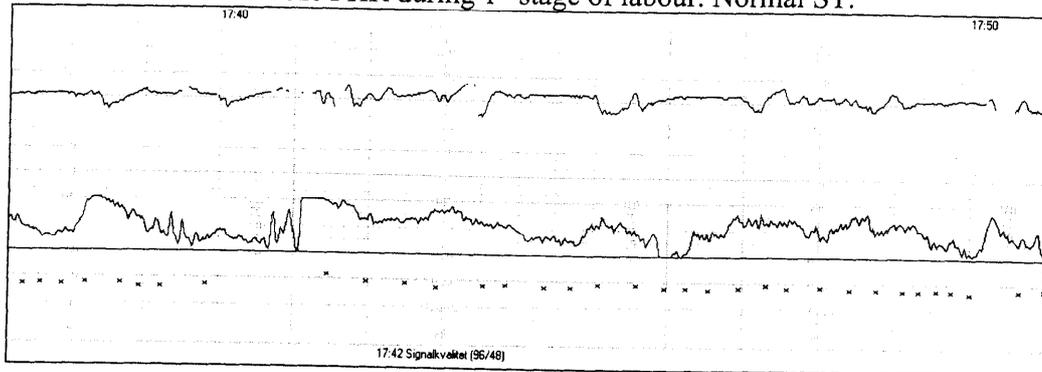
Male: 3835 g  
Apgar: 7-10-10  
Cord artery: pH 6.96  
PCO<sub>2</sub> 8.89 kPa  
BDecf 15.0 mmol/l  
Cord vein: pH 7.37  
PCO<sub>2</sub> 4.62 kPa  
BDecf 4.4 mmol/l

### **Neonatal outcome**

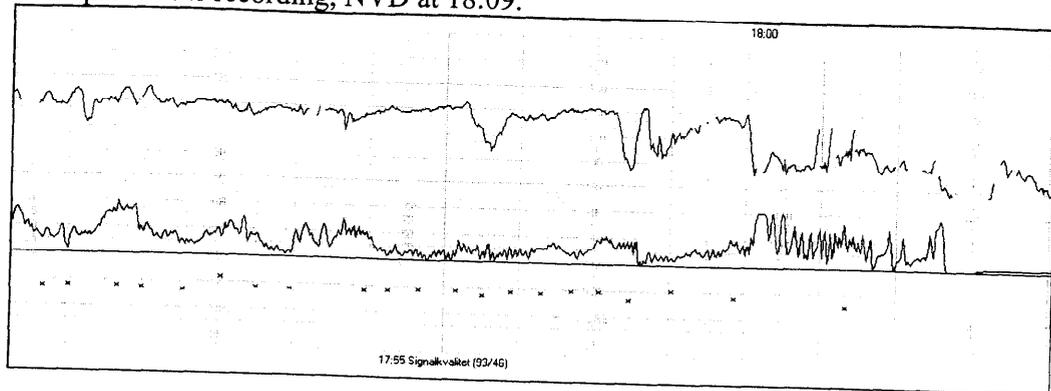
Normal neonatal outcome.

### **Assessment of recording**

Some increase in baseline FHR during 1<sup>st</sup> stage of labour. Normal ST.



Final part of the recording, NVD at 18:09.



### Comments

Selective cord metabolic acidosis indicating an acute hypoxia during the last phase of labor, typically seen with cord entanglement.  
Normal ST waveforms. No FHR abnormalities either.

## **OEH 267**

### **Clinical data**

Para 0. Normal pregnancy. Spontaneous onset of labour after 40 weeks of gestation  
Meconium, epidural, augmented labor. Maternal pyrexia of unknown cause.  
Active pushing commenced at 17:30  
NVD at 18:45

### **Neonatal data**

Female: 4060 g

Apgar: 8-10-10

Cord artery: pH 6.93  
PCO<sub>2</sub> 10.55 kPa  
BDecf 14.0 mmol/l

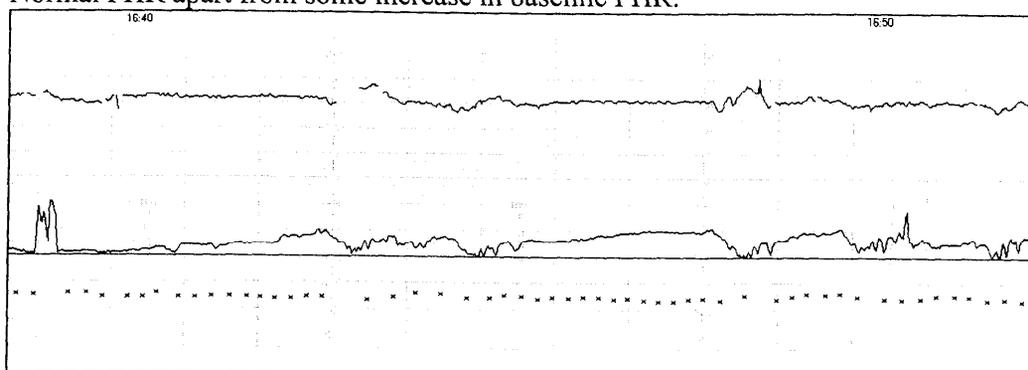
Cord vein: pH 7.04  
PCO<sub>2</sub> 8.81 kPa  
BDecf 11.2mmol/l

### **Neonatal outcome**

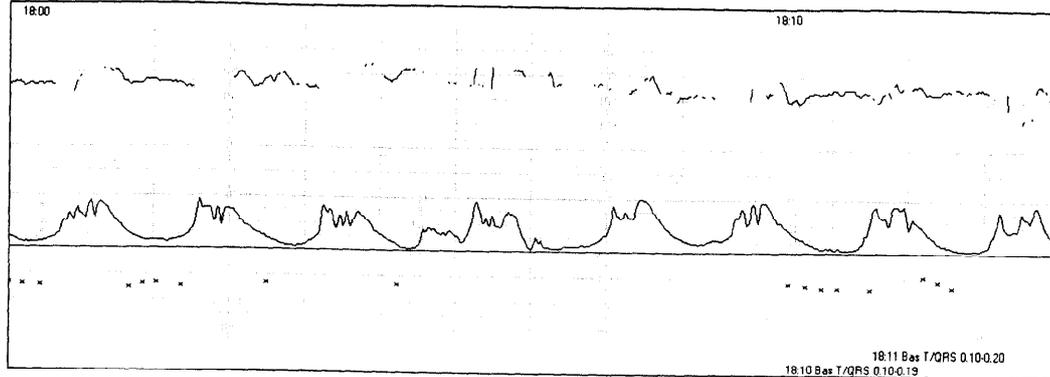
Normal neonatal outcome.

### **Assessment of recording**

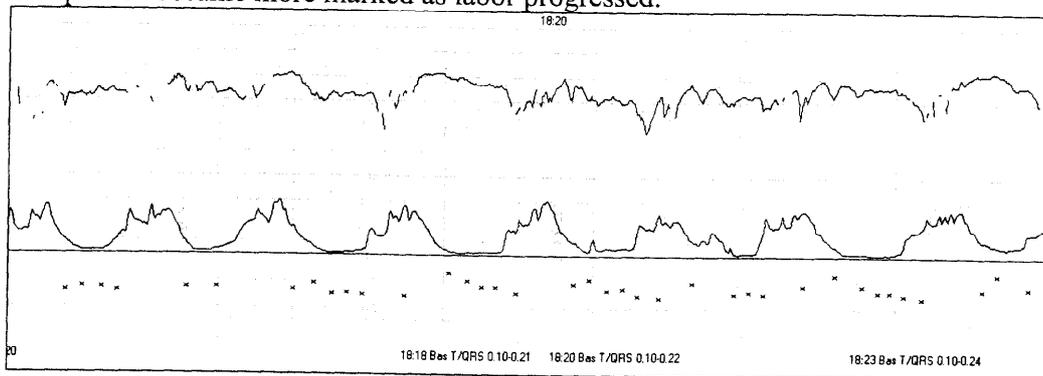
Normal FHR apart from some increase in baseline FHR.



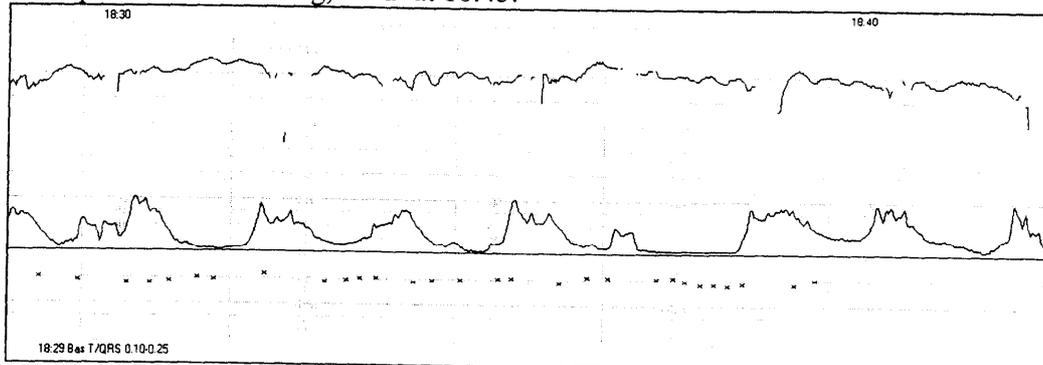
During 2<sup>nd</sup> stage a further increase in baseline FHR was noted with a rise in baseline T/QRS.



The pattern became more marked as labor progressed.



Final part of the recording, NVD at 18:45.



## Comments

Intrapartum hypoxia in 2<sup>nd</sup> stage of labor. Tachycardia and ST rise indicating a fetal alarm reaction that enables the neonate to manage its neonatal adaptation well. According to CTG+ST guidelines, there was an indication to intervene at 18:18 (intermediary FHR + baseline T/QRS rise of 0.11).

## **OEI 327**

### **Clinical data**

Para 1. Normal pregnancy. Spontaneous onset of labour after 40 weeks of gestation  
Clear liquor, augmented labor.  
Active pushing commenced at 08:00  
NVD at 08:50

### **Neonatal data**

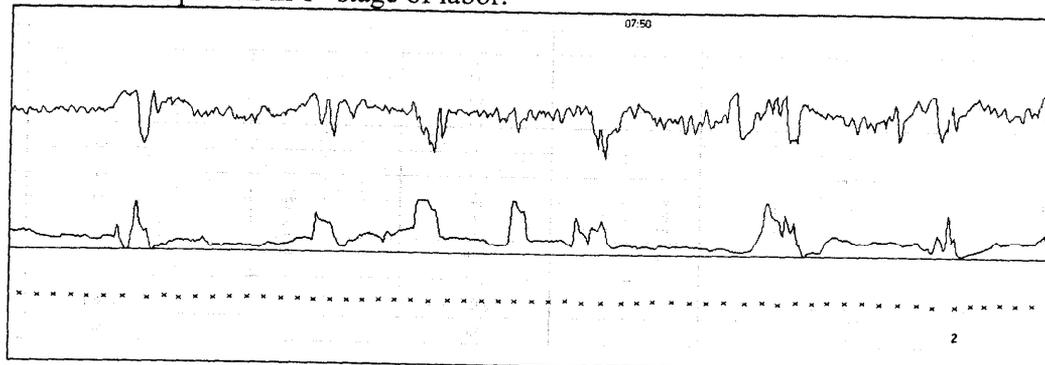
Female: 3835 g  
Apgar: 9-10-10  
Cord artery: pH 7.04  
PCO<sub>2</sub> 8.11 kPa  
BDecf 12.5 mmol/l  
Cord vein: pH 7.10  
PCO<sub>2</sub> 6.78 kPa  
BDecf 12.2 mmol/l

### **Neonatal outcome**

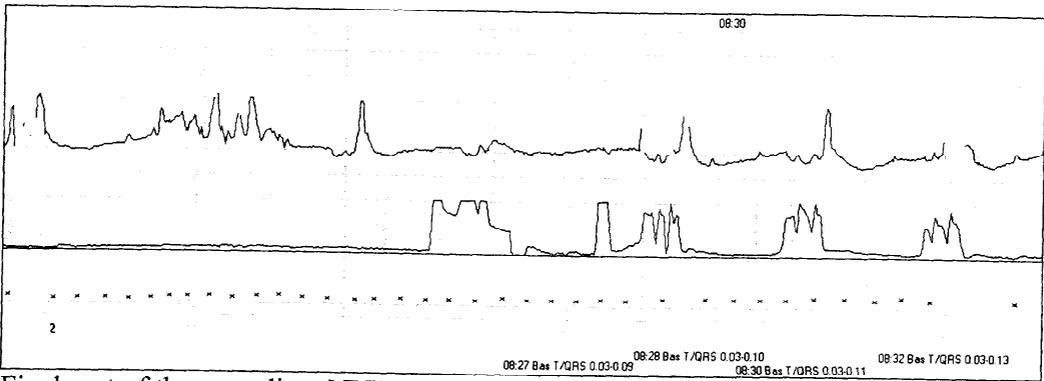
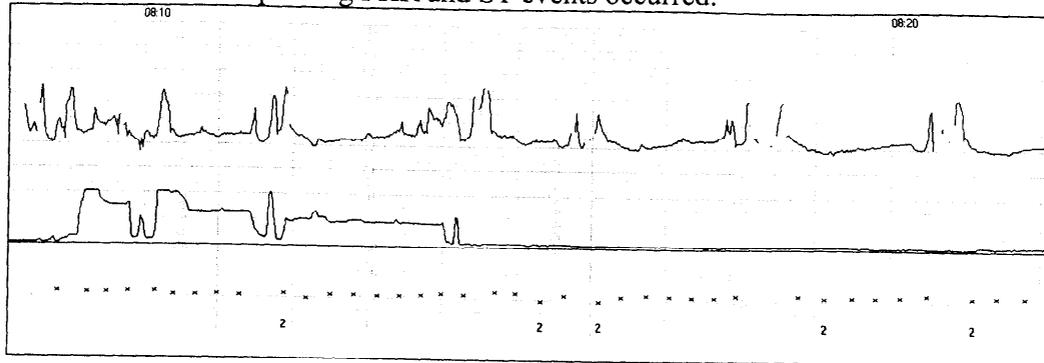
Normal neonatal outcome.

### **Assessment of recording**

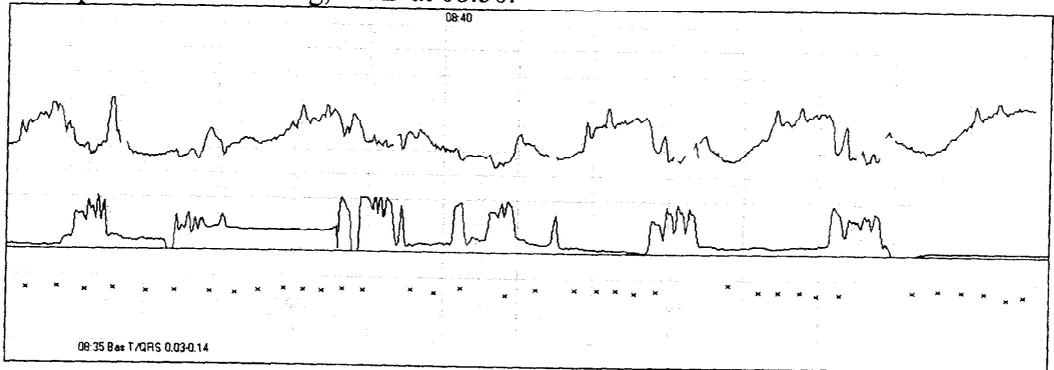
Normal FHR pattern in 1<sup>st</sup> stage of labor.



With onset of active pushing FHR and ST events occurred.



Final part of the recording, NVD at 08:50.



### Comments

A case of hypoxia developing during 2<sup>nd</sup> stage. Indication to deliver at 08:30.

## OEK 384

### Clinical data

Para 0. Normal pregnancy. Spontaneous onset of labour after 42 weeks of gestation  
Meconium, epidural, augmented labor.  
Active pushing commenced at 11:11  
NVD at 11:58

### Neonatal data

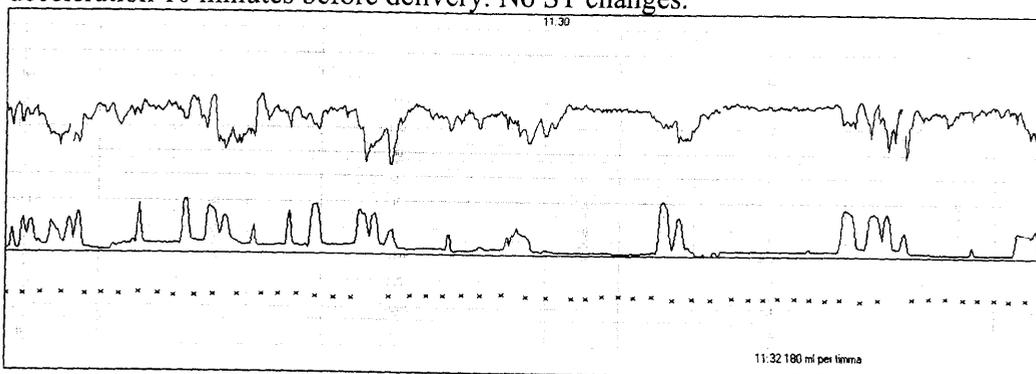
Female: 3350 g  
Apgar: 9-10-10  
Cord artery: pH 6.86  
PCO<sub>2</sub> 10.9 kPa  
BDecf 16.9 mmol/l  
Cord vein: pH 7.04  
PCO<sub>2</sub> 7.22kPa  
BDecf 14.2 mmol/l

### Neonatal outcome

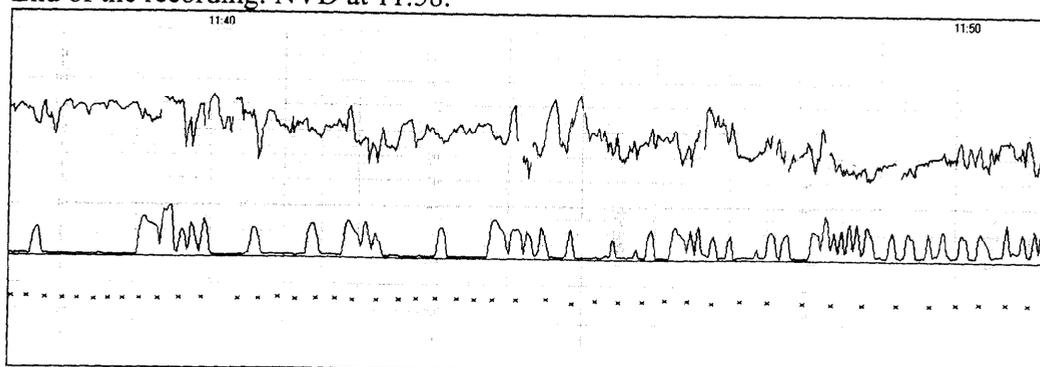
Normal neonatal outcome.

### Assessment of recording

Apart from some increase in baseline FHR, normal FHR pattern during 1<sup>st</sup> stage of labor. Uncomplicated variable decelerations during 2<sup>nd</sup> stage finishing with a deceleration 10 minutes before delivery. No ST changes.



End of the recording. NVD at 11:58.



## **Comments**

Remarkably low cord pH with metabolic acidosis considering a largely normal FHR and ST pattern. Vigorous neonate.