

Fetal heart patterns and their clinical interpretation

This text of fetal monitoring was prepared for
Sonicaid Limited by

Professor R. W. Beard, M. D., F. R.C.O.G.,
Department of Obstetrics & Gynaecology,
St Mary's Hospital, London W2.

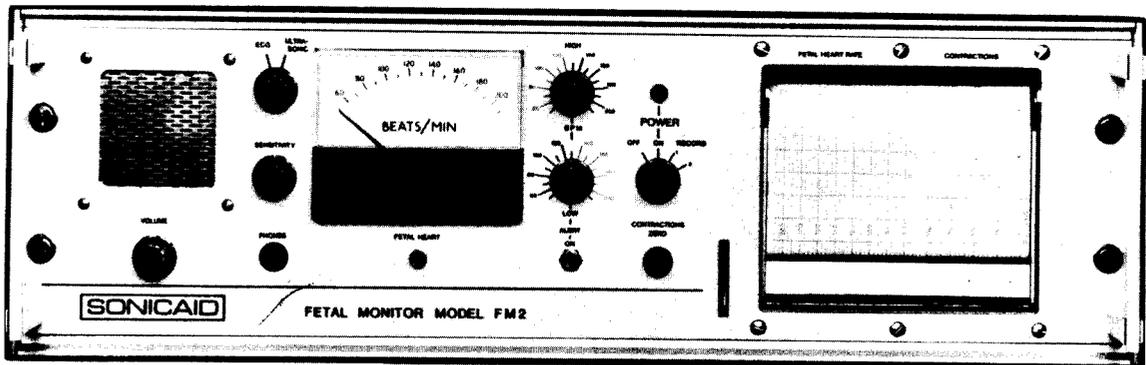
assisted by

T. S. Finnegan, B.Sc.,
Technical Director,
Sonicaid Limited, Bognor Regis, Sussex.

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Editor's Note : All of the tracings contained in this
publication were recorded at a speed of 1 cm/minute
unless otherwise noted.

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Principles of Fetal Monitoring

For any obstetrician who is new to fetal monitoring, it is important to understand from the outset that the continuous fetal heart rate monitor is not simply a sophisticated form of fetal stethoscope. Intermittent recording of the fetal heart rate (FHR) with a fetal stethoscope is still the most commonly used method for monitoring the condition of the fetus in labour. Observations are usually made every 15 to 30 minutes between contractions, and slowing of the heart rate is generally considered to be evidence of fetal asphyxia. The monitor also records the FHR, but since it is able to do this continually, the rate is measured both between and during contractions, thus providing a great deal more information about the condition of the fetus than the intermittent record. This continuous record requires careful study, and therefore cannot be interpreted in the same manner as the intermittent observations made with a fetal stethoscope.

The principle underlying the detection of fetal asphyxia in labour by continuous FHR monitoring is that the uterine contractions are a form of stress to the fetus, which is followed by a period of recovery between contractions. With each contraction there is a temporary reduction in the blood flow to the placenta which is of little consequence to the fetus if it is well oxygenated. If, on the other hand, placental function is compromised in some way, the fetus becomes temporarily asphyxiated with each contraction accompanied by some abnormality in the FHR. Initially the FHR abnormality is confined to the contraction phase but, in time, extends into the period of recovery between contractions.

The interpretation of the FHR trace is complicated by the fact that alterations in the FHR which seem to be abnormal may appear for causes other than asphyxia. This can happen, for example, during the second stage when the fetal head is being compressed as it descends in the pelvis, resulting in deep decelerations of the FHR similar to those seen during asphyxia. Clearly if all FHR decelerations were regarded as evidence of asphyxia quite a few babies would be delivered unnecessarily by Caesarean section.

For these reasons it is recommended that the technique of fetal blood sampling for pH determination should be instituted in conjunction with continuous FHR monitoring, to make the diagnosis more definite. Although we do not know precisely at what point tissue damage occurs in the asphyxial process it seems unlikely that the fetus will be in any danger if the scalp blood pH is above 7.25.

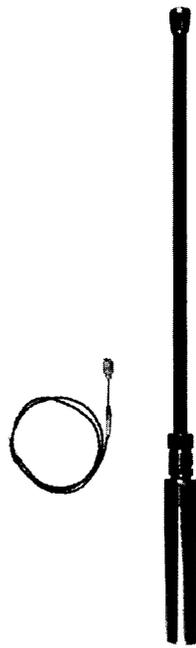
It is hoped that the description of FHR monitoring which follows will serve as an introduction to the subject for obstetricians and midwives unfamiliar with monitoring. It is in no way a substitute for the knowledge that can only be gained by long and continuous use of monitoring on the labour ward.

Monitoring Techniques - Measurement of FHR

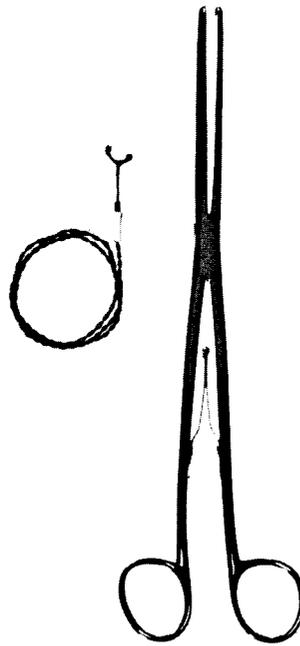
Both internal and external methods for determining the FHR and uterine contractions are available, the selection of either technique being mainly dependent upon clinical circumstances. In either case of FHR measurement the instantaneous beat-to-beat rate is computed by measuring the interval between paired beats and then converting this measurement by a cardiometer into the equivalent rate in beats per minute.

Internal method - A unipolar electrode screw or clip is attached to the fetal scalp (or buttocks if a breech presents). This picks up the fetal ECG, with a separate electrode in contact with the vagina of the mother acting as the other pole. The cardiometer is triggered by the R-wave of the fetal ECG and provides a recording of instantaneous FHR which is essentially free of errors caused by external factors. This method is therefore considered to give a more precise recording than that given by the external method.

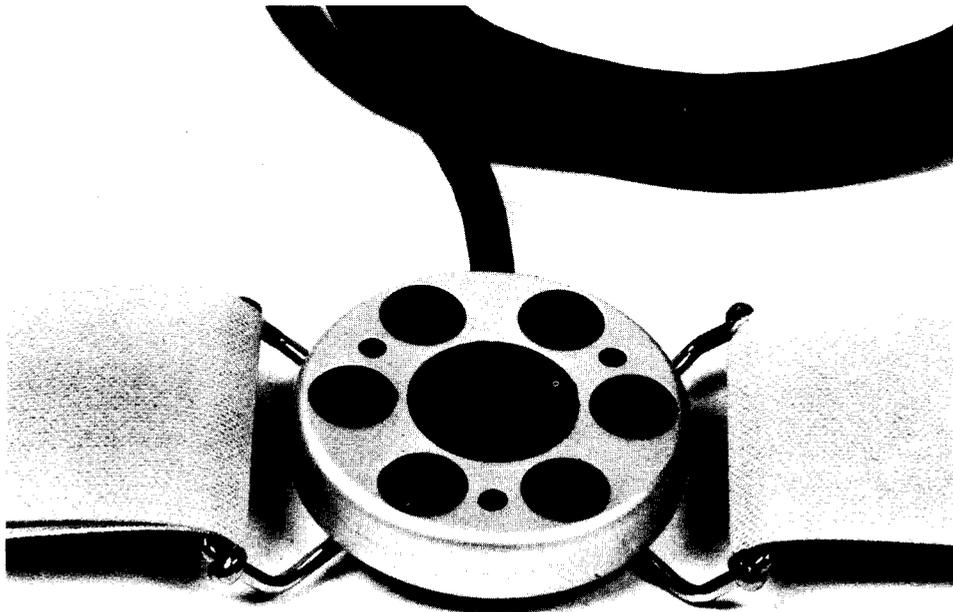
External method - The external method is valuable when it is not possible to use an internal method, as for example when the cervix is tightly closed, or in the case of the second twin, (Steer & Beard, 1973). Movements of the fetal heart are detected by a beam of acoustic energy transmitted by a transducer attached to the mother's abdomen. Because of the shape and arrangement of the multi-elements on the transducer head, a wide angle of emitted sound can be achieved which allows a certain amount of fetal movement without loss of signal. The cardiometer is triggered by a signal thought to originate from movement of the heart wall, and therefore provides a recording of FHR which derives from the mechanical activity of the fetal heart. This is a different parameter from that measured by the internal method, since the ECG record is derived from the electrical activity of the heart. The external records have different characteristics which make the beat-to-beat variation of the FHR more difficult to interpret, and at the time of writing the relevance of this beat-to-beat variation has not yet been so fully evaluated as it has been from the measurement by ECG.



Screw electrode



Clip electrode

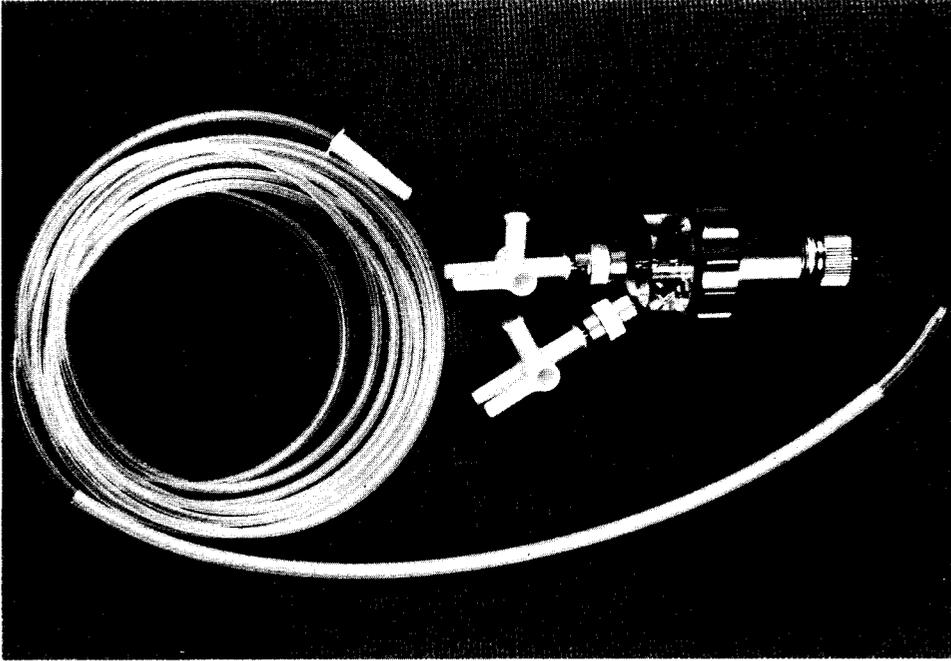


External monitoring transducer

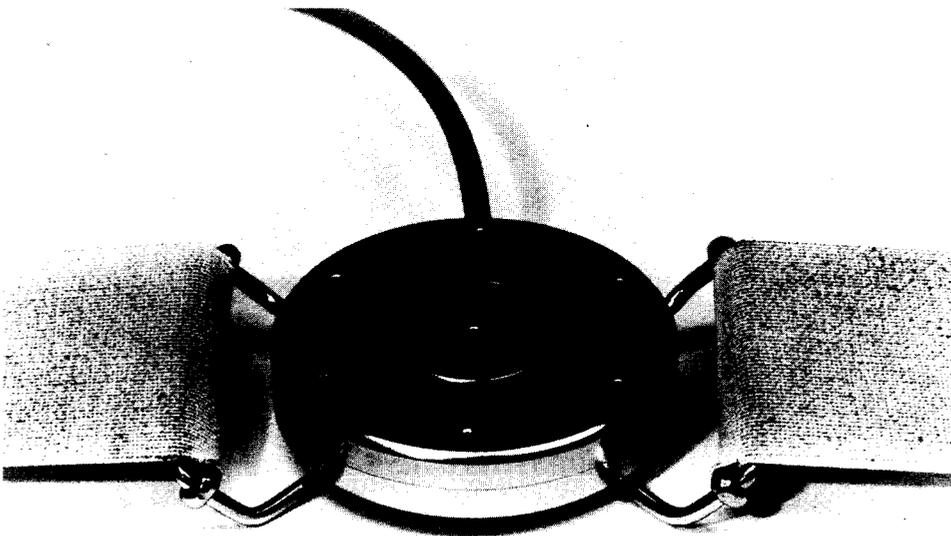
Monitoring Techniques - Measurement of Uterine Contractions

Internal method - A pressure transducer and a long polythene catheter filled with sterile saline are used for this purpose. The catheter is fed through the cervix by means of an introducer so that the tip comes to lie behind the head of the baby. The catheter is mostly used when the membranes are ruptured, but with care it can be inserted extra-amniotically without rupturing the membranes. For technical reasons this method of recording uterine contractions is generally not used in clinical practice, except when it is important to know what the intra-uterine pressure is, as for example, if syntocinon is being used in a woman who has had a Caesarean section in a previous pregnancy. However, it is a method with which all who are involved in monitoring should be familiar.

External method-A tocodynamometer of the 'guard-ring' type is used for this purpose. It is applied to the mother's abdomen near the fundus and responds to the forward displacement of the uterus as it contracts. It is important to understand that, while recording the duration and frequency of contractions, it does **not** provide an absolute measurement of basal or peak uterine pressure. However, it does provide a record of the frequency and duration of contractions, and because of the ease of application of the transducer the external method is most widely used in clinical practice.



Pressure transducer and catheter



External tocodynamometer

Nomenclature

It is necessary to agree on a nomenclature for describing an FHR trace which will be clear to all members of the medical and nursing staff on a labour ward. One of the earliest workers in the field, Caldeyro-Barcia, made an important contribution to monitoring when he divided the slowing of the FHR during contractions into Type 1 and Type 2 dips. This description is used widely throughout the world but has the limitation of only characterising the timing of the deceleration without providing information on the amplitude or duration. In addition, practical experience has shown that considerable confusion exists as to exactly what the distinction is between Type 1 and Type 2 dips. These difficulties have given rise to the following nomenclature used in this publication which is a modification of that proposed by Hon (1963, 1968), and which has the advantage of describing in simple terms all the significant characteristics of the FHR trace.

Definition of terms - see Figure 1.

Baseline FHR - *the* rate *between* contractions

Deceleration - *the* slowing of the FHR during a contraction.

If the FHR *increases* during a contraction, this is referred to as an '**Acceleration**'.

Lag-time - the time that elapses between the peak of a contraction and the lowest point of a deceleration.

Beat-to-beat variation - a term used to describe the variation in the FHR that is observed on the trace. It is a rather non-specific term which includes FHR variations that are not strictly 'beat-to-beat' having a longer time base. The term has the advantage of being easily understood and has been retained until a more precise method of quantitating FHR variability has evolved.

Basal tone - *the* resting pressure within the uterus between contractions. It can only be determined by internal methods of pressure measurement.

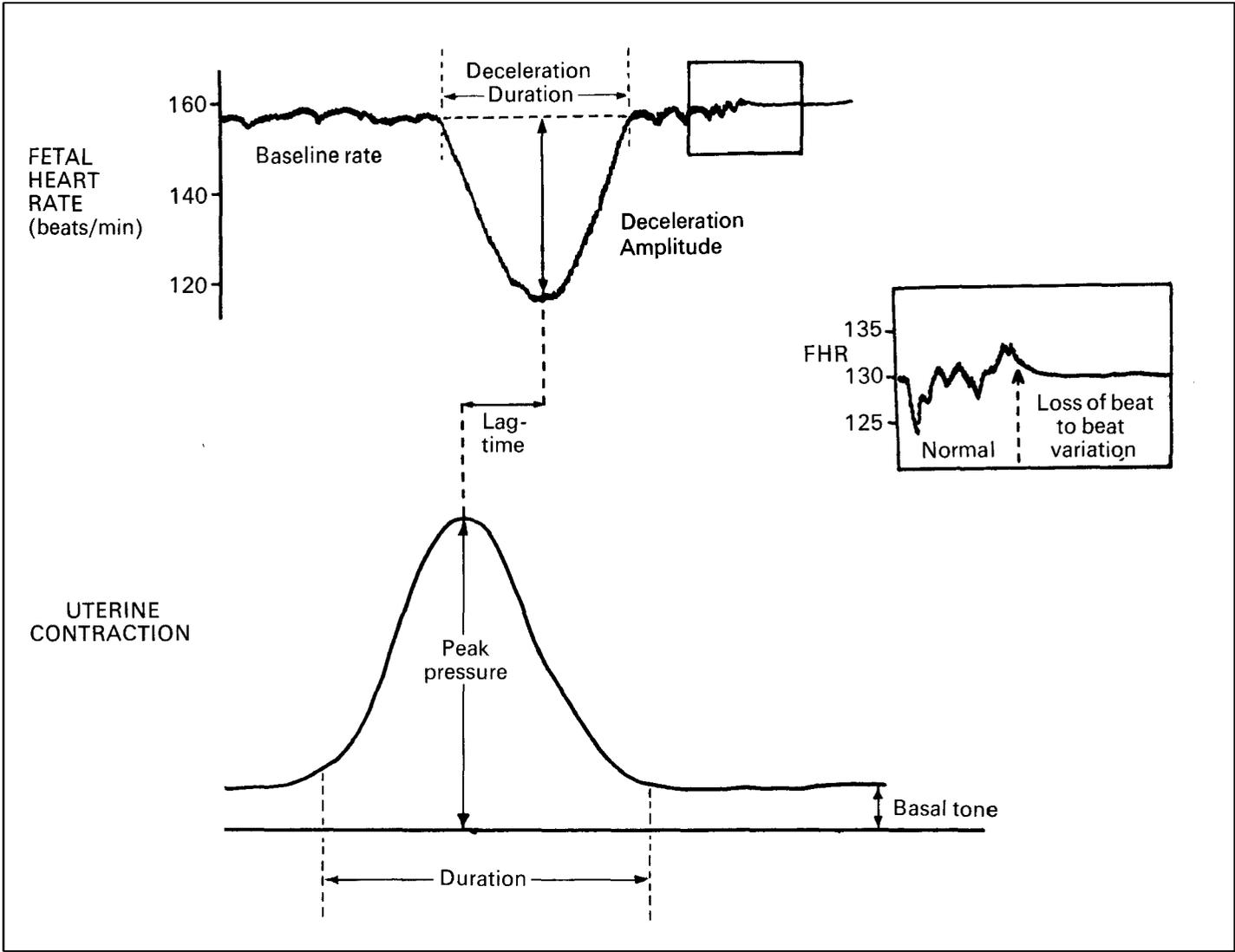
Peak pressure - *the* maximum intrauterine pressure achieved during a contraction. Again an internal method must be used to measure it.

Frequency of contractions - *usually* expressed as the number of contractions occurring over a 10 minute period, e.g. normally 3 or 4 in 10.

Duration of a contraction - *the* interval between the time when the uterus is first observed to contract, to when the pressure has returned to the resting level.

Hon, E. H. (1963). The classification of fetal heart rate, I. A working classification. *Obstetrics & Gynaecology*, 22,137.

Hon, E. H. (1968). An atlas of fetal heart rate patterns. Harty Press Inc., New Haven, Connecticut.



TERMS USED IN THE STUDY OF CONTINUOUS RECORDS OF FHR

Figure1

Significance of FHR traces relative to pH

As yet there is no generally agreed reference point against which the significance of FHR patterns can be assessed; what is needed is a reliable index of the effect that asphyxia is having on the condition of the fetus. Damage to fetal tissues will not occur until the tissues are so depleted of oxygen that lactic acid starts to accumulate. This being so, then the fetus is not in danger as long as its pH is maintained, whereas a fall in pH is evidence of significant asphyxia, particularly if this fall is progressive.

A comparison of FHR patterns against pH is presented in Figure 2 from Beard *et al* (1971). This shows that, although certain continuous FHR abnormalities are associated with a higher incidence of acidosis than others, there is still a considerable overlap. Even the worst pattern (complicated tachycardia) has only a 53% incidence of fetal acidosis (pH $\times 7.25$), and this underlines the need to use pH determinations as an adjunct to FHR monitoring, for neither tells the whole story on its own.

The traces in the following section are used to illustrate the nomenclature and to indicate the clinical significance of certain fetal heart patterns. Although typical traces have been selected, it should be recognised that because of the considerable degree of variation commonly found in clinical practice, a classical trace of any pattern rarely occurs. The classification of FHR patterns that has been adopted is proposed as a guide to the clinician to enable him to decide whether further investigation by pH measurement is necessary. Mean pH values for particular patterns are taken from the study by Beard *et al* (1971).

For reference purposes, a summary of these fetal heart rate patterns and their clinical significance is provided on page 54.

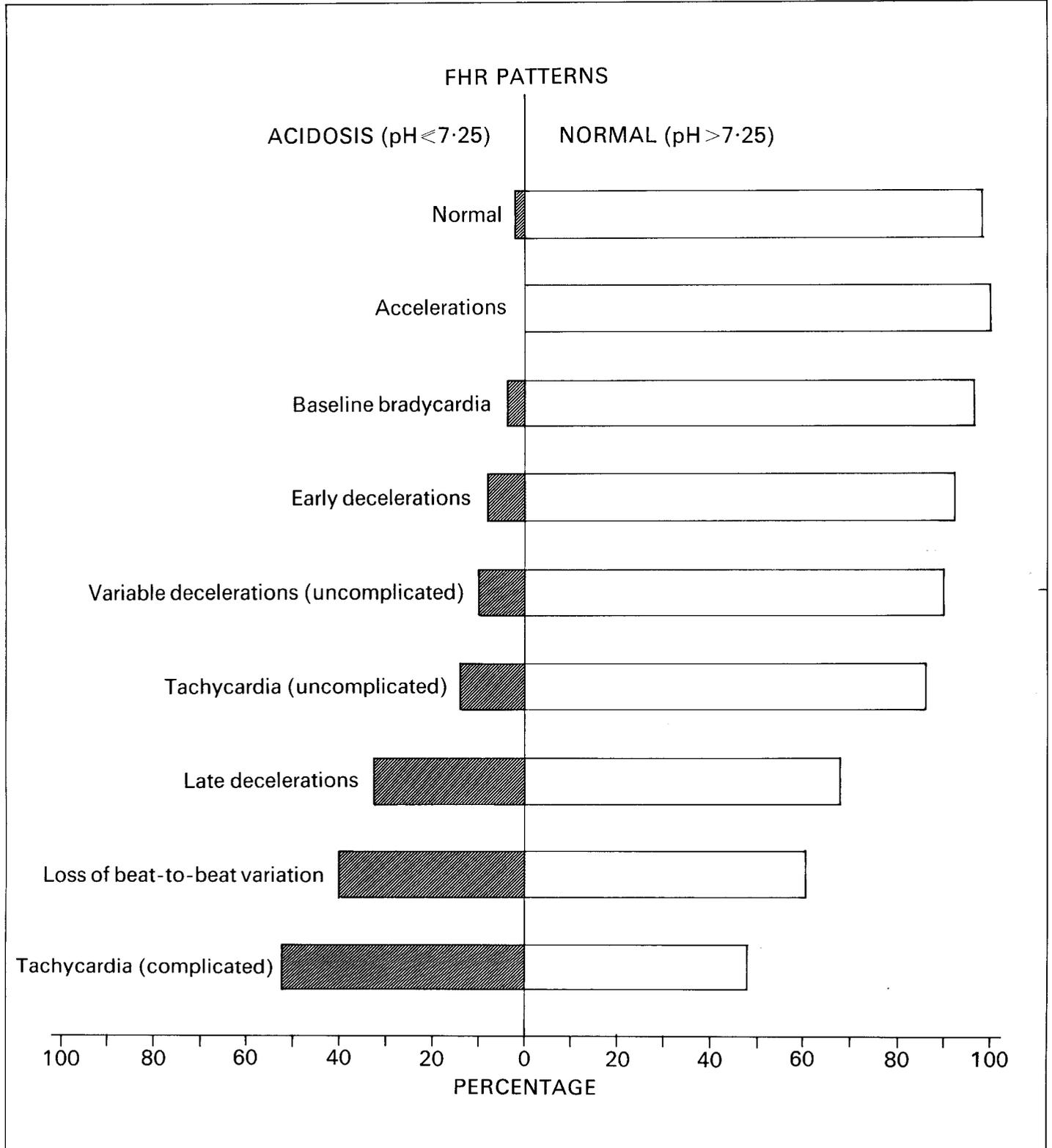


Figure 2

Normal

Normal pattern has the following characteristics

- a rate within the range of 120 to 160 beats/minute.
- no change in rate, during the uterine contraction.
- variability ('beat-to-beat variation') of five or more beats/minute.

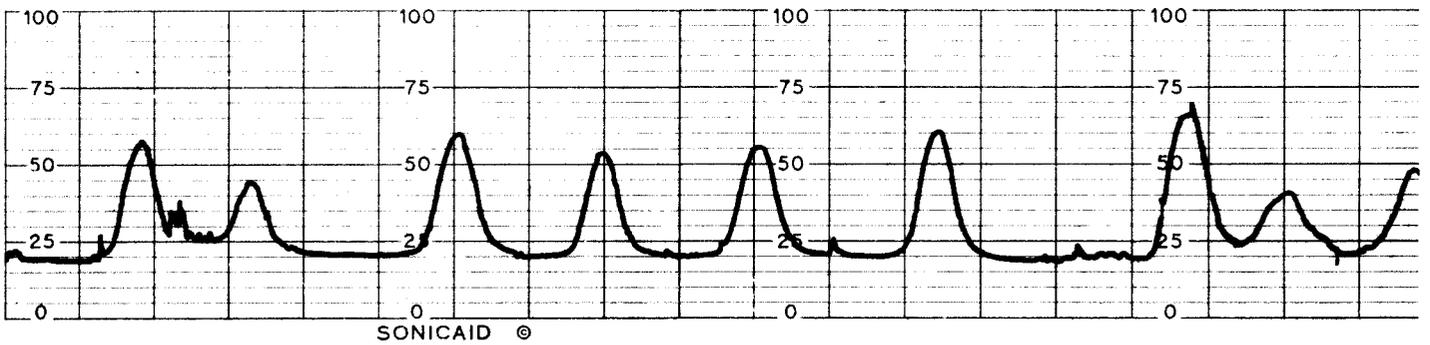
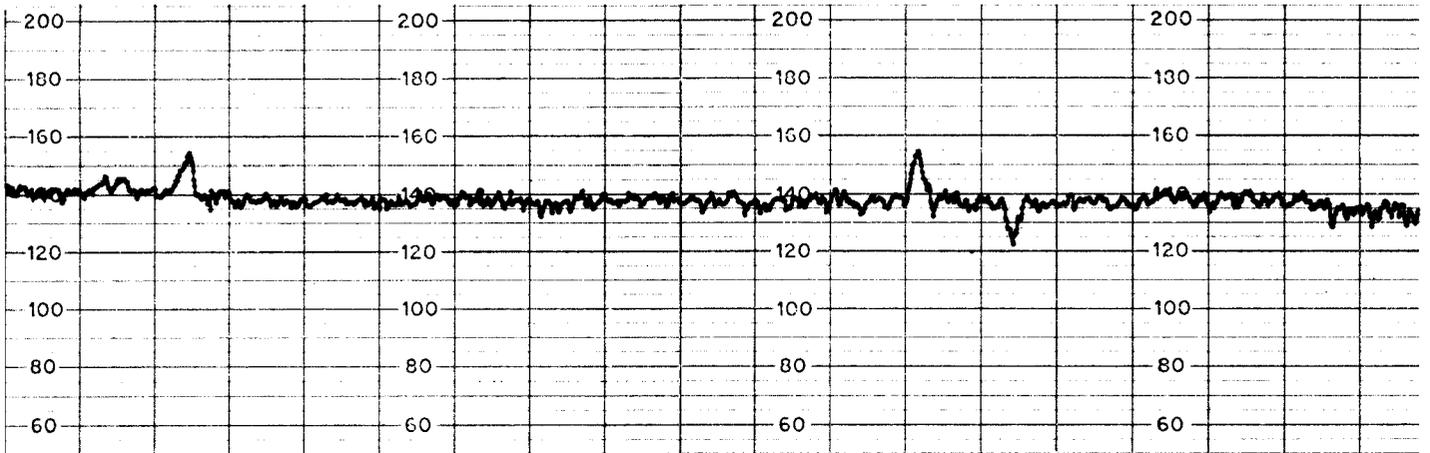
A normal pattern is reliable evidence that the fetus is in good condition, and it is unnecessary to investigate the fetus further by pH measurement so long as this pattern persists.

(Mean fetal pH 7.34 ± 0.056)

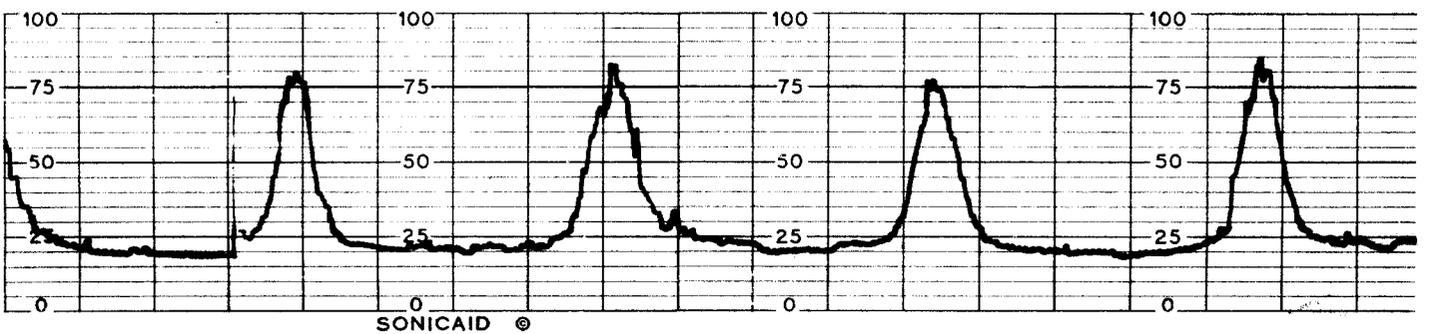
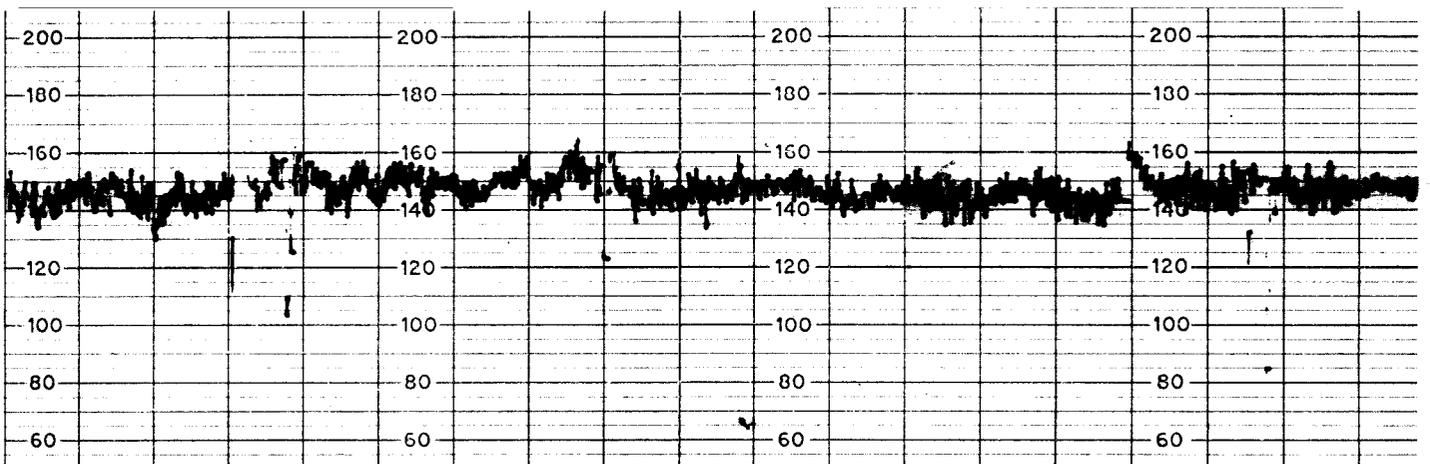
ILLUSTRATIVE FHR TRACES

Moan

Normal trace - ECG



Normal trace- Ultrasound



Baseline Bradycardia

Baseline bradycardia is a fetal heart rate of less than 120 beats/minute.

The pattern *is* **uncomplicated** if it shows good beat-to-beat variation without decelerations during contractions as in the upper trace opposite.

This is *not* an adverse pattern and is probably evidence of a vagal response. It is not necessary to determine the fetal pH unless the trace becomes abnormal in some way.

(Mean fetal pH 7.31 ±0.043)

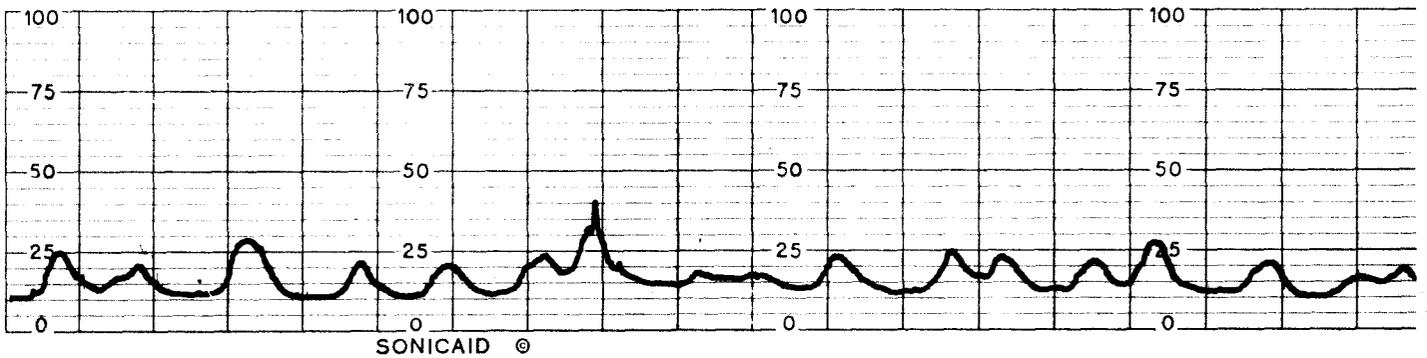
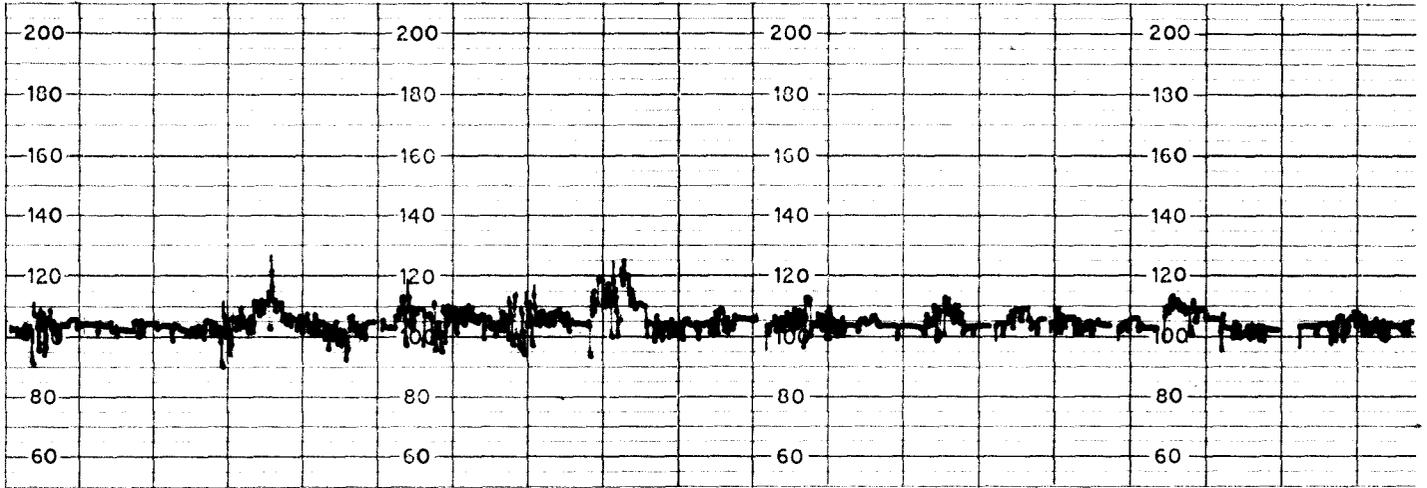
The pattern *is* **complicated** if the trace shows any abnormality such as loss of beat-to-beat variation or decelerations. Fortunately this pattern is rare as it is commonly caused by fetal asphyxia.

The pattern in the lower trace opposite is particularly serious showing profound baseline bradycardia with marked loss of beat-to-beat variation. Some recovery has occurred at the end of the trace but late decelerations are present. The patient should be turned on her side, given oxygen, and the fetal pH determined. If the trace returns to normal labour may continue, but if the trace remains abnormal and the fetus is acidotic, delivery should be performed without further delay.

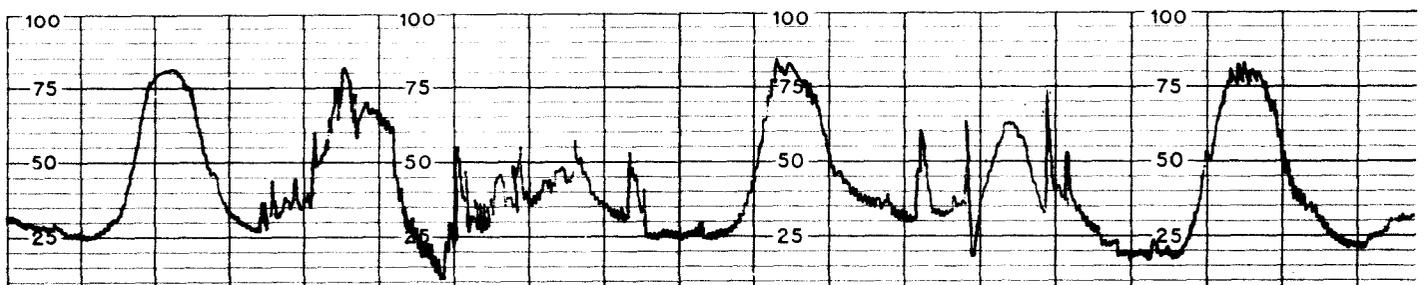
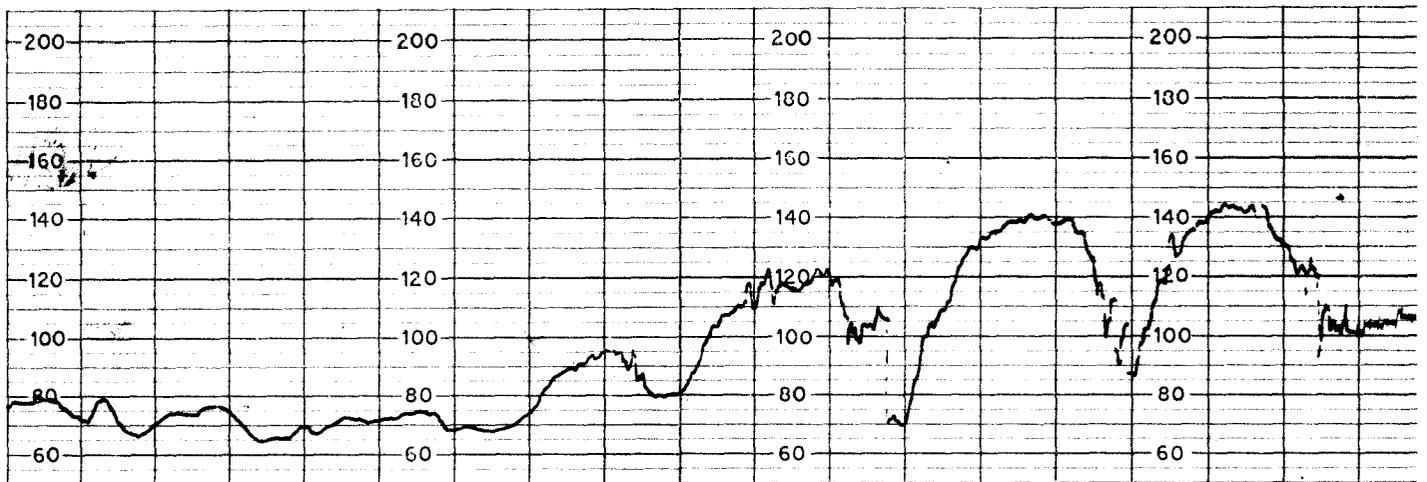
ILL US TRA TI VE MR TRACES

Baseline Bradycardia

Uncomplicated baseline bradycardia — Ultrasound



Complicated baseline bradycardia — ECG



Baseline Tachycardia

Baseline tachycardia is a fetal heart rate of 160 or more beats/minute.

The pattern is **uncomplicated** if it is not associated with decelerations during contractions.

Commonly there is some apparent loss of beat-to-beat variation on the trace which is usually non-asphyxial in origin. This is *not* an adverse pattern unless it is associated with maternal pyrexia or ketosis. It is wise to estimate the pH and temperature of the mother. The fetal pH should also be measured, but it should be remembered that fetal acidosis is only a terminal event when a fetus dies from intrauterine infection.

(Mean fetal pH 7.33 ± 0.052)

Both traces on the opposite page are examples of uncomplicated baseline tachycardia.

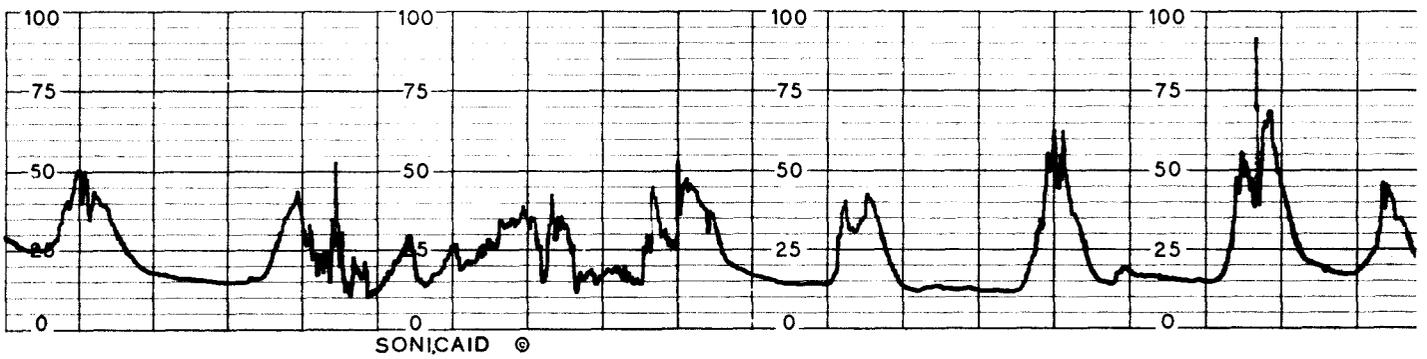
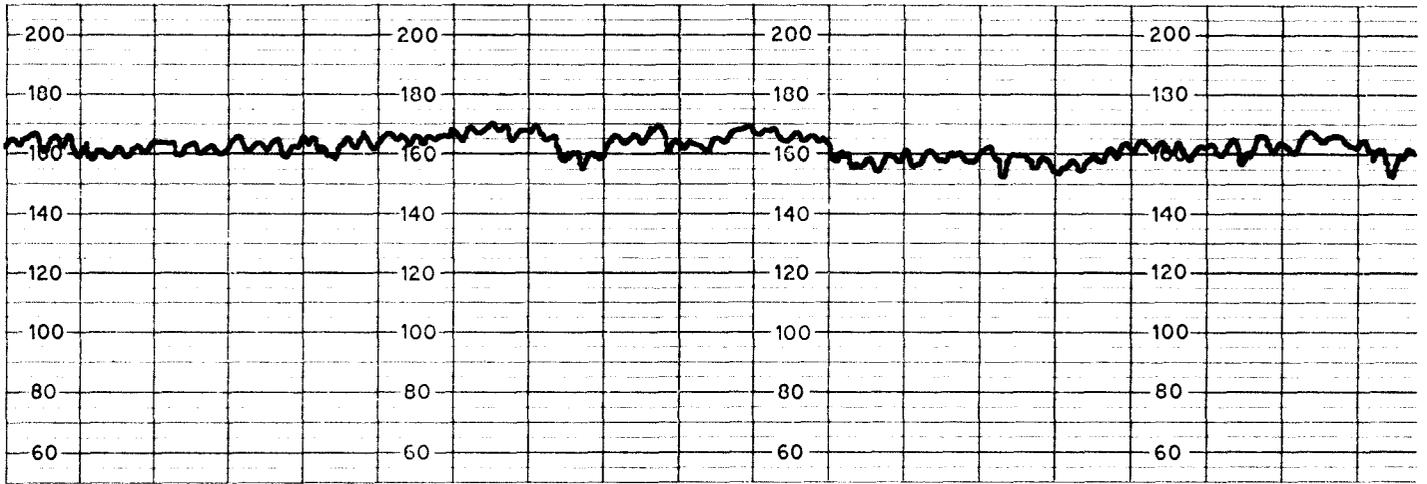
The pattern is **complicated** if decelerations of any variety occur during contractions.

Examples of this pattern are covered by the traces of 'complicated variable decelerations' - page 25. The fetal pH should always be estimated when this pattern is present.

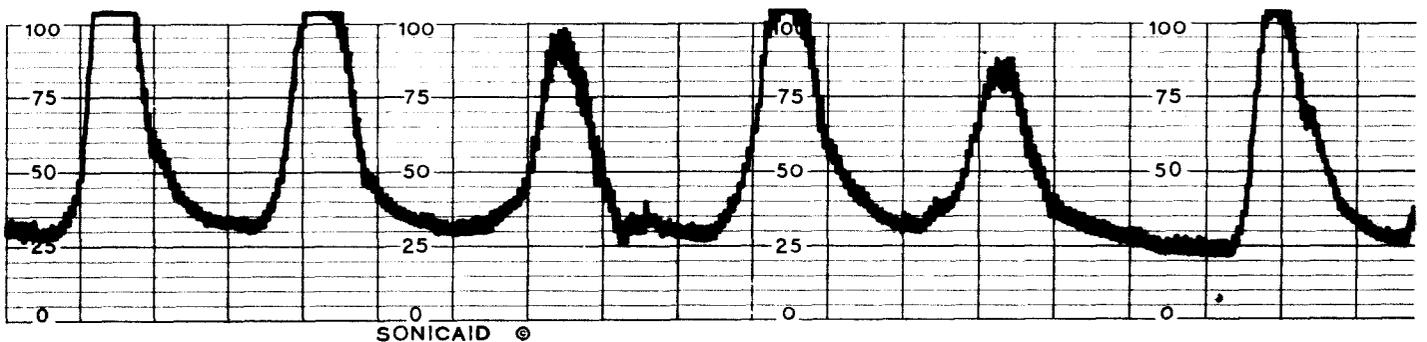
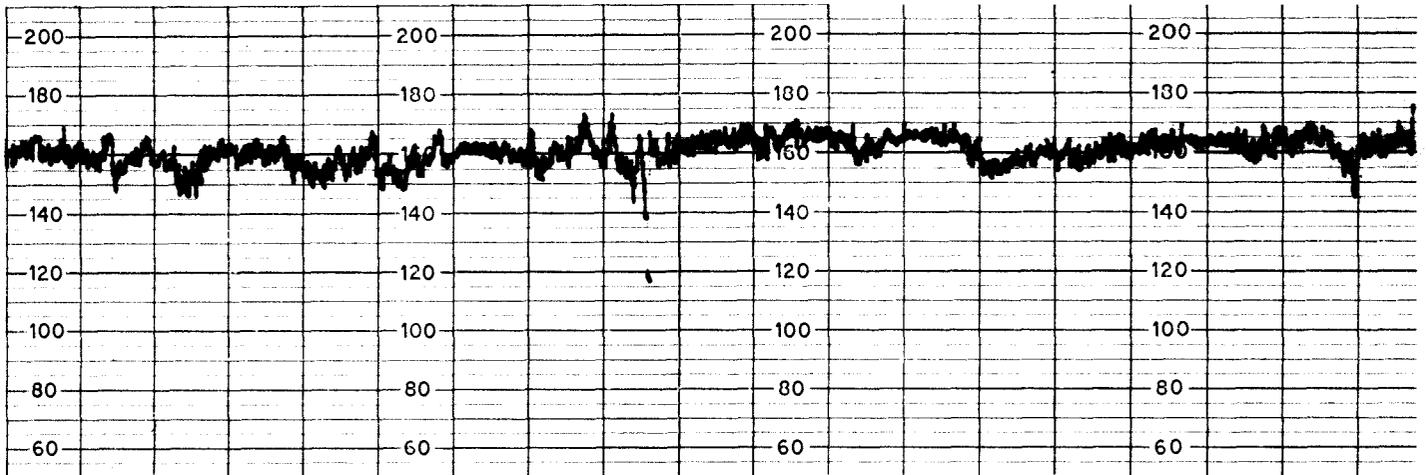
ILLUSTRATIVE FHR TRACES

Baseline Tachycardia

Uncomplicated baseline tachycardia — ECG



Uncomplicated baseline tachycardia- Ultrasound



Acceleration

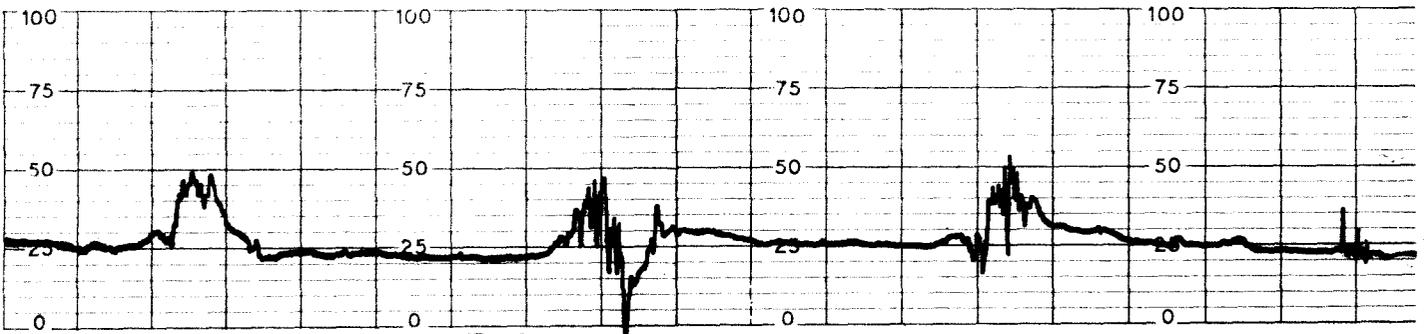
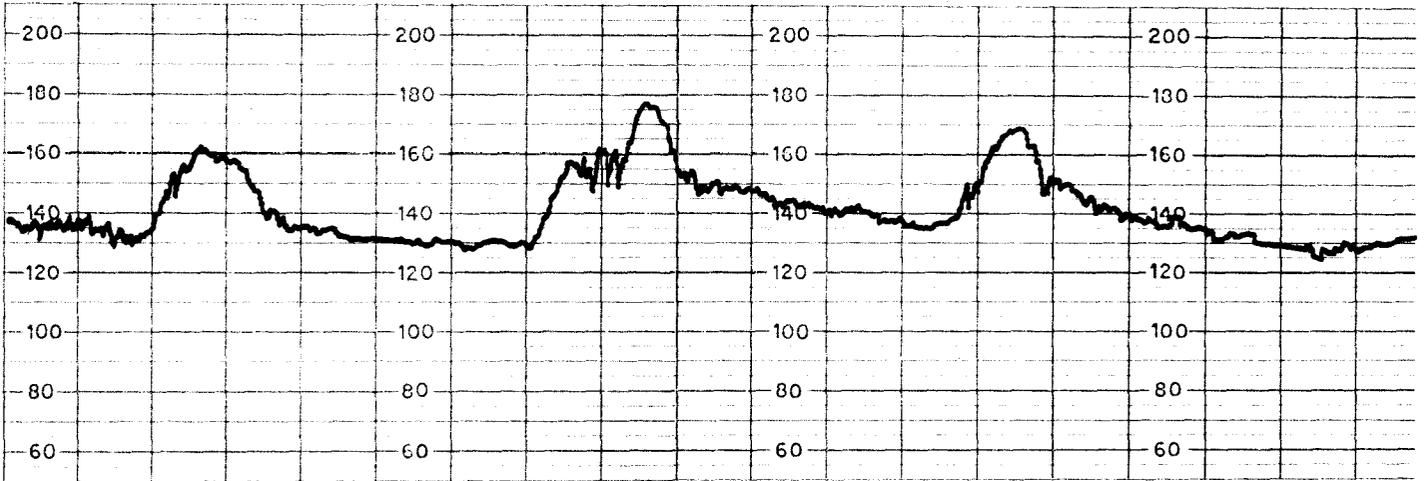
Acceleration pattern is an increase in fetal heart rate at the start of a uterine contraction, returning to the baseline rate before, or sometimes after, the end of the contraction. It is *not* an adverse pattern, and indicates good reflex responsiveness of the fetal circulation. No further investigation is required.

(Mean fetal pH 7.34 ± 0.033)

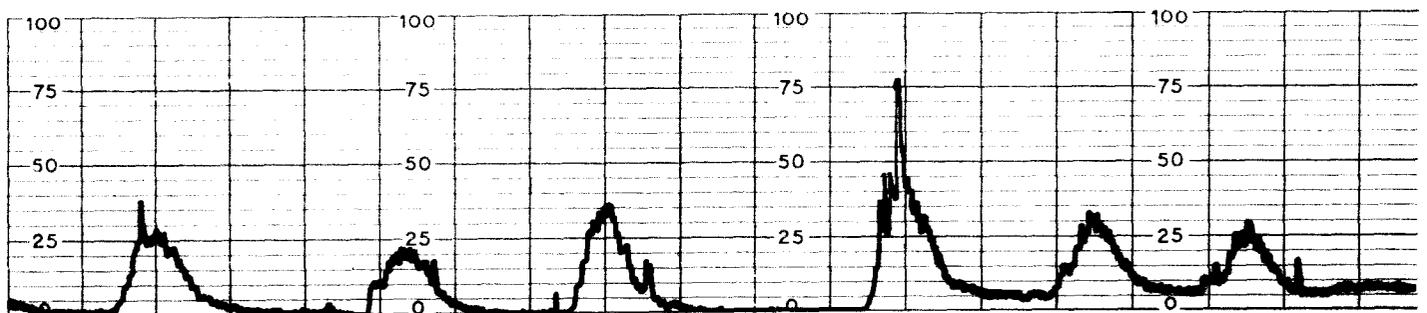
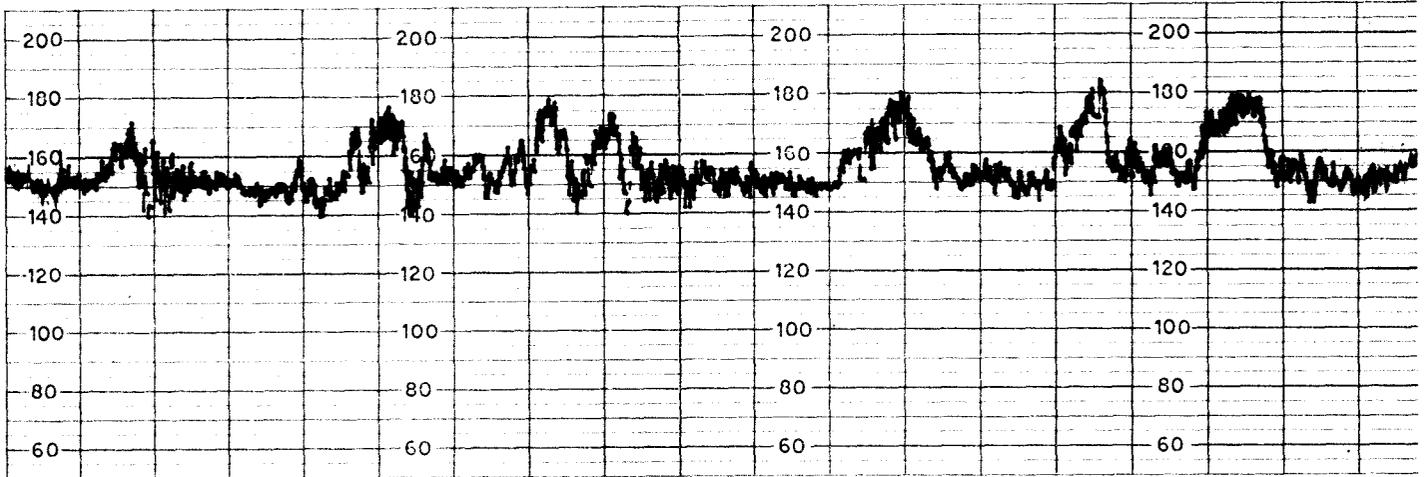
ILLUSTRATIVE FHR TRACES

Acceleration

Accelerations — ECG



Accelerations - Ultrasound



Early Deceleration (Type I dip)

Early deceleration pattern (Type 1 dip) has the following characteristics

- onset of the decelerations is usually at the start of the contraction.
- recovery of the baseline FHR occurs by the end of the contraction.
- the amplitude of the deceleration is relatively small usually being less than 40 beats/minute.

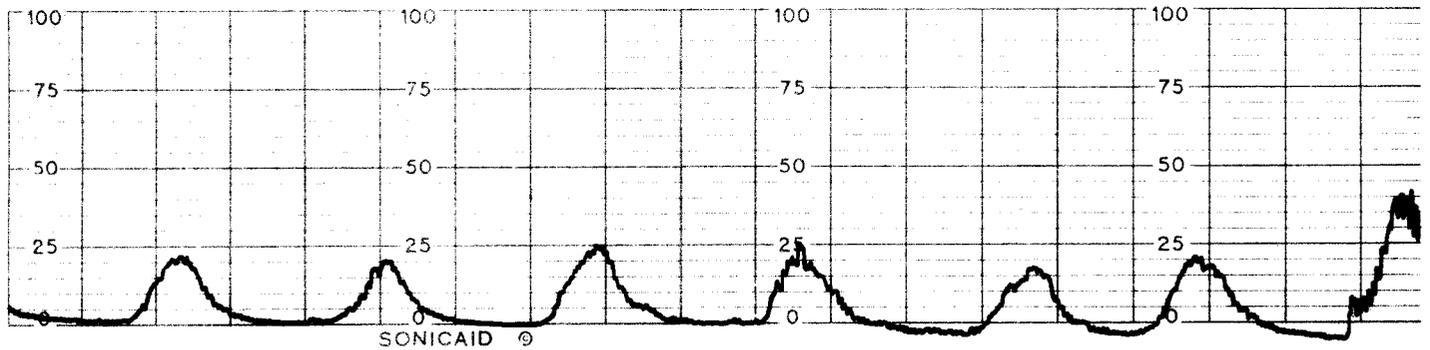
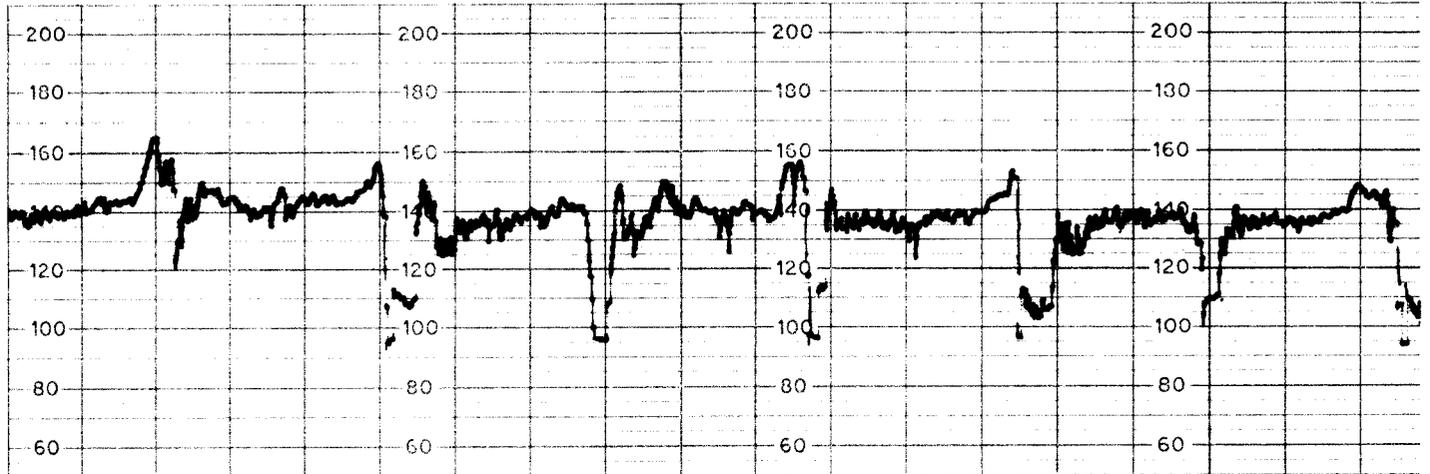
A trace that is normal apart from early decelerations is usually associated with a fetus in good condition. However, while such a pattern may be associated with a non-asphyxial condition such as head compression, it may also be an early warning of asphyxia due to umbilical cord compression or placental insufficiency. For this reason early decelerations should be watched carefully - if they remain unaltered no further investigation is necessary, but if they develop into 'variable' decelerations it will be necessary to obtain a fetal blood sample in order to estimate the fetal pH.

(Mean fetal pH 7.33 ± 0.045)

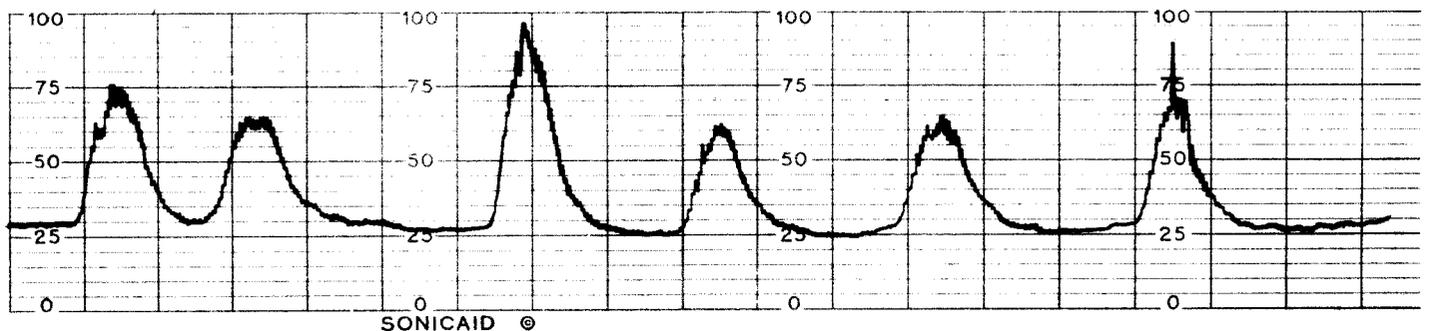
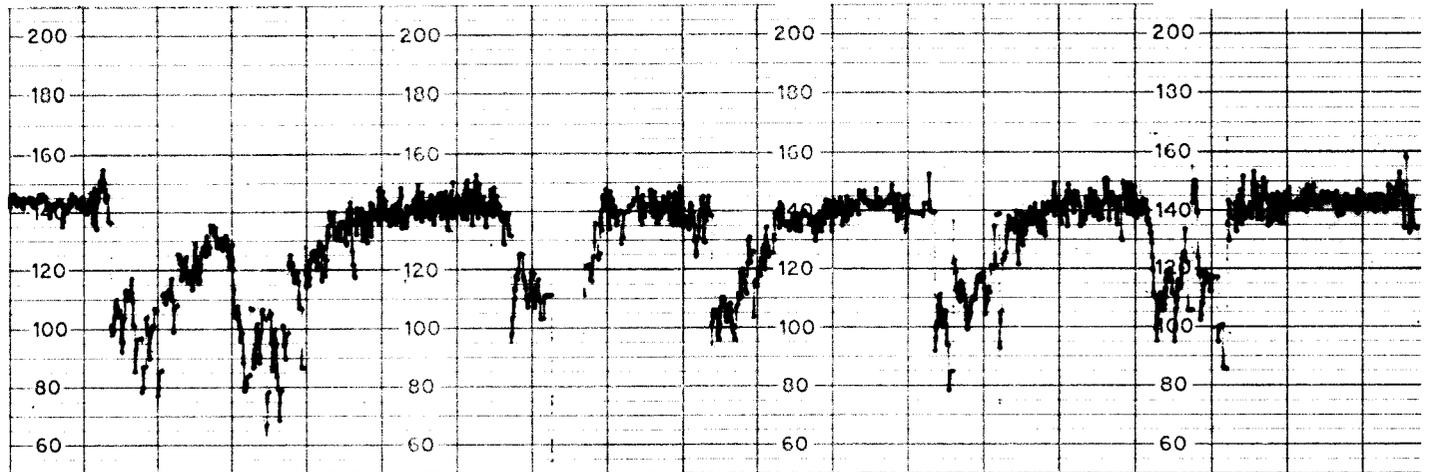
ILLUSTRATIVE FHR TRACES

Early Deceleration (Type 1 dip)

Early deceleration — ECG



Early deceleration -Ultrasound



Variable Deceleration

Variable deceleration pattern has the following characteristics

- appearance either at the onset of, or later in the contraction phase.
- the deceleration has an irregular shape which is variable, with an amplitude of more than 50 beats/minute.

The pattern is **uncomplicated** if the baseline rate and beat-to-beat variation are within normal limits.

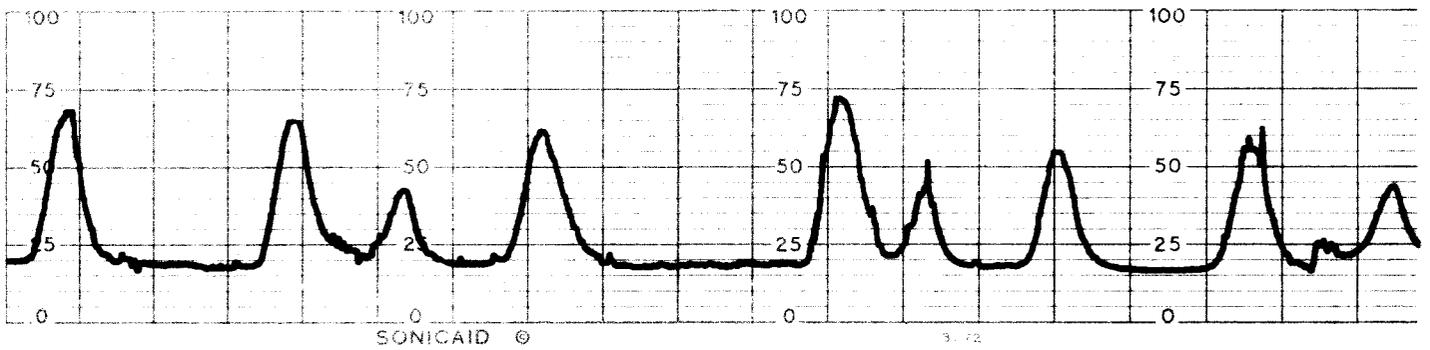
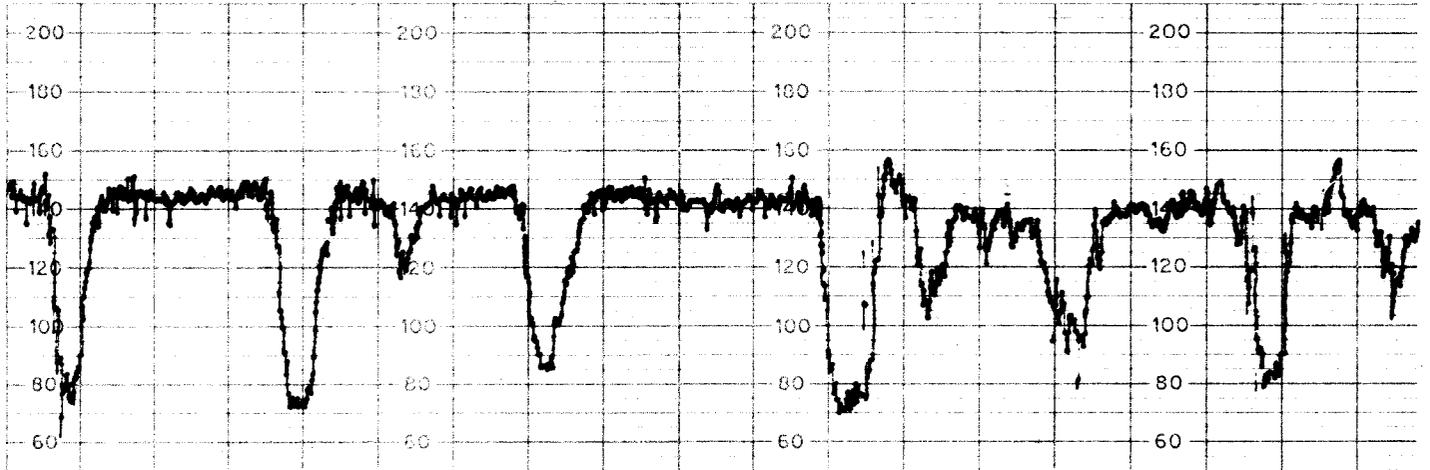
Like the 'early' deceleration it may be a preliminary to a more abnormal pattern associated with fetal asphyxia particularly if it appears consistently with each contraction.

(Mean fetal pH 7.31 ± 0.048)

ILLUSTRATIVE FHR TRACES

Variable Deceleration

Uncomplicated variable decelerations — ECG



Variable Deceleration

The pattern is **complicated** if it is associated with baseline tachycardia and/or loss of beat-to-beat variation.

It is an abnormal pattern which may be evidence of fetal asphyxia.

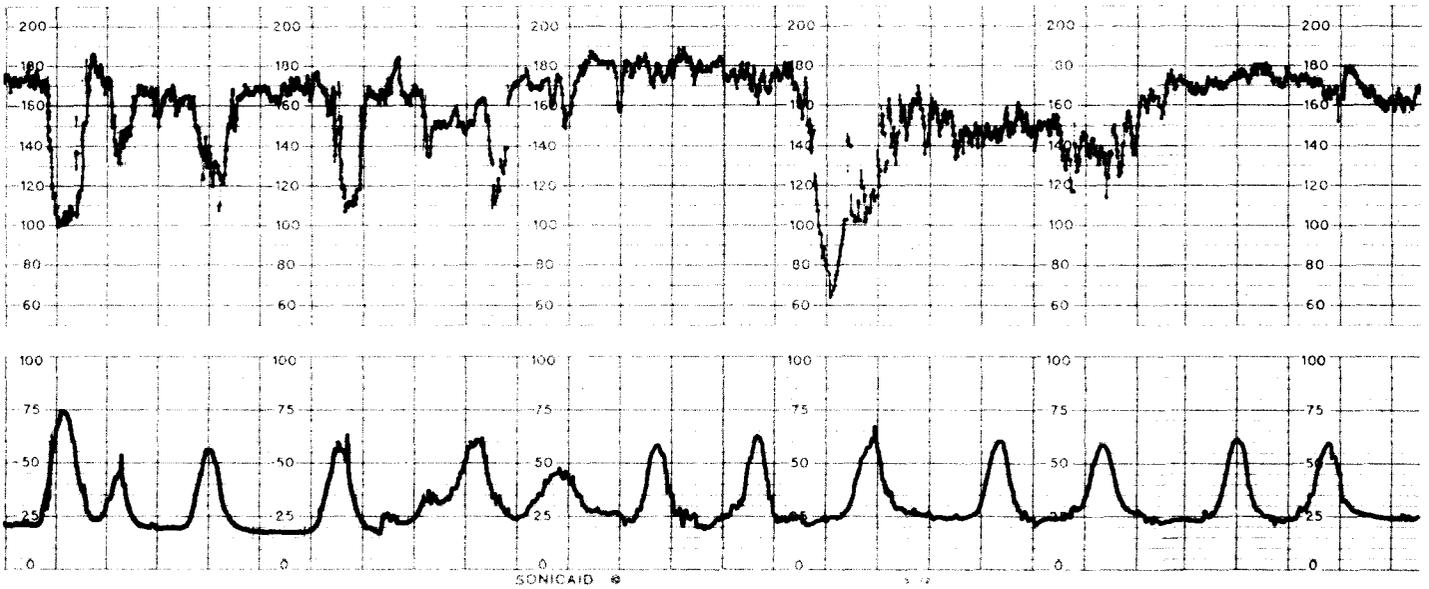
(Mean fetal pH 7.22 ± 0.075)

The clinical significance of variable decelerations is often difficult to determine. Single or intermittent decelerations are obviously of less significance than those appearing with every contraction. In general if variable decelerations recur after turning the patient on her side it is wise to determine the fetal pH.

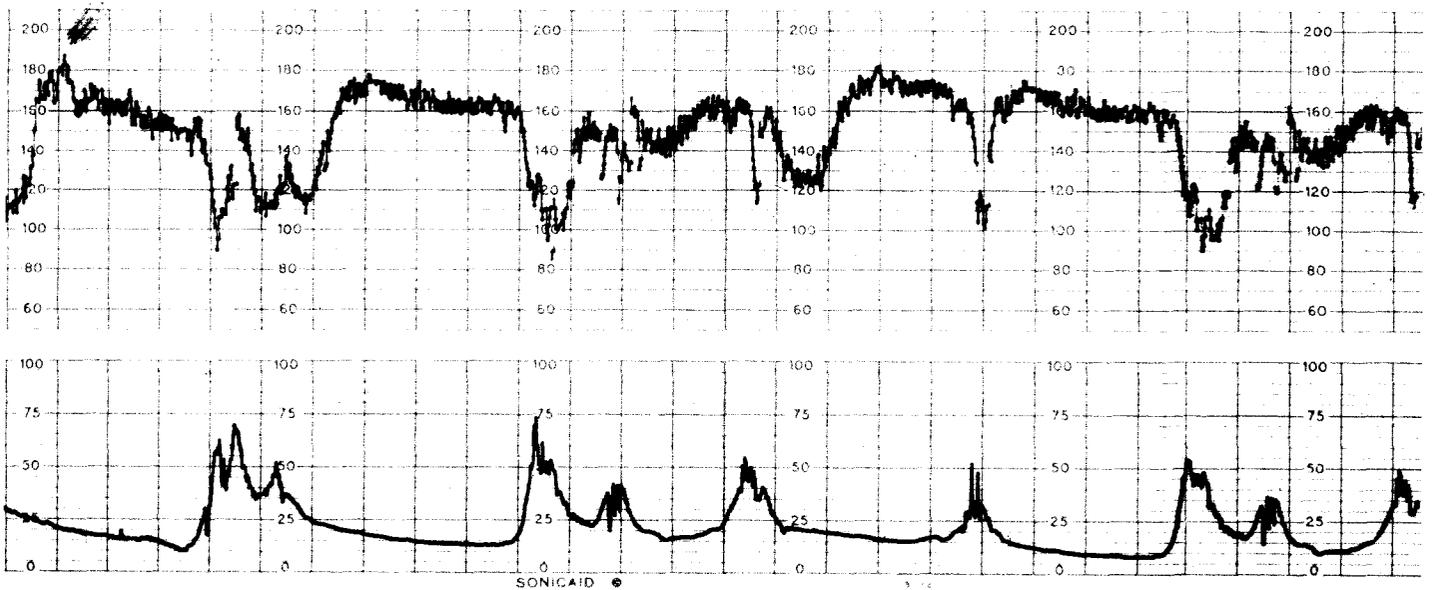
ILLUSTRATIVE FHR TRACES

Variable Deceleration

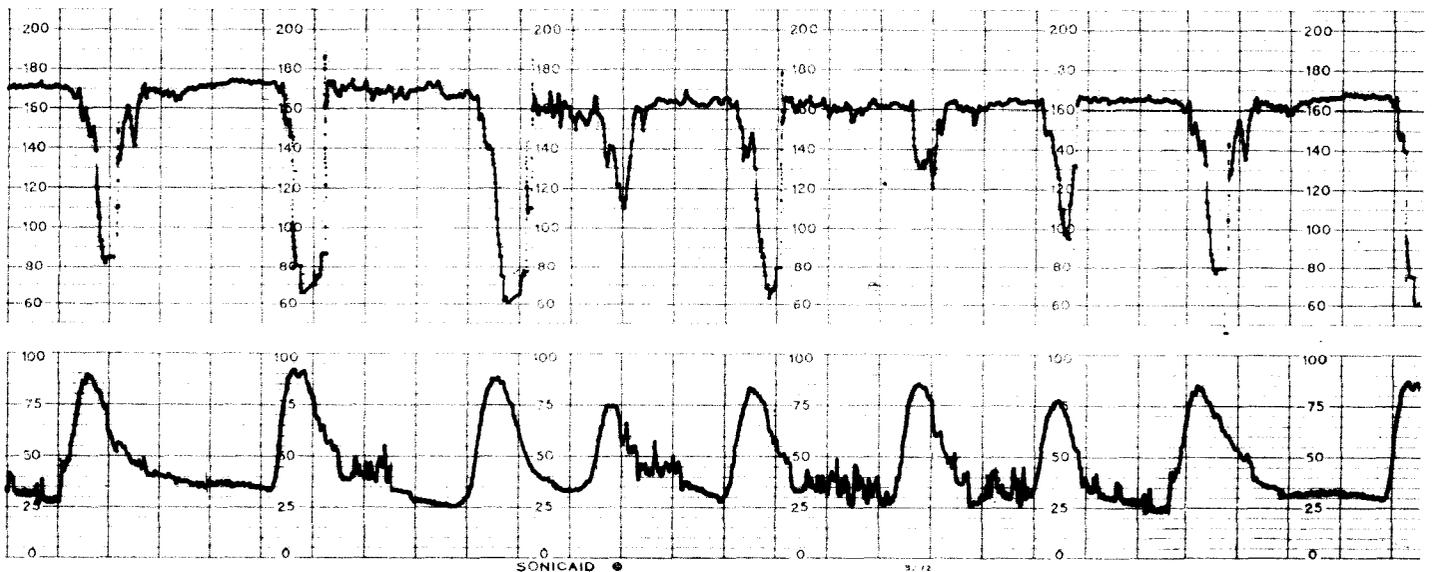
Complicated variable deceleration (with baseline tachycardia) — ECG



Complicated variable deceleration (with baseline tachycardia) — Ultrasound



Complicated variable deceleration (with baseline tachycardia and loss of beat-to-beat variation) — Ultrasound



Late Deceleration (Type 2 dip)

Late deceleration pattern (Type 2 dip) describes any deceleration whose lowest point is past the peak of the contraction and thus has lag-time. For example, a variable deceleration with lag-time is described as a 'late variable deceleration'. In general the greater the lag-time, the more serious is the condition of the fetus. The most ominous form of late deceleration in this respect is the one that is shallow with an associated baseline tachycardia and loss of beat-to-beat variation as shown in the upper trace opposite. This pattern was recorded in the recovery phase following the administration of epidural anaesthesia. (See Case History 3 - page 42 - for a discussion of the effects of this drug.)

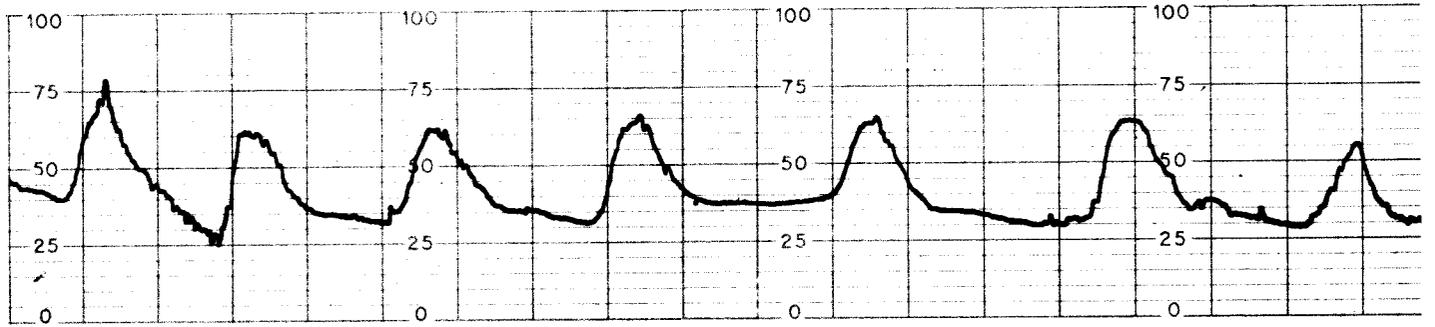
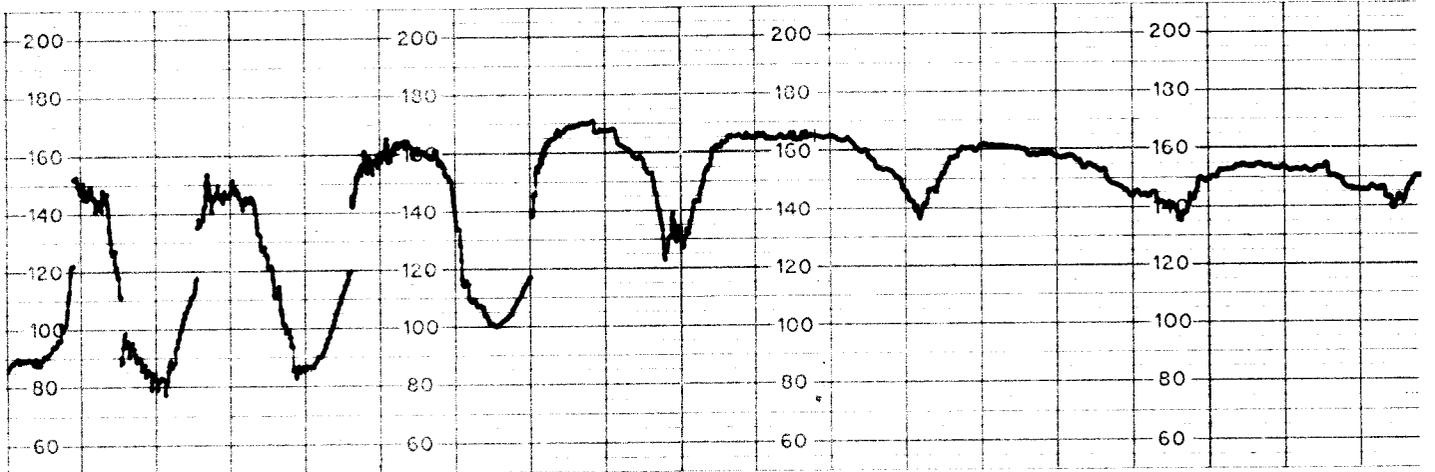
(Mean fetal pH 7.24 ± 0.073)

Another variety is shown in the lower trace opposite. (Note that the trace was recorded by ultrasound so that it is unwise to rely entirely on the apparently good beat-to-beat variation.)

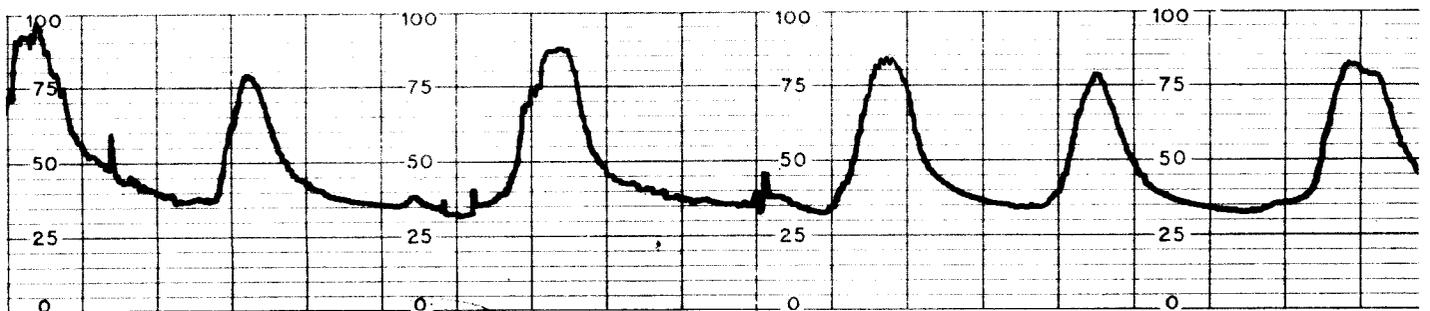
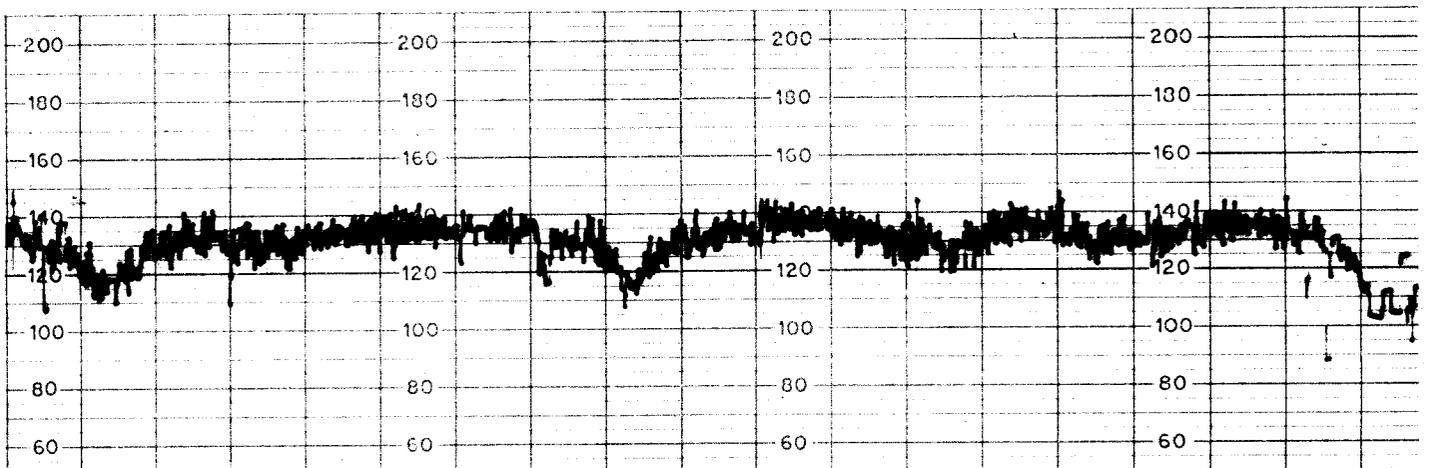
ILLUSTRATIVE FHR TRACES

Late Deceleration (Type 2 dip)

Late decelerations — ECG



Late decelerations — Ultrasound



Loss of beat-to-beat variation

Loss of beat-to-beat variation describes the instantaneous fetal heart rate with a variability of less than 5 beats/minute. At the moment, until more precise methods of quantitation are evolved, it is necessary to assess beat-to-beat variation from the appearance of the trace.

The pattern is **uncomplicated** if it is not accompanied by decelerations.

The cause of uncomplicated loss of beat-to-beat variation is not fully understood but it is known that a number of drugs commonly used in labour such as pethidine and diazepam reduce FHR variability. Thus a 'normal' trace may appear abnormal because of the absence of beat-to-beat variation even though the fetus is well oxygenated.

(Mean fetal pH 7.30 ± 0.061)

The pattern is **complicated** if the loss of beat-to-beat variation is accompanied by an abnormal baseline or by decelerations.

A pattern of this kind is frequently associated with asphyxia to some degree particularly if the deceleration is late and shallow. (See the patterns of complicated variable decelerations-page 25, and late decelerations-page 27.)

(Mean fetal pH 7.24 ± 0.073)

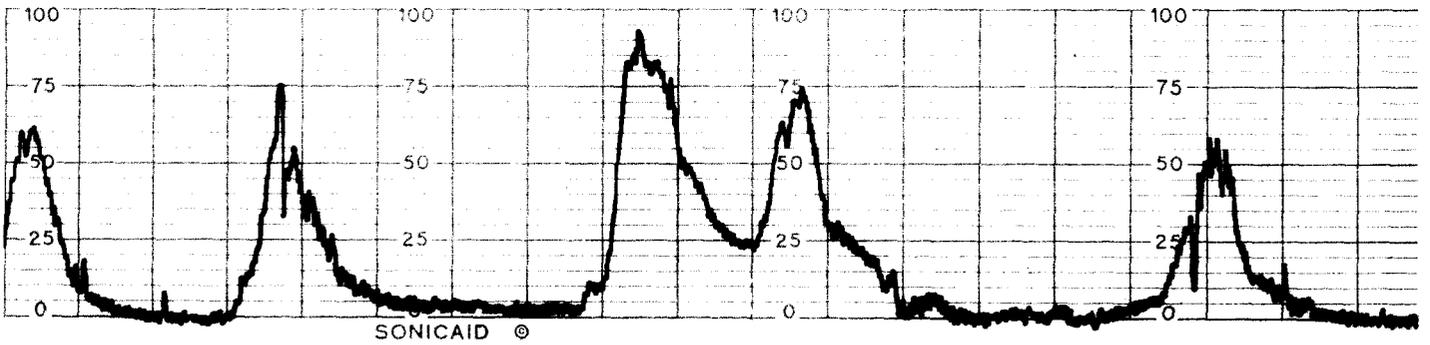
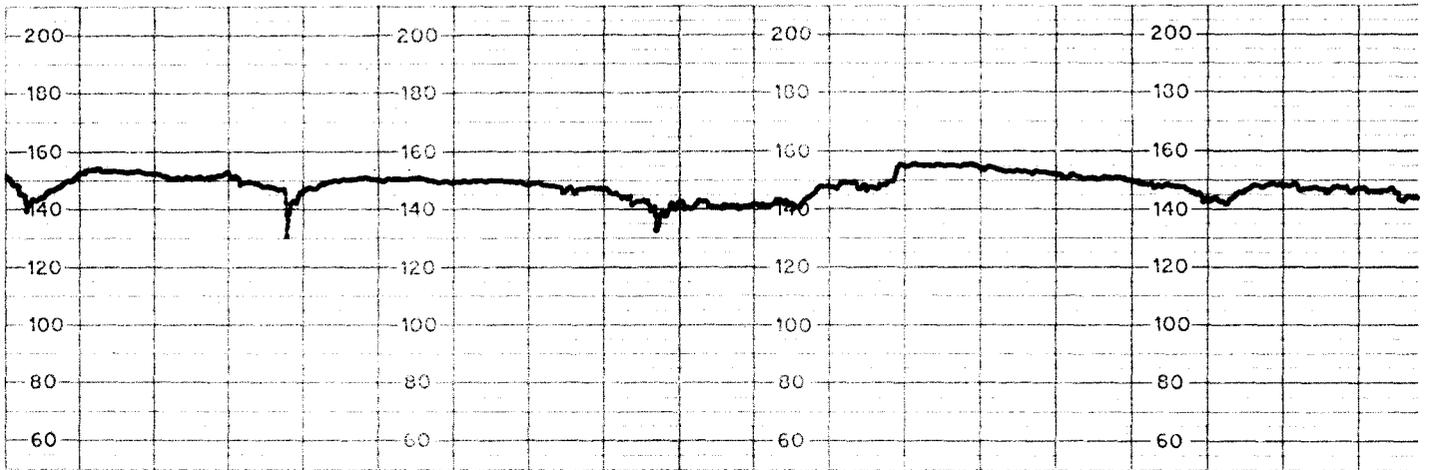
In general it is wise to estimate the fetal pH if the trace shows a persistent loss of beat-to-beat variation.

Uncomplicated loss of beat-to-beat variation is shown in the recordings opposite. The ultrasound trace shows an abrupt change as beat-to-beat variation disappears following drug administration.

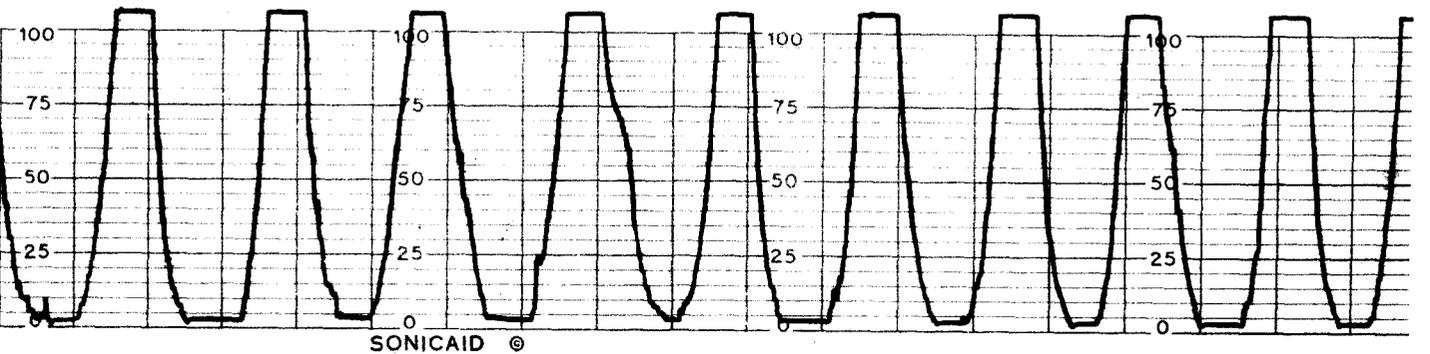
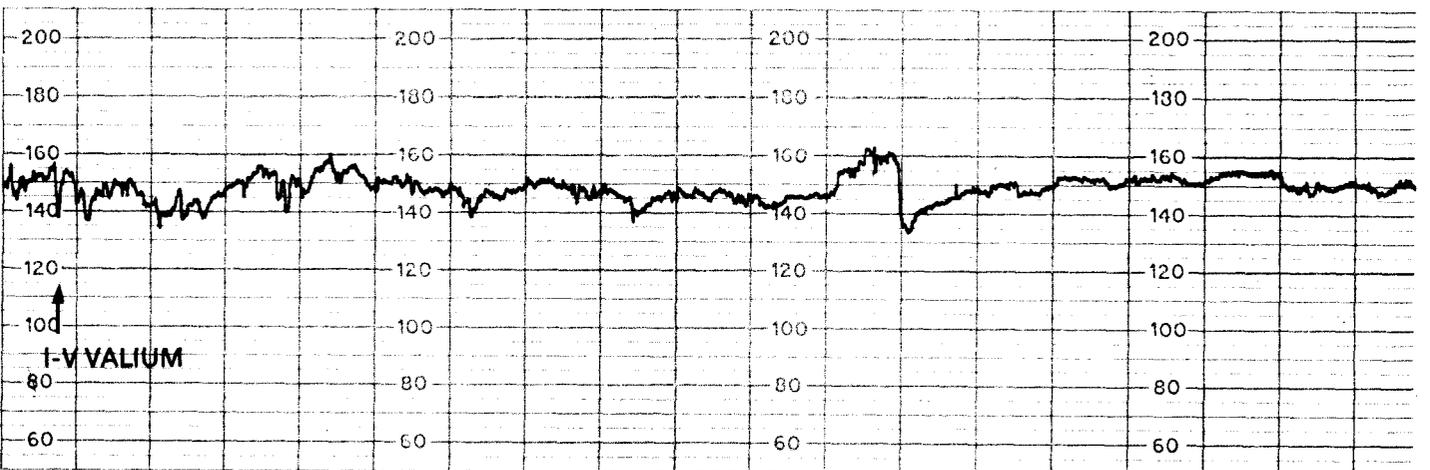
LUSTRATIVE FHR TRACES

Loss of beat-to-beat variation

Non-asphyxial loss of beat-to-beat variation — ECG



Uncomplicated loss of beat-to-beat variation — Ultrasound



Normal

Normal contractions in the first stage have the following characteristics

- a frequency in the range 3 to 4 contractions every 10 minutes
- a duration up to 75 seconds
- basal tone of 5 to 12mm Hg
- peak pressure in the range 30 to 60mm Hg

Upper trace **First stage** contractions recorded *by intrauterine catheter*

Frequency	3-5 contractions every 10 minutes
Duration	70 seconds
Basal tone	5 to 7mm Hg
Peak pressure	45 to 65mm Hg

Middle trace **First stage** recorded *by external transducer*

Frequency	3 contractions every 10 minutes
Duration	65 seconds
Basal tone and peak pressure cannot be recorded by external means.	
N.B. Paper speed 3cm/min.	

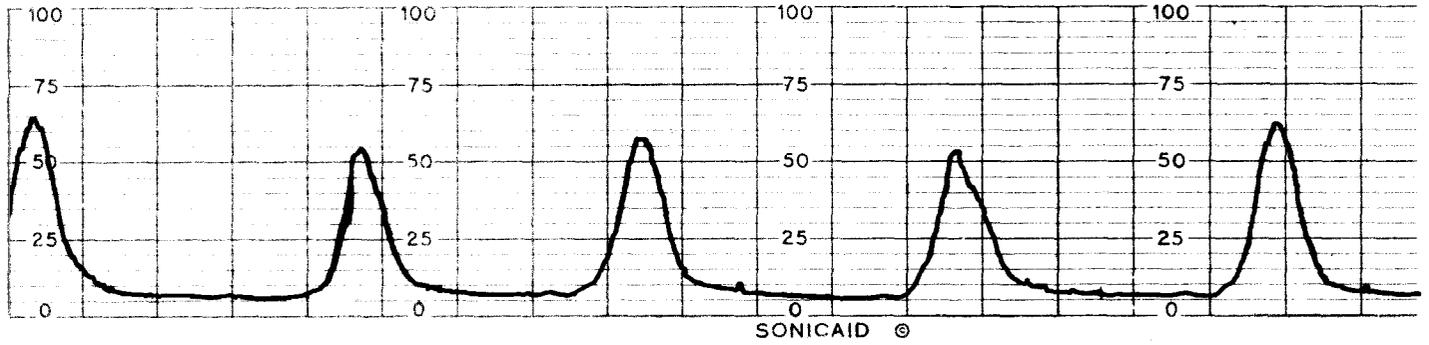
Lower trace **Second stage** recorded *by external transducer*

Multi-spike contractions typical of second stage due to superimposition of maternal 'pushing' and respiratory effort.	
Frequency	4-5 contractions every 10 minutes
Duration	60 to 85 seconds.

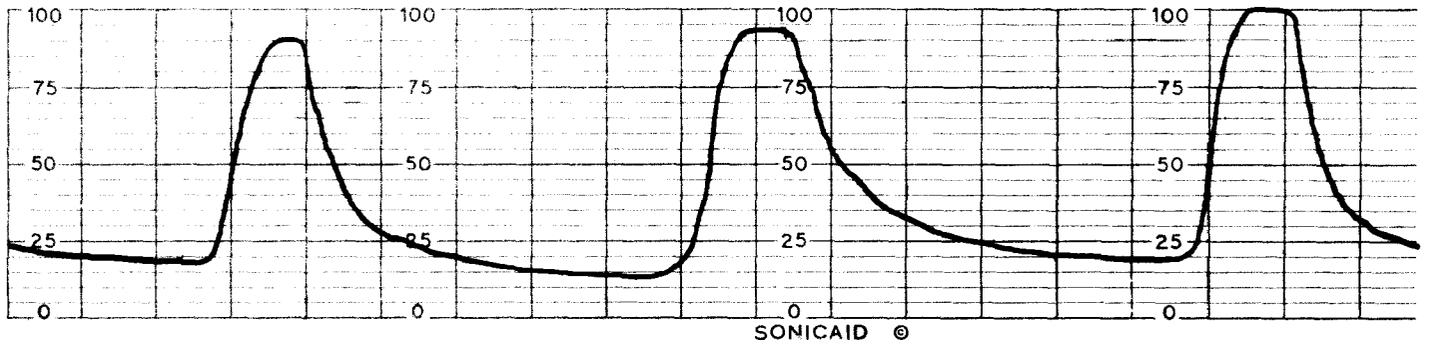
UTERINE CONTRACTIONS

Norm W

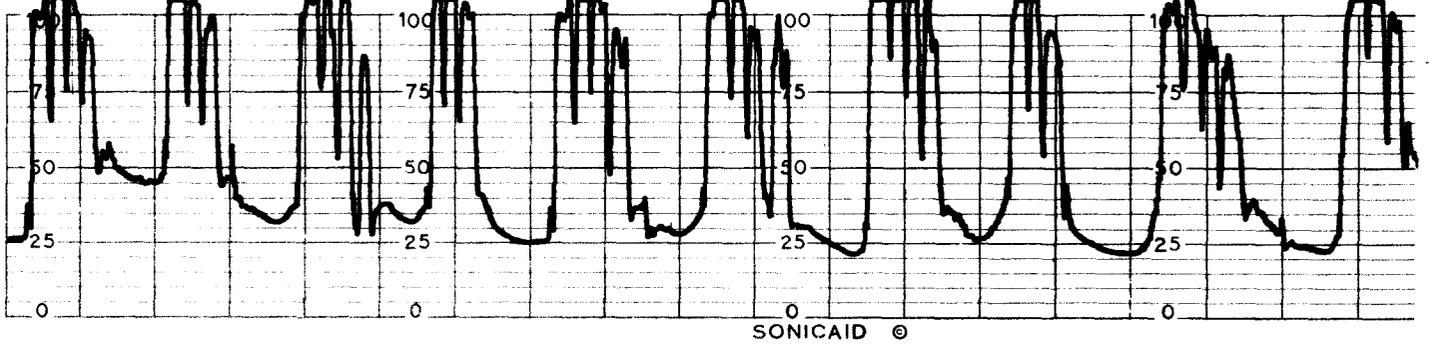
Normal contraction trace - internal



Normal contraction trace- external (at 3 cm/min)



Normal second stage contraction trace - external



Abnormal

Respiratory artefact is exhibited on the upper contraction trace opposite which shows first stage uterine contractions with irregular wave form caused by maternal respiratory effort. Patient restless and hyperventilating.

Abnormal uterine contractions of three different types are shown together opposite.

Upper trace	Severely disordered uterine activity with basal tone raised intermittently from 0 to 25mm Hg. Occasional regular contractions followed by 'notched' contractions with from 40 to 75mm Hg.
Middle trace	More normal trace of uterine activity. Irregular contractions with peak pressures ranging from 25 to 65mm Hg. Note how a contraction which appears normal at the onset may be followed, before full uterine relaxation has been reached, by another contraction (often referred to as 'coupling').
Lower trace	Major abnormality is shown by a tendency for the basal tone to remain elevated and an abnormal frequency of 6 contractions every 10 minutes.

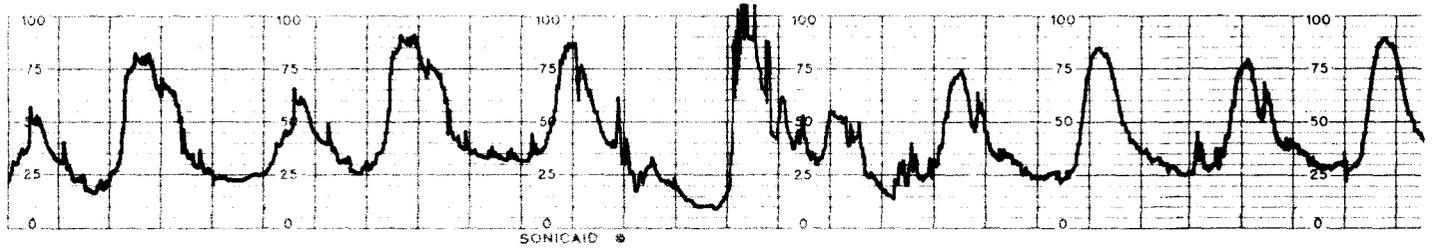
These three cases are examples of the over-administration of oxytocin and were induced without rupture of the membranes. Similar records are occasionally obtained in women in spontaneous labour usually with cephalopelvic disproportion.

Management Reduce the amount of oxytocin infused until a normal pressure trace is obtained.

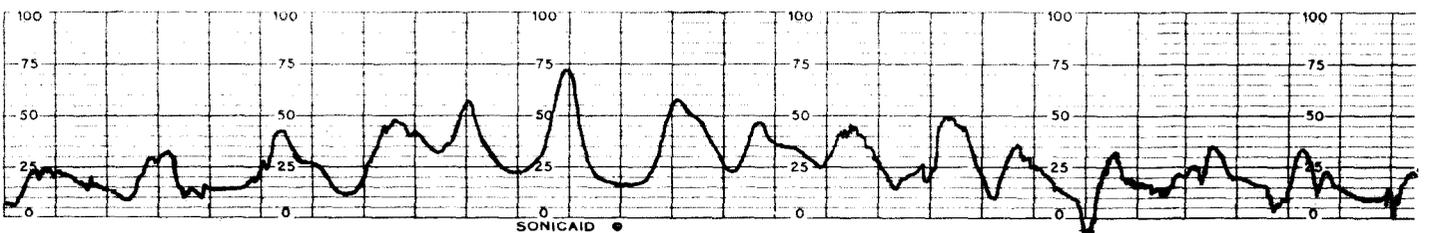
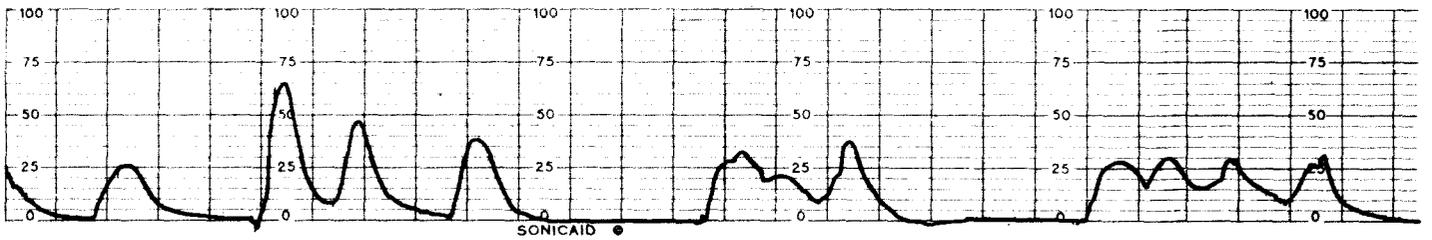
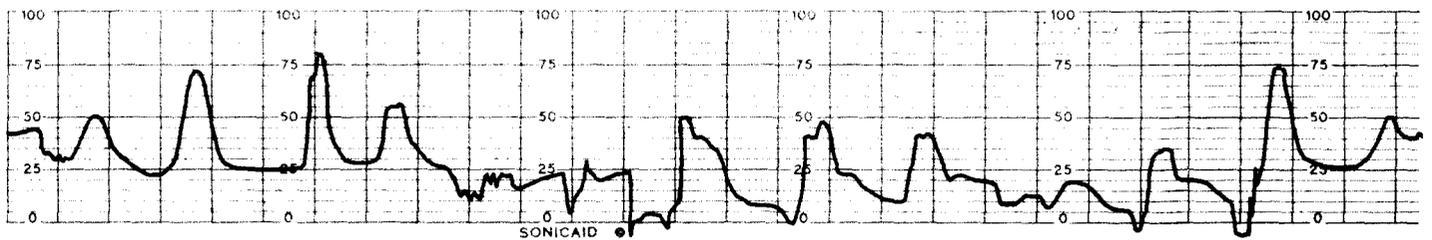
UTERINE CONTRACTIONS

Abnommi

Respiration artefact



Abnormal contractions (over-administration of oxytocin)



Poor application of scalp electrodes

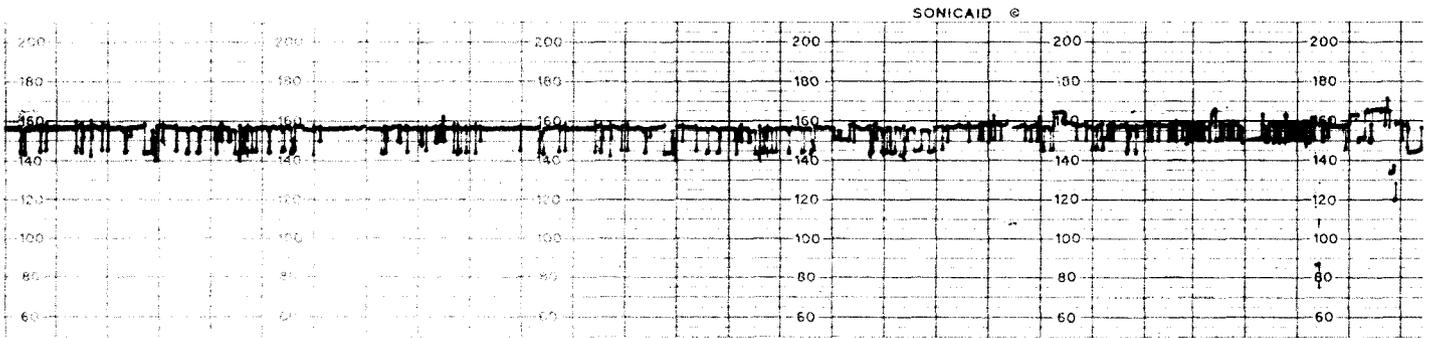
This type of trace with a 'flat' appearance accompanied by multiple artefacts is evidence of poor application of the scalp electrode. Care must be taken during application to avoid contamination of the electrode with antiseptic cream. Application is done best under direct vision through an amnioscope so that the fetal skin can be thoroughly dried. If a clip electrode is used the points must be checked to ensure that they are not contaminated with insulating material and that the angle of the points is correct.

Poor placement of ultrasound transducer

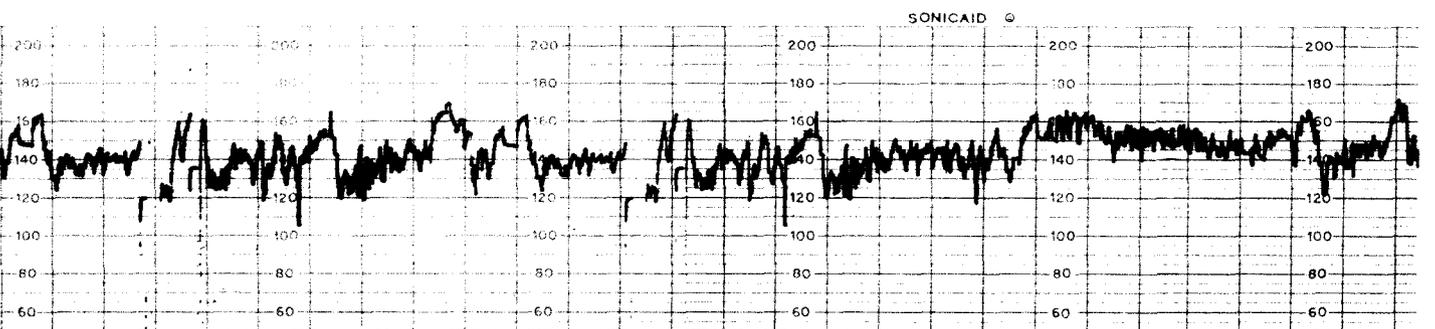
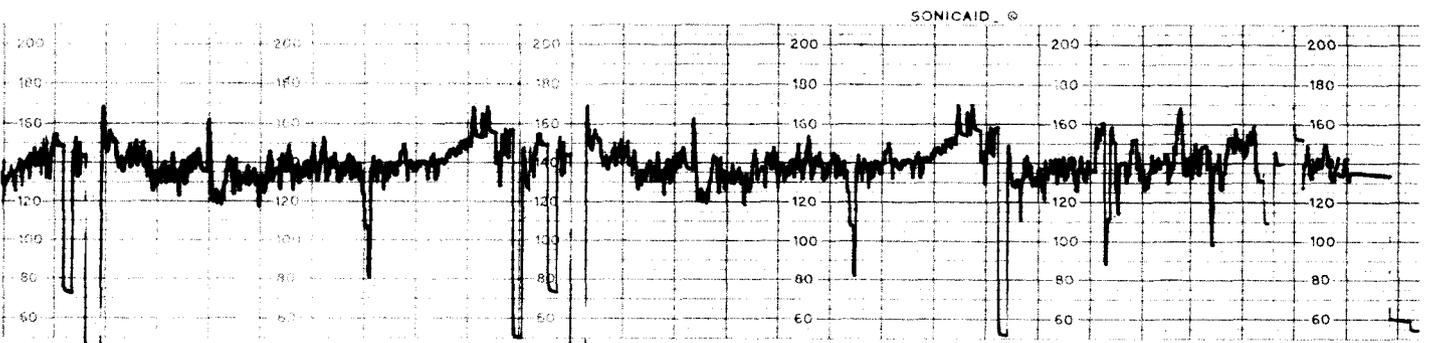
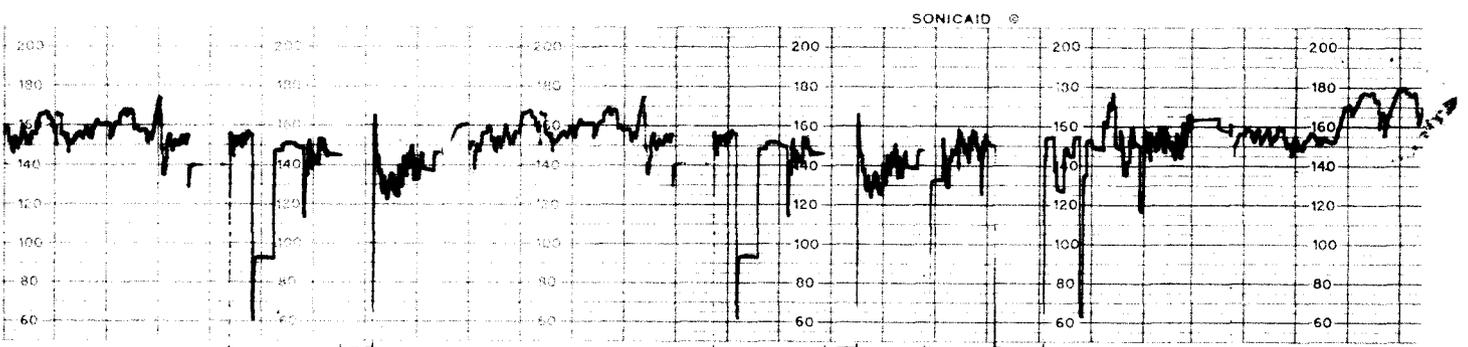
Upper trace	Trace showing many artefacts diagnostic of failure to place the transducer on to the optimal site on the mother's abdomen for recording the FHR.
Middle trace	(transducer repositioned) Better trace than previous one, but some artefacts still present.
Lower trace	(transducer repositioned again) Good ultrasound trace without artefacts.

RECORDING ARTEFACTS

Poor electrode application



Poor placement of ultrasound transducer



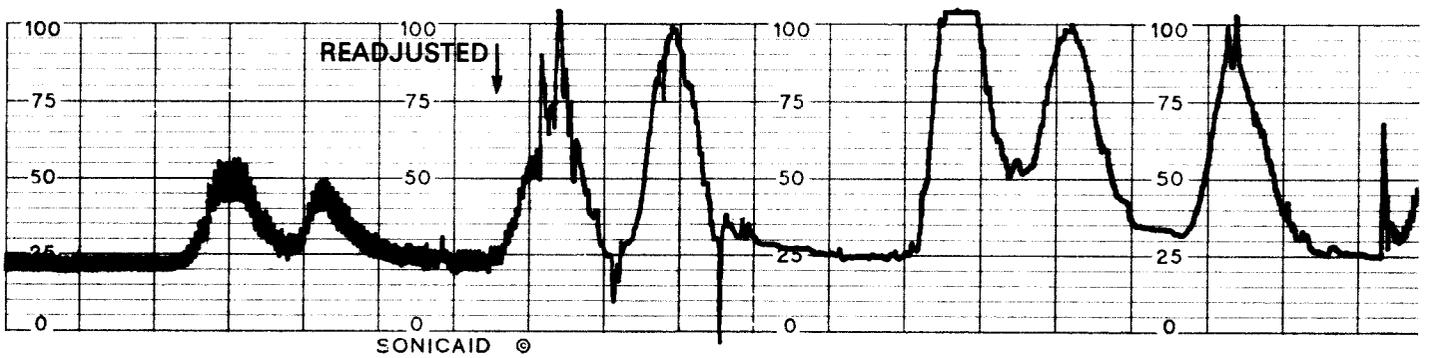
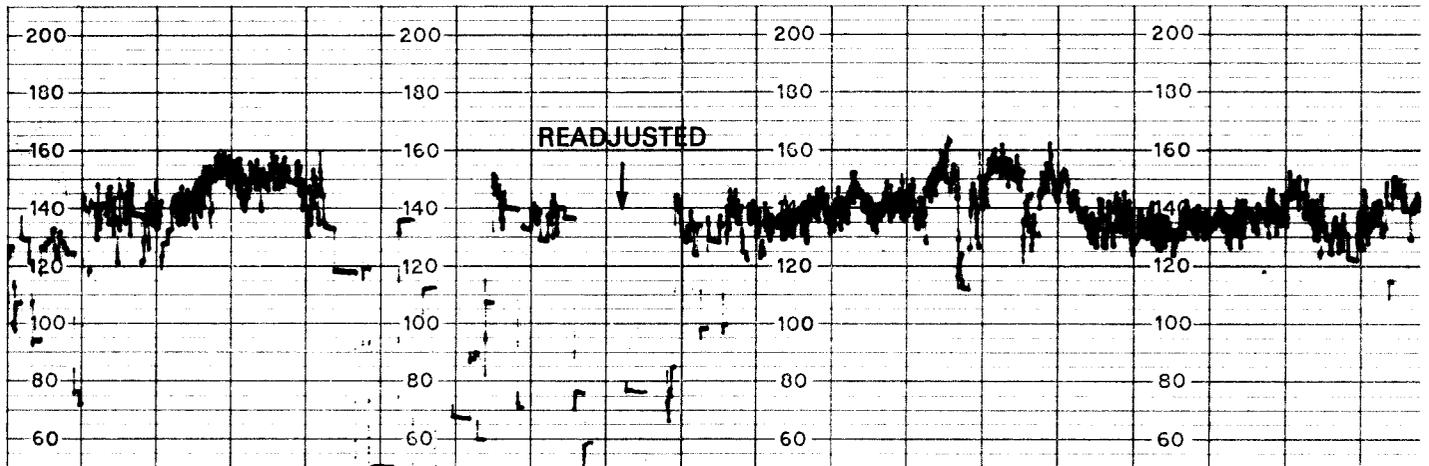
Poor placement of ultrasound and external pressure transducers which are subsequently correctly repositioned

Multiple and prolonged ultrasound artefacts accompanied by a poor pressure record. Repositioning of both transducers resulted in a satisfactory FHR and pressure trace.

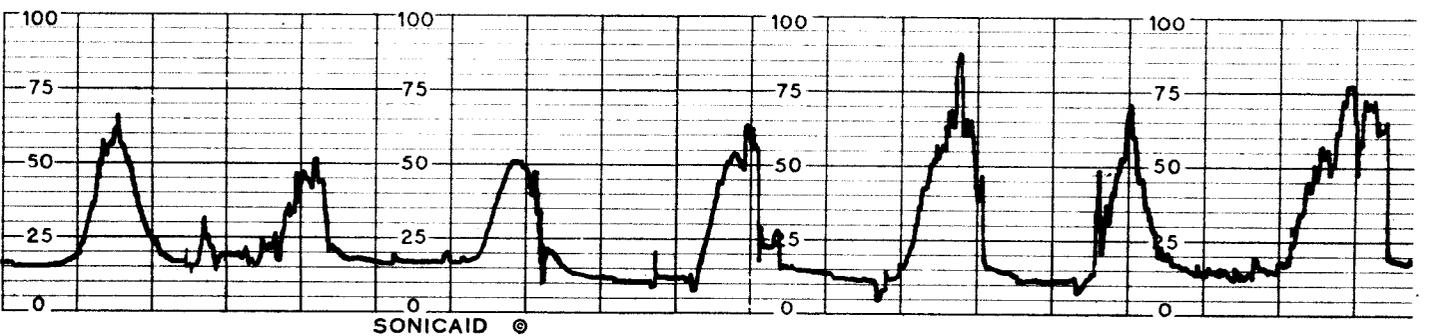
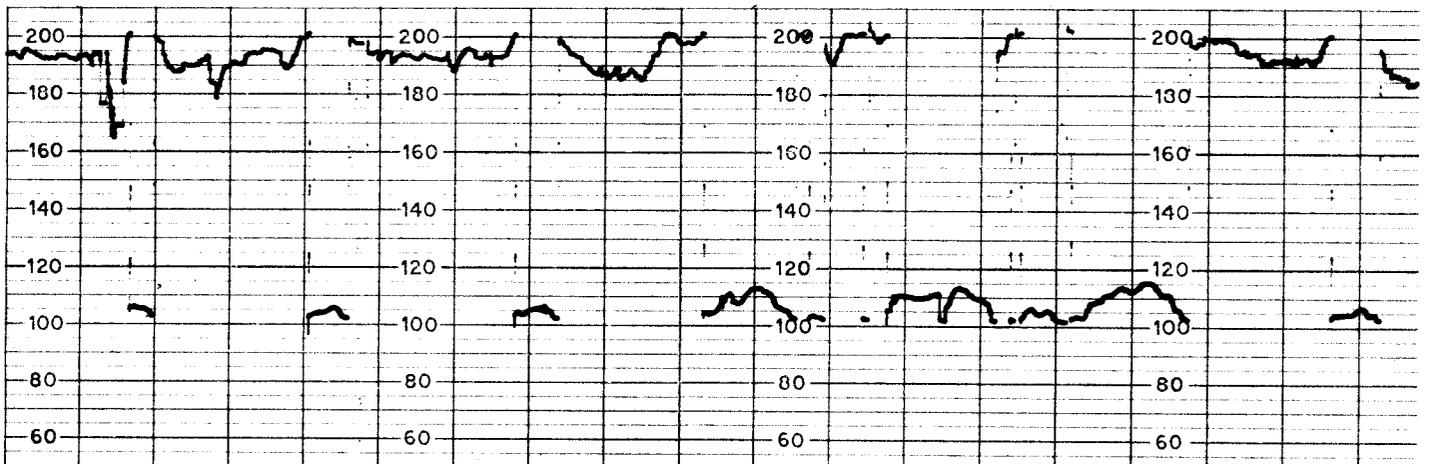
Halving artefact

FHR 190 beats/minute. Genuine recording given intermittently interspersed with false recording at approximately half the rate. This artefact is rare and is easily recognisable. It can be overcome by changing the signal, e.g. from ultrasound to ECG.

Poor placement of both external transducers



Halving artefact



Normal

1 Changes in FHR and uterine pressure patterns which occur at full dilatation

FHR-ultrasound

Contractions-external transducer

Upper trace End of first stage - uncomplicated variable decelerations with contractions 4 every 10 minutes.

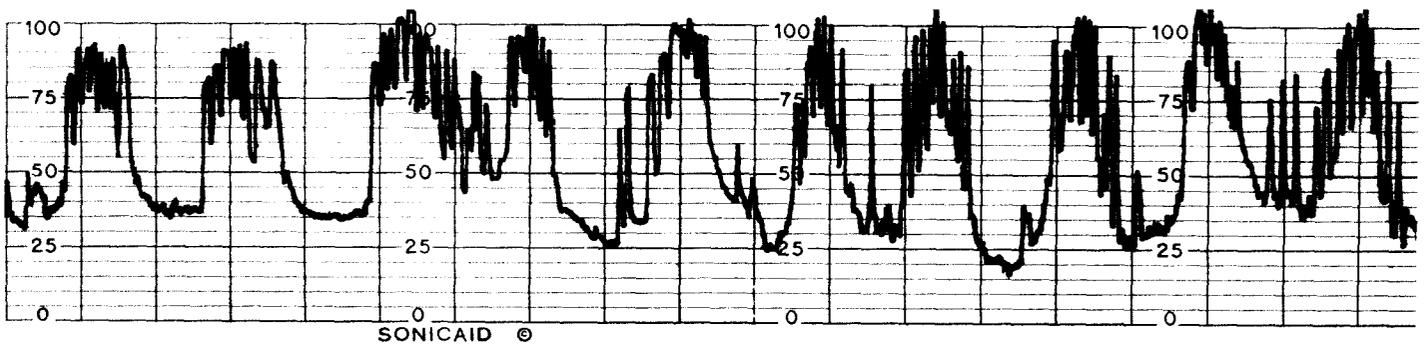
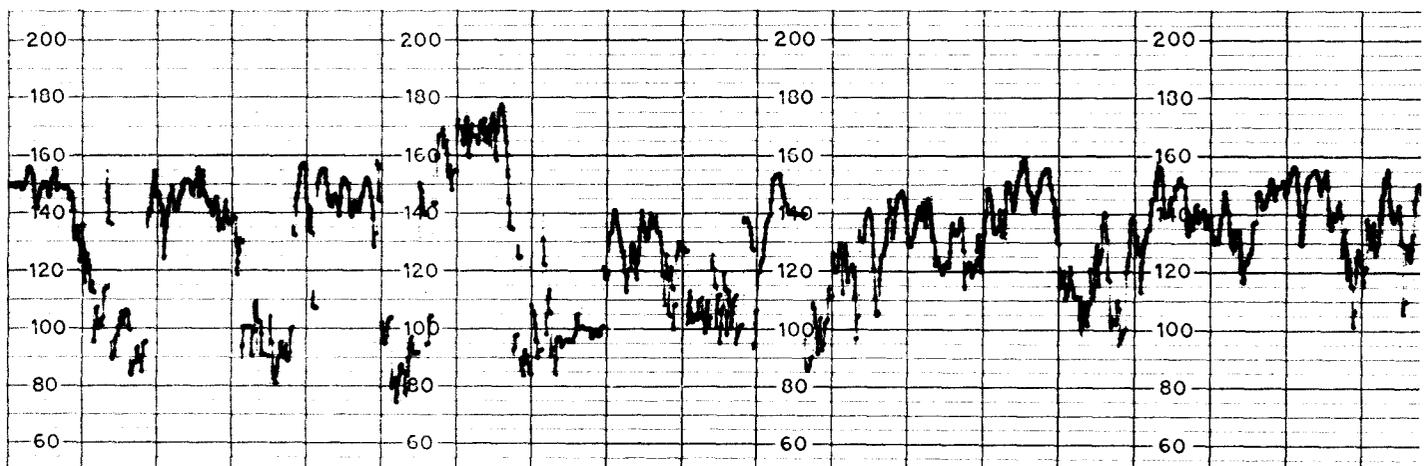
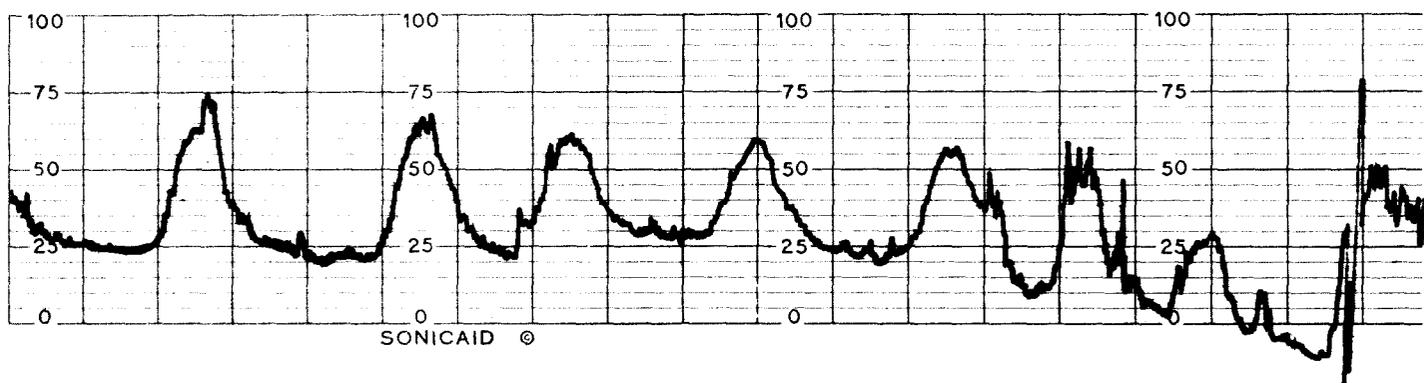
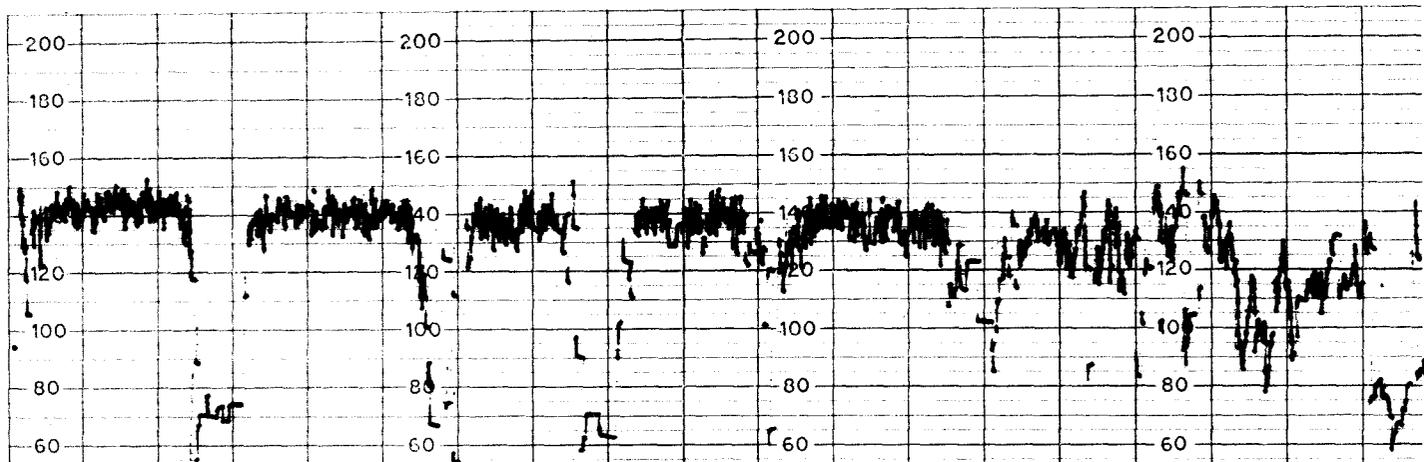
Management Careful observation only.

Lower trace Second stage - uncomplicated variable deceleration with a more disordered pattern. Good beat-to-beat variation and normal baseline remains.

Contractions 5-5 every 10 minutes and typical of second stage with superimposed multi-spike artefact due to pushing by mother.

Management Observation, noting if decelerations become prolonged or 'complicated' which is indicative of possible fetal asphyxia.

Measurement of fetal pH even at this late stage may be useful in deciding on management.



Effects of drugs

2 Recovery following episode of acute asphyxia (post-epidural anaesthesia)

FH R - scalp electrode

Contractions - external transducer

The three traces opposite form a continuous record showing the recovery following an episode of acute asphyxia.

Upper trace Late decelerations with loss of beat-to-beat variation and baseline tachycardia. Contractions 4-5 every 10 minutes.

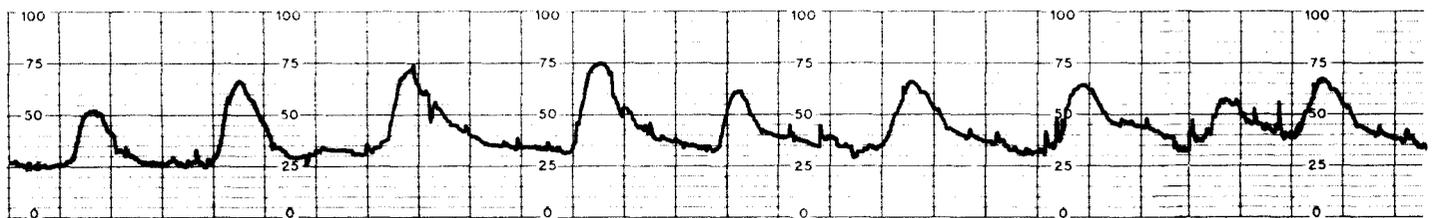
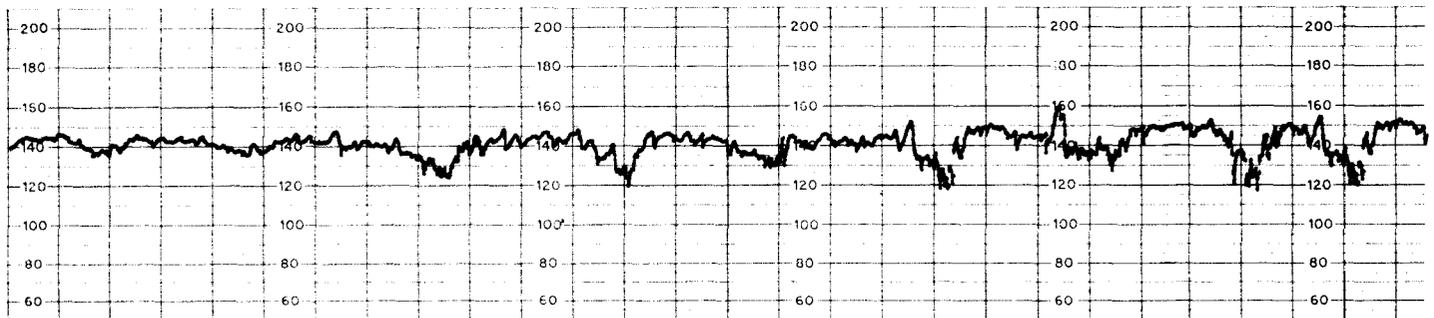
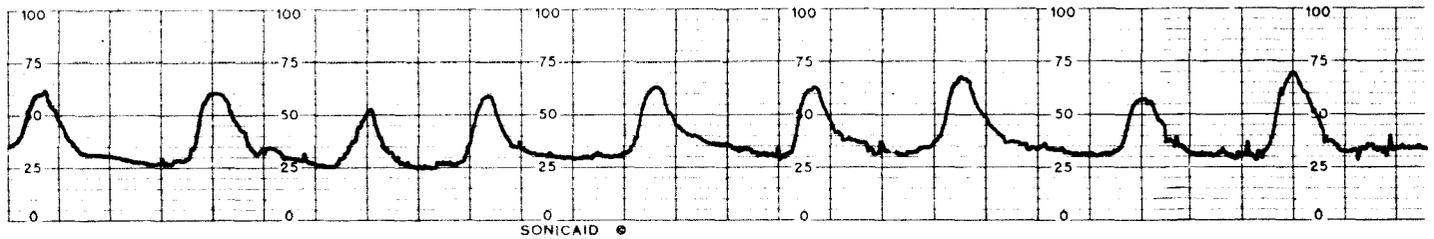
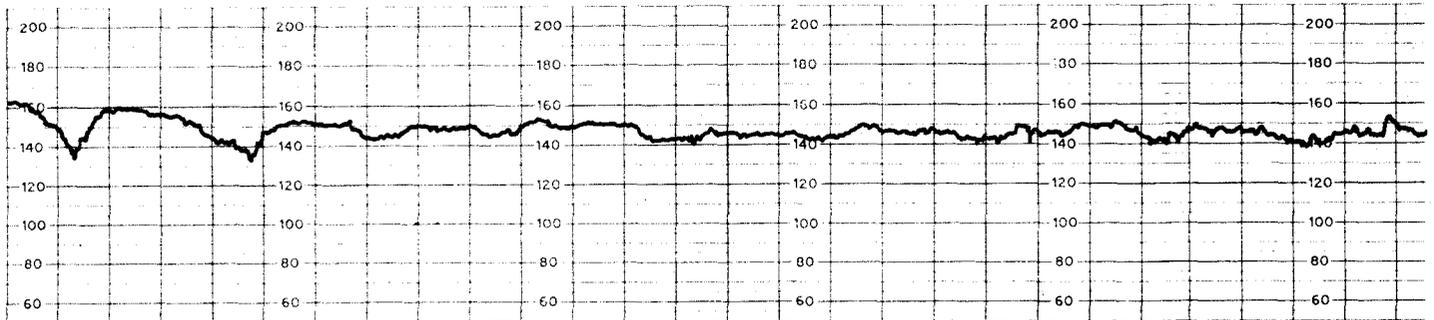
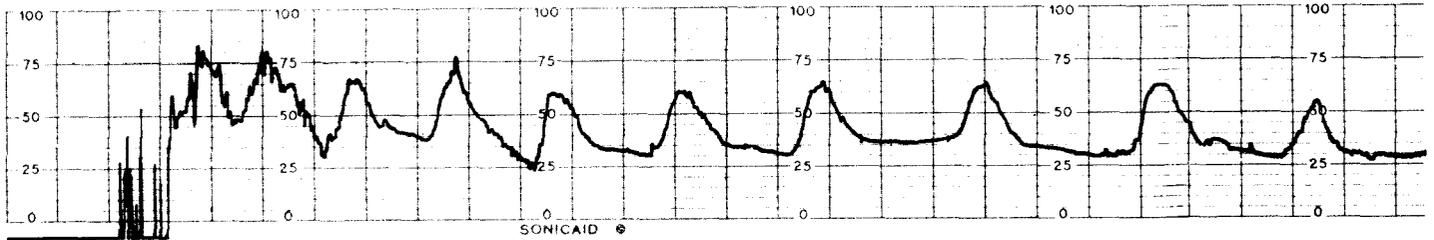
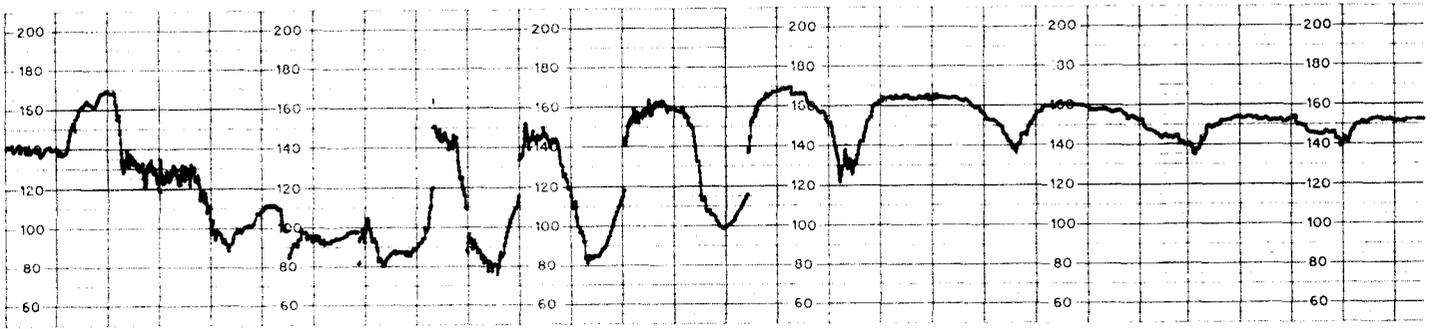
Middle trace Decelerations have disappeared with return to normal baseline. Contractions unaltered.

Lower trace Normal beat-to-beat variation with normal baseline. Occasional late decelerations.

Management Careful observation. Fetal pH determination if late decelerations persist.

CASE HISTORIES

Effects of drugs



3 FHR changes following epidural 'top-up'

FHR -scalp electrode

Contractions-external transducer

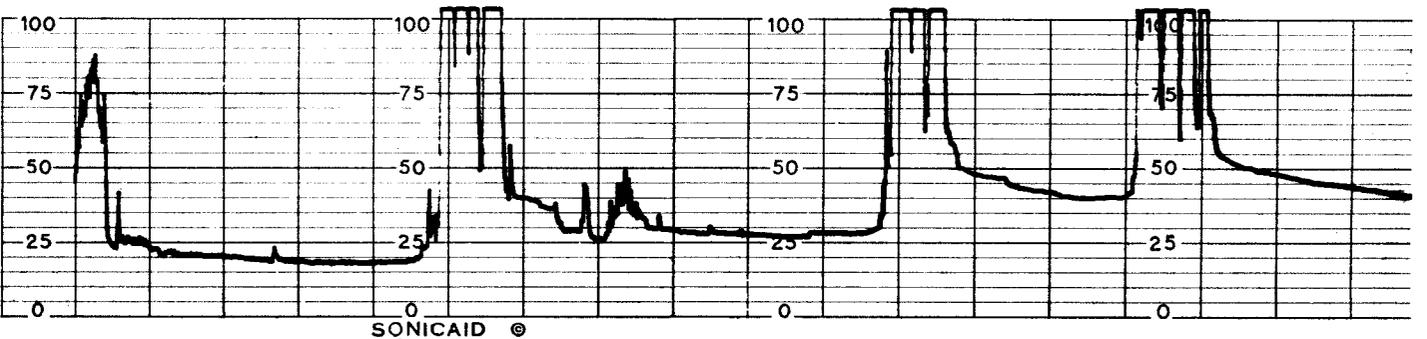
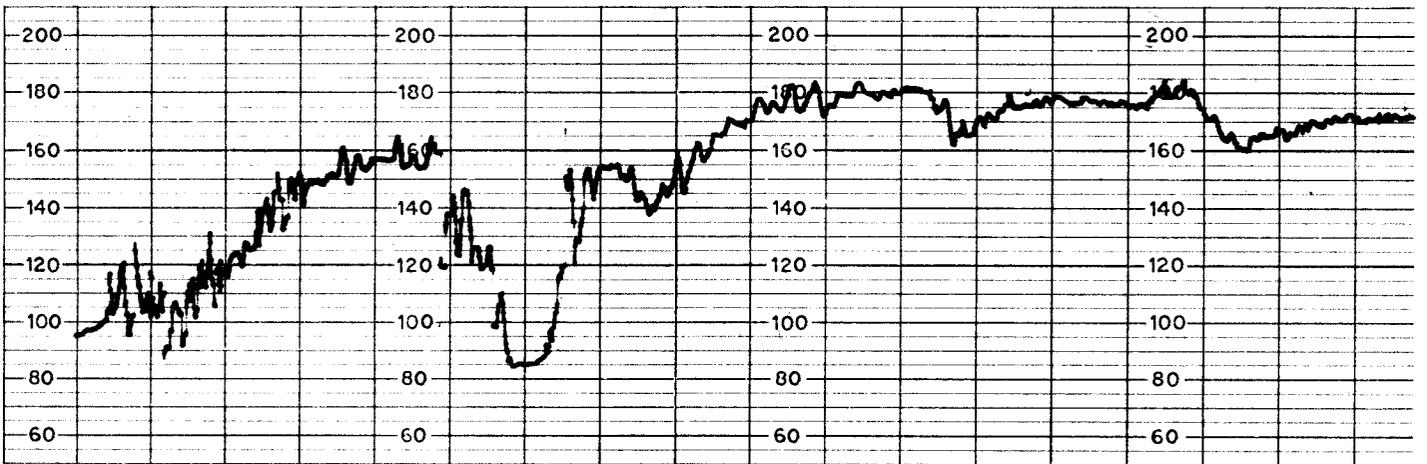
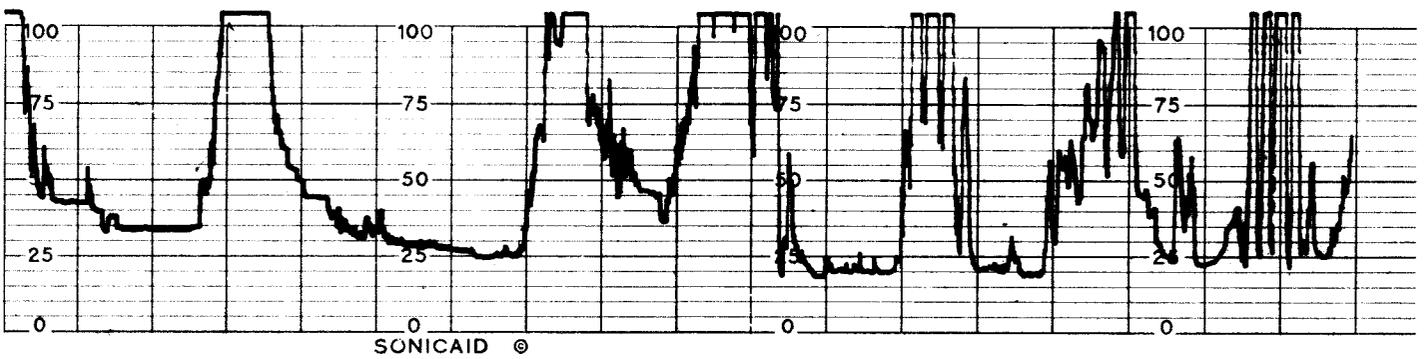
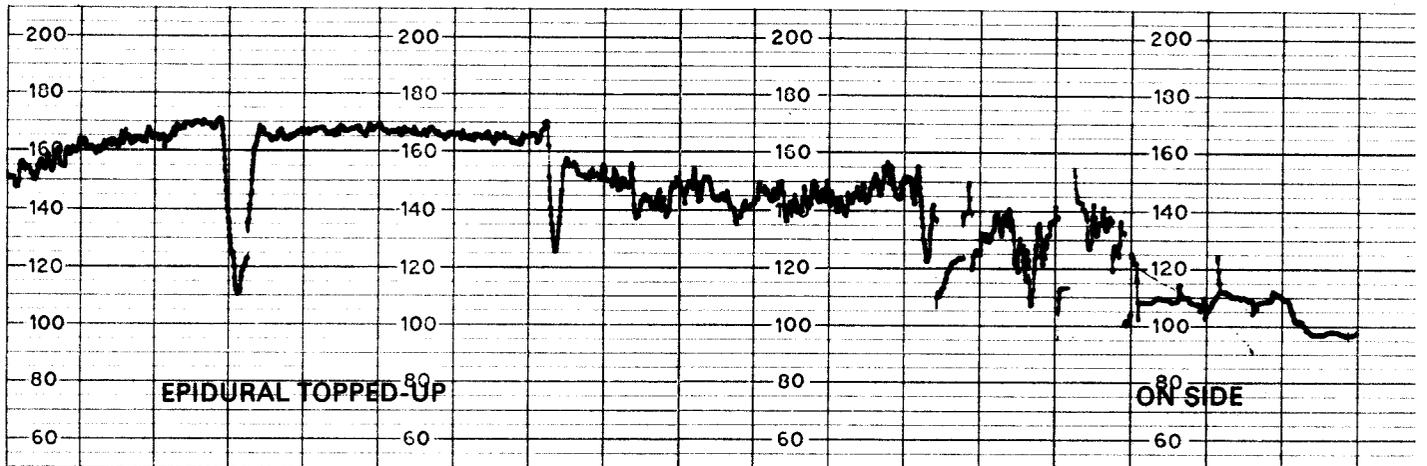
Episode of bradycardia unrelated to contractions starting 4 to 5 minutes after epidural 'top-up'. Bradycardia maximal 11 minutes after 'top-up' and lasting 4-5 minutes followed by recovery as FHR returns to normal baseline 2-5 minutes after patient turned on her side. Then single late deceleration followed by baseline tachycardia. Contractions characteristic of second stage.

N.B. The two traces form a continuous record.

Management Epidural 'top-up' should have been given with patient on her side. In this case patient was on her back but was turned on her side as soon as bradycardia was recognised while, at the same time the syntocinon infusion was turned off. Immediately an improvement in the FHR trace was apparent.

Epidural/ Anaesthesia is commonly used in modern obstetric practice for pain relief in labour, and acts by anaesthetising sensory nerves supplying the uterus. It also affects the autonomic nerve supply with a result that there is a tendency for maternal hypotension to develop which is most marked in the utero-placental circulation. In addition, local anaesthetic agents are known to be rapidly absorbed from the extradural space into the maternal circulation and then to cross the placenta into the fetal circulation. Abnormalities in the fetal heart rate ranging from a short episode of tachycardia to profound and prolonged deceleration are frequently seen following the administration of epidural, caudal or paracervical anaesthesia. It is often difficult to determine whether these abnormalities in FHR are asphyxial in origin or due to the 'quinidine like' effect of local anaesthetic agents on the fetal myocardium. However these changes in FHR are an indication of the potentially harmful effects of regional anaesthesia (excessive dosage or too rapid administration, or the patient in the wrong position) and of the need to monitor the fetus when epidural anaesthesia is used.

CASE HISTORIES
Effects of drugs!



Effects of drugs

4 Effects of drugs administered during labour on the FHR pattern

FH R - ultrasound

Contractions -external transducer

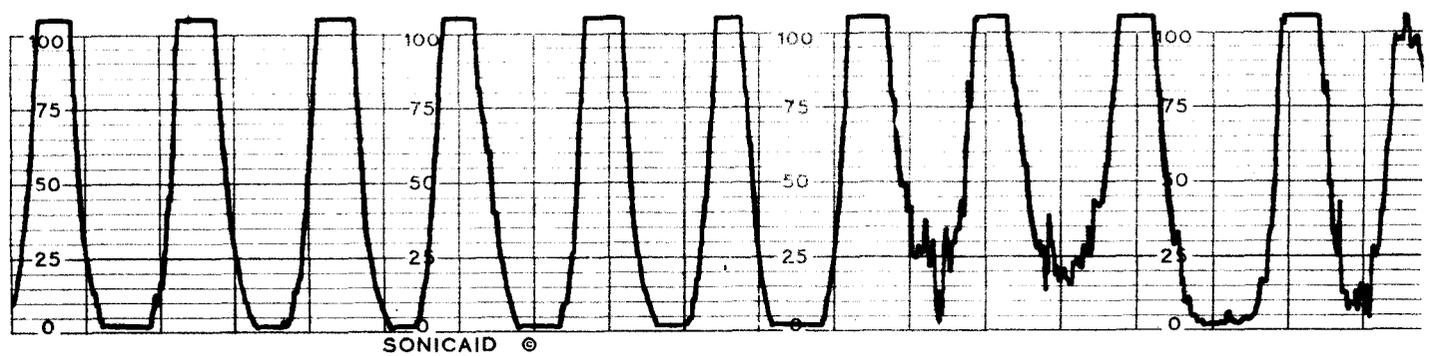
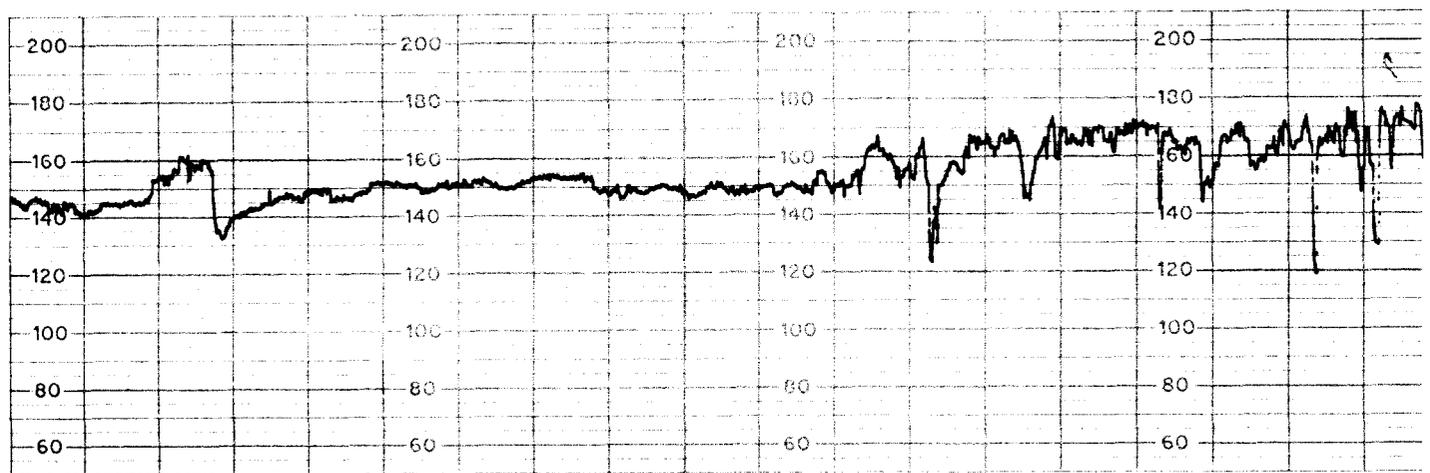
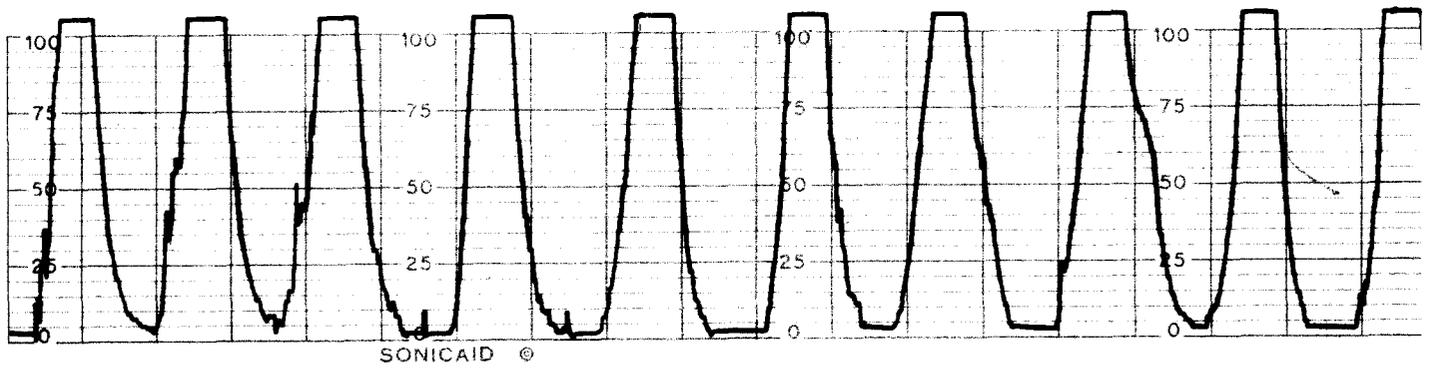
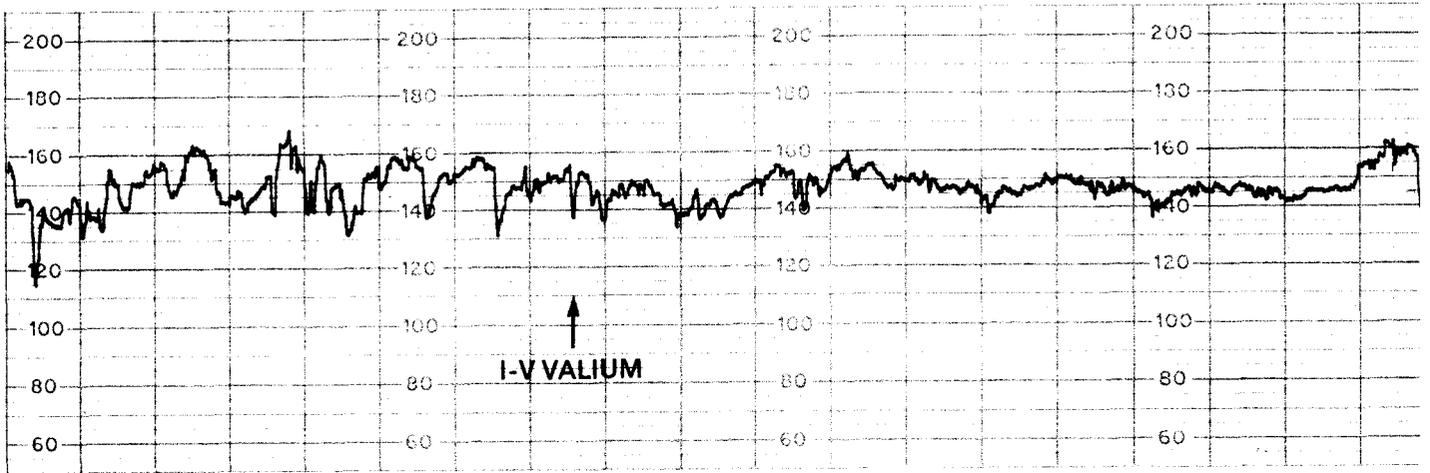
The trace shows the effect of drugs such as valium and pethidine on the beat-to-beat variations. Prior to administration of the drug there is a normal heart rate with good beat-to-beat variation. Within two minutes of drug administration there is a recognisable loss of beat-to-beat variation which persists for 9 minutes. There is then a sudden return to normal FH R which occurs spontaneously.

N.B. The two traces form a continuous record.

Management Observe the patient. A fetal pH determination is only necessary if the loss of beat-to-beat variation becomes complicated by a baseline abnormality or decelerations.

CASE HISTORIES

Effects of drugs



Uterine hyperstimulation

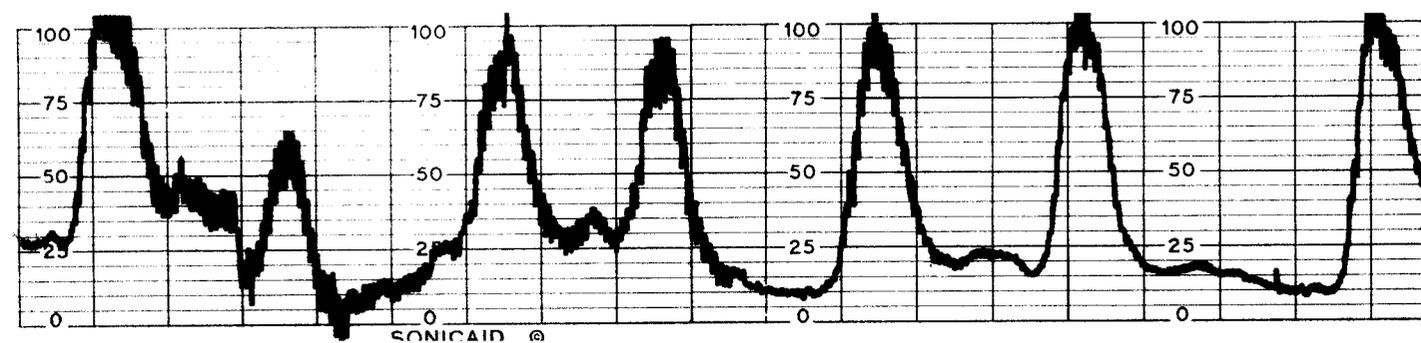
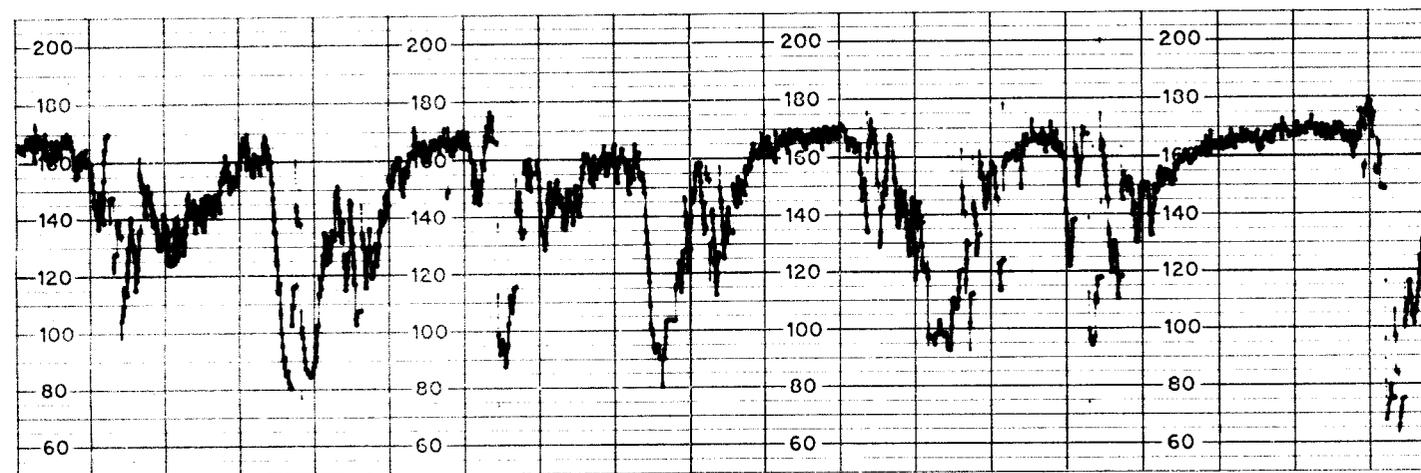
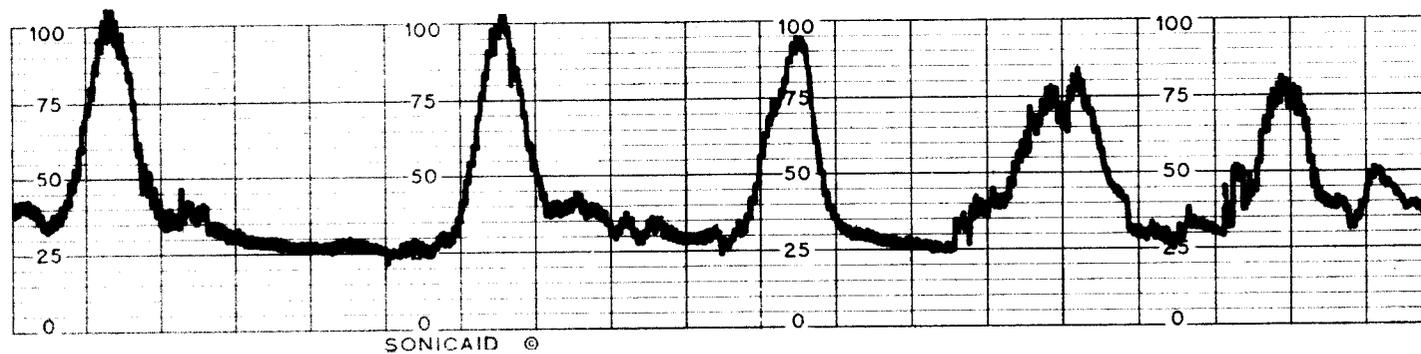
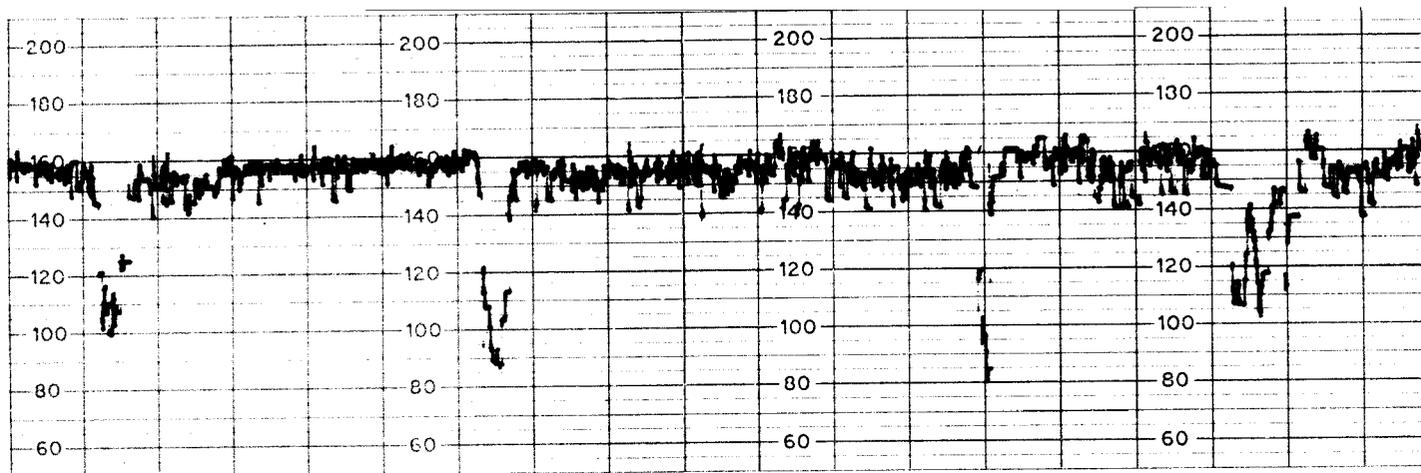
5 FHR abnormalities accompanying uterine hyperstimulation

FHR-ultrasound

Contractions-external transducer

Upper trace	Early decelerations with normal baseline. Contractions 3 every 10 minutes stimulated by 8 milliunits of oxytocin/minute.
Lower trace	Variable decelerations with baseline tachycardia, some of which have lag time. Contractions now 4 every 10 minutes following increase in oxytocin infusion to 10 milliunits/minute.
Management	Turn off oxytocin infusion and turn patient on side. If FHR trace becomes normal oxytocin can be increased again slowly to previous concentration that preceded appearance of FHR abnormalities. If FHR abnormalities persist collect fetal blood sample for pH determination.

CASE HISTORIES
Uterine hyperstimulation



Uterine hyperstimulation

5 FHR abnormalities accompanying uterine hyperstimulation (continued)

FH R - ultrasound

Contractions - external transducer

Upper trace

Disordered FH R pattern to variable deceleration and baseline tachycardia. Contractions - very abnormal with multiple peaks and raised baseline.

Management

Turn off oxytocin infusion (16 milliunits/minute) and turn patient on side. If FH R trace becomes normal oxytocin can be increased again slowly to previous concentration that preceded appearance of FHR abnormalities. If FHR abnormalities persist collect fetal blood sample for pH determination.

FH R - scalp electrode

Contractions-external transducer

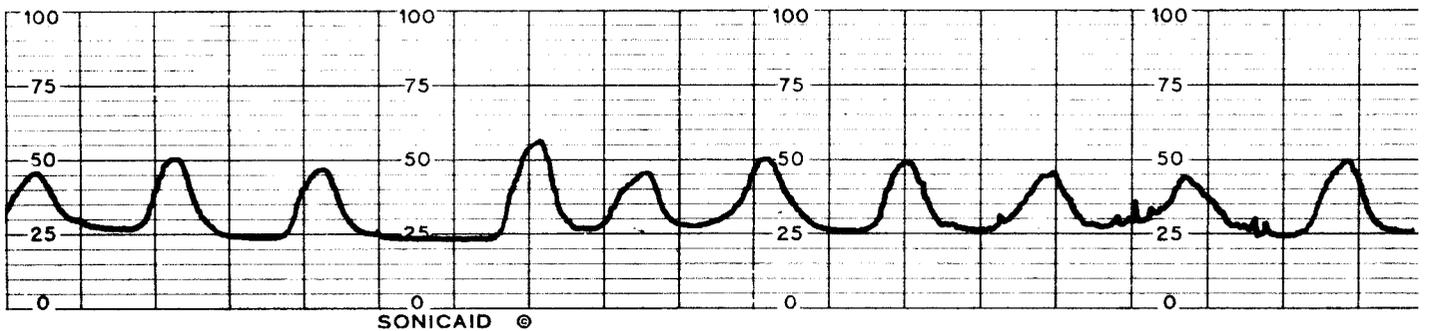
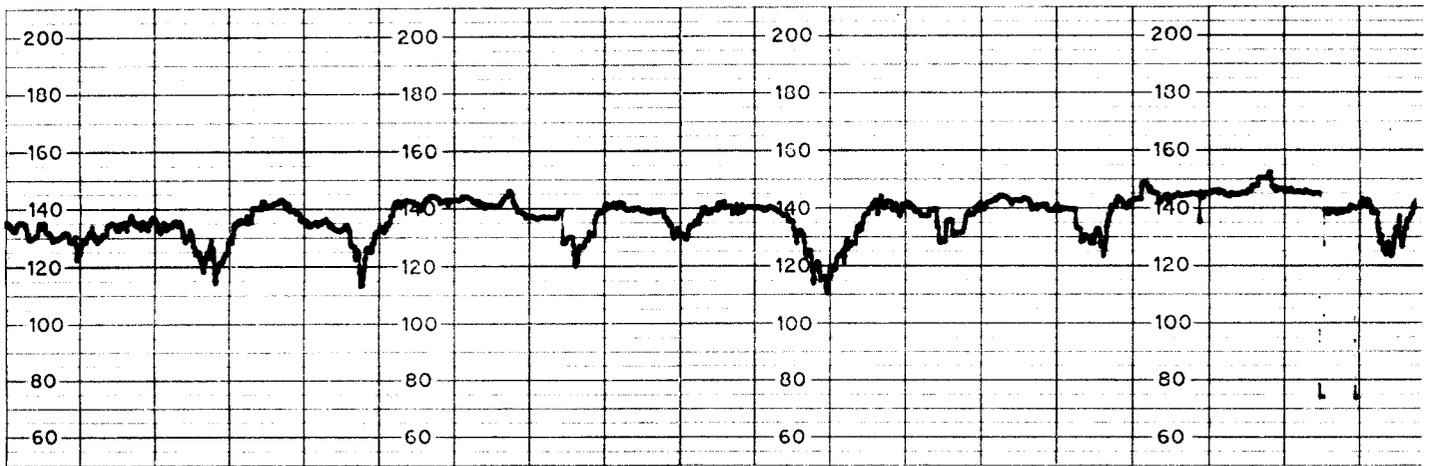
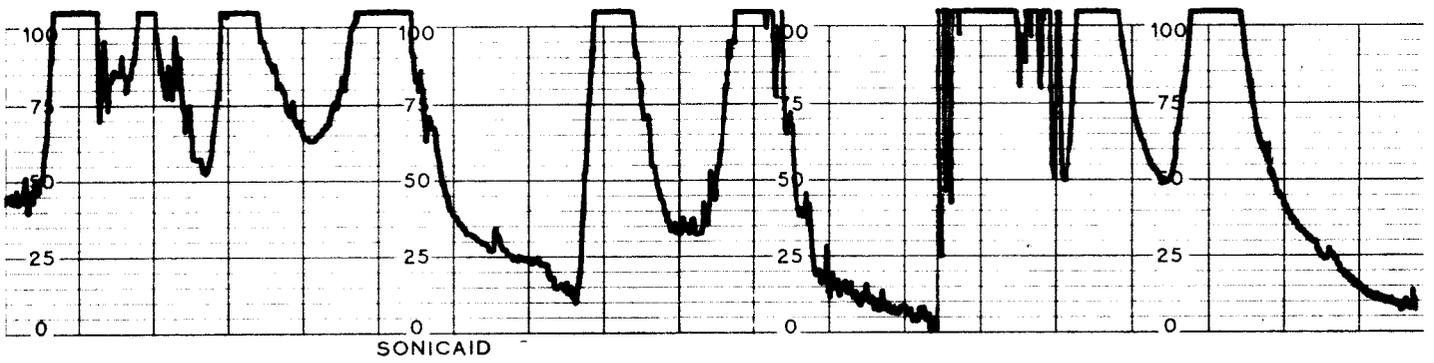
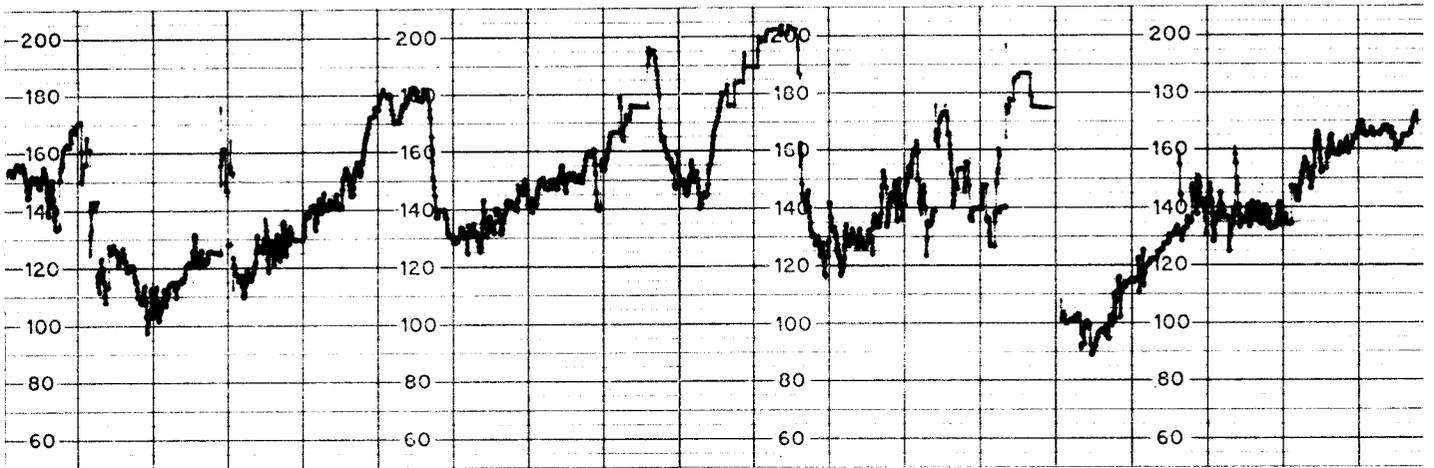
decelerations of small amplitude. The favourable features are a normal baseline with only mild loss of beat-to-beat variation.

Management

Reduce rate of oxytocin infusion until frequency of contractions is no more than 4 every 10 minutes and turn patient on her side. If late decelerations persist collect fetal blood sample to determine fetal pH.

CASE HISTORIES

Uterine hyperstimulation r



6 Uterine hyperstimulation due to blockage of oxytocin infusion catheter

FH R - ultrasound

Contractions - external transducer

Oxytocin being administered by infusion pump when, unnoticed by staff, the intravenous catheter became blocked. The catheter was cleared and the oxytocin infusion started at the concentration immediately prior to blockage. Contractions previously regular showed an immediate increase in basal tone lasting for 4-5 minutes. The episode of hyperstimulation was accompanied by FHR bradycardia to 80 beats per minute with full recovery only when the uterine tone had returned to normal.

Management If infusion stops, clear intravenous catheter, flush through drip tubing and start oxytocin at lower concentration with careful observation of FH R and contraction trace.

7 Uncomplicated loss of beat-to-beat variation associated with maternal pyrexia

FH R -scalp electrode

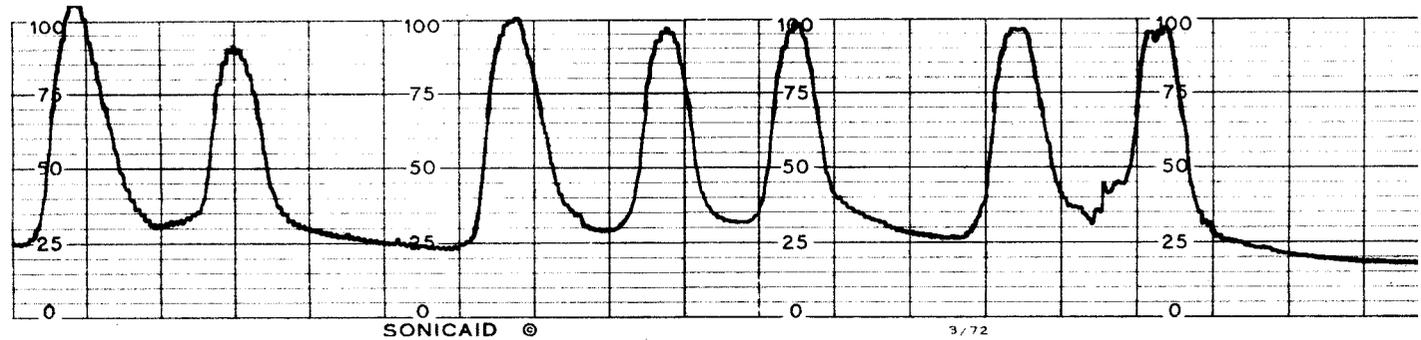
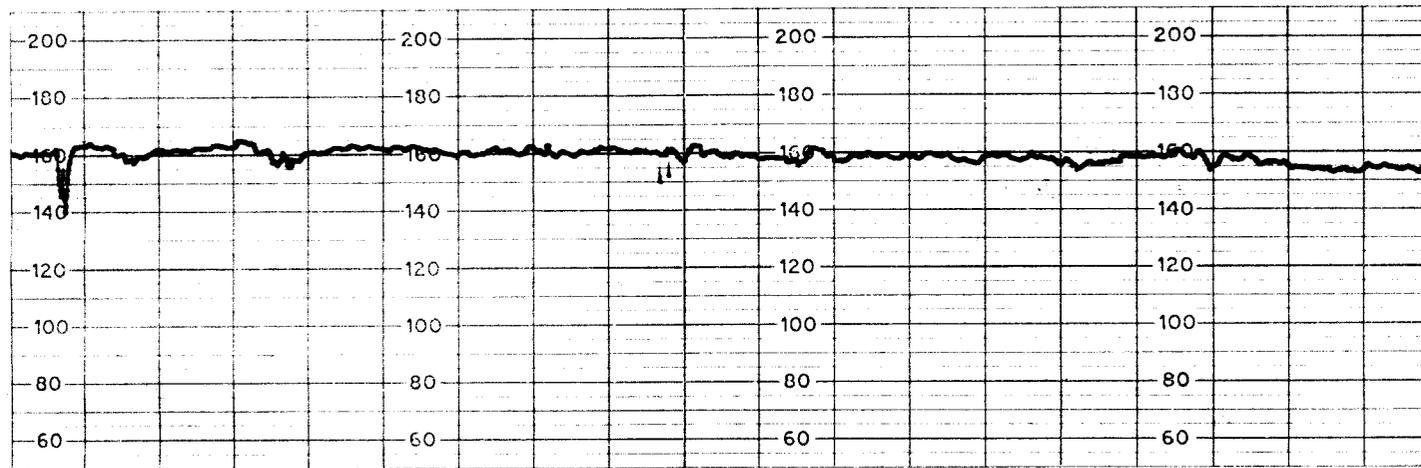
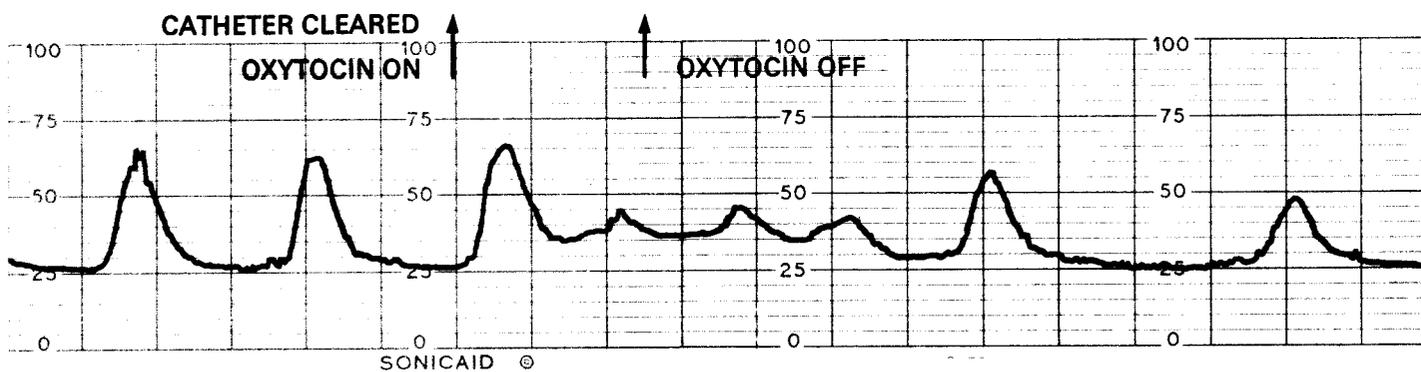
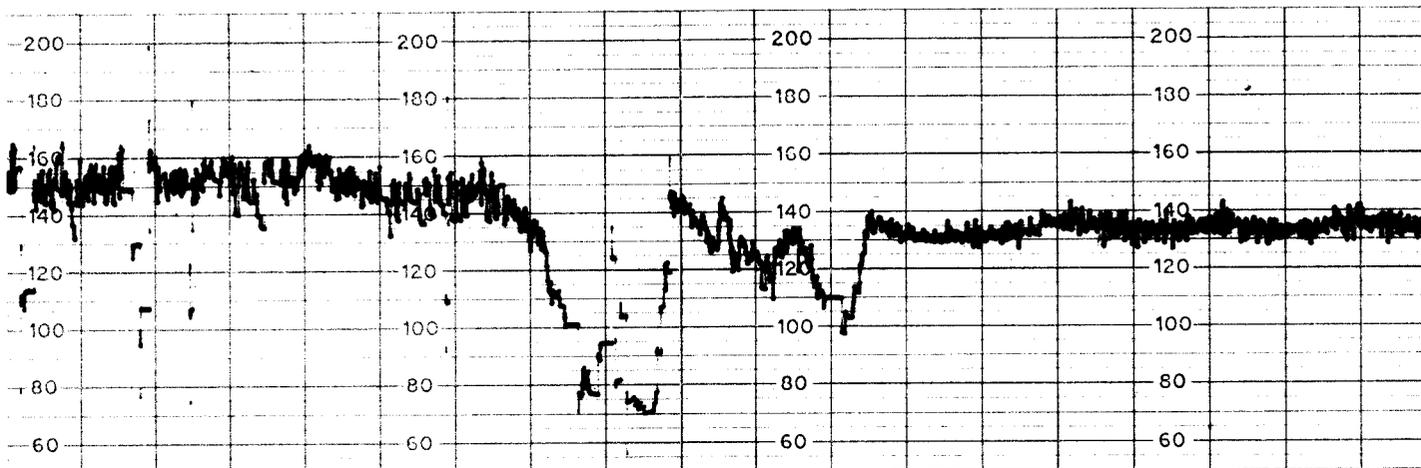
Contractions-intrauterine catheter

Loss of beat-to-beat variation and baseline tachycardia although no decelerations present. Temperature of mother 38°C. Fetal pH 7.30.

Management Progress of labour in this case was rapid, the patient delivering within 4 hours of the appearance of pyrexia. Abnormalities in continuous FH R record and fetal pH only precede intrauterine death by a short while and cannot be relied upon as an index of the condition of the fetus.

CASE HISTORIES

Miscellaneous:



8 Effect of posture on FHR

FHR-scalp electrode

Contractions-external transducer

Patient known to have a tendency to develop supine hypotension. Three minutes after turning patient on to her back her blood pressure had fallen from 140/70 to 80/unrecordable. FHR fell from 140 to 100 but recovered as soon as patient turned on side. Effect reproduced a second time.

Management All patients should be nursed on their side during labour. If they are not, bradycardia (or any FH R pattern suggestive of fetal asphyxia) should be an indication for turning patient on her side and giving her oxygen by face mask.

9 'Bedpan effect'

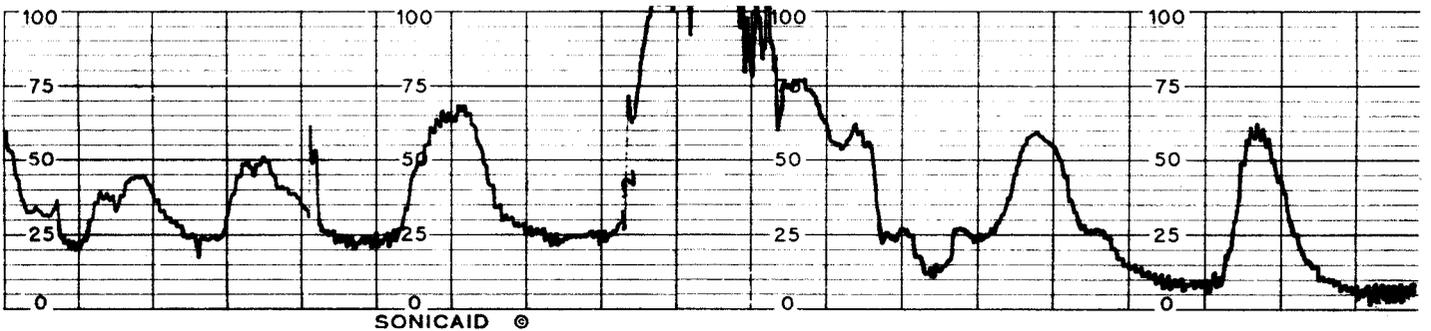
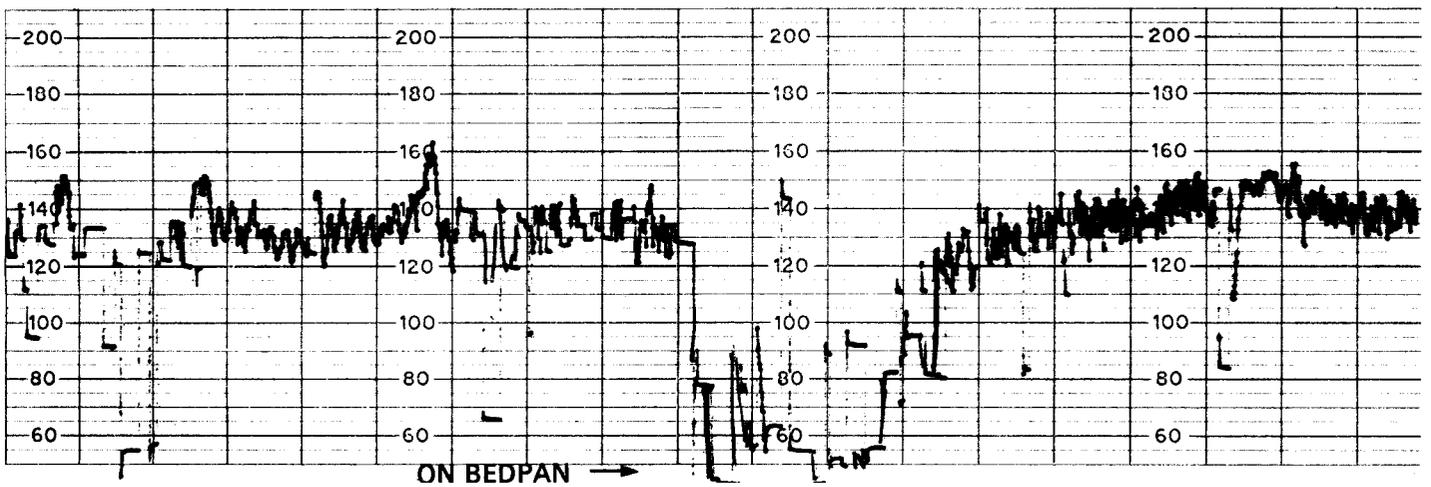
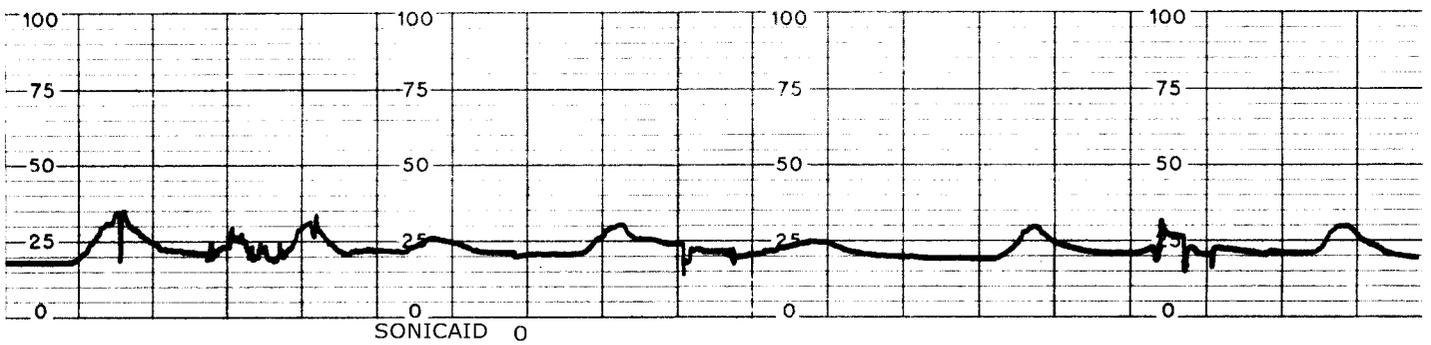
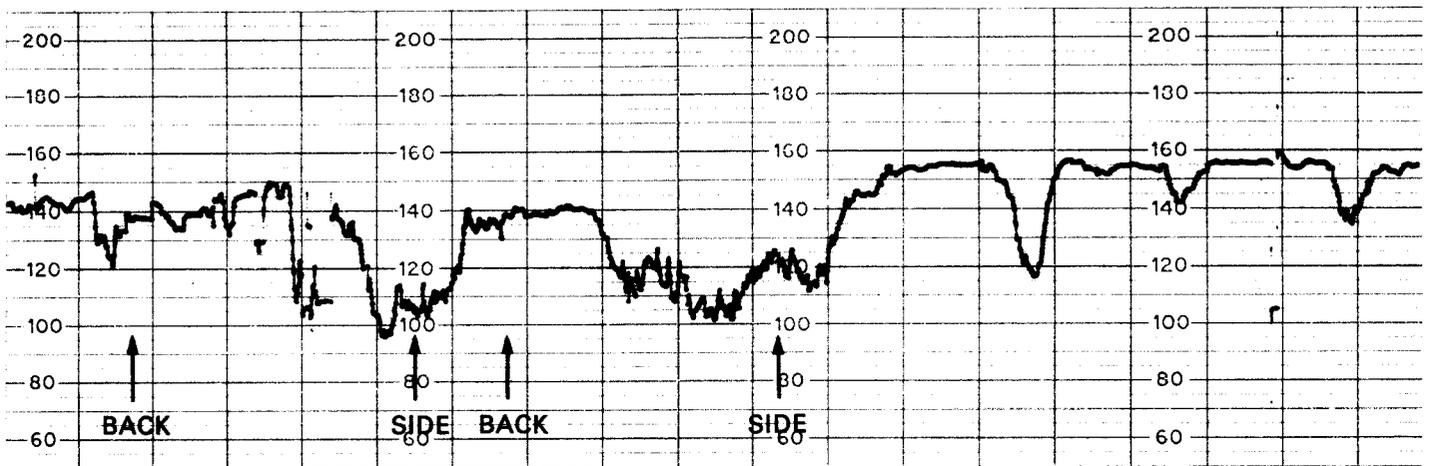
FH R - ultrasound

Contractions-external transducer

Deep and prolonged FHR deceleration accompanying prolonged uterine contraction starting as patient is put on to a bedpan and only returning to normal when she comes off.

Management Avoid use of bedpans in labour. The marked rise in intrauterine pressure may be harmless to a healthy fetus but can result in marked deterioration of the condition of a fetus that is already compromised.

CASE HISTORIES
miscellaneous



Summary of FHR patterns and their clinical significance

PATTERN	CHARACTERISTICS			CLINICAL SIGNIFICANCE
Normal	Rate within the range 120 to 160 beats/min. No rate change during contractions. Beat-to-beat variability > 5 beats/min			Not adverse
Baseline Bradycardia	Rate <120 beats/min	<i>uncomplicated</i>	Good beat-to-beat variability	Not adverse
		<i>complicated</i>	Any other abnormality	Adverse
Baseline Tachycardia	Rate >160 beats/min	<i>uncomplicated</i>	No decelerations	Not adverse but should be observed
		<i>complicated</i>	Decelerations of any variety	Adverse
Acceleration	Increase followed by a decrease in rate during a contraction			Not adverse
Early Deceleration	Onset at the start of the contraction. Recovery by the end of the contraction Amplitude <40 beats/min			Not adverse but should be observed
Variable Deceleration	Irregular shaped deceleration Amplitude >50 beats/min	<i>uncomplicated</i>	Baseline rate and beat-to-beat variability normal	Not adverse but should be observed
		<i>complicated</i>	Baseline tachycardia and/or loss of variability	Adverse
Late Deceleration	Any deceleration where lowest point is past the peak of the contraction			Adverse
Loss of beat-to-beat Variation	Variability <5 beats/min	<i>uncomplicated</i>	No decelerations normal baseline	Not adverse but should be observed
		<i>complicated</i>	Decelerations and/or abnormal baseline	Adverse

When the pattern is 'adverse' the fetal pH should be determined.

If the pattern is 'not adverse but should be observed' the fetal pH should be determined if the trace develops any other abnormal features.