

Nursing Education 2016: Improved Fetal Heart Rate Study Using Update Actocardiogram- Kazuo Maeda- Tottori University Medical School

Kazuo Maeda

Tottori University Medical School, Yonago, Japan

Introduction: Fetal abnormality was studied by Hon and Caldeyro-Barcia, detecting fetal bradycardia, late deceleration and loss of variability. However, developing mechanism of FHR changes was almost unknown, while subjective Fetal Heart Rate (FHR) patterns were discussed in clinical studies, then discrepancies between FHR deceleration and fetal outcome were discussed, and CTG was difficult to clarify fetal complications, though perinatal outcome was reported improved by fetal monitoring. Fetal scalp lead ECG was used to record FHR, then changed to fetal heart sound by Hammaher and Maeda, then further changed to ultrasonic Doppler fetal heart beat signals treated by autocorrelation heart rate meter, because the Doppler fetal heart signal was clearly detected even in the labor and autocorrelation heart rate meter recorded FHR as clearly as fetal scalp ECG. Ominous hypoxic signs were almost unknown, benign physiologic sinusoidal FHR was not separated from ominous pathologic sinusoidal one, fetal non-reactive state was diagnosed by maternal perception of fetal movement, and fetal hiccupping movement was unable to record on the CTG. Discrepancy was discussed between late decelerations and fetal outcome.

The author intended to compare the FHR to objective fetal movement record on the recording chart, and studied ultrasonic Doppler signals of fetal movement and fetal heart beat, then achieved to objectively differentiate their Doppler signals by their frequencies. Maternal motions developed large Doppler signals; however they were differentiated by their very low frequency.

Methods: Production of actocardiograph made by the author's hand

The author measured Doppler frequency of fetal movement by real-time FFT frequency analyzer lis-

tening noises of ultrasonic Doppler FHR monitor, fetal movement was identified by the observation of uterine wall movement, then detected fetal movement Doppler frequency to be 20 to 50 Hz when ultrasound was 2 MHz, while already we knew that Doppler frequency of fetal heart was 100 or more Hz in the analysis of Doppler fetal heart signal analysis, then it was possible to separate fetal heart signal from fetal movement one using ultrasound Doppler signals passing through a band pass filter, if the ultrasonic fetal monitor is used. Then TOITU TN400 ultrasound fetal CTG monitor (Tokyo) was remodeled attaching new electronic circuit by the author's hand, where maternal motion signals, of which frequency was 2 or lower Hz, were rejected by a CR high-pass filter, of which cut-off was 8 Hz, -6 dB/Oct to observe fetal Doppler signals with oscilloscope. FHR was recorded using original autocorrelation ultrasonic Doppler heart rate meter of TN400. The fetal movement Doppler signal was extracted by a band-pass filter, of which cut-off frequencies were 20 and 80 Hz, -18dB/Oct, in the prototype model. Movement spike signal was recorded on the channel which originally recorded uterine contraction; Commercial ACG models prepare 3 channels including FHR, fetal movement (associated a dot record) and proper channel to record uterine contraction to prepare CTG function Fetal highly active state was characterized by prolonged fetal movement burst and transient tachycardia, which were usually temporally and safe. Fetal hiccupping's were repeated sharp spikes with 2-3 sec interval, where total hiccupping duration is 10 or more min. Some fetuses repeatedly develop repeated hiccupping movements twice in a daytime, while fetal hiccupping is physiologic and not hazardous. Fetal hiccupping movements accompanied no FHR acceleration, because the hiccupping movements may be diaphragmatic convulsion which will

not stimulate fetal brain then did not develop FHR acceleration, but it is not a pathologic phenomenon. The proto-type originally produced by the author's hand was changed to commercial models by the request of the author to TOITU (Tokyo).

Production of prototype is about 50 pregnant women. Confirmation of the possibility of prototype is about 100 normal pregnant women. ACG function confirmation by world researchers is 100 pregnant women. Feta hiccupping movements is about 40 by the author and colleague. A/B ratio studies were carried out with about 50 normal and pathologic pregnancy cases. The fetus of central nervous system diseases is about 30 cases. Fetal disorders studied by the author are about 50 cases.

Recording method of ACG

The placement of ultrasound probe was the same as that of CTG, namely, the probe was placed on maternal abdomen via ultrasound jelly at the place of the most clearly listening fetal heart beat, corresponding fetal chest. Two probes were attached in case of twin pregnancy, where two heart beats were clearly listened; contraction probe was placed nearby uterine fundus. Each probe was fixed by belts.

The ACG should be recorded to include active and resting fetal states, of which duration may be 10-30 min each. Active state is characterized by frequent fetal movement bursts and responding FHR accelerations. Recording of no acceleration against fetal movement bursts is non-reactive FHR caused by mild hypoxia possibly followed by severe hypoxia, so that early delivery may be recommended in non-reactive FHR. FHR pattern was recognized by the CTG function.

Fetal resting state was characterized by neither FHR

acceleration nor fetal movement spike was recorded, where baseline variability was preserved. It will be a dangerous situation when both variability and acceleration are lost, which meant severe fetal brain damage caused by heavy hypoxia.

Results: More than 420 cases were studied and the resulted as follows:

Correct fetal movement spikes recorded on ACG chart

A steel ball was moved in water tank against the ACG probe. The steel ball movement was measured with a telescope. The relation of steel ball moving span and the spike amplitude was compared in the prototype model by the author, where the movement spike amplitude was completely parallel to the steel ball moving span. As steel ball motion represent fetal movement, therefore, movement spike recorded on the chart correctly represented fetal movement.

Earliest gestational weeks to record fetal movement

Fetal movement was recorded in 14 weeks of pregnancy with the ACG, while the FHR acceleration was associated in 20 or more weeks of pregnancy. Fetal brain will respond to fetal movement after 20 weeks of pregnancy.

ACG was checked by us and researchers in the world

The primary commercial ACG model was tested by world researchers, where almost all of fetal movements were recorded by the ACG to confirm the utility of ACG. Fetal movements were visually checked on the monitor screen of real-time ultrasound B-mode imaging device by a colleague of the author and the movement event was marked on the ACG record by clicking a rapid Morse code key, where the event mark was fully corresponded to ACG spikes.