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Prevention of Infantile Cerebral Palsy & Fetal Demise with Novel Hypoxia Index and FHR Score

Kazuo Maeda[1]*, Masaji Utsu[2]

[1]*Honorary Professor, Obstet Gynecol Tottori University Medical School Yonago, Japan.

[2]Department of Obstetrics Gynecology, Seirei Mikatahara Hospital, Hamamatsu, Japan.

maedak@mocha.ocn.ne.jp

***Corresponding Author:** Kazuo Maea, Postal: 3-125 Nadamachi, Yonago, Tottoriken, 683-0835 Japan.*

Abstract

Fetal heart rate (FHR)curve evaluation is changed from visual FHR pattern classification to objective numeric analyses including hypoxia index, FHR score, frequency spectrum, A /B ratio, artificial neural network, etc. Early 3 items are fit update FHR analysis. Hypoxia index covers all 4 FHR patterns, preventing infantile cerebral palsy, FHR score predicts Apgar score and UApH, preventing fetal/neonatal demise, and FHR frequency spectrum detects pathologic sinusoidal FHR and severe fetal anemia preventing feta demise. Numeric FHR analysis isfully objective and suitable to computerized FHR diagnosis, of which diagnosis is totally correct and improves busy works of Obstetricians. Novel hypoxia index, FHR score and frequency spectrum diagnosis are studied.In FHR monitoring in the present report.

Keywords: *FHR monitoring. Cerebral palsy, Hypoxia index, FHR score, Apgar score, UApH, Sinusoidal FHR*

Introduction

The diagnosis was done by the visual recognition of FHR pattern classification, where obervers difference was allowed, namely, it was subjective and incorrect sometime. There was no numeric threshold to prevent cerebral palsy in fetal monitoring. The author intended such numeric threshold to prevent cerebral palsy and fetal/neonatal demise in the present report. Thus, you are standing at the entrance of truly useful landmark to cure the fetus and infants from cerebral palsy and fetal/neonatal demise.

Methods

Hypoxia Index

As the corresponding author recognized completely normal neonate, whose

Apgar score was 9, after appearance of 3 connected typical late decelerations, despite the outcome must be ominous according to past reports of late deceleration [1], while frequently repeated late decelerations appeared in 50 minutes were followed by heavy asphyxia, of which Apgar score 3, and the loss of baseline variability followed by severe brain damage. In addition in a definition, a late deceleration must repeat for more than 15 minutes before the definition.

Thus, late deceleration was ominous not by late appearance of deceleration, but frequently repeated FHR decelerations, namely, the vagal nerve center located in medulla oblongata was stimulated and excited by the hypoxia, then develops FHR deceleration (transient bradycardia), as well as continuous fetal bradycardia, namely, FHR deceleration was a hypoxic area, thus, repeated decelerations means repeated hypoxia, and repeated hypoxia is effective to damage fetus in the repeated decelerations, where 3 decelerations' hypoxia is weak and frequently repeated deelerations are fully hypoxic and hazardous, thus, **novel Hypoxia Index was the sum of FHR deceleration durations (min), divided by the lowest FHR (bpm) because it is the intensity of hypoxia (Figure 1), and multiplied by 100 to keep the index an integer.** Six cases of cerebral palsy and 16 cases of no cerebral palsy cases were collected, who were diagnosed in pediatric clinic, and their hypoxia indices were calculated in the FHR curves recorded in intrapartum fetal monitoring and preserved in obstetric ward in the retrospective studies.

The hypoxia index of all 6 cerebral palsy [2] cases were 25 or more, while the hypoxia index of all 16 no cerebral palsy cases were 24 or less, and there was significant difference of cerebral palsy cases in high and low hypoxia index groups. Since the *P* of Chi^2 test, which shows the probability of error diagnosis was almost zero (Table1), we decided there will be no infantile cerebral palsy, if the hypoxia index is 24 or less.

Parturient woman is requested to take lateral posture when a FHR deceleration appears in fetal monitoring to prevent further deceleration and high hypoxia index to develop cerebral palsy, as late deceleration disappeared by lateral posture [6,7]. The fetus whose hypoxia index was 25 or more can receive early treatments for the cerebral palsy even in neonatal stage.

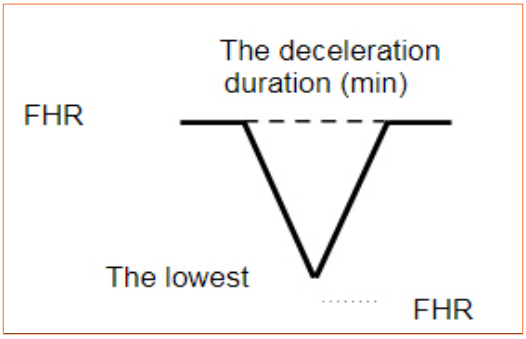

Fig 1. *Measurement of deceleration duration (min) and the lowest FHR (bpm)*

Table 1. *The hypoxia index of all 6 cerebral palsy cases were 25 or more, while it was 24 or less in all 16 cases of no cerebral palsy cases.*

Hypoxia index	Cerebral palsy	
	Yes	No
25 or more	6	0
24 or less	0	16

Chi^2 test of cerebral palsy case numbers: p=0.000008 Significant difference

FHR score

A mathematical FHR score is calculated in FHR decelerations in every 5 Minutes of fetal monitoring, which is calculated by the sum of evaluation scores of 9 FHR deceleration parts in 5 min (Figure 2 and Table 3). The evaluation scores were calculated by the percentage of lower Apgar score than 7 in each deceleration parts of FHR. Apgar score and umbilical cord blood pH were calculated with regression equations of FHR score and Apgar score as well as umbilical cord blood pH (UApH) [3,4]. For example Table 2.

Table 2. *Examples of Apgar score and umbilical cord blood pH (UApH) predicted by the FHR score calculated in the 1st stage of labor.*

FHR score	Apgar score	UApH
10	6	normal
15	4	acidemia
20	3	acidemia
24	0	(demise)

PHR score, Apgar score & UApH are predicted even in the first stage of labor, thus, early caesarean delivery is indicated even in the1st stage of labor.

Pathologic sinusoidal FHR

A truly pathologic sinusoidal FHR caused by severe fetal anemia or heavy asphyxia should be separated from physiologic sinusoidal FHR, which is fully favorable, while its wave form is close to pathologic one. Physiologic favorable one is caused by cyclic fetal mouthing or respiratory movements and separated from pathologic one when it is recorded by actocardiogram (ACG) but not by cardiotocogram (CTG).

Pathologic sinusoidal one is also diagnosed by frequency spectrum analysis, namely, La/Ta ratio is more than 39 % and at the same time PPSD is 300 or more in frequency spectrum analysis [5]. True pathologic sinusoidal FHR fetus should receive early caesarean delivery, followed by neonatal blood transfusion, if it caused by fetal anemia.

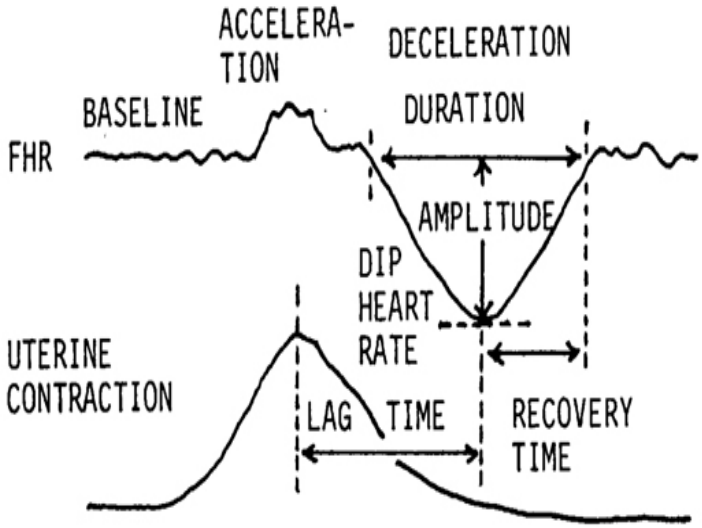

Fig 2. *FHR parameters to be used for the calculation of FHR score.*

Table 3. *FHR score is the sum of evaluation scores in 5 minutes.*

	FHR changes	Apgar<7 %	Evaluation score
Baseline FHR	110-130 or 160-180	28	1
Deceleration	<110 or >180	71	3
Lowest FHR	<100bpm	37	2
Amplitude	>50 bpm	50	2
Duration	>60 sec	71	3
Recovery time	>40sec	63	3
Lag time	>40sec	71	3
No acceleration	-	45	2
W-shape & loss of variability	-	100	4

Other Techniques

Artificial neural network computer was able to diagnose the probability to be

normal, suspicious or pathologic outcome of fetus, however, the result is the same as FHR score, thus, it is not included in clinical FHR diagnostic computer.

Apgar score was less than 7 when the ratio of Acceleration duration/movement Burst duration (A/B) ratio [8], however, the result was the same as the results of FHR score, thus, the A/B ratio was not included in common computerized FHR diagnosis.

Discussion

Hypoxia index was based on the facts of vague outcome of scarce and Frequently repeated late decelerations. Although "Cerebral palsy" is a summarized disease name [2], the cerebral palsy and normal cases were grouped also according to the facts. Two groups of hypoxia index were composed of "cerebral palsy" and "no cerebral palsy"cases, which were suitable to separate two groups separated by a clear numeric threshold, which was repeatedly requested to estimate the outcome of fetal monitoring. Statistics established significant difference between two groups, where the threshold is hypoxia index, which is able to separate the outcome at present. Clinical state, e.g. Apgar score or UApH is diagnosed, if suitable regression equations are obtained in the future. Frequency spectrum analysis decided pathologic sinusoidal FHR [5]. FHR score, hypoxia index and FHR frequency spectrum will be sufficient for fetal diagnosis at present. Such simple computer composed 3 parameters should be constructed.

Although obstetric doctor was able to prevent fetal death by early caesarean delivery in severe FHR pattern changes depending doctors but unable to prevent cerebral palsy in Dublin, where they had no numeric threshold to prevent cerebral palsy. As hypoxia index is a numeric and objective threshold,

cerebral palsy will be reduced in the world, if the objective method is distributed, instead of subjective method of FHR pattern classification in the past.

Conclusion

New field is open in FHR monitoring by setting numeric criteria to prevent infantile cerebral palsy with hypoxia index and other update mathematical analysis, instead of subjective fetal outcome estimation with FHR deceleration pattern classification. It is recommended to introduce mathematical analysis into computerized FHR monitoring.

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