66回日本産科婦人科学会学術講演会
2014.4.18

専攻医教育プログラム6
胎児機能不全

宮崎大学産婦人科
鮫島　浩

FHRの理解：80~90%は単純明快

産科医療補償制度

脳性麻痺事例の胎児心拍数陣痛図

波形パターンの判読と注意点

2014年1月

公益財団法人 日本医療機能評価機構
胎児心拍数モニターに関するワーキンググループ

胎児機能不全
non-reassuring fetal status

1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST

胎児機能不全の定義

生理学的定義

胎児が子宮内で呼吸ならびに循環機能が障害された状態

胎児機能検査の評価

『胎児が健康である』所見とは異なる所見

FHRでの胎児機能不全

FHRの評価

『胎児が健康である』所見とは異なる所見

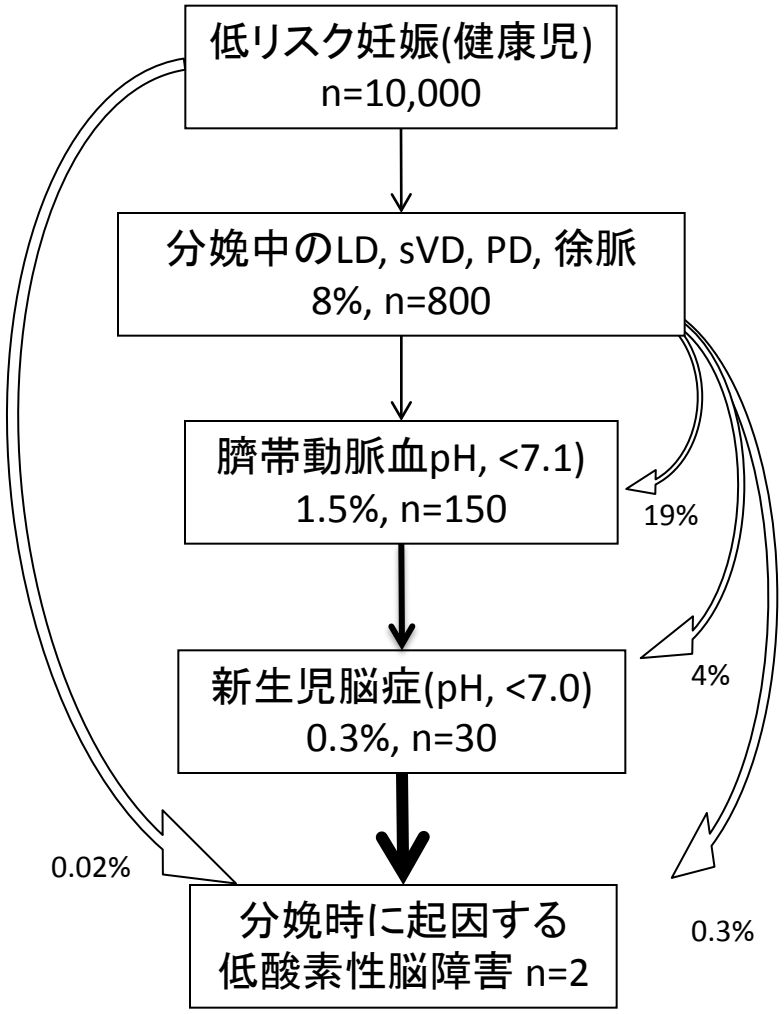
『胎児ジストレス、fetal distress』

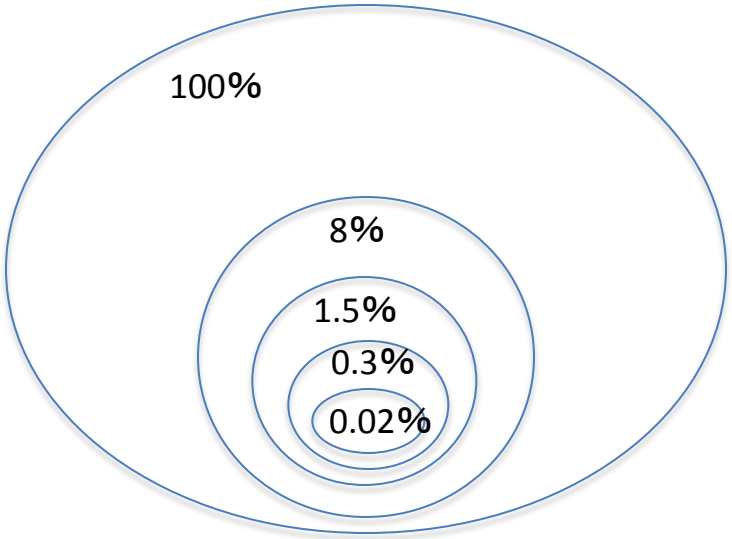
healthy – stress - distress (dying) - death

『non-reassuring fetal status, NRFS』

『胎児機能不全』

胎児心拍数モニタリングの目的





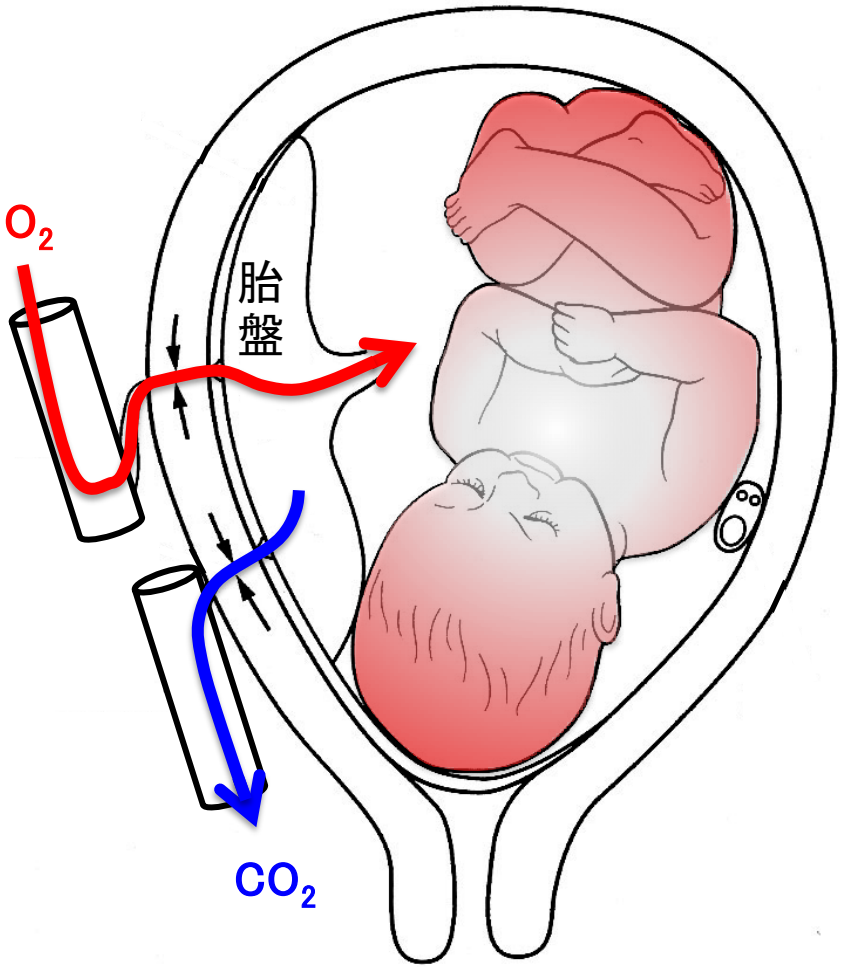
疫学(Nelson)：99%以上が偽陽性
管理が正しければ100%偽陽性

低リスク妊娠であれば1.6/10,000

胎児機能不全
non-reassuring fetal status

1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST

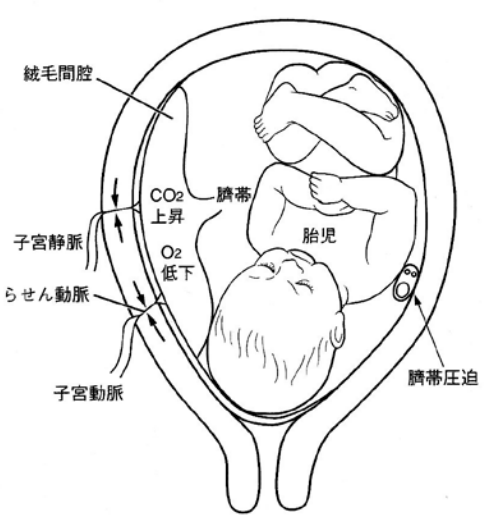
FHRの基本
分娩時FHR(intrapartum, UCあり)



子宮動脈の
筋層貫通部
物理的圧迫

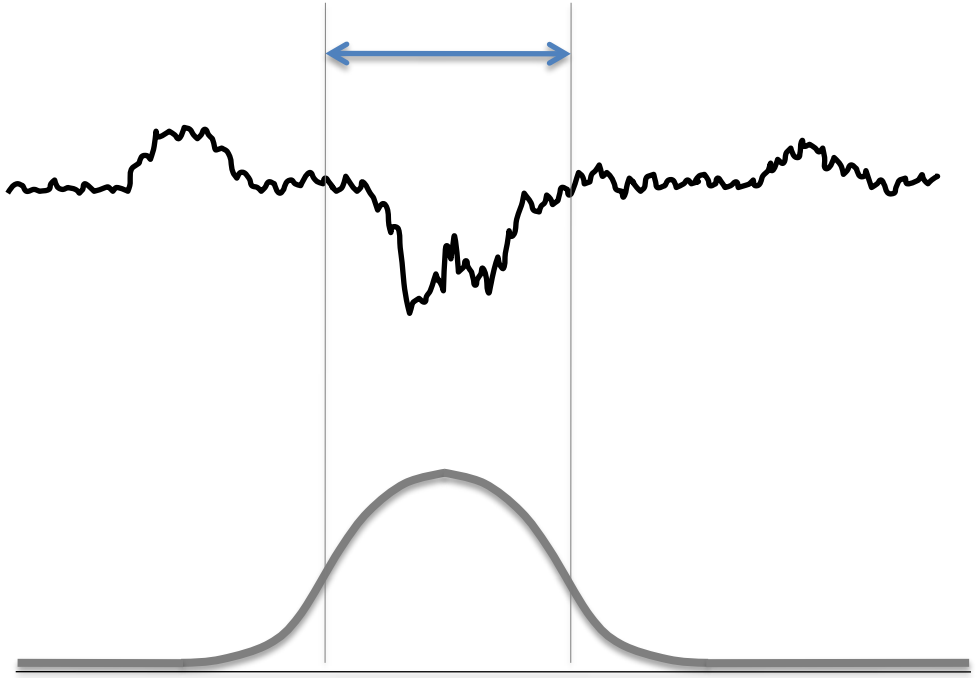
臍帯の
物理的圧迫

FHRの基本
分娩時(intrapartum, UCあり)



Stress-free時の反応
(Resting condition)

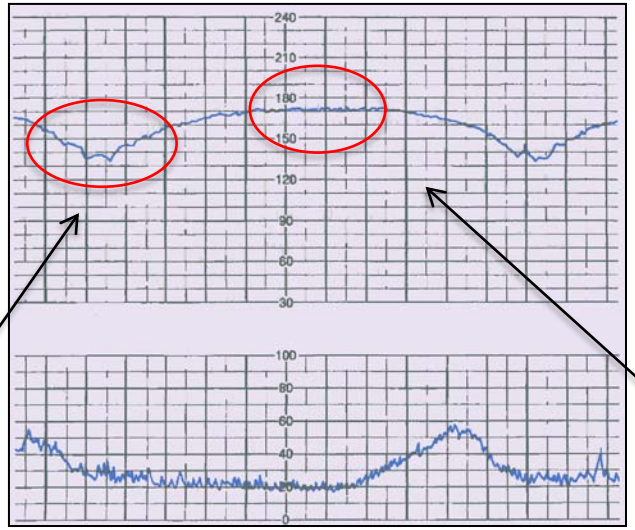
Stressへの反応
刺激へのresponse



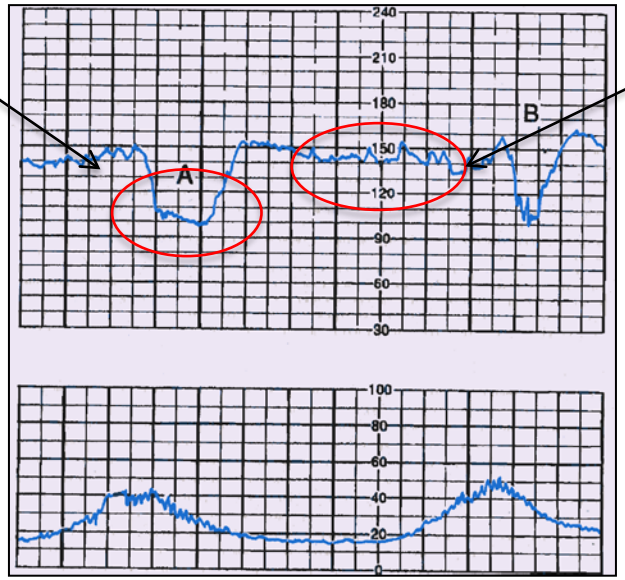
胎盤機能不全
胎児低酸素血症

Acidosis疑

一過性徐脈は
病因を示唆し
ストレスへの反応性



基線細変動は
restingでの病態
acidosisの有無



Acidosisなし

臍帯因子

Williams Obstetrics, 23rd Ed

胎児機能不全
non-reassuring fetal status

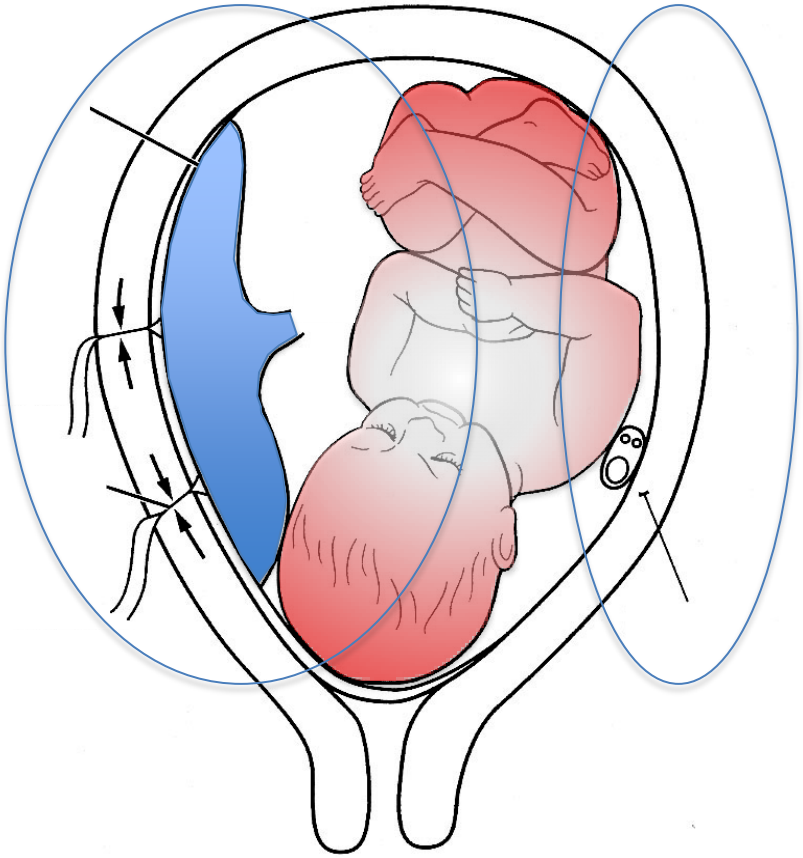
1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST

胎児=胎盤依存性(Hon/Quilligan)

胎盤因子
胎児因子

LD, late deceleration

子宮収縮の度に
似たようなパターン
繰り返し出現
uniform(同一ではない)



臍帯因子

VD, variable deceleration

子宮収縮の度に
異なるパターン
variable

Hon・Quilligan分類

一過性徐脈
- uniform
  - UCの度にほぼ同じ形：同じ病態
- variable
  - UC毎に異なる形

Hon EH, Quilligan EJ. The classification of fetal heart rate.
Conn Med 31(11) 1967

Hon・Quilligan分類

Uniform Decel

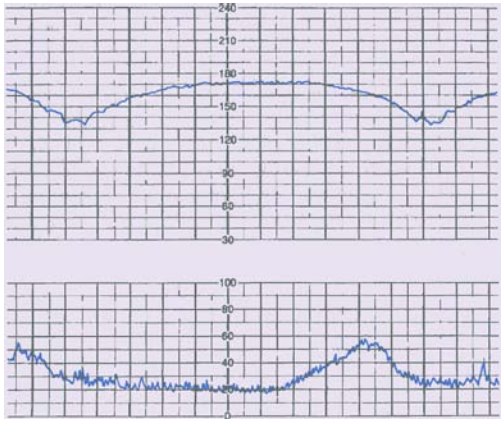
The FHR waveform is relatively uniform in appearance, and the slope of the descending limb is falling at about the same rate that the ascending slope of the associated UC is rising, so that each FHR pattern largely reflects the shape of the associated UC.

Hon EH, Quilligan EJ. The classification of fetal heart rate. Conn Med 31(11) 1967

ユニフォームとは

子宮収縮毎に、割りと同様のパターンを示す。

一過性徐脈の下降曲線は、子宮収縮曲線の上昇曲線と　ほぼ同じ傾きである



Williams Obstetrics, 23rd Ed

Hon・Quilligan分類

Variable Decel

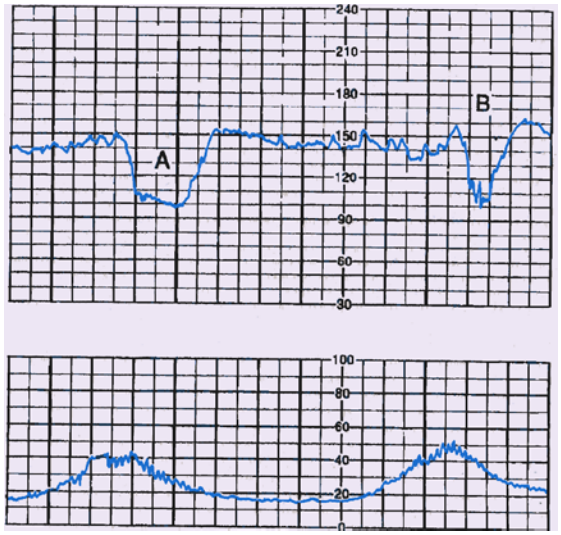
The slope of the descending limb of the FHR pattern is falling faster than the ascending slope of the associated UC is rising, and the FHR pattern varies in shape from from contraction to contraction.

Hon EH, Quilligan EJ. The classification of fetal heart rate. Conn Med 31(11) 1967

変動ー過性徐脈

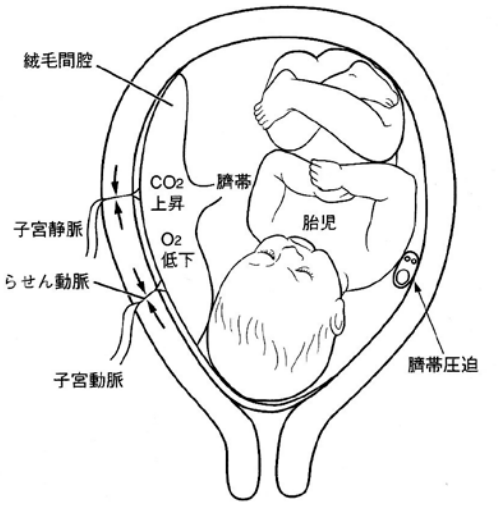
ー過性徐脈の下降曲線は、子宮収縮曲線の上昇曲線よりも、傾きが急である。

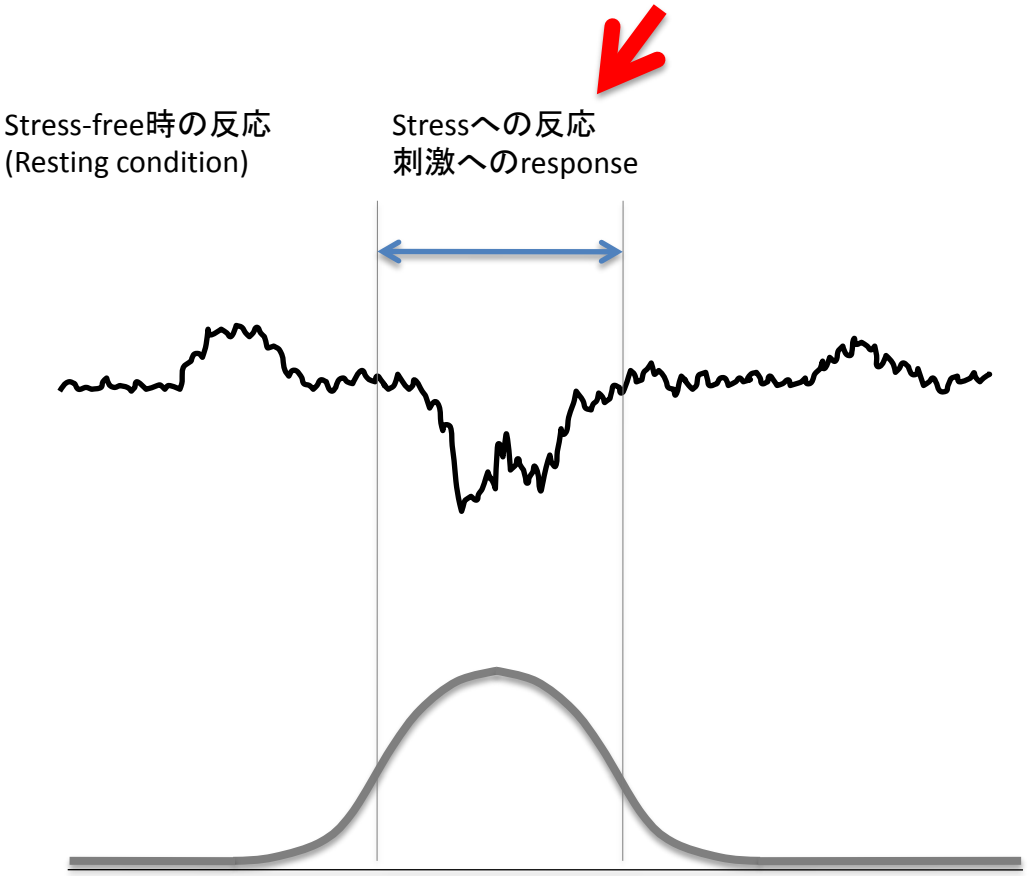
ー過性徐脈は、子宮収縮毎に形が異なる



Williams Obstetrics, 23rd Ed

FHRの基本
分娩時(intrapartum, UCあり)





臨床研究

Observations on heart rate and pH in the human fetus during labor

F. W. KUBLI, M.D.
EDWARD H. HON, M.D.
A. F. KHAZIN, M.D.
H. TAKEMURA, M.D.

Eighty-five human fetuses were studied during labor by continuously monitoring the fetal heart rate (FHR) and uterine contractions and correlating FHR patterns with 218 averaged values of fetal pH derived from 618 single samples. The FHR patterns in the 20 minutes immediately preceding the fetal blood sampling period were used for correlation. In general, the correlation between FHR base-line levels and fetal pH is poor. When tachycardia was present slightly more than half of the pH values were in the pH range above 7.25, and slightly less than 30 per cent were in the range of 7.20 or less. Specific FHR deceleration patterns are definitely associated with disturbances in acid-base balance. This is especially true of late deceleration and severe variable deceleration. Moderate variable deceleration is also associated with a minor shift to the acid side. Of the 102 pH values associated with an innocuous FHR pattern, 94 per cent were above 7.25 pH units.

Am J Obstet Gynecol 1969;104:1190-1206

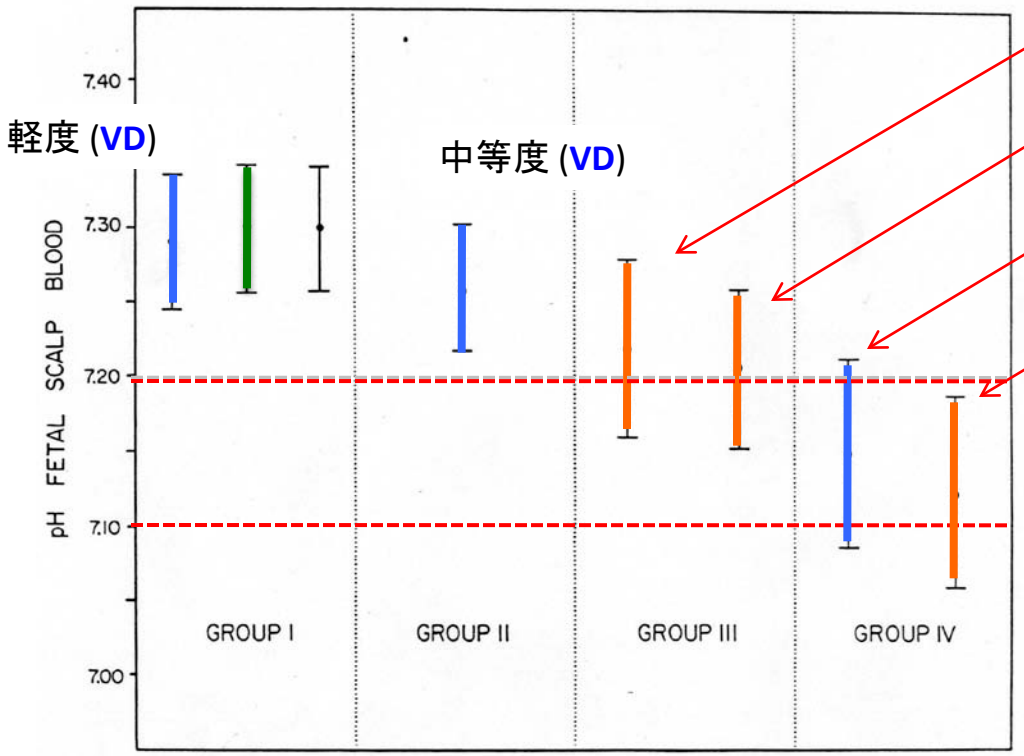


Fig. 3. Graph showing relationship between pH of fetal scalp blood and FHR patterns (85 patients, 218 averaged pH determinations, 618 single pH determinations). Note four separate groups of mean pH together with the standard deviation for each category (see Table II for details).

Table II. FHR patterns and pH values

Group	*FHR pattern*	*Mean ± S.D.*	*Averaged samples* (No.)*
I	Variable deceleration (CC)—mild	7.29 ± 0.046	42
	No deceleration	7.30 ± 0.042	71
	Early deceleration (HC)	7.30 ± 0.041	16
II	Variable deceleration (CC)—moderate	7.26 ± 0.044	35
III	Late deceleration (UPI)—mild	7.22 ± 0.060	27
	Late deceleration (UPI)—moderate	7.21 ± 0.054	7
IV	Variable deceleration (CC)—severe	7.15 ± 0.069	10
	Late deceleration (UPI)—severe	7.12 ± 0.066	10

*218 averaged pH samples from 618 single pH samples.

重度になるにつれてpH低下
pH:7.1-7.2は、VDでは高度で、LDでは全て

VD (変動一過性徐脈)

	>30sec	>60sec
<80bpm	軽度	軽度	軽度
	軽度	軽度	中等度
<70bpm	軽度	中等度	重度

一過性頻脈なし	7.30±0.04
軽度	7.29±0.05
中等度	7.26±0.04
重度	7.15±0.07

LD (遅発一過性徐脈)

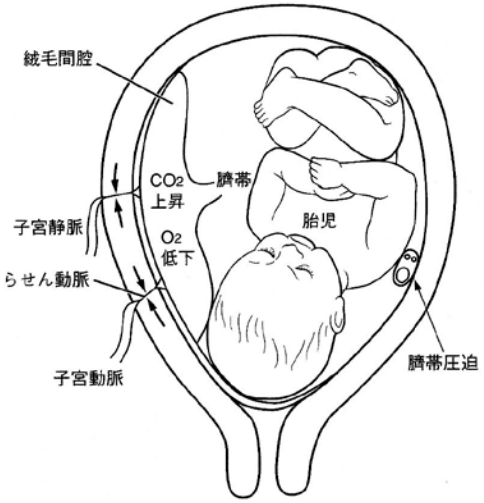
Deceleration深さ	
	軽度
↓15bpm	中等度
↓45bpm	重度

no deceleration	7.30±0.04
軽度	7.22±0.06
中等度	7.21±0.05
重度	7.12±0.07

胎児機能不全
non-reassuring fetal status

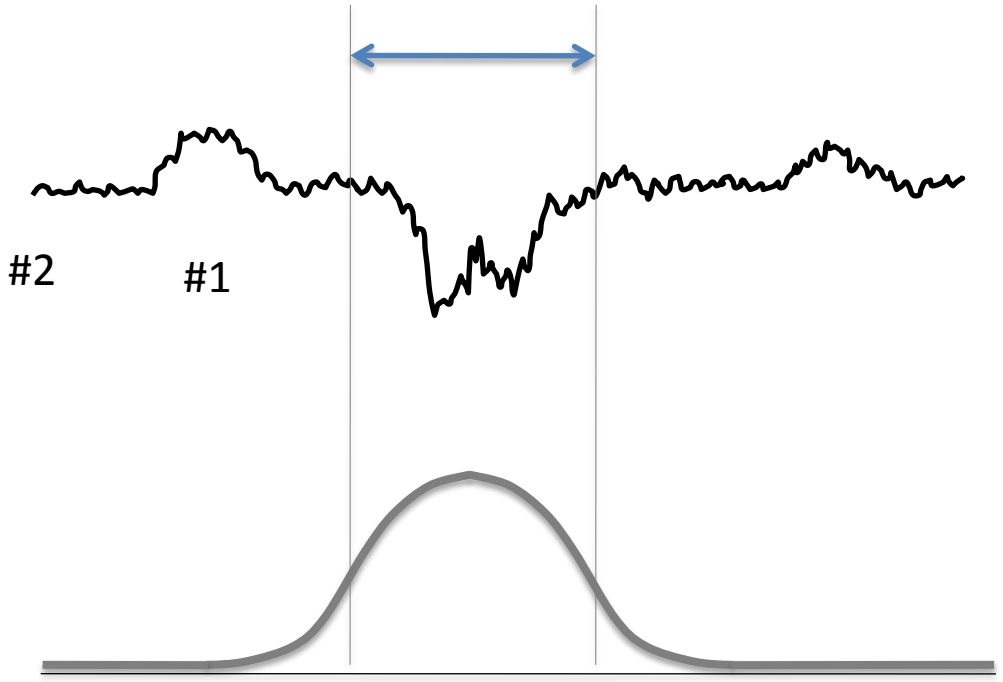
1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST

FHRの基本
分娩時(intrapartum, UCあり)



Stress-free時の反応
(Resting condition)

Stressへの反応
刺激へのresponse



#2臨床研究

The scalp stimulation test: A clinical alternative to fetal scalp blood sampling

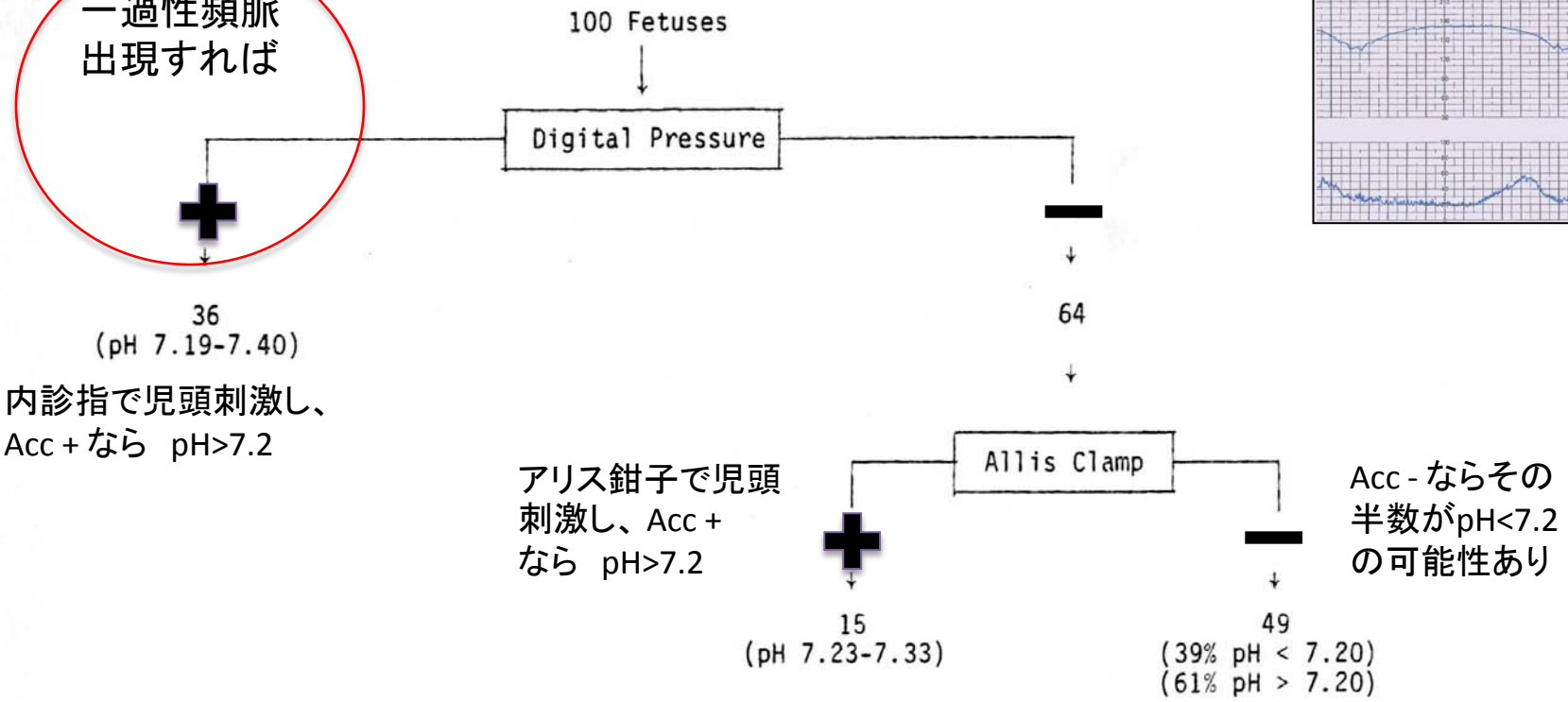
Steven L. Clark, M.D., Martin L. Gimovsky, M.D., and Frank C. Miller, M.D.
Los Angeles, California

Intrapartum fetal heart rate response to various scalp stimuli and its correlation with scalp pH was studied in a prospective manner. One hundred fetuses with heart rate tracings judged by the resident responsible for the patient to be suggestive of fetal asphyxia were entered into the study. Each fetus was subjected to firm digital pressure on the head followed by a gentle pinch of the scalp with an atraumatic clamp. Scalp blood sampling was then performed in the usual manner. Rcsponse to either of these stimuli by an acceleration of the fetal heart rate of 15 bpm lasting at least 15 seconds was uniformly associated with a scalp blood pH of ≥7.19. Fifty-one fetuses so stimulated responded with an acceleration. Of the remaining fetuses, 19 had a scalp pH <7.19 and 30 were associated with a pH >7.19. Clinical application of such a scalp stimulation test could, therefore, reduce the necessity for scalp blood sampling by approximately 50% in the presence of a fetal heart rate pattern suggesting acidosis. Such a provocative test may also be very useful with an abnormal fetal heart rate pattern suggestive of acidosis when the cervix is sufficiently dilated to permit scalp blood sampling. (AM. J. OBSTET. GYNECOL. 148:274, 1984.)

Clark SL, et al. Am J Ob Gyn 1984;148:274

分娩中にFHRパターンに異常があり、レジデントが
*胎児アスフィキシア*と判断した100症例を対象
(96例 ≥37w, 4例 33-35w)

一過性頻脈
出現すれば



内診指で児頭刺激し、
Acc + なら　pH>7.2

アリス鉗子で児頭
刺激し、Acc +
なら　pH>7.2

Acc - ならその
半数がpH<7.2
の可能性あり

Fig. 2. Response to fetal scalp stimulation.

Acc(+)でpH>7.2、Acc(-)で半数はpH<7.2. 児頭血採血は、児頭刺激試験の普及で、米国ではほとんど行われなくなった。欧州ではいまでも行われている。

Clark SL, et al. Am J Ob Gyn 1984;148:274

#5臨床研究

Clinical fetal monitoring

VII. The evaluation and significance of intrapartum baseline FHR variability

RICHARD H. PAUL, M.D.
AIDA KHAZIN SUIDAN, M.D.
SZE-YA YEH, M.D.
BARRY S. SCHIFRIN, M.D.
EDWARD H. HON, M.D.
Los Angeles, California

The clinical usage of intrapartum fetal monitoring has increased dramatically in the past few years. Understanding of the pathophysiologic significance of FHR patterns has been further elucidated, but quantitation and prediction on an individual basis at times present a practical clinical dilemma. Baseline FHR variability was evaluated in order to see if it provided additional commentary on fetal status. The presence of FHR variability appears to be a favorable commentary regarding both fetal and newborn status. A clinical method of appraising FHR is presented and the significance of FHR variability suggested.

Am J Obstet Gynecol 1975;123:206-210

遅発ー過性徐脈と基線細変動との組み合わせが重要

Late decelerations

軽症

中等症

重症

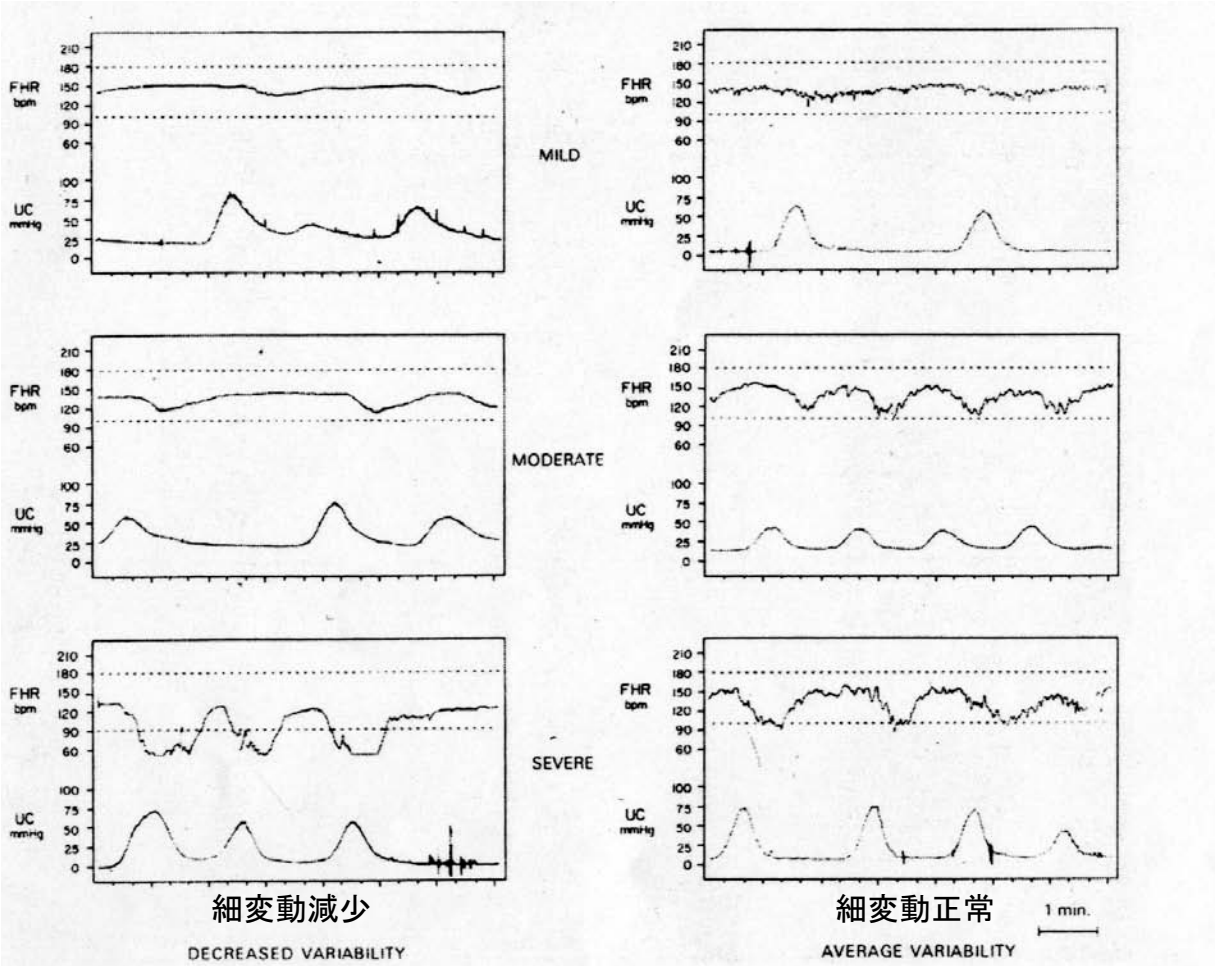


Fig. 2. Late decelerations FHR patterns are separated into mild (<15 b.p.m.), moderate (15 to 40 b.p.m.), and severe (>40 b.p.m.) groups. Examples associated with decreased variability, on the left, can be contrasted with those showing average or greater variability on the right.

Am J Obstet Gynecol 1975;123:206-210

Variability comes first!

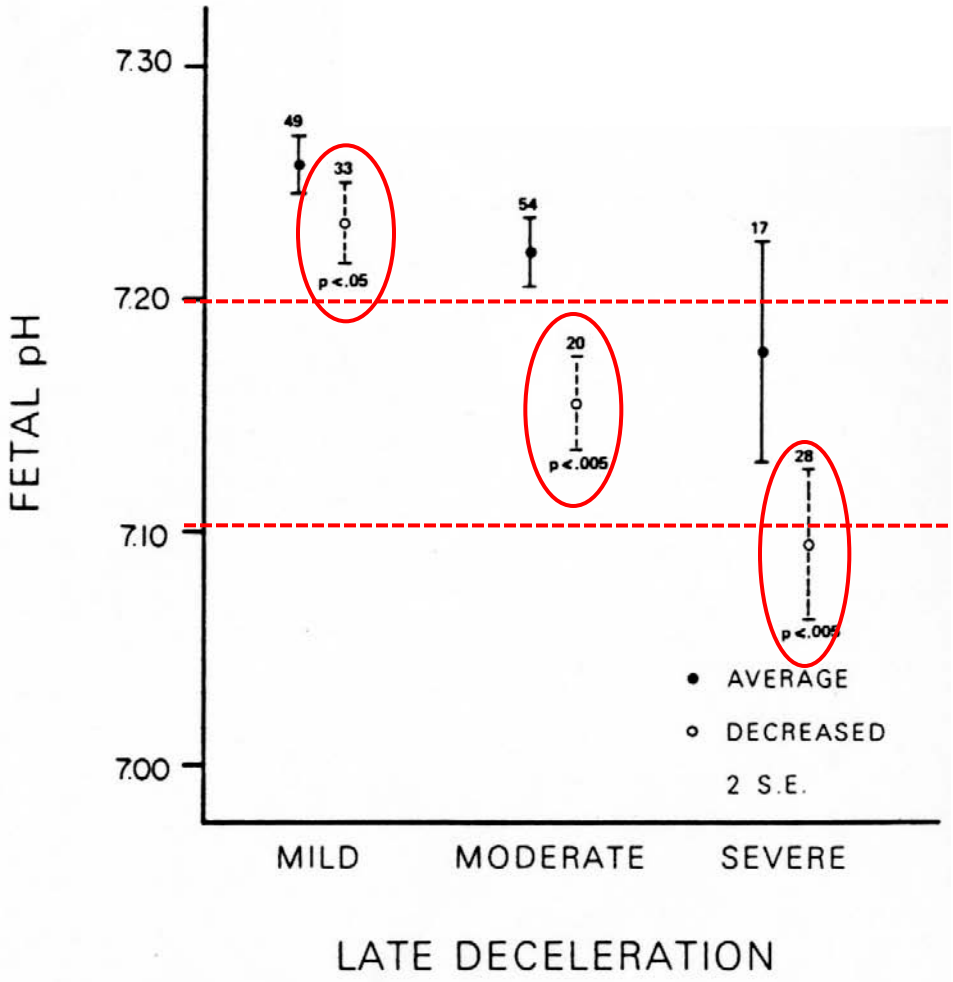


Fig. 3. As late deceleration patterns become more marked, the mean pH value falls. However, when FHR variability is present in association with late deceleration patterns, the mean pH is consistently higher than when it is absent.

Variable deceleration
でも、多分、同様

細変動減少で有意にpHが低下：細変動の重要性

Am J Obstet Gynecol 1975;123:206-210

胎児機能不全
non-reassuring fetal status

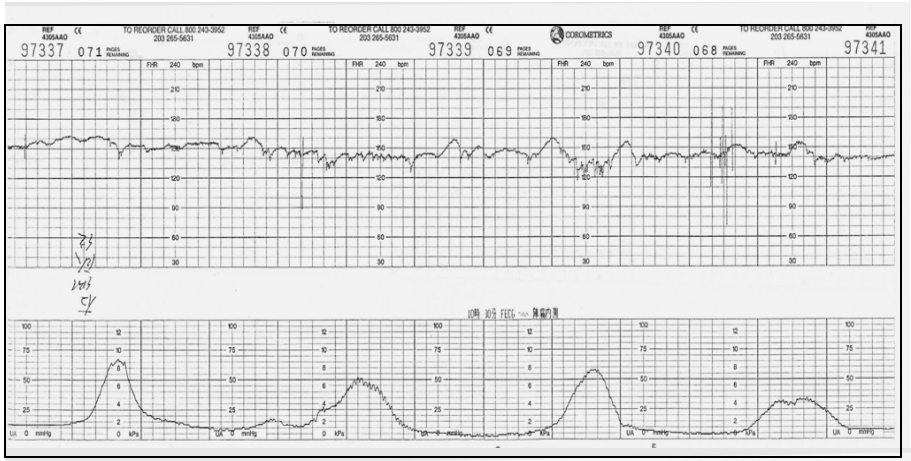
1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST

経時的変化

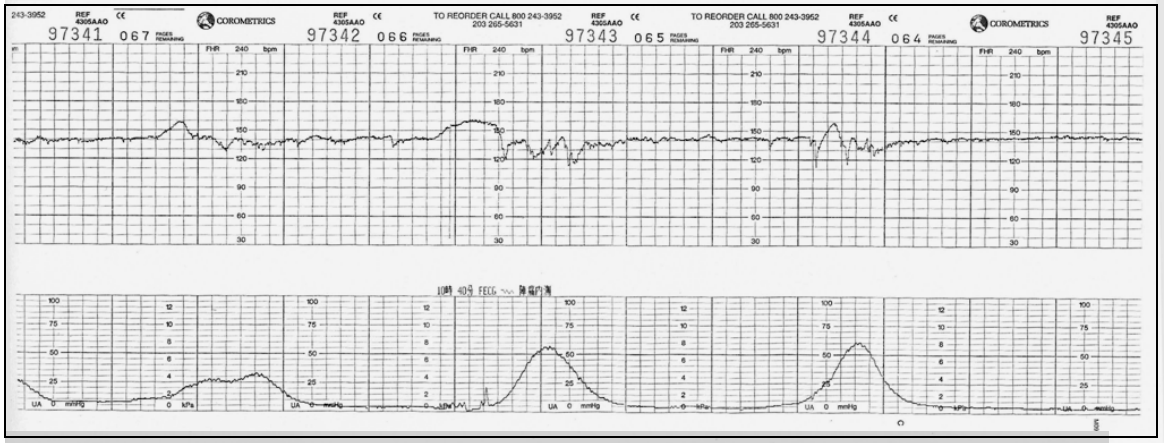
因子	正常	異常	
Acceleration	present (absent)	absent	
Variability (V)	moderate	Decreased Minimal to absent	
Deceleration Late decel	absent	Intermittent to recurrent	shallow – deeper – shallow (V+) (V-)
Deceleration Variable decel	absent (mild)	Moderate to severe (V+) ~ (V-)	

モニタリングの継続と、定期的な評価が大切

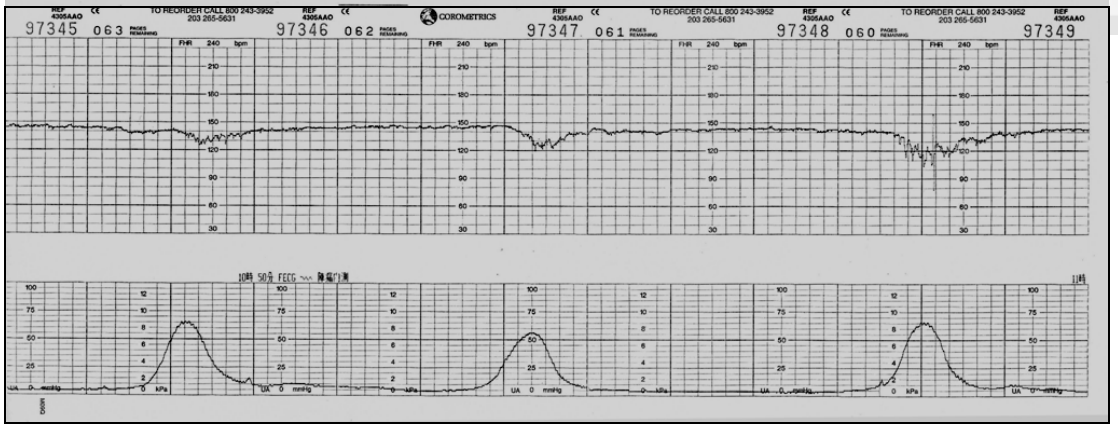
3/15



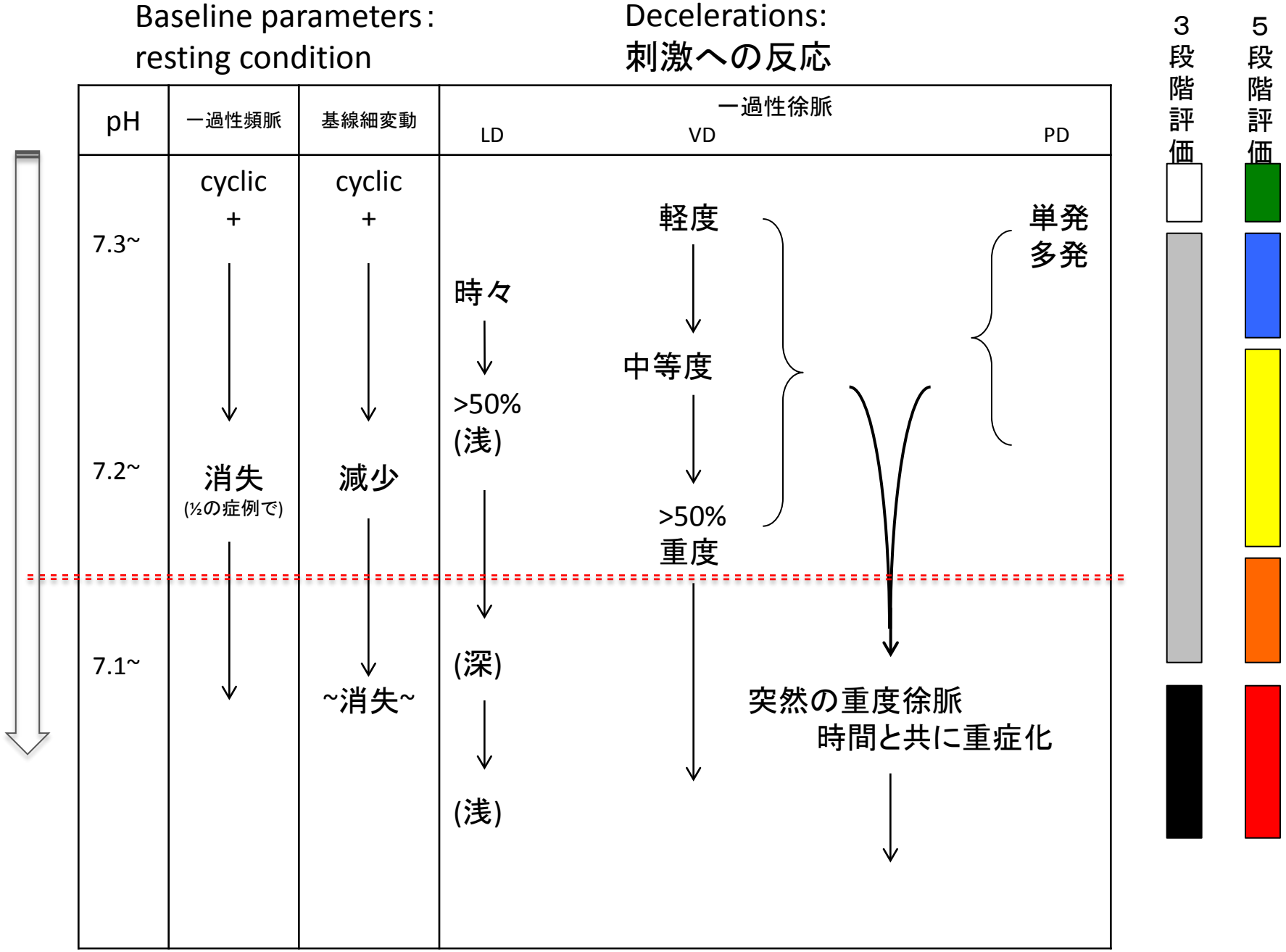
連続1



連続2

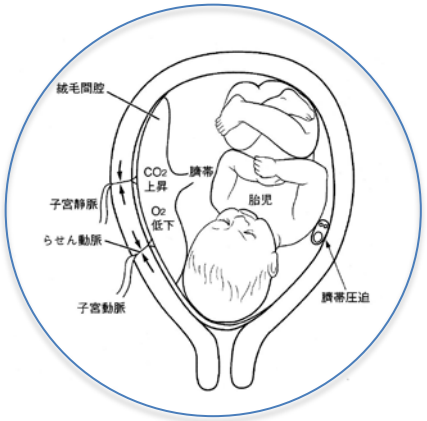


30分後CS
pH 7.04
abruption


Baseline parameters :
resting condition
Decelerations:
刺激への反応
pH
一過性頻脈
基線細変動
一過性徐脈
LD
VD
PD
7.3~
7.2~
7.1~
cyclic
+
cyclic
+
消失
(½の症例で)
減少
~消失~
時々
>50%
(浅)
(深)
(浅)
軽度
中等度
>50%
重度
単発
多発
突然の重度徐脈
時間と共に重症化
3段階評価
5段階評価

胎児機能不全
non-reassuring fetal status

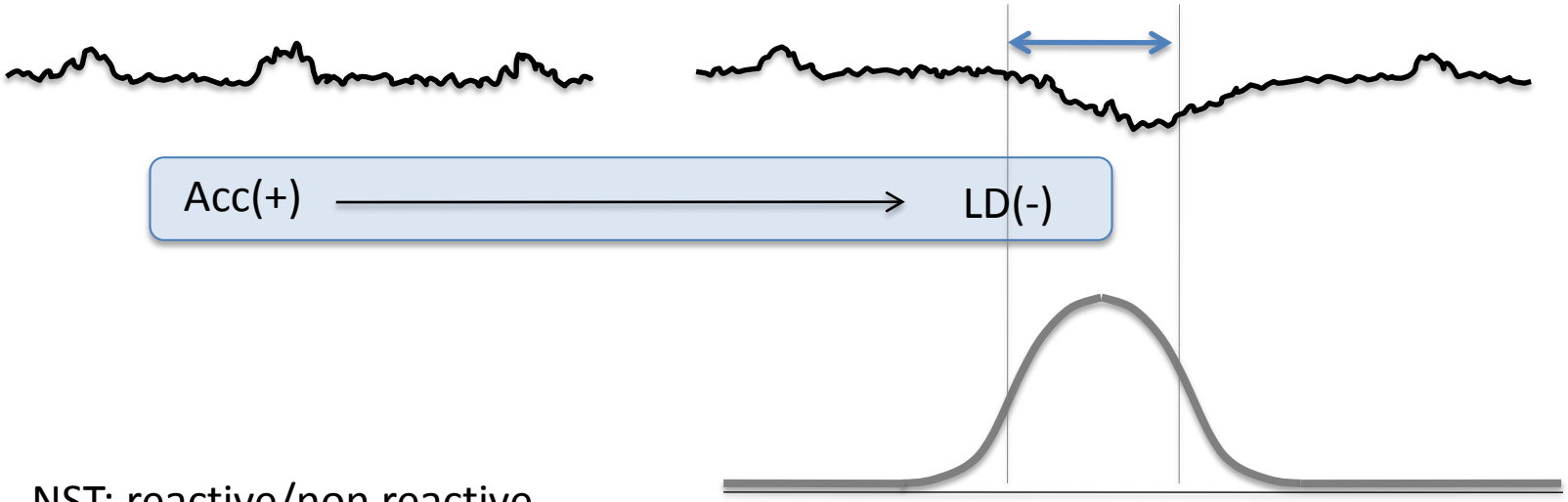
1. 胎児機能不全とは
2. FHRの基本
3. Decelerationとは
4. 基線の細変動とaccelerationとは
5. 経時的変化
6. NSTとCST



FHRの基本 (antepartum, UCなし)

Stress-free時の反応
(Resting condition)

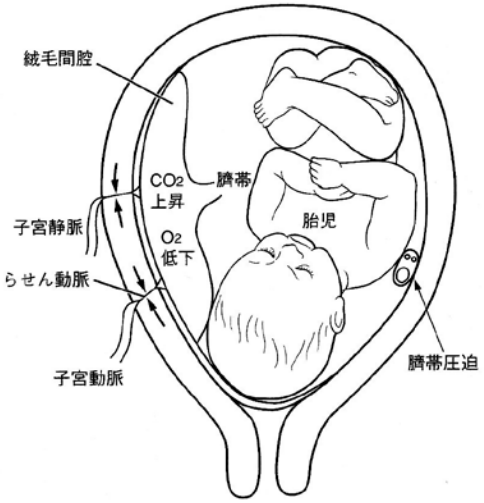
Stressへの反応
刺激へのresponse

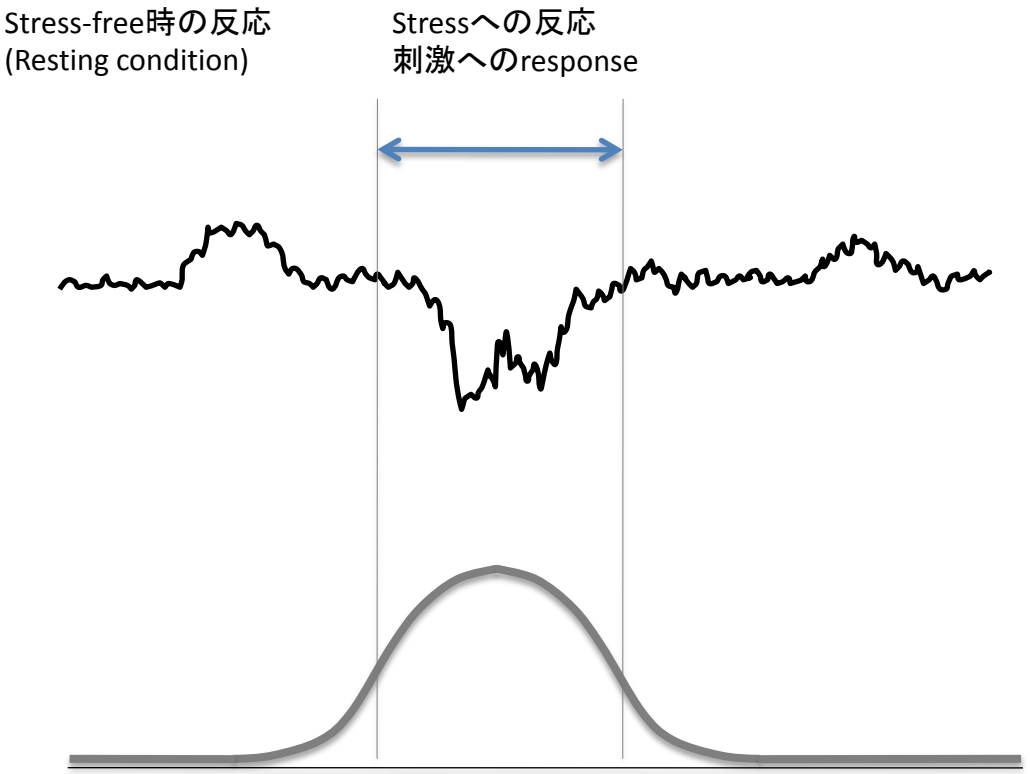


NST: reactive/non reactive

NST ← CST: positive/negative/equivocal

FHRの基本
基線(variability)と刺激への反応(deceleration)





病態　　病因