Review article

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The present situation of clinical monitoring of the fetus during labor*

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During the last ten to twelve years progress has been made in clinical monitoring of the fetus during parturition such as never before achieved in the history of obstetrics. Rather than viewing these successes as advances in a highly theoretical and scientific field we must consider them to be the result of the realisation of various necessary preconditions, required to make up for the great scientific and clinical lag in fetal monitoring and thus merely catching up with the progress made in other medical fields.

It would be foolish to expect that perinatal dangers could be decreased by technical progress alone. Improvements of organisation and preventive measures remain the most important factors. Thus technically and clinically perfect perinatal monitoring is of little avail when many pregnant women are not subjected to good prenatal care.

Curriculum vitae

JOACHIM WOLFRAM DUDENHAUSEN *co-author of the article was born in 1943 in Werdohl (Westphalia) and attended school in Lüdenscheid from 1949 to 1962. From 1962 to 1964 he was enroled at the medical college of Johannes-Gutenberg-University in Mainz. Thereafter he studied at the Free University of Berlin were he passed his state-board- examinations in medicine at the beginning of 1968. He received his M. D. degree upon the acceptance of his doctoral thesis on a topic in perinatal medicine in 1969. Since the beginning of 1969 he has been working as a member of the Unit Perinatal Medicine of Free University Berlin at the Dept. of Obstetrics and Gynecology of the Municipal Hospital Berlin-Neukölln.*

1. The most important aims of modern clinical monitoring of the fetus during parturition

a) To obtain the most reliable data **on the state of the fetus at the time of the patient's admission** to the clinic, deciding whether or not it faces increased dangers.

b) An **early detection of fetal hypoxia occurring slowly** during the further course of parturition, and of the **occurence of cord complications or other hypoxic dangers.**

Two further points are of secondary importance:

c) Diagnosis of **severe Rh-Erythroblastosis** at the beginning of labor.

d) **Early diagnosis of fetal hypoglycemia** and reduced glycogen-reserves during parturition.

2. Methods of modern fetal monitoring during parturition

2.1 Admission aminioscopy

Correct monitoring of the endangered fetus needs to have already been started within several minutes after the admission of the parturient to the clinic. It would be a mistake if, after admission to the clinic, the patient were to be subjected to time-consuming routine, e. g. shaving,

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enema, bath and the usual preparations such as taking a case history and making external and rectal examinations. The most important diagnostic measures (amnioscopy, apparative monitoring of the FHR and possibly the determination of the blood pH) would thus be delayed until the mother is finally in the labor room.

A single ausculation of the fetal heart-beats with a stethoscope or with an ultrasound pulse-detector when the patient is admitted to the clinic **is not sufficient,** since this no longer corresponds to modern procedures. Today's admission procedures are such that even fetuses at high risk remain without surveillance for thirty to sixty minutes at the beginning of labor in otherwise progressively-run clinics. Hence, we have recommended at least for **fetuses at high risk that amnioscopy be performed immediately after the arrival** of the patient at the clinic [76]. Other authors [16, 70] agree with this recommendation.

If the amniotic fluid inspected by amnioscopy at the start of labor is clear, the critical period of preparation and examination procedures can be bridged much more safely. If, however, amnioscopy shows meconium-stained liquor or if no amniotic fluid is present, **other procedures of intensive monitoring have to be employed.** These include continuous recording of the fetal heart-rate and, if necessary, fetal blood analysis after opening the amniotic sac.

If contraction-related decelerations of the fetal heart-rate (FHR), the so-called alarm-dips, are absent, and if the baseline FHR is normal, all other preparations and examinations can proceed until the patient is finally in the labor room. From that time on the FHR can be recorded continuously until the end of delivery. However, should the FHR recording show suspicious changes, fetal blood analysis must be performed without delay.

In general — if contractions are present — cardiotocography could be performed **instead** of admission amnioscopy. Cardiotocography is being taken, but not during the other procedures (e. g. external examination, enema, bath, etc.) as the FHR recording would be considerably disturbed during these procedures. Amnioscopy, on the other hand, if a special room is available, can be performed within a few minutes.

2.2 Cardiotocography

2.2.1 Is fetal heart-rate monitoring worthwhile?

This question often arises during discussions particularly concerned with the excessive use of technical procedures in obstetrics, and is raised almost exclusively by colleagues who have little or no personal experience in this field. This doubt is basically unfounded. Nearly all obstetricians consider it obvious that the fetal heart sounds be monitored by auscultation during parturition at certain intervals so that, should the recording reveal certain suspect sounds, a Caesarean section or surgical vaginal delivery can be performed. Hence, those who accept the "classical" methods of simple auscultation can hardly doubt the usefulness of method used in a considerably improved form.

2.2.2 Classification of the fetal heart rate

Recommendations published to date: The most important contraction-related patterns are to be mentioned here, as described by CALDEYRO-BARCIA et al. [22], HAMMACHER et al. [32], HON et al. [43], SUREAU [87], SHELLEY and TIPTON [73] and WOOD et al. [96]. A graph shows these characteristics and differences most clearly (Fig. 1). The term "alarm-dips", as used particularly by clinicians in our country, requires no graphic representation. It includes all patterns indicative of hypoxia, particularly late and variable decelerations. The papers referred to above contain further details.

2.2.3 Patterns of importance to clinicians today

We have taken the clinically most important patterns from recommendations proposed by an international committee which met in Amsterdam at the end of March 1972. These recommendations are still not definite but an agreement on nomenclature was largely reached. The detailed information will be published shortly by the National Foundation in the United States. The committee members who also are clinicians, were: CALDEYRO-BARCIA (Montevideo), DE HAAN (Amsterdam), HAMMACHER (Basel) HON (Los

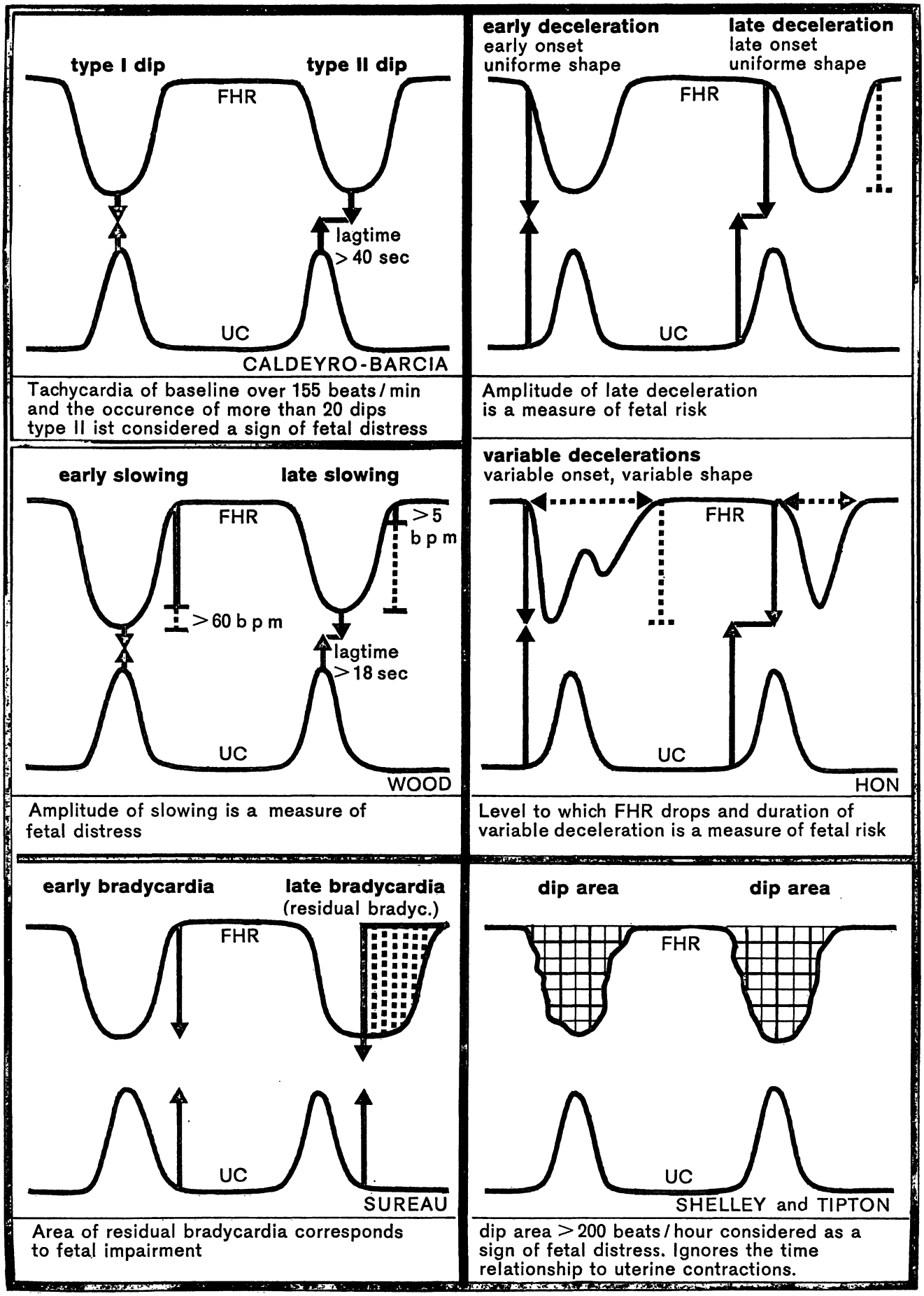

Fig. 1. Schematic representation of characteristics of decelerations caused by hypoxia, as described by various authors. FHR = Fetal Heart Rate, UC = Uterine Contractions, bpm = beats per minute.

Angeles), JAMES (New York), PAUL (Los Angeles), SALING (Berlin), SUREAU (Paris).

I. Baseline FHR is that fetal heart rate recorded **between contraction-related changes.**

A. Subdivisions:

marked bradycardia	99 or less
mild bradycardia	100—119
normal FHR	120—150
mild tachycardia	151—160
moderate tachycardia	161—180
marked tachycardia	181 or more

B. There are three types of **variations** commonly observed in the baseline FHR:

1. Oscillations = fluctuations (Fig. 2): These have both a) **frequency** (expressed in cycles per

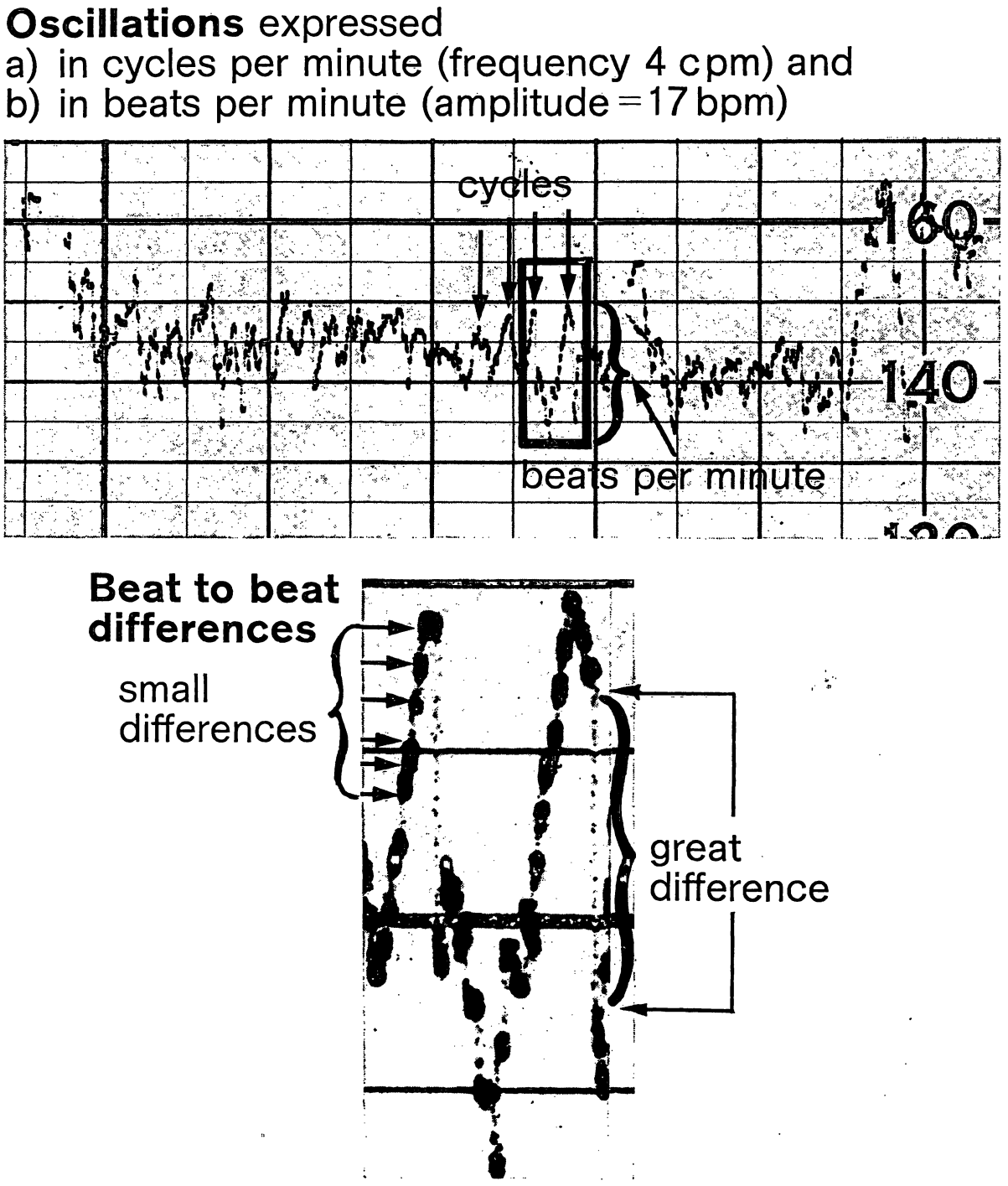

Fig. 2. Differentiation between oscillations and beat-to-beat-differences in an enlarged cardiotocogram section.

minute) and b) **amplitude** (expressed in beats per minute).
The frequency of the oscillations is in the range of 2—6 cycles per minute.

The amplitude of the oscillations is classified as follows:

Minimal	0—2 bpm
Decreased	3—5 bpm
Moderate	6—10 bpm
Increased	11—25 bpm
Marked	>25 bpm

2. Beat-to-beat differences (Fig. 2): These are the differences in heart-rate between two successive heart-rate measurements.

3. Sporadic changes: These are FHR changes occurring at a rate of less than two per minute.

II. Contraction-related FHR

A. Decelerations (Fig. 3): (For the sake of clarity, in the following text only the patterns indicating hypoxia are mentioned.)

1. Uniform decelerations: Late decelerations (late dips) — these have an onset and maximal decrease late in the contractionphase with recovery occurring following the contraction.

2. Non-uniform decelerations:

1. **Variable** decelerations — these have a variable time of onset, recovery and/or waveform;

2. **Combined** decelerations — these consist of **any** combinations of early, late or variable decelerations, or acceleration combined with deceleration.

B. Accelerations: An increase of FHR related to a contraction.

2.2.4 The significance of the different FHR patterns

When recording of FHR was in its early stages and before fetal blood analysis (FBA) was introduced, it was difficult to determine the significance of the different FHR patterns with and without relation to contractions. There have been attempts to ascribe a certain pathognomonic significance to different suspect patterns, particularly to contraction-related patterns. It followed naturally that upon the occurrence of such patterns, labor had to be terminated by operation. In the meantime, however, it has become more widely accepted that the **different patterns, although of different significance, are not always related to fetal hypoxia.** Tabs. I and II show relationships between different FHR-patterns and fetal blood parameters, as well as the APGAR-score in Tab. I.
Results to date can lead to only one logical conclusion, that the FBA has first to be performed in order to determine whether or not there is imminent fetal hypoxia [8, 25, 81, 95]. At present,

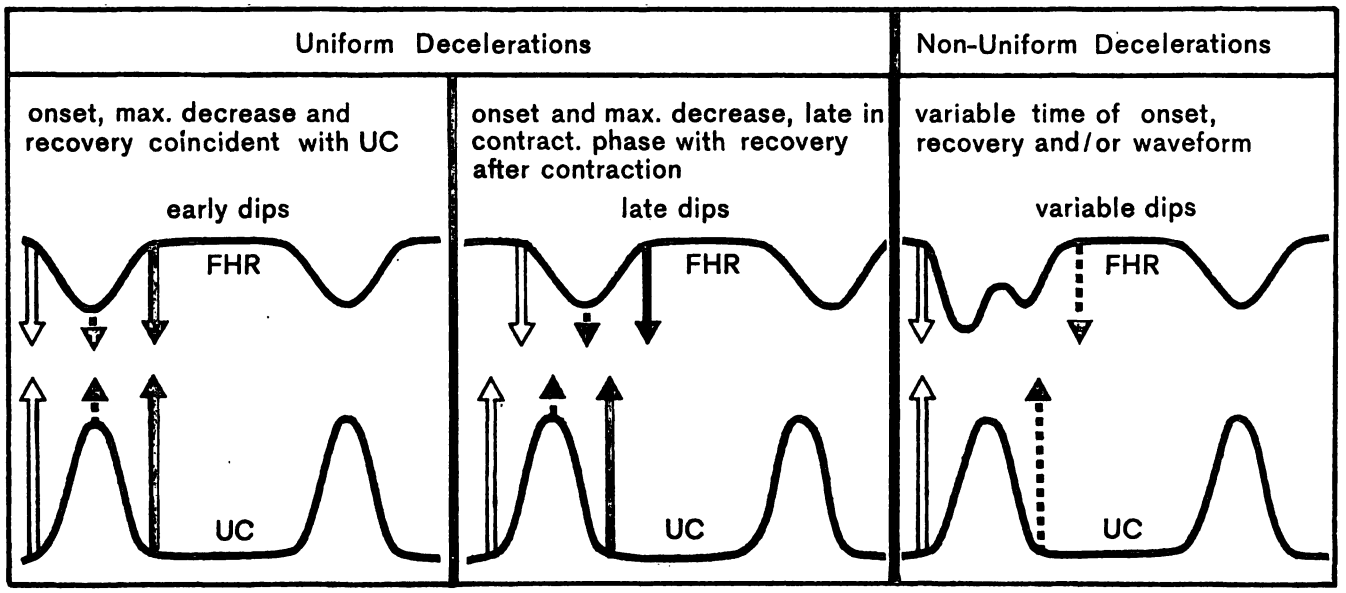

Fig. 3. Schematic representation of the decelerations in the new classification of intrapartum fetal heart rate.

Tab. I. Results of different authors concerning the relationship between different FHR patterns and acidity (mean pH-

	pH					O_2-Saturation (%)	
	Wood et al. [96]	Caldeyro et al. [19]	Beard et al. [8]	Kubli et al. [52]	Mendez-Bauer et al. [60]	Mendez-Bauer et al. [60]	Caldeyro et al. [19]
Normal trace or no deceleration	7.32	7.266	7.337	7.30	7.28—7.35	55—65	47.9
Accelerations			7.34				
Early decelerations	7.27		7.33	7.30			
Type II dips		7.15					24.8
Type II dips >5 bpm							
UPI patt.	7.10						
Late dec., mild	7.14			7.22			
Late dec., moderate				7.21			
Late dec., severe				7.12			
Late dec., abnormal baseline			7.28				
Variable dec., normal baseline			7.311				
Variable dec., abnormal baseline			7.223				
CC patt.	7.24						
CC patt. + Tachycardia	7.17						
Variable dec., mild				7.29			
Variable dec., moderate				7.26			
Variable dec., severe				7.15			
Slowing 30—60	7.25						
Slowing >60	7.16						
Tachycardia (uncomplicated)			7.306				
Bradycardia (uncomplicated)			7.326				
Loss of beat to beat var. (uncomplicated)			7.301				
Loss of beat to beat var. (complicated)			7.242				

the most important data from the literature give the following picture: concerning contraction-related **decelerations,** clinically the most frequent and hence most important signs, a study of the extensive literature reveals that from all deceleration patterns **late dips** are believed **to be more frequently related to fetal hypoxia** [20, 22, 25, 43, 44, 52, 96]. According to Hon [39], late dips are an expression of an utero-placental insufficiency. Schifrin [69] says this in a more general form, considering it a result of reduced uterine blood flow. This formulation seems more exact since insufficiency indicates a more permanent functional defect of one or more organs. Late dips can also occur during noxious influences of short duration as shown for instance in animal experiments by James et al. [46].

Variable dips, on the other hand, **are more often related to umbilical cord complications** according to Hon [38]. Our data [44] show them to be somewhat less frequently associated with hypoxia than are late dips (Tabs. I and II), but,

values), O_2-saturation, Po_2, Pco_2, BD and APGAR scores.

Po_2 (Torr)		Pco_2 (Torr)		BD (mEq/l)			APGAR score	
CALDEYRO et al.	WOOD et al.	CALDEYRO et al.	WOOD et al.	HON et al.	CALDEYRO et al.	WOOD et al.	WOOD et al.	BEARD et al.
[19]	[96]	[19]	[96]	[43]	[19]	[96]	[95]	[8]
23.2	23.44	47.23	42.76	6.98	6.87	7.03	7.0	7.8
								8.0
	19.75		55.50	6.97		7.1		8.2
17.2		68.11			6.96			
							3.8	
	21.67		58.00			3.8		
	21.4		55.15	9.29 10.79 12.88		5.4		
								4.0
								8.5
								6.2
	18.83		50.18			6.81		
	18.80		53.23			5.18		
				7.84				
				8.98				
				10.17				
	20.6		50.60			7.07		
	20.6		55.62			5.82	5.8	
								8.1
								8.4
								8.0
								6.2

nevertheless, a **warning signal of fetal risk.** These dangers are discussed in more detail by the author referred to above.

TIPTON and FINCH [91] as well as TIPTON and SHELLEY [73, 92] see the closest relationship between deceleration and risk to the fetus in the **"dip area"** as shown in Fig. 1, in contradiction to the above-mentioned etiological explanations. Their evaluation is based on the clinical state of the fetus at birth only and not on the much more reliable biochemical parameters, such as blood pH from the fetal scalp or the umbilical artery. The data of WOOD et al. [65, 95] and more recent findings of BEARD et al. [8] are somewhat better grounded. WOOD et al. found that even **early decelerations** when they are considerable **(decrease by > 60 bpm)** must be considered as indicators of hypoxia. BEARD et al. come to a similar conclusion by associating at least in part of their cases the different contraction-related decelerations to pH values. They showed that in deep decelerations up to < 50 bpm, ab-

Tab. II. Results of different authors concerning the relationship between different FHR patterns and acidity in the fetus (expressed in %).

	pH normal >7.25			Precidosis 7.24—7.20			Acidosis <7.20		
	Kubli et al. [52]	Imhof et al. [44]	Destro et al. [25]	Kubli et al. [52]	Imhof et al. [44]	Destro et al. [25]	Kubli et al. [52]	Imhof et al. [44]	Destro et al. [25]
Normal trace or no deceleration	89.1	88	64.1	4.7	11	21	6.2	1	14.9
Accelerations	96.2			3.8					
Early deceleration	94		62.2	6		34.4			3.4
Late and/or var. deceler.		64			20			16	
Late deceler., mild	37.1		50	33.3			29.6		16.6
Late deceler., moderate	14.3		21.4	57.1			28.6		39.3
Late deceler., severe	10		16.4				90		58.3
Deceler. var., mild	90.4		32	4.8		42	4.8		26
Deceler. var., moderate	37.1		25	31.4		25	5.7		50
Deceler. var., severe				30			70		100
Tachycardia		87			10			3	
Tachycardia with late and/or var. deceler.		57			20			23	
Bradycardia		57			10			33	
Bradycardia with late and/or var. deceler.		46			23			31	
Marked varying baseline FHR > 40 bpm		73			17			10	

normal pH values occur even without a time-lag.

According to Hon [41] contraction-related **accelerations** may be the earliest indicator of possible fetal compromise. Our unpublished results [72] indicate that accelerations are particularly **related to umbilical cord complications.** In several such cases we have been able to observe a change of accelerations into variable dips as shown in Fig. 4.

Bradycardia plays an important role in baseline FHR patterns. This suspect pattern has been known for many decades in the stethoscope era. We must indeed consider bradycardia from two points of view:

a) The **suddenly occurring form,** particularly when **associated** with the silent oscillation-type and/or late or variable dips, must be considered to be **strongly indicative of acute hypoxic complications** [22, 40, 44, 57].

b) **Persistent bradycardia** without suspicious contraction-related decelerations, particularly when associated with a good oscillation type, may be considered **harmless.** Beard et al. [8] refer to it as "uncomplicated bradycardia". Hon [41] states: "Persistent bradycardia has not been associated with depressed newborns. It may be associated with congenital heart lesions". Fig. 5 shows a particularly illustrative case from our observation. Bradycardia was observed for nearly eleven hours together with a silent oscillation type. The pH values of fetal blood, however, were repeatedly normal, and the infant was born spontaneously with normal pH values. The cause was found to be an A. V. block that disappeared several hours after delivery.

It is important to know whether or not **tachycardia** is associated with contraction-related decelerations. It is obvious that such a **combination** is more dangerous than the isolated occurrence of **"uncomplicated tachycardia"**, a term used by Beard. Wood et al. [96] show that in cases with cord complication patterns (CC-patterns) without tachycardia the mean fetal pH was 7.24, whereas in cases with CC-patterns and tachycardia 7.17 was measured. We observed [44] that in cases with isolated tachycardia (without alarm dips) pH values were

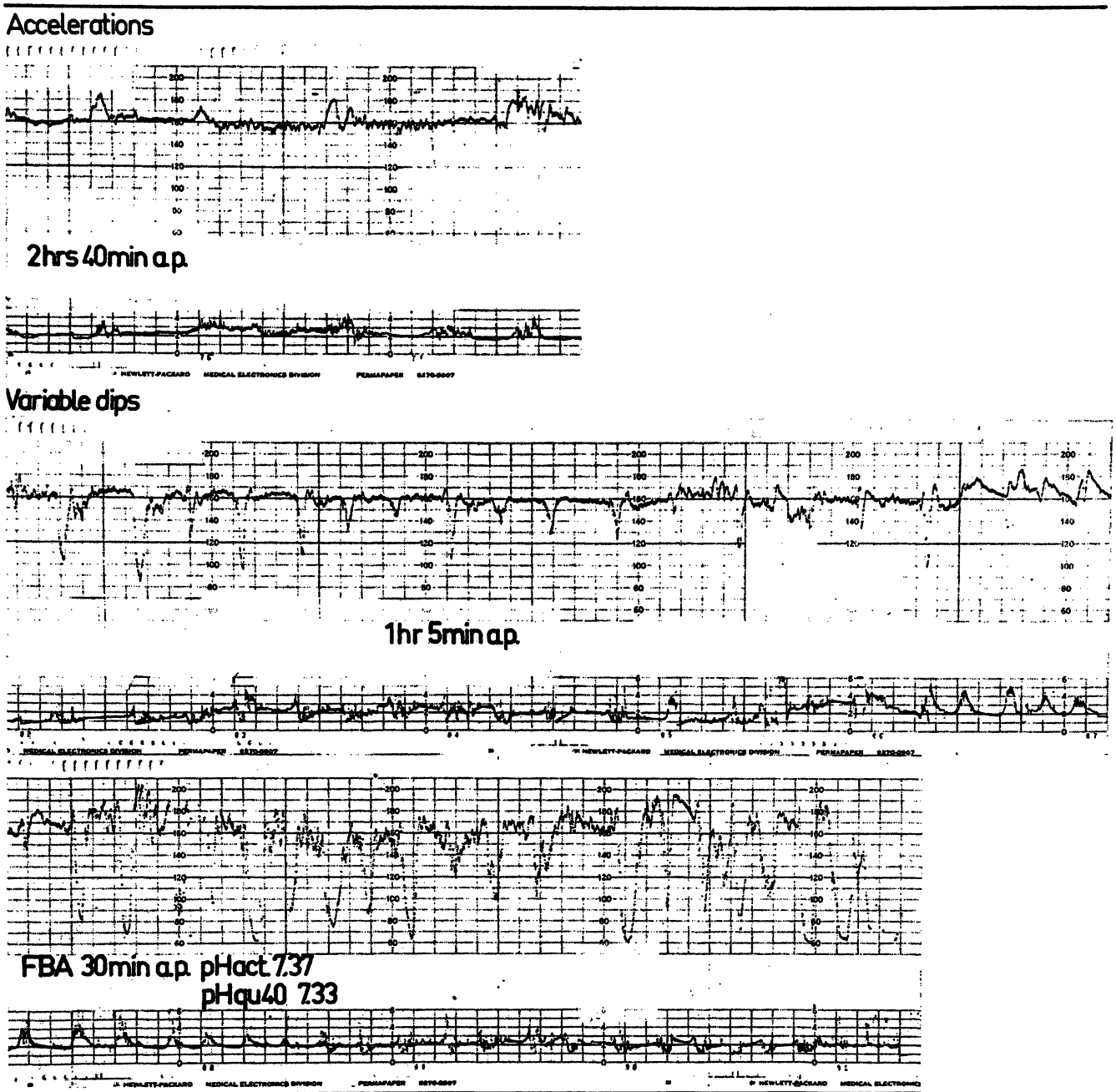

Fig. 4. Cardiotocogram of a case with primarily occurring accelerations and later occurring variable dips with cord around the neck.

normal in 87%, preacidotic in 10% and acidotic in only 3% of the cases. However, in cases with tachycardia and suspect decelerations, pH values were normal in only 57%, preacidotic in 20% and acidotic in 23%.

In publications from 1960—1963 by Cox, Hon, Labo et al., Roszkowski et al. [24, 42, 54, 66] and also by Caldeyro-Barcia in a review-lecture presented at the World Congress in 1967 [22] the opinion is voiced that **tachycardia itself is already a sign of intrauterine hypoxia.** In 1968 Hon wrote: "Tachycardia is frequently

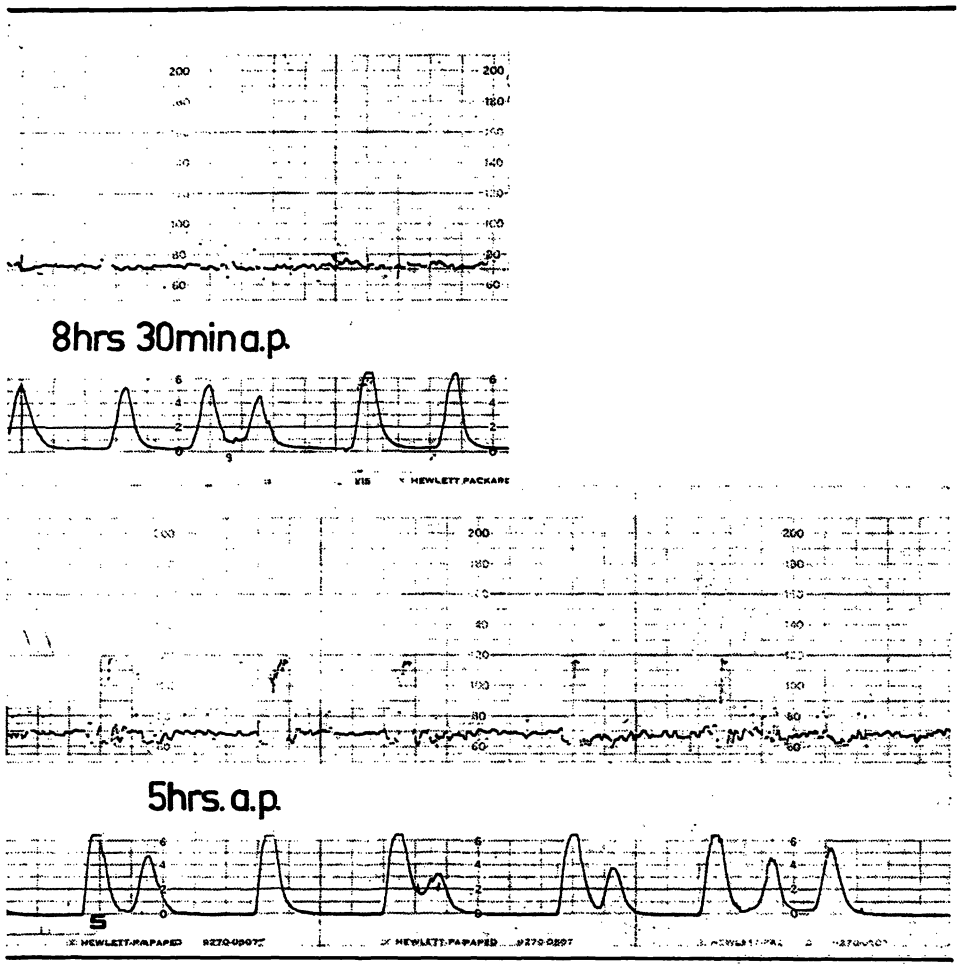

Fig. 5. Cardiotocogram of a case with fetal bradycardia lasting several hours with a silent oscillation type and normal fetal pH.

associated with maturity, maternal fever, and minimal fetal hypoxia" [41].

Today, **isolated "uncomplicated" tachycardia is not usually considered to be an important sign indicating direct imminent fetal hypoxia** [8, 84]. Nevertheless, tachycardia is not to be disregarded in the clinic since it is a sympton of a certain **fetal stress** and a sign of chronic overload frequently leading to complications in the newborn period. Together with SCHÖNFELD we demonstrated [71] that the frequency of clinical depression in infants is significantly higher following **prolonged fetal tachycardia** than without previous tachycardia. HOBEL [37] has had similar results. He has pointed out that after tachycardia, fetuses rarely show any biochemical changes, but that **neonatal morbidity is considerably higher.** Therefore we have recommended that if tachycardia lasts **longer than two hours** and if spontaneous delivery cannot be expected within the next one to two hours, parturition should be terminated surgically even if the pH values are normal [84].

Oscillation-types and beat-to-beat-frequency:

The above-mentioned international committee, in elaborating the descriptive classification of intra-

partum FHR, determined that a distinction must be made between the beat-to-beat-frequency and the oscillations (Synonym: fluctuations).

It is not clear as yet whether **beat-to-beat differences** — HON [41] previously called them beat-to-beat arrythmias — are of clinical significance. A certain significance is ascribed to the oscillation-types called "baseline irregularity" by HON [41] and "rapid fluctuations" by CALDEYRO-BARCIA et al. [19]. HAMMACHER [30], who labelled these forms "silent", was the first to emphasize that **silent oscillation-types are of particular importance.** HON later [41] was of a similar opinion: "FHR-baseline irregularity may prove to be a sensitive indicator of fetal condition." BEARD et al. [8] have ascertained that while loss of beat-to-beat variations "uncomplicated" by decelerations show no fall in the pH value, **beat-to-beat variations "complicated" by decelerations** are associated with decrease. We have been able to show [82] that **during parturition** the silent oscillation-type plays **a less important role,** appearing relatively rarely, except when caused by medication. The greater frequencies observed by other authors might be due to the diagnosis of a pH-decrease in a somewhat later stage.

It may be added that according to our observations, silent oscillation-types hardly ever occur alone, but always with contraction-related decelerations (late and/or variable dips). Since these dips usually appear earlier and are more easily diagnosed, they are a sufficient indication for FBA.

2.2.5 Indications for operative termination of labor in the presence of suspect FHR patterns

The literature concerning the diagnostic possibility of different FHR patterns is extensive. Yet one rarely finds exact and satisfactory data as to when labor is to be terminated from the fetal point of view in the presence of suspect patterns. SZE-YA YEH and HON [88] recommend operative termination of labor if ominous FHR patterns persist for **30 minutes or more.** KUBLI and RÜTTGERS [53] recommend operative termination of labor if a definite pathological FHR pattern **persists or becomes worse in spite of conservative measures.** They do in fact give detailed data but conclude this paragraph with the remark: "Without doubt, difficulties are encountered in the interpretation of the FHR patterns, even if recording was technically perfect and particularly if the cardiotocogram was defective. This is valid even for trained personnel. The decision of the obstetrician in these cases is aided by FBA which gives additional information". It may be added that external **registration** based on the phonocardiographic principle provided us with good and sufficient results in only 57% of the cases, while in 34% the data were insufficient [80].

LAMBERTI et al. [55] recommend surgical **termination of labor,** if during the second stage the obstetrician observes more than **4 to 5 dips II** (variable dips). Delaying labor may lead to considerable disturbances in the acid base balance. We calculated from the material of these authors that 12% of all labors had to be terminated surgically because of this indication only. This figure shows unequivocally that the incidence of surgery is high if only cardiotocographic monitoring must be relied upon. In a number of these cases our experience indicates that a spontaneous delivery would have been possible without any danger to the fetus after several more contractions if FBA had also been performed. Exact diagnosis plays particularly an important clinical role in cases in which an unnecessary severe vaginal operation (high vacuum extraction or forceps) can be avoided.

The decreased reliability of the recommendations mentioned at the beginning of the last paragraph follows from the case shown in Fig. 6. This is not a single case but a typical example which can be seen relatively often. The frequency of this kind of case is being studied.

Such cases, when only monitored by FHR often lead to unnecessary surgical intervention.

There is an **increasing number of authors** who are convinced that it is clinically much more reliable **to do fetal blood analysis in cases of suspect FHR patterns** [5, 8, 18, 25, 27, 31, 35, 37, 95].

Rational basis: If in spite of suspect FHR patterns there is no imminent hypoxic danger, then

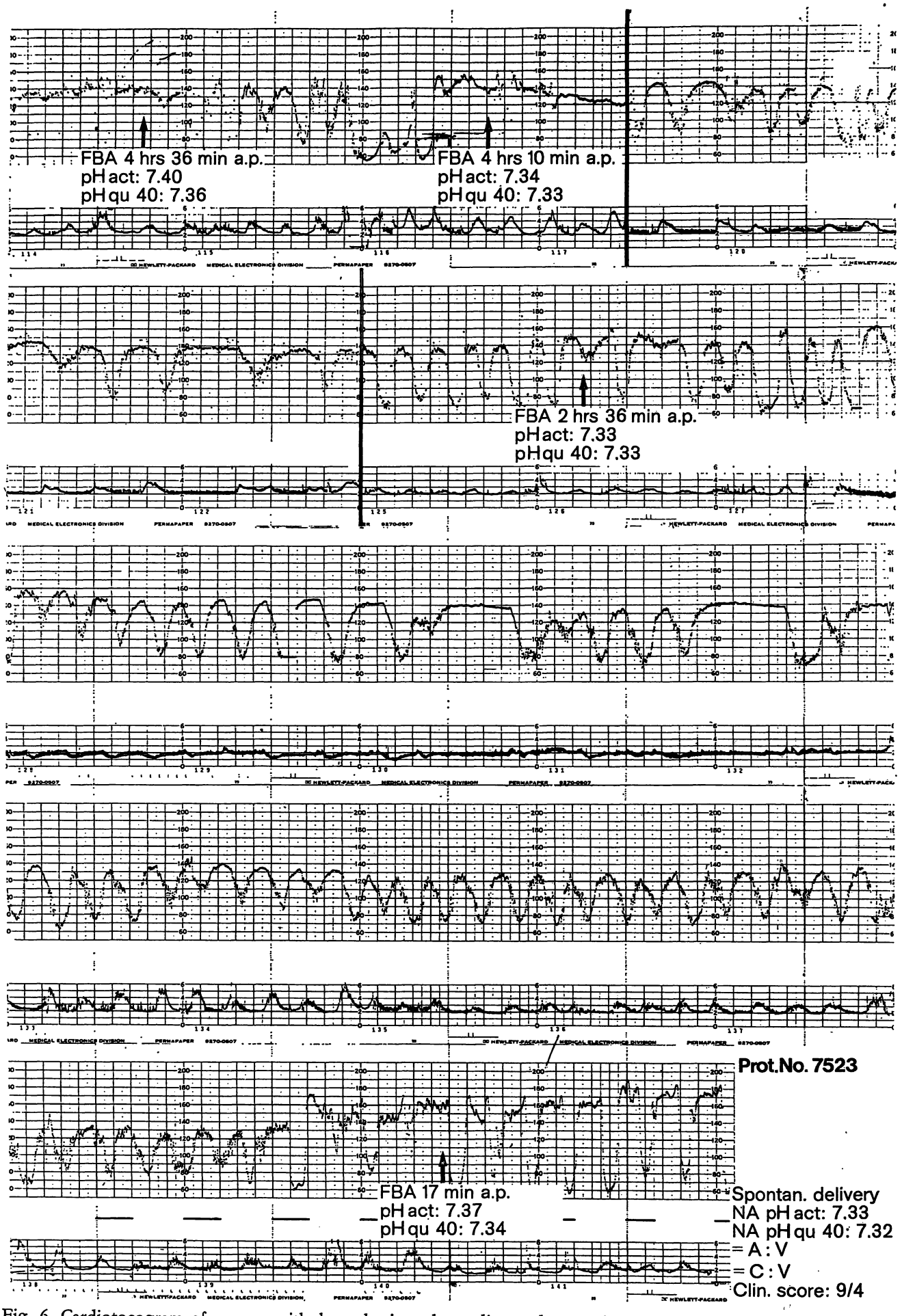

Fig. 6. Cardiotocogram of a case with long lasting alarm dips and normal pH. The child was born spontaneously with a good clinical score and normal pH in umbilical artery.

a) as long as parturition is proceeding well, there is a good chance of a spontaneous delivery. Except in breech presentations spontaneous delivery is less dangerous for the child than vaginal operative delivery and is sometimes less dangerous than a Caesarean section. Also in most cases an uncomplicated spontaneous delivery is less harmful to the mother, especially when compared with Caesarean section.
b) If during the further course of parturition hypoxia and acidosis do occur in the fetus, then it should be possible in a number of cases to deliver the child operatively through the vagina (of particular advantage to the mother) instead of using Caesarean section, or to proceed with a simpler vaginal operative delivery (advantageous for mother and child) instead of a severer vaginal operation.

2.2.6 Remarks concerning the recording of contractions

Clinically, contractions are recorded mainly for two reasons:

a) Such recordings are essential for the correct interpretation of FHR patterns.
b) They serve to judge contraction activity.
For reasons of simplicity, contractions are today recorded for the most part externally. For routine purposes it is sufficient to obtain some information on the frequency and duration of contractions. Internal recording of uterine contractions is recommended only in cases where exact data concerning contraction intensity are necessary, e. g. a) in **dystocia** of various origins and b) after **past history Caesarean section** in order to avoid too strong contraction activity (danger of rupture of the uterus). A detailed review of contraction-recordings and their significance is found in a publication by CALDEYRO-BARCIA et al. [21].

2.3. Fetal blood analysis (FBA)

The first publication on FBA appeared in 1961 [74]. Since then, this method has been the subject of many papers. Opinions range from semi-fictional polemic [3] to objective scientific evaluations concerning the basic principles and the significance of this method (literature, see below). As for all clinical methods it is necessary to know the diagnostic value, possibilities of errors and the disadvantages of FBA. A review by BRETSCHER [13, 14] gives the most important data concerning sources of error, precision and procedures of calculation. BRETSCHER explains the significance of double determination of pH in scalp blood [15]. The precision for pHact for single determinations is $\pm$ 0.026 and $\pm$ 0.018 for double determinations. LUMLEY et al. [58] also give more detailed data on the possible sources of error. It has been shown by several authors that in the majority of fetuses, values found in peripheral blood samples give a representative picture of the total fetal blood [2, 29, 34, 49, 51, 79].

2.3.1 Is fetal blood analysis worth-while?

The validity of a question concerning the worth of FBA is as doubtful as one concerning "fetal monitoring". Every method is worth-while that can be applied clinically without excessive effort and which increases the safety factor for mother and child in utero by making it possible to avoid unnecessary surgical procedures.
We have shown in earlier publications [62, 75, 81, 82] that **the diagnosis of fetal hypoxia during parturition can be made most reliably by using FBA.** Other publications [10, 16, 25, 44, 52, 60, 95, 96] have clearly shown that in numerous cases no acidosis is present in fetuses with previous FHR patterns indicative of hypoxia. We have observed cases in which the course of the fetal heart frequency did by no means reflect sufficiently the hypoxic state; we published an example of this three years ago [77]. It is of much greater clinical significance, however, that in cases of suspect FHR patterns hypoxic danger to the fetus can be excluded by FBA.
Any obstetrician sufficiently critical of his clinical work and determined to intervene operatively only when justified cannot work without FBA today. This view is supported by the results and recommendations for instance of WOOD et al. [95], DESTRO et al. [25] and BEARD et al. [8].

2.3.2 Parameters important to the clinician during monitoring of the fetus by FBA

Hypoxic danger to the fetus is best assessed by

pH determinations which reflect metabolic reactions to hypoxia [76], since those are much less dependent on circulatory factors than are blood gases. Variations in blood gases are much more frequent and of shorter duration than variations in metabolic acidity and can lead to erroneous interpretations. This has been confirmed by KERENY et al. [48].

The use of pHact and of pHqu40 has proved valuable in our clinical work, since **the relation between respiratory and metabolic acidity is expressed in the same unit** system. Since the blood oxygen saturation which is considerably lower in the fetus than in the adult, is not taken into account it is impossible to obtain exact Pco_2-values; but an adequate clinically useful evaluation of the relationship "respiratory or metabolic" increased acidity can be made. STOLL [86] considers the pHqu40 value a reliable parameter for the evaluation of metabolic acidity by the clinician.

Other authors often use **base excess values** (BE). These BE-values have somewhat lost their reliability and significance since WINTERS [94] has shown that there are changing relations between the intravascular and extra-vascular space. An attempt was then made to use the BE_{Hb5} (base excess for a theoretical Hb value of 5 g%) [47]. In the meantime we have shown together with RAHNE [84] as was later proved by ROVERSI et al. [67] that pHqu40-values give comparable results, e. g. in evaluating the relationship of metabolic acidosis between mother and fetus. The materno-fetal correlation coefficient between ΔBE_{Hb5} and ΔpHqu40 was $r = 0.98$, as shown in Fig. 7.

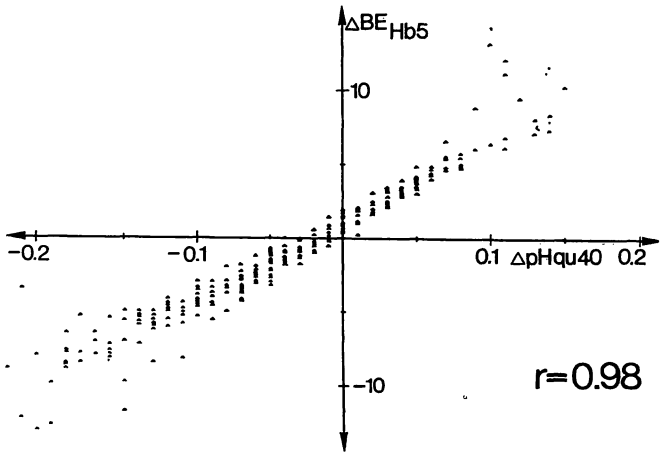

Fig. 7. Strong correlation between BE_{Hb5} and pHqu40.

The **Coombs Test, hemoglobin values and the blood group of the fetus** should be determined for the diagnosis of erythroblastosis. Here the usual pH-monitoring also plays an important role (see below).

Blood sugar determinations of fetal blood are suitable in order to evaluate the glycemia.

2.3.3 Remarks concerning the techniques of FBA

An improvement worth mentioning here is the suggestion of PAUL and HON [63] that fetal blood samples should be taken with the **mother lying in lateral position.** We found that this technique is of particular value when the patient is prone to vena cava compression syndrome. No other essential changes in the technique of fetal blood sampling have been introduced, except that we **no longer apply chlorethyl** to induce hyperemia of the skin, since occasionally long-lasting peripheral vasoconstriction can occur in the fetus. Animal experiments by ADAMSONS et al. [1] showed that in scalp samples without preceding hyperemia the blood-values lay between those of the carotid artery and the jugular vein; proving that no errors had been introduced.

Modifications in the instruments used seem due exclusively to industrial and commercial interests. Altered instrumentation has not brought about real improvement in FBA or increased safety.

A blood sampling tube with a **suction device at its tip** [6, 50] has been recommended but does not seem to be used extensively, perhaps for the following reasons: the application of the tube is made difficult at the critical moment (immediately after the rupture of the amniotic sac when considerable amounts of amniotic fluid are leaving the uterus), because the cervix is not yet dilated sufficiently to allow the introduction of the relatively bulky suction device.

2.3.4 Indications for single and repeated FBA

FBA is usually **indicated when FHR patterns suspect of hypoxia are recorded by FHR-monitoring.** The patterns are discussed in the paragraph "Significance of the different FHR patterns".

The question whether or not FBA should be repeated is best answered by the character of the suspected disturbance. If acute complications (e. g. appearance of acute bradycardia) are suspected, a first, a second and, if necessary, a third blood sample should be taken in rapid succession. Only in this FHR pattern are hypoxia and acidosis observed in the first 10 minutes [82]. For all other changes in the FHR frequency the first fetal blood sample should be taken after about 10 minutes and then at 15-minute intervals, and should, if the case requires, be continued for several hours at longer intervals. Thus in the presence of late or variable dips, particularly if the pattern becomes more and more obvious, and if the first pH-value was normal, further blood samples should be taken about every 15 minutes. If, however the pH-value of the first blood sample was below 7.3, FBA should be repeated at shorter intervals (e. g. 5—10 minutes). If, on the other hand the intensity of the suspect patterns remains unchanged or the patterns disappear altogether the intervals between blood samplings can be extended and eventually FBA discontinued.
Obviously we cannot discuss in this article every possible situation that might occur during parturition. The above data serve only as a rough orientation.

2.3.5 Consequences of FBA

A decrease in the pH-value is essentially due to the following causes:

1. **Fetal hypoxia** (the most frequent and clinically the most important cause).

2. **Increased fetal acidosis due to the maternal factors,** particularly to the transfer of lactic acid.

3. **Impairment of the peripheral circulation** in the presenting part of the fetus.

Ad 1: A **steep decrease** in the fetal pH is nearly always an **alarming sign,** an expression of **acute fetal hypoxia** and an indication for **rapid termination of labor.**

a) **Tocolysis: A supportive measure of surgical termination of labor.** Since this acute danger is nearly always related to contractions, it is recommended to follow the suggestion of Poseiro et al. [64] and to alleviate this danger, at least partially, by immediate inhibition of the contractions. This gives a better chance to the child **until it can be delivered operatively.** We use Berotec (Boehringer/Mannheim) either as injections or as drip infusion. For injections the solution consists of 1 amp. Berotec (0.08) and 19 ml of a 0.9 NaCl solution. 1 ml of this solution is given intravenously every minute. For infusions, we use 2 amp. (1.0) Berotec and 500 ml of an electrolyte solution and infuse, depending on the effect, 20—40 drops per minute. Single injections have the advantage that the patient can be moved to the operating theater without transporting a container and stand to hold the infusion system.

b) **Change in the position of the patient.** If variable decelerations (variable dips) with or without a drop in pH occur, it is advisable to follow the recommendation of Hon [41] to change the position of the patient. Sometimes it is possible to treat cord complications conservatively in this manner.

c) Operative termination of labor is also indicated if the **fetal pH decreases slowly to pre-pathological values** and if this tendency continues. An increase in metabolic acidity due to maternal factors in these cases must be excluded.
Attempts at conservative therapy by tocolysis: We agree with the recommendation of Esteban-Altirriba et al. [28] to delay by an initial inhibition of contractions the final decision on operative termination of labor in some cases. The intention is not to delay operation, but in some cases a persisting success with the conservative therapy may make surgical interference unnecessary. **It is important to make sure that contractions are inhibited transiently before the pH-value has sunk too low.** The recuperation would then last too long and the child would be exposed too long to an increased acidity. The reason for such therapy would then be questionable. Our experience indicates that the best results are obtained if contractions are inhibited at a pHqu40 between 7.27 and 7.23. In a number of such cases it is then possible to obtain uncomplicated continuation of labor, contractions reappearing without a new decrease in

the pH-value. It is not yet clear why, following tocolysis, the original **complications do not reappear,** perhaps better hemodynamic conditions can develop in the utero-placental region.

Raised pH-limits for the operative termination of labor: Previously we had recommended operative termination of labor at a pH lower than 7.20 [76]. Experiences have since shown, however, that sometimes too much time elapses between the decision and the operative delivery of the infant; as a result, hypoxia and acidosis as well as the clinical depression of the infant may be too pronounced. Hence we have recommended [78] that **labor be terminated operatively if the pH value drops to below 7.25.**

Ad 2: Increased acidity due to maternal factors does not seem as dangerous for the fetus as an overload of acid valences due to hypoxia of the fetus itself [10, 79]. BLECHNER et al. [11] has indeed shown that after infusion of ammonium chloride to the mother, fetal oxygen saturation decreases and therefore the blood oxygen content as well. We consider it doubtful, however, whether it is justified to compare acidosis due to a rapid infusion of ammonium chloride, particularly under full anesthesia with the increase in acidity due to the transfer of lactic acid from the mother in the unesthetised woman during labor.

Possible disadvantage of an increase in fetal acidity due to maternal factors: A decrease in the buffer reserves. Particularly if additional complications occur the effect on the fetus may be delererious.

Possible advantages of increased acidity due to the mother:

a) The lactic acid transported to the fetus from the mother serves as an **additional energy source.** Since the oxygen supply of the fetus usually remains undisturbed, the lactic acid can be oxidized to CO_2 and water.

b) Fetal metabolism is slightly inhibited by **an increase in acidity, leading to a decrease in oxygen consumption.** Administration of buffer to the mother, thus increasing the pH-value, may lead to the **opposite reaction** in the fetus according to BRETSCHER et al. [17], i. e. to a decrease in Po_2. We feel that the decrease in Po_2 is due to an increase in oxygen consumption induced by the rise in the pH-value.

Diagnosis of increased acidity due to maternal factors: The diagnosis is best achieved by **simultaneously determining the pHqu40 in mother and fetus.** Originally we defined the limit of the ΔpHqu40 empirically as 0.05 [79]. ROVERSI and CANUSSIO [67] have later confirmed by experiment that this limit is of good practical value. It has already been pointed out that the pHqu40 values are of equal practical use as the recently recommended BE^{Hb5}-values.

Practical clinical implications: If the pH-value of the fetus is reduced to less than 7.3, the maternal pHqu40 should also be determined. **If the ΔpHqu40 between mother and fetus is 0.05 or less,** increased acidity in the fetus is due to maternal metabolic factors. Such a situation does not have the same implication for surgical termination of labor as imminent fetal hypoxia [79].

The frequency of increased acidity due to maternal factors: This is shown in Tab. III using the data of ROVERSI et al. and our own.

Tab. III. Frequency of maternogenic increased fetal metabolic acidity during labor and immediately after delivery.

Authors	1st stage	2nd stage	Partus
ROVERSI and CANUSSIO [68]	8.5%	28%	55%
SALING [79]	18%	26%	31%

Ad 3: HICKL has shown that **caput succedaneum has no significant effect** on the pH of scalp blood [34]. When we first introduced FBA and compared blood samples from a) the visible head immediately before delivery and b) immediately after delivery before the first respiration from the umbilical vessels we could show that blood from the scalp showed an acidosis and in the umbilical arterial blood non acidotic values only in 3% of all cases [76].

Only in cases with scalp blood values calling for operative measures in which umbilical arterial blood later showed normal pH-values are we justified in saying with a few exceptions [76] that an error of diagnosis (over-diagnosis) has been made. The rare disturbances in the peripheral circulation leading to an erroneous diagnosis of fetal acidosis occur most frequently in cases of **very pronounced caput succedaneum.** Since more active obstetric care in recent years has reduced the number of prolonged labors, the frequency of very pronounced caput succedaneum has also decreased considerably. Tab. IV shows this frequency as obtained in a study undertaken together with COLEMAN a few years ago (unpublished data).

Tab. IV. Frequency of caput succedaneum related to its severity (n = 2100), according to COLEMAN and SALING.

	No	Minimal	Moderate	Severe
n =	1570	222	257	51
in %	74.8	10.6	12.2	2.4

Practical clinical implications when circulatory disturbances in the presenting part of the fetus are expected: If with a pronounced caput succedaneum pH-values are below 7.25, the cardiotocogram should serve as an additional diagnostic aid. If the heart rate frequency does not show a definite suspect pattern it is not necessary to terminate labor operatively. If, however, the pattern is suspect, surgery must be resorted to since no better diagnosis is possible.

2.3.6 Treatment of cases with erythroblastosis or fetal hypoglycemia

If erythroblastosis is suspected, delivery is best supervised by assessing the pH as in fetuses with imminent hypoxia. TERAMO et al. [90] rely on the pH-value in cases of fetal erythroblastosis as, in their opinion, hypoxia will lead to acidosis in anemic fetuses as well. According to HOBEL [36], **acidosis occurs more frequently in anemic fetuses.**

If severe erythroblastosis is suspected, usually diagnosed from the ΔE values in the amniotic fluid, fetal blood sampling should already be started at the onset of labor. If Hb-values shows an anemia, for instance less than 12 g%, **preparations for an exchange transfusion** should be made immediately, requiring the **blood group** of the fetus. A further small blood sample is necessary for **crossmatching.** Usually it is possible to perform all necessary examinations before delivery of the child so that the exchange transfusion can be commenced **5—10 minutes after delivery,** that is as soon as the umbilical vessels are catheterised. For more severe cases, this diagnosis during labor for the eventual post-delivery exchange transfusion is certainly of great value.

Disturbances in the energy exchange of the fetus are to be expected if hypoglycemia occurs. Values lower than 30 mg% are always suspect and should be treated by infusing a 10% glucose solution to the mother. Even though glucose given to the mother does not immediately increase the fetal glycogen reserves, it leads to a higher fetal blood glucose level, with little or no demand on the glycogen reserves.

3. Selection of patients for modern monitoring techniques

3.1 Admission amnioscopy

Previously only patients at risk during pregnancy were subjected to amnioscopy on admission. Years ago, however, we decided to subject every patient admitted during labor to amnioscopy. Our results confirm the usefulness of this method. **Amniotic fluid containing meconium was found in 11% of all cases** [26], indicating that it was a high-risk labor and hence had to be monitored more intensively.

3.2 FHR-monitoring

Ideally, **every parturient** should be monitored. An inquiry of the situation in West Germany and West-Berlin in 1971 [93] showed that 58% of the participating clinics try to monitor all labors, i. e. also normal labors. Thus, in cases of insufficient perinatal care, where no indications of increased

risk had been observed, fetal danger in parturition could nevertheless be diagnosed in time. Acute complications (umbilical complications were by far the most frequent) were recognised from the monitor recording without delay. As mentioned above, there are some early warning signs of such complications.

3.3 Fetal Blood Analysis

In contrast to FHR monitoring which will probably be routine in the near future in modern clinics, **FBA remains a procedure used only in specially indicated cases** when suspect FHR-patterns are present. This situation will change only if we succeed in developing pH-electrodes for continuous monitoring of the presenting fetal part.

3.3.1 Hematological and serological examinations

These should be performed in any women whose previous antibody tests and examinations of amniotic fluid led us to suspect moderate or severe fetal erythroblastosis.

3.3.2 Glucose analysis in the fetus

Reduced glycogen stores may be suspected when a) **placental insufficiency** on the basis of the previous history (e. g. toxemia) is probable, b) **retarded fetal growth** was noted during pregnancy using ultrasound examinations [85] or when c) the **pH falls slowly during labor.** In all these cases it is recommended either to **infuse glucose during parturition** or to determine by FBA the blood glucose level in the fetus as well as the pH. It may also be useful to determine the fetal blood sugar values in diabetic women. BEARD et al. [7] published data on a case of maternal hypoglycemia causing fetal tachycardia. After the infusion of glucose, the FHR returned to normal.

4. Types and numbers of intruments for modern monitoring during labor

4.1 Admission amnioscopy

Simple, slightly conical tubes without any additional lens systems for magnification or deminution have proved most advantageous. Reason: The unaided eye is best-trained to recognise changes in the color of amniotic fluid.

Required instruments: For 1000 deliveries per year, a set consisting of the following is required:
a) One transformer with a conventional illumination device or one generator of cold light with glass fiber cable and a device for illumination.
b) 5 tubes (2 with 20 mm outer diameter, 2 with 16 mm and 1 with 12 mm)
c) 1 swab-holder.

4.2 FHR-monitors

Type of instruments: At present, 4 different recording principles are utilised. These are 3 external methods: a) Phonocardiography, b) Ultrasonocardiography and c) Abdominal electrocardiography, and
one internal method: direct fetal electrocardiography.
We recommend instruments that, if at all possible, permit both the recording of internal impulses through skin (scalp) electrodes (ECG) and also one or two external impulse recordings using transducers (phono- and/or ultrasono-cardiography).
For contraction recordings, the monitors should possess equipment, not only for external, but also in particular situations for internal recordings of contractions.

Number of required FHR monitors: For 1000 deliveries it is recommended to have at least two or better still three monitors. A clinic with a low annual delivery rate (less than 1000 per year) must have at least two monitors as replacement, in spite of constantly improving service by the industry, as mentioned in an earlier critique [84].

4.3 Equipment for FBA

Regardless of the size of the clinic a pH-meter is required. For purely clinical work, a simple device for pHact and pHqu40 determination in small blood samples is sufficient. Versatile but much more expensive are instruments that also permit the determination of blood gases; these offer no advantage because analysis-time is not shortened nor are the clinical diagnostic data improved [83].
Diagnosis of erythroblastosis: Here the usual equipment available to any clinical laboratory is required.
Analysis of glucose in the fetus: We consider the BECKMAN Glucose Analyser most suitable, as results are obtained within a few minutes. Since the instrument is expensive, clinics with limited financial means must consider the possibility of infusing glucose in all suspect cases.

5. Disadvantages and dangers of modern clinical monitoring

5.1 Admission amnioscopy

The danger of **ascending infections** in the mother or child plays no important role at the

end of pregnancy and during parturition [12, 56]. Special care is only required with patients bleeding from the uterus; when, for instance, the amnioscope is introduced without sufficient care, placenta praevia may cause considerable bleeding.

5.2 FHR-monitoring

The staff in the delivery room often work under the false assumption that, with the monitor running, modern surveillance of labor has been achieved. This psychological error combined with the performance of other urgent measures in the delivery room repeatedly causes a situation in which the recording is inspected only at lengthy intervals and consequently the suspect pattern is recognised too late. The actual success of modern monitoring can be very much impeded in this case.

Compression syndrome of the vena cava: External recording of the FHR usually occurs with the patient in a supine position. This frequently leads to a compression of the vena cava; if this complication is not diagnosed correctly, and the patient is not put into the lateral position, surgical intervention which could have been avoided becomes necessary.

Erroneous diagnosis of imminent danger to the fetus due to isolated FHR monitoring: Erroneous diagnoses are made in a number of cases in clinics with FHR monitoring as the only method used. If suspect patterns occur, it is assumed that a complication has arisen and labor is terminated operatively. In actual fact FBA could have shown in a considerable number of cases that there was **no** danger of hypoxia and that no operation was necessary.

Additional financial costs: The constant use of FHR monitoring leads to considerable current expenditures due to repairs and to the tremendous supply of recording paper required. For 1000 labors, monitored for an average of 8 hours, the cost of paper alone is $1400 at the recording speed of 1 cm/min, a speed considered too slow and only useful for screening purposes.
It also seems important to note that the use of monitors does **not lead to a reduction in personnel** although heart sounds are not auscultated constantly.

Direct complications: Haverkamp and Bowes [33] report that the uterus was perforated by the head of the intrauterine catheter in the parturient. Cordero et al. [23] report two abscesses of the scalp in 2003 patients monitored with scalp electrodes.

5.3 Fetal blood analysis

Additional requirements: Blood sampling from the presenting part of the fetus calls to a certain degree for additional effort, as this is a transvaginal and transcervical procedure. This may be considered a minor problem when weighed against the benefits to the mother and child. Risks due to an otherwise necessary surgical delivery are avoided.
The time required to obtain results from FBA has in part been erroneously reported in the literature. Tatelbaum and Rosen [89] give a figure of 20 min between the decision to perform FBA and the obtaining of results, based on 86 cases. Our experience with more than 8000 cases, shows these figures to be typical of novices in this procedure and must not be considered standard. **A fairly well-trained team can obtain results without any particular difficulties within three to five minutes.** A greater loss of time which would endanger the child is unnecessary. If acute complications develop the preparations for operation and the collection of blood may be performed simultaneously.

Risk of infection: Since these are vaginal procedures, a slightly increased risk for mother and child must be taken into account. This is not statistically significant and hence a minor factor. James et al. [45] in publication reviewing complications report that the sites of incision in the newborn show infections particularly after vacuum extraction. Balfourt et al. [4] report six complications in 1200 FBA on 678 fetuses; in 3 fetuses an abscess developed in the scalp and in the other 3 prolonged hemorrhages occurred.
Fetal deaths due to diagnostic procedure: Three cases of letal fetal hemorrhages after

FBA have been described [9, 16]. In one case the incision was too deep, so that the lateral vein of the sagital sinus was severed. In the other two cases, fetal coagulopathies were present. BRETSCHER [16] observed hemorrhages in the fetal scalp in 0.6% of all cases. In our clinic we have not encountered any serious incident.

Other complications: MCDONALD [59] observed a serious injury to the scalp and two hematomas in the scalp in his series. Recently NELSON et al. [61] reported the breaking of the incision-shaft in the scalp of one fetus. We suspect that the shafts used by these authors were too thin. In the other clinics, which use the instruments we recommend, no such incident has been reported for more than 20,000 cases.

Keywords: Admission- amnioscopy, heart-rate-monitoring, fetus, labor, deceleration, acceleration, beat-to-beat difference, hypoxia-pattern, bradycardia, tachycardia, oscillation-type, fetal-blood-analysis, tocolysis, erythroblastosis, hypoglycemia.

Zusammenfassung

Gegenwärtige Situation der klinischen Überwachung des Feten sub partu

Die wichtigsten Ziele der modernen klinischen Überwachung sub partu sind das Erheben eines **status präsens des Feten zum Zeitpunkt der Aufnahme der Patientin in der Klinik** und die **Früherkennung hypoxischer Gefahren während des weiteren Geburtsverlaufes.** Daneben spielen die **Diagnose der schweren Rh-Erythroblastose** zu Beginn der Geburt und die **Früherkennung fetaler Hypoglykämien** sub partu auch eine gewisse Rolle.

Methoden der modernen Überwachung des Feten sub partu

1. Aufnahme-Amnioskopie. Zeitraubende Routinemaßnahmen sollten zugunsten einer gezielten Zustandsdiagnostik des Feten in den Hintergrund treten. Allzuoft unterbleiben die wichtigsten Untersuchungen (Amnioskopie, apparative Herzschlagüberwachung und gegebenenfalls Bestimmung des Blut-pH-Wertes) bis zur eigentlichen Lagerung der Patientin im Entbindungsraum. Als Erstmaßnahme haben wir deshalb empfohlen, zumindest in jedem Risikofall, sofort nach Ankunft der Patientin in der Klinik, sofern die Fruchtblase noch steht, eine Aufnahme-Amnioskopie vorzunehmen. Falls klares Fruchtwasser vorliegt, ermöglicht die Amnioskopie, die kritische Periode der Vorbereitung mit weit größerer Sicherheit als bisher zu überbrücken. Wird jedoch mekoniumhaltiges oder fehlendes Fruchtwasser festgestellt, müssen sofort die weiteren Verfahren der Intensivüberwachung eingesetzt werden.

2. Kardiotokographie. Lohnt die Kardiotokographie überhaupt? Wer die „klassische" Methode der einfachen Auskultation der Herztöne akzeptiert, kann kaum ernsthaft daran zweifeln, daß die gleiche Methode in wesentlich verbesserter Form klinisch nützlich ist.

Einteilung der Herzschlagfrequenz: Die Eigenschaften und Unterschiede der wichtigsten bisher beschriebenen wehenabhängigen Herzfrequenzmuster lassen sich am einfachsten zeichnerisch darstellen **(Abb. 1).** Die Bezeichnung „Alarm-Tiefs" beinhaltet alle hypoxie-suspekten Herzfrequenzmuster, besonders die Spät- und die variablen Tiefs.

Die heute für den Kliniker wichtigsten Herzfrequenzmuster werden eingeteilt in:

I. die **Basalfrequenz** mit ihren verschiedenen Frequenzbereichen, wobei man bei einer Frequenz zwischen 151 und 160 Schl./Min. bereits von einer leichten Tachykardie spricht. Die drei Typen der Variationen der Basalfrequenz sind: a) die **Oszillationen (Abb. 2),** b) die **Schlag-zu-Schlag-Differenz (Abb. 2)** und c) die **sporadischen Änderungen.**

Die wichtigsten Muster überhaupt sind:

II. die wehenabhängigen Frequenzmuster **(Abb. 3),** wobei die **gleichförmigen Dezelerationen (Spät-Tiefs)** von den **ungleichförmigen Dezelerationen (variable Tiefs u. kombinierte Tiefs)** und den **Akzelerationen** unterschieden werden.

In den Anfängen der apparativen Registrierung der fetalen Herzfrequenz war es schwierig, die Bedeutung der verschiedenen Herzschlagfrequenzmuster sowohl der wehenbezogenen als auch der nicht-wehenbezogenen zu interpretieren. Es ist versucht worden, verschiedenen suspekten, besonders den wehenabhängigen Herzfrequenzmustern pathognomonische Bedeutung zuzusprechen. Es hat sich aber die Ansicht durchgesetzt, daß die **verschiedenen Muster zwar hinsichtlich ihrer Bedeutung unterschiedlich ernst zu bewerten sind, daß sie aber nicht immer eine fetale Hypoxie bedeuten (Tab. I, II).** Bei suspekten Herzfrequenzmustern muß also zunächst durch eine FBA überprüft werden, ob eine drohende fetale Hypoxie vorliegt oder nicht.

Bei den wehenabhängigen Dezelerationen herrscht die Ansicht vor, daß die **Spät-Tiefs** am häufigsten mit einer fetalen Hypoxie vergesellschaftet sind, sie sollen **Ausdruck einer utero-plazentaren Insuffizienz oder einer reduzierten uterinen Durchblutung** sein.

Die **variablen Tiefs werden dagegen mehr auf Nabelschnurkomplikationen** zurückgeführt. Sie sind etwas seltener als die Spät-Tiefs mit Hypoxien vergesellschaftet,

trotzdem aber eindeutig als Warnzeichen einer fetalen Gefährdung anzusehen.

Wehenabhängige **Akzelerationen** können **das früheste Zeichen einer fetalen Gefährdung** sein. Die Akzelerationen scheinen nach unseren Beobachtungen unter anderem Vorboten von Nabelschnurkomplikationen zu sein. Nicht selten ist der in **Abb. 4** dargestellte Wechsel von Akzelerationen in variable Tiefs zu beobachten.

Bei den Mustern der Basalfrequenz muß die **Bradykardie** von zwei Gesichtspunkten aus gesehen werden:

a) die **plötzlich auftretende Form,** besonders wenn sie mit dem **silenten Oszillationstyp und/oder den Spät- oder variablen Tiefs vergesellschaftet** ist, muß als äußerst suspekt für eine akute hypoxische Komplikation angesehen werden.

b) die **gleichmäßige, ohne suspekte wehenabhängige Dezelerationen auftretende Bradykardieform** wird als **harmlos** angesehen **(Abb. 5).**

Bei der **Tachykardie** muß unterschieden werden, ob die Tachykardie mit wehenabhängigen Dezelerationen vergesellschaftet ist oder nicht. Die isolierte **unkomplizierte Tachykardie** ist **kein** ins Gewicht fallendes Zeichen der direkt drohenden **fetalen Hypoxie.** Trotzdem muß man die Tachykardie klinisch ernst nehmen, weil sie oft auch **Ausdruck eines fetalen Streßzustandes** ist und damit ein Zeichen chronischer Überlastung darstellt. Feten zeigen nach Tachykardien ohne Alarm-Tiefs biochemisch wenn überhaupt so nur geringfügige Abweichungen, die neonatale Morbidität ist aber wesentlich erhöht. Es ist deshalb zu empfehlen, bereits nach 2 Stunden lang anhaltender Tachykardie die klinische Situation in einem solchen Fall zu überdenken und falls nicht innerhalb der folgenden 1—2 Stunden mit einer Spontangeburt zu rechnen ist, die Geburt auch bei normalen pH-Werten operativ zu beenden.

Ob **Schlag-zu-Schlag-Differenzen** irgendwelche Beziehungen zu Gefahrenzuständen des Feten haben, ist noch unklar. Dagegen wird den **Oszillationstypen** eine gewisse Bedeutung beigemessen. Besonders der **silente** Oszillationstyp **soll wichtige Aussagen** ermöglichen.Wir haben gezeigt, daß der silente Oszillationstyp sub partu wegen seines relativ seltenen Auftretens klinisch keine stark ins Gewicht fallende Rolle spielt. Hinzu kommt, daß es unseren bisherigen Beobachtungen nach so gut wie nie isoliert zum Auftreten des silenten Oszillationstypes als Verdachtsfaktor kommt, sondern immer auch zu wehenabhängigen Dezelerationen.

Man findet nur spärlich exakte und befriedigende Angaben, wann eigentlich auf **Grund suspekter Herzfrequenzmuster die Geburt aus fetaler Sicht operativ zu beenden** ist. Es gibt Empfehlungen, bei immer stärkerem Ausprägungsgrad suspekter Herzschlagfrequenzmuster oder wenn diese länger als 30 Minuten auftreten, die Geburt operativ zu beenden, ferner auch, wenn eindeutig pathologische Herzfrequenzmuster trotz konservativer Maßnahmen bestehen bleiben oder sich verschlechtern. Es überwiegen aber Autoren, die meinen, daß man klinisch weit zuverlässiger arbeitet, wenn beim **Auftreten suspekter Herzfrequenzmuster zusätzlich eine FBA durchgeführt wird.** Das kombinierte Vorgehen bietet Vorteile für Mutter und Kind. Liegt trotz suspekter Herzfrequenzmuster keine hypoxische Gefährdung vor, besteht bei gutem Geburtsfortschritt die begründete Chance für eine Spontangeburt. Falls während des weiteren Geburtsverlaufes sich beim Feten doch noch eine Hypoxie und Azidose ereignet, wird es in einer Reihe von Fällen möglich sein, statt einer Sektio eine vaginal-operative Entbindung oder anstatt einer schwierigen vaginal-operativen eine einfachere vaginal-operative Entbindung durchzuführen.

3. Fetalblutanalyse (FBA). Wie bei allen klinischen Methoden muß man neben der Aussagekraft der Fetalblutanalysen auch deren Fehlermöglichkeiten und Nachteile kennen. Inzwischen ist von mehreren Autoren gezeigt worden, daß **am vorangehenden Teil des Feten aus der Peripherie gewonnene Blutproben eine für den gesamten Feten repräsentative Aussage erlauben.** Die beste Aussage über die Hypoxiegefährdung des Feten erlauben pH-Messungen, weil sie, weit weniger abhängig von zirkulatorischen Faktoren als Blutgase, die metabolische Reaktion auf eine Hypoxie reflektieren. Blutgase schwanken auch wesentlich kurzfristiger als die metabolische Azidität und geben dadurch zu Täuschungen Anlaß. In unserem klinischen Einsatz hat sich der Gebrauch des pH akt und des pHqu40 gut bewährt, da die Beziehungen der respiratorischen zur metabolischen Azidität im gleichen Einheitensystem abzuschätzen sind. Andere Autoren benutzen häufig Base-Excess-Werte oder den BE_{Hb5} (Base Excess bei einem theoretischen Hb-Wert von 5 g%). Der Korrelations-Koeffizient zwischen ΔBE_{Hb5} und ΔpHqu40 zwischen Mutter und Fet — beide Werte benutzt man zur Objektivierung der maternogenen Aziditätssteigerung — zeigte den ausgezeichneten Wert von $r = 0{,}98$ **(Abb. 7).**

An Verbesserungen zur Technik der FBA erwähnenswert ist der Vorschlag, die **Fetalblutentnahme in Seitenlage** durchzuführen. Diese Technik empfiehlt sich besonders dann, wenn eine Patientin zum Vena-cava-Kompressionssyndrom neigt. Seit einigen Jahren **verzichten wir auf die Applikation von Chloräthyl zum Hyperämisieren der Haut am vorangehenden Teil** wegen der gelegentlich bei beeinträchtigten Feten zu lange anhaltenden peripheren Vasokonstriktion.

Die **Indikation zu einer FBA** ist in den meisten Fällen dann gegeben, wenn **hypoxiesuspekte Herzfrequenzmuster** auftreten. Die **Wiederholung einer FBA** richtet sich am besten nach dem Charakter der vermutlichen Störung. Beim Verdacht auf eine akute Komplikation sollte man so schnell wie möglich die erste und sofort anschließend die zweite und falls erforderlich auch die dritte Blutprobe entnehmen und analysieren. Nur bei einer **akuten Bradykardie** sind bereits innerhalb der ersten 10 Minuten des Auftretens Hypoxien und Azidosen zu beobachten. Bei allen anderen Hinweisen seitens der fetalen Herzfrequenz sollte die erste Fetalblutentnahme etwa 10 Minuten nach dem Auftreten und die dann folgenden FBA in Abständen zwischen 15 Minuten bis zu mehreren Stunden durchgeführt werden. So wird man beim Vorliegen von **Spät- oder variablen Tiefs** und einem ersten unauffälligen pH-Wert in etwa 15minütigen Abständen weitere Blutentnahmen vornehmen. Lag bei der

ersten Blutentnahme dagegen ein pH-Wert von unter 7,3 vor, sollte die Fetalblutanalyse in kürzeren Abständen wiederholt werden. Bei gleichbleibender Intensität oder beim Verschwinden der suspekten Muster können die Blutentnahmeabstände von Mal zu Mal vergrößert und anschließend auf weitere Entnahmen verzichtet werden.
Ein **Absinken der pH-Werte** wird im wesentlichen durch folgende Ursachen bedingt:
1. **Fetale Hypoxie** (häufigste und klinisch wichtigste Ursache);
2. **Maternogene,** durch Übertritt besonders der Milchsäure bedingte **Aziditätssteigerung** beim Feten;
3. Durch Auswirkung von **Störfaktoren auf die periphere Zirkulation** am vorangehenden Teil des Feten bedingte Ursachen.

Zu 1.: Ein **steiles** Absinken der fetalen pH-Werte ist so gut wie immer ein ernstes Alarmzeichen, das Ausdruck einer **akuten fetalen Hypoxie** ist und damit eine **Indikation zu einem Schnelleingriff** darstellt. Um die akute Gefahr, deren Fortschreiten fast immer mit der Wehentätigkeit in engem Zusammenhang steht, wenigstens teilweise zu beheben, empfiehlt es sich, eine **sofortige Tokolyse** einzuleiten. Auf diese Weise wird die Zeit, bis zur operativen Entwicklung des Kindes besser überbrückt.
Treten **variable Dezelerationen mit oder ohne pH-Abfall** auf, sollte man die Patientin **anders lagern.** Manchmal lassen sich auf diese Weise **Nabelschnurkomplikationen** mit Erfolg konservativ behandeln.
Beim **chronischen Absinken** der fetalen pH-Werte in den präpathologischen Bereich ist eine operative Geburtsbeendigung ebenfalls indiziert, vorausgesetzt es besteht auch weiterhin eine deutlich sinkende Tendenz der pH-Werte bei nicht maternogen bedingter Aziditätssteigerung. Auch hier empfiehlt es sich, in manchen Fällen vor der endgültigen Entscheidung zur operativen Geburtsbeendigung eine **Tokolyse** durchzuführen. Primär geht es hier allerdings nicht darum, den operativen Eingriff hinauszuschieben, sondern im Falle eines dauerhaften Erfolges durch diese **konservative Therapie** einen operativen Eingriff überhaupt einzusparen. Wichtig ist, daß die **vorübergehende Wehenhemmung nicht erst bei zu tief abgesunkenen pH-Werten** einsetzt. Am günstigsten ist es, die Tokolyse in Bereichen zwischen **pHqu40 7,27 und 7,23** einzuleiten. In einer Reihe dieser Fälle gelingt es bei Wiederingangkommen von Wehen, einen unkomplizierten Geburtsfortschritt ohne erneutes Absinken der pH-Werte zu erzielen. Bei eindeutiger Tendenz der pH-Werte zum Abfall empfehlen wir seit Jahren, sich zur **operativen Geburtsbedingung bereits im präpathologischen Bereich (pH = 7,24 bis 7,20)** zu entschließen. Auf diese Weise sollen unter Berücksichtigung der Operationsdauer eine gefährliche Hypoxie und Azidose vermieden werden.

Zu 2.: Eine **maternogene Aziditätssteigerung** scheint nicht die gleiche Gefährdung für den Feten darzustellen wie die durch Hypoxie im Feten selbst entstandene Überlastung mit sauren Valenzen. Ein möglicher **Nachteil** der maternogenen Aziditätssteigerung ist die **Abnahme der Pufferreserven.** Ein möglicher **Vorteil** ist, daß die auf den Feten von der Mutter übergetretene Milchsäure ihm als **zusätzliche Energiequelle** dient. Der fetale Stoffwechsel wird durch die maternogene Aziditätssteigerung gering gehemmt. Dadurch **sinkt der Gesamt-O_2-Verbrauch.** Puffergaben an die Mutter und dadurch erzielte pH-Anstiege können beim Feten zur Abnahme des pO_2 führen. Eine maternogene Aziditätssteigerung des Feten kann auf einfachste Weise durch gleichzeitige Bestimmung der pHqu40-Werte bei Mutter und Fet diagnostiziert werden. Eine pH-Messung bei der Mutter sollte immer dann erfolgen, wenn die fetalen pH-Werte auf unter 7,30 reduziert sind. Liegen die **ΔpHqu40-Werte zwischen Mutter und Fet bei 0,05 oder weniger,** handelt es sich um eine maternogene metabolische Aziditätssteigerung beim Feten. Eine solche Situation zwingt nicht in gleichem Umfang wie die drohende fetale Hypoxie die Geburt sofort operativ zu beenden. Ein Anhalt für die Häufigkeit der maternogenen Aziditätssteigerung geht aus **Tab. III** hervor.

Zu 3.: Die seltenen Störungen, die in der peripheren Zirkulation auftreten und zur irrtümlichen Annahme einer fetalen Azidose führen könnten, gehen zumeist mit einem **hochgradig ausgeprägtem Caput succedaneum** einher. Durch das mehr aktive Vorgehen in der heutigen Geburtsmedizin werden stark prolongierte Geburten jedoch immer seltener. Daher hat auch die Frequenz des hochgradig ausgeprägten Caput succedaneum stark abgenommen. Eine Aufstellung über die bei uns in den letzten Jahren gegebene Häufigkeit geht aus **Tab. IV** hervor. Liegen bei stark ausgeprägtem Caput succedaneum auf unter 7,25 reduzierte pH-Werte vor, sollte man das **Kardiotokogramm als zusätzliches Diagnostikum** hinzuziehen. Zeigt die Herzschlagfrequenz keine eindeutig suspekten Muster, ist es nicht erforderlich, die Geburt operativ zu beenden. Liegen dagegen suspekte Muster vor, muß man konsequenterweise, da keine bessere Diagnostik möglich ist, die Geburt operativ zu Ende führen.

Bei **Verdacht auf Erythroblastose** wird sich die Geburtsleitung am besten wie bei sonst hypoxiegefährdeten Feten auf pH-Messungen stützen. Liegt der Verdacht auf eine schwerere Erythroblastose vor, empfiehlt es sich bereits zu Beginn der Geburt außer pH-Messungen auch **hämatologische und serologische Untersuchungen am Feten** durchzuführen. Ergibt sich dabei z. B. eine **Anämie von < 12 g% Hb** und ist der Coombs-Test positiv, sollten sofort, also während der Eröffnungsperiode Vorbereitungen für eine wenige Minuten nach der Geburt vorzunehmende Austauschtransfusion getroffen werden.
Störungen im Energiehaushalt sind zu befürchten, wenn beim Feten eine **Hypoglykämie** auftritt. **Werte von < 30 g%** sind auf jeden Fall suspekt und sollten durch **Infusion von 10%iger Glukoselösung** an die Mutter behandelt werden.

Welche Patientinen sollten mit Hilfe der modernen Methoden überwacht werden?
Aufnahme-Amnioskopie: Wir sind seit Jahren dazu übergegangen, bei **jeder** Patientin, die mit Geburtsvorgängen in der Klinik aufgenommen wird, eine Aufnahme-Amnioskopie durchzuführen.

Kardiotokographie: Die Optimallösung wird sein, **jede Geburt,** auch diejenige ohne primäre Risikohinweise, apparativ zu überwachen. Dadurch könnten fast alle akuten Komplikationen, wobei Nabelschnurkomplikationen bei weitem dominieren, auf dem Monitorprotokoll rechtzeitig erkannt werden.

Fetalblutanalyse: Die FBA bleibt nach wie vor nur **indizierten Fällen** vorbehalten, in denen besonders seitens suspekter Herzschlagfrequenzmuster ein Hypoxieverdacht besteht.

Nachteile und Gefahren der modernen klinischen Überwachungsmethoden

Aufnahme-Amnioskopie: Keine ins Gewicht fallenden Nachteile.

Kardiotokographie: Das externe Registrieren der fetalen Herzfrequenz erfolgt zumeist in Rückenlage der Patientin. Das führt gehäuft zum **Vena-cava-Kompressionssyndrom** und falls eine solche Komplikation nicht richtig erkannt und nicht durch Seitenlage behoben wird, resultieren unnötige operative Geburtsbeendigungen. In Kliniken, die die Registrierung der fetalen Herzfrequenz isoliert als einzige Methode einsetzen, kommt es in einer Reihe von Fällen zu Fehldiagnosen.
Der ständige Einsatz von Monitoren führt zu **beträchtlichen laufenden Ausgaben,** die einmal durch Reparatur, zum anderen durch den hohen Registrierpapierverbrauch entstehen.

Fetalblutanalyse: Die Blutentnahmen am vorangehenden Teil sind mit einem gewissen **Mehraufwand** verbunden. Das zusätzliche Risiko für den Feten wie **Nachblutung** aus der Inzisionsstelle und **Infektion der Inzisionsstelle** läßt sich beim Befolgen einer korrekten Technik auf ein nicht mehr ins Gewicht fallendes Minimum reduzieren.

Schlüsselwörter: Aufnahme-Amnioskopie, Herzfrequenz-Überwachung, Fet, Wehe, Dezeleration, Akzeleration, Schlag-zu-Schlag-Differenzen, Hypoxie-Muster, Bradykardie, Tachykardie, Oszillationstypen, Fetalblutanalyse, Tokolyse, Erythroblastose, Hypoglykämie.

Résumé

Situation actuelle de la surveillance clinique du foetus au cours du travail
Les objectifs les plus importants d'une surveillance clinique moderne au cours du travail sont d'une part la connaissance de **l'état actuel du foetus au moment de l'admission** de la patiente à la Clinique, d'autre part le **diagnostic précoce d'un risque d'hypoxie** pendant le déroulement du travail. Par ailleurs, le diagnostic d'une **érythroblastose foetale grave** au début de l'accouchement, et le **dépistage d'hypoglycémie** foetale au cours du travail joue également un certain rôle.
Méthodes modernes de surveillance du foetus au cours du travail
1. Amnioscopie d'admission. Les mesures routinières et fastidieuses devraient céder le pas à une méthode de diagnostic spécifique de l'état du foetus. Trop souvent les méthodes les plus importantes de surveillance (amnioscopie, enregistrements des bruits du coeur et éventuellement détermination du pH sanguin) sont différées jusqu'à l'admission définitive de la patiente en salle de travail. De ce fait, nous avons conseillé la pratique de l'amnioscopie d'admission, du moins dans chaque cas à risque élevé, dès que la patiente est admise à la Clinique et dans la mesure où la poche est encore intacte. Chaque fois que le liquide est clair, l'amnioscopie permet ainsi de franchir la période de préparation avec une plus grande sécurité que par le passé. Si toutefois l'on constate un liquide méconial ou un oligamnios les autres méthodes de surveillance intensive doivent immédiatement être mises en route.
2. Cardiotocographie. La cardiotocographie est-elle réellement utile ? L'acceptation de la valeur clinique de la méthode «classique» d'auscultation des bruits du coeur implique logiquement celle d'une méthode nettement améliorée.
Classification de la fréquence cardiaque: Les caractéristiques des modifications les plus importantes du rythme cardiaque foetal en rapport avec les contractions utérines et qui ont été décrites jusqu'à présent sont aisément schématisées sur **la fig. 1.** La désignation «ralentissement d'alarme» comprend toutes les modifications suspectes de traduire une hypoxie, particulièrement les ralentissements tardifs et variables.
Les critères d'appréciation de la fréquence cardiaque actuellement les plus importants pour le clinicien sont les suivants:
I. **La fréquence basale** avec ses différentes zones, où l'on parle par exemple de tachycardie légère si la fréquence se situe entre 151 et 160 battements par minute. Les trois types de variation de la fréquence basale sont: a) les **oscillations (fig. 2),** b) les **variations de battement à battement (fig. 2),** c) les **variations sporadiques.**
En fait, les variations les plus importantes sont:
II. **Les variations qui sont en rapport avec la contraction utérine (fig. 3),** où l'on distingue les **ralentissements de forme régulière (ralentissements tardifs),** les **ralentissements d'allure irrégulière (ralentissements variables et combinés)** et les **accélérations.**
Au début de l'enregistrement automatique de la fréquence cardiaque foetale, l'interprétation de ces modifications était difficile, tant pour celles qui dépendaient de la contraction utérine que pour celles qui n'en dependaient pas. On a essayé par la suite de leur donner une signification pathognomonique, surtout à celles qui dépendaient de la contraction. Finalement a prévalu l'opinion que si

l'on pouvait attribuer une plus ou moins **grande importance aux diverses modifications en fonction de leur signification, elle n'était de loin pas toujours l'expression d'une hypoxie foetale (tab. I et II).** En présence de modifications suspectes, il faut donc vérifier, à l'aide des micro-analyses sanguines foetales, s'il existe une hypoxie menaçante ou non.

Pour les ralentissements qui sont en rapport avec la contraction utérine, il est admis que ce sont les **ralentissements tardifs** qui s'associent le plus souvent à une hypoxie foetale et qu'ils semblent être **l'expression d'une insuffisance utéro-placentaire ou d'une diminution du débit sanguin dans l'utérus.**

Les **ralentissements variables** sont, par contre, plutôt ramenés à des **complications inhérentes au cordon ombilical.** Ils sont moins souvent associés à des hypoxies, mais doivent être indiscutablement considérés comme le signe d'alarme d'une menace pour le foetus.

Les **accélérations** associées à la contraction peuvent être le **signe le plus précoce d'une menace foetale.** D'après nos constatations elles peuvent également être le signe annonciateur d'une complication funiculaire. Il n'est pas rare d'observer **(fig. 1)** le passage d'accélération à des ralentissements variables.

Parmi les modifications de la fréquence cardiaque basale, la **bradycardie** doit être comprise du double point de vue suivant:

a) la **bradycardie d'apparition brutale,** surtout si elle **s'associe à des oscillations de type silencieux et/ou à des ralentissements tardifs ou variables,** doit être considérée comme un signe extrêmement suspect en faveur d'une complication hypoxique aiguë.

b) la **bradycardie régulière,** sans ralentissements périodiques, est considérée comme inoffensive **(fig. 5).**

Pour la **tachycardie,** il est également important de s'assurer si elle est ou non associée à des ralentissements périodiques, au cours des contractions. La **tachycardie isolée** n'est pas un argument en faveur d'une hypoxie foetale imminente. Néanmoins il faut la prendre cliniquement au sérieux, parce qu'elle est fréquemment **l'expression d'un état de stress** du foetus et est ainsi le signe d'une surcharge chronique. Les foetus ne présentent pratiquement pas de modification biochimique après cette tachycardie isolée, mais la morbidité néonatale est plus élevée. Il est recommandé de ce fait, après deux heures de tachycardie, de reconsidérer l'ensemble de la situation et de terminer l'accouchement si on ne peut pas s'attendre à un accouchement spontané dans l'heure ou dans les deux heures qui suivent, même si les valeurs de pH restent normales.

Les rapports entre **les modifications battement à battement** et le risque foetal sont encore peu précisés. Par contre, on accorde une certaine signification au **type d'oscillation.** Le **type silencieux,** en particulier, **est censé fournir d'importantes indications.** Nous avons montré que le type d'oscillation silencieux apparu au cours du travail ne joue pas un rôle prédominant, à cause de sa fréquence de survenue relativement basse. A cela il faut ajouter, d'après nos observations, que l'apparition du type silencieux n'est pas un facteur de suspicion s'il apparaît seul, mais uniquement s'il s'associe à des ralentissements périodiques.

On ne trouve que de manière très limitée des indications précises et satisfaisantes pour savoir quand exactement, **sur la base d'un rythme cardiaque pathologique, il faut terminer un accouchement pour des raisons foetales.** Il existe des recommandations pour terminer l'accouchement quand le degré de gravité des modifications suspectes du rythme cardiaque augmente constamment, quand les altérations durent plus de 30 mn et aussi quand des modifications indiscutablement pathologiques persistent ou s'aggravent en dépit de la mise en oeuvre de traitements à visée conservative. Mais une majorité d'auteurs pense qu'on travaille d'une manière bien plus sûre du point de vue clinique quand on s'adresse à la **micro-analyse sanguine chaque fois que surviennent des modifications suspectes du rythme cardiaque.** La méthode combinée présente des avantages pour la mère et pour l'enfant. Si, malgré la présence de modifications suspectes du rythme cardiaque il n'y a pas de risques d'hypoxie, l'accouchement spontané a des chances raisonnables de pouvoir se faire, à condition que la progression du travail soit régulière. Si par la suite une hypoxie ou une acidose devaient tout de même survenir, il serait possible, dans toute une série de cas, de pratiquer un accouchement par voie basse au lieu d'une césarienne ou d'éviter une intervention vaginale difficile au profit d'une intervention vaginale aisée.

3. Micro-analyses sanguines foetales (M. A. S.). Comme pour toute méthode clinique, il est indispensable de connaître, en plus de la signification des micro-analyses sanguines foetales, leurs possibilités d'erreurs et leurs désavantages. Plusieurs auteurs ont montré que **le sang foetal périphérique obtenu par ponction au niveau de la présentation est représentatif pour l'ensemble du foetus.** Ces mesures du pH constituent le meilleur indice pour apprécier le risque hypoxique du foetus, parce que, dépendant moins des facteurs circulatoires que les gaz du sang, elles reflètent la réaction métabolique à l'hypoxie. Les gaz du sang se modifient de manière plus rapide que l'acidose métabolique et peuvent par conséquent prêter à confusion. Dans notre pratique clinique courante l'utilisation du pH actuel et du pHqu40 s'est avérée utile, du fait que les relations entre acidose métabolique et respiratoire sont étudiées dans le même système d'unités. D'autres auteurs utilisent fréquemment les valeurs de l'excès en bases ou le BE_{Hb5} (excès de bases pour une valeur théorique de Hb de 5 g%). Ce coefficient de corrélation entre ΔBE_{Hb5} et ΔpHqu 40 entre la mère et l'enfant — les deux valeurs sont utilisées pour objectiver l'augmentation de l'acidose d'origine maternelle — montrait l'excellente valeur de $r = 0{,}98$ **(fig. 7).**

Du point de vue des améliorations techniques de la M. A. S., il faut citer le prélèvement **en décubitus latéral.** Cette technique est particulièrement recommandée quand la patiente a tendance à présenter un syndrome de compression de la veine cave. Depuis quelques années, **nous avons renoncé à l'application du chloréthyl destinée à produire une hyperhémie cutanée chez des foetus menacés,**

susceptibles d'être en vasoconstriction périphérique prolongée.

L'indication d'une M. A. S. découle dans la majorité des cas de l'apparition de **modifications du rythme cardiaque suspectes d'hypoxie. La répétition d'une M. A. S.** découle surtout de la nature du trouble supposé. En cas de suspicion d'une complication aiguë, on devrait faire dès que possible le premier examen, immédiatement suivi du second et éventuellement du troisième. Ce n'est que dans les **bradycardies aiguës** que l'on peut observer l'apparition d'hypoxie et d'acidose au cours des dix premières minutes. Dans toutes les autres indications issues du rythme cardiaque foetal la première ponction devrait être faite quelque dix minutes après l'apparition des modifications et les ponctions ultérieures dans des intervalles variant de 15 mn à plusieurs heures. C'est ainsi qu'en présence de **ralentissements tardifs ou variables** et d'un premier pH normal, les échantillons ultérieurs seront prélevés à des intervalles de 15 mn. Si par contre la première analyse avait montré un pH inférieur à 7,3, les intervalles devraient être plus courts. Si les modifications suspectes ne s'aggravent pas ou disparaissent, les intervalles peuvent être progressivement allongés et l'on peut même renoncer à poursuivre les prélèvements.

Une **diminution des valeurs du pH** est en principe due aux causes suivantes:

1. **Hypoxie foetale** (cause la plus fréquente et la plus importante du point de vue clinique).
2. **Acidose d'origine maternelle,** due en particulier au passage d'acides lactiques.
3. Effets de facteurs de **perturbation au niveau de la circulation périphérique** de la présentation.

Pour le premier point: une chute rapide de la valeur du pH foetal est de toute manière un signe d'alarme sérieux, qui est **l'expression d'une hypoxie foetale aiguë** et constitue **l'indication d'un acte d'urgence.** Pour limiter, du moins partiellement, le danger, et dans la mesure où il est presque toujours en rapport étroit avec l'activité utérine, il va de soi d'entreprendre immédiatement une **inhibition des contractions utérines.** De cette manière, le temps nécessaire à la préparation de l'intervention est franchi dans de meilleures conditions.

Quand surviennent des **ralentissements variables, accompagnés ou non d'une chute du pH,** il convient de modifier la position de la patiente. Quelquefois des **complications inhérentes au cordon** peuvent être traitées de manière non chirurgicale.

En cas de **chute lente du pH,** dans la zone pré-pathologique, une intervention est également indiquée, si toutefois cette tendance persiste en l'absence d'une acidose maternelle. Dans certains de ces cas une **inhibition des contractions** peut également être recommandée, avant de décider d'intervenir. En fait, la préoccupation essentielle n'est pas ici de différer l'intervention, mais de limiter au cas où le traitement médical est suivi d'un succès durable. Il est important de ne pas entreprendre cette **inhibition temporaire à partir de valeurs trop abaissées du pH.** Son meilleur domaine d'indication se situe entre des valeurs de **pHqu40** comprises entre **7,27 et 7,23.** Dans un certain nombre de ces cas, il est possible, après la reprise des contractions, de s'attendre à la poursuite du travail sans nouvelle chute du pH. Dans les cas où le pH a indiscutablement tendance à chuter, nous recommandons depuis des annés de se décider à intervenir dans la zone **pré-pathologique (pH 7,24 à 7,20).** De cette manière, et compte tenu de la durée de l'intervention, une hypoxie et une acidose dangereuses doivent pouvoir être évitées.

Pour le deuxième point: une acidose d'origine maternelle ne semble pas représenter pour le foetus le même danger que l'inondation d'ions acides d'origine endogène. Un **inconvénient** possible de l'acidose d'origine maternelle est **la diminution des réserves en bases. En compensation,** existe la possibilité que l'acide lactique transféré de la mère au foetus puisse servir à ce dernier de **source d'énergie complémentaire.** Le métabolisme foetal n'est que peu entravé par l'augmentation d'acidité en provenance de la mère. De ce fait la **consommation globale en oxygène diminue.** L'administration de bases à la mère destinée à remonter le pH peut conduire chez le foetus à une diminution de la Po_2. Une acidose foetale d'origine maternelle peut être diagnostiquée de la manière la plus simple par une détermination concomitante du **pHqu40 chez la mère et chez le foetus.** Une mesure du pH chez la mère devrait toujours se faire quand les valeurs du pH foetal descendent au-dessous de 7,30. Si la valeur du **ΔpHqu40 entre mère et foetus est de 0,05 au moins,** il s'agit chez le foetus d'une acidose métabolique d'origine maternelle. Une telle situation n'oblige pas à terminer l'accouchement d'une manière aussi impérative que la menace d'hypoxie foetale. Le **tab. III** donne une idée de la fréquence des cas d'acidose d'origine maternelle.

Pour le troisième point: les rares perturbations qui surgissent dans la circulation périphérique et qui peuvent donner lieu à une erreur d'appréciation de l'acidose foetale sont surtout celles qui peuvent se recontrer dans **une importante bosse séro-sanguine.** En fait la tendance plus interventioniste de l'obstétrique actuelle diminue grandement la fréquence du travail prolongé et par conséquent celle des grosses bosses séro-sanguines. Le **tab. IV** montre notre propre fréquence au cours des dernières années. En présence d'une forte bosse séro-sanguine, les valeurs de pH inférieures à 7,25 doivent faire prendre le **cardiotocogramme comme moyen de diagnostic complémentaire.** Si le rythme cardiaque ne montre pas de modifications franchement suspectes, il n'est pas nécessaire d'intervenir. Il faut le faire par contre en présence de modifications suspectes, parce qu'il n'y a pas d'autre possibilité de diagnostic.

En cas de **suspicion d'érythroblastose** la conduite du travail bénéficiera des mesures du pH, comme chez tout foetus menacé d'hypoxie. Si une érythroblastose grave est soupçonnée, il est recommandé dès le début du travail d'ajouter aux mesures du pH des **examens hématologiques et sérologiques** chez le foetus. Si l'on constate ainsi, par exemple, une **anémie de moins de 12 g% Hb,** et si le test de Coombs est positif, il conviendrait de prévoir dès ce moment une exsanguino-transfusion pour les premières minutes après la naissance.

Des troubles du métabolisme énergétique sont à craindre quand surgit une hypoglycémie foetale. Des

valeurs de moins de 30 g% seront de toute manière suspectes et devraient être traitées par **perfusions de sérum glucosé à 10% à la mère.**

Quelles patientes devraient être surveillées à l'aide des méthodes modernes ?

Amnioscopie d'admission: depuis des années nous avons pris l'habitude de faire une amnioscopie d'admission à toute patiente admise à la clinique en début de travail.

Cardiotocographie: la solution la meilleure sera de surveiller ainsi tout accouchement, y compris celui ne présentant pas de risques prévisibles. Ainsi pourraient être reconnues à temps, sur l'enregistrement, presque toutes les complications aiguës, et parmi lesquelles les complications funiculaires sont de loin la cause dominante.

Micro-analyse sanguine foetale: elle est comme elle l'a toujours été uniquement destinée à des cas qui en justifient l'indication, et essentiellement ceux où les modifications du rythme cardiaque font suspecter une hypoxie.

Les avantages et dangers des méthodes modernes de surveillance clinique:

Amnioscopie d'admission: aucun inconvénient qui puisse peser dans la balance.

Cardiotocographie: l'enregistrement externe du rythme cardiaque foetal se fait le plus souvent en décubitus dorsal. Ceci conduit fréquemment à un **syndrome de compression de la veine cave** et si cette complication n'est pas reconnue à temps et traitée par la mise en décubitus latéral, il en résulte d'inutiles interventions pour terminer l'accouchement. Dans des cliniques qui n'utilisent que l'enregistrement du rythme cardiaque foetal surviennent des erreurs de diagnostic dans un certain nombre de cas.
L'utilisation permanente des moniteurs augmente notablement les dépenses courantes, soit du fait des réparations, soit par la consommation importante de papier d'enregistrement.

Analyses sanguines foetales: les prélèvements sanguins au niveau de la présentation sollicitent davantage l'intendance. Le risque supplémentaire pour le foetus que constitue **l'hémorragie** ou **l'infection** de la zone d'incision, peut être évité par une technique satisfaisante et réduit à un minimum qui ne pèse plus dans la balance.

Mots-clés: Accélération, amnioscopie, amnioscopie d'admission, bradycardie, cardiotocographie, contraction utérine, enregistrement de la fréquence cardiaque foetale, foetus, érythroblastose, micro-analyses sanguines foetales, ralentissement (r. variable, r. tardif, r. combiné).

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