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Analysis of the First Cry of the Newborns in Case of Vaginal Delivery and Caesarean Section

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Abstract: Nearly all of the newborns are coming into the world with crying. The first cry carries significant information about the baby's wellbeing, about his successful adaptation to the extrauterin life. The quality of first cry is a part of the Apgar score system which is used to assess the condition of newborns after delivery. The powerful first cry can carry the message for parents about the arrival of a healthy baby or the feeble cry immediately arises anxiety. In many countries the number of caesarean section has been increasing. The differences in the first cry can represent a subtle parameter which can reflect the start of life in a different way. The first cry samples of 10 vaginally born babies and 10 babies born by caesarean section were analysed. The analysis took place by subjective test with the participation of infant care specialists and with objective measurements based on signal analysis. The groups of cry samples showed definite differences besides that the cry samples in both groups were in the normal range. The results can contribute to the decision making process about the way of delivery knowing that the events in the perinatal period create the base for the later physical, mental, emotional development.

Keywords: first cry, infant cry, cry analysis, delivery and cry, early development and cry

1. INTRODUCTION

The birth of a child, the birth of our own children, is one the most significant, most complex, most inspiring, and most emotionally challenging moments of our life.

There is an expectation in the everyday practice that the newborn would be crying when he comes into the world. It belongs to the so called "good delivery" to have a baby with a loud cry. The mothers can recognize without any specific training if the first cry carries a good message.

The quality of the first cry is a relatively easy and quick evaluation index about the wellbeing of the newborn, about his successful adaptation from the intauterin life to the extrauterin one. The wellbeing of the newborn at birth is the result of a complex process. The crying can provide the perception of wholeness about the functions of the newborn.

The modification of the physiological process of delivery by external factors may influence the adaptation to the extrauterin life of the newborn in a short or long run. The effect of it can be very subtle, at the edge of measurable manifestation or easily observable.

The process of vaginal delivery without complication and the delivery by caesarean section are different and it is difficult to compare them. The most important similarity in both cases is the output, the expected healthy baby, the necessity of the loud first cry.

One of the significant changes in the mentality about the period of birth during the latest decades is the recognition that the experiences, events happened in the perinatal period – as well as the delivery itself - create the fundament for the later physical, mental, emotional development of the newborn.

The number of caesarean section has been increasing in most of the countries all over the world and it appears in the list of indication more and more the request of mothers owing to their anxiety.

The rate of childbirth by caesarean section - highlight the figures only some countries- can show its increasing role in our everyday life (see Fig. 1).

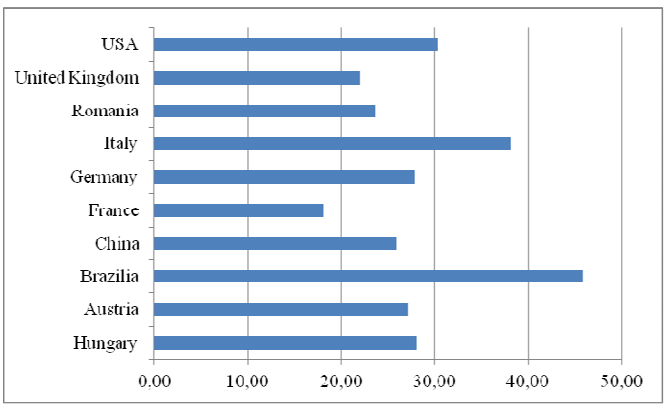

Fig. 1. The rate of caesarean sections in different countries in 2008. WHO report (2010) Background paper, 30

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2. THE PURPOSE OF OUR RESEARCH

• to find subtle marks in the cry samples which can refer to even the slightly altered condition of newborns

• to compare the first cry of the newborns delivered by vaginally and by caesarean section

3. BACKGROUND

The first cry of a newborn has significant messages both for the families and for the professional birth attendants.

3.1 This quotations--collected during my clinical work-come from the belief system of the families which can contribute to the formation of their emotions and their behaviour:

„The babies cry immediately at birth because they are grabbed rudely by the doctors, this does not happen in deliveries by midwives only."

„The baby starts to cry immediately after birth if everything goes normal. The doctors say that this how babies' lungs start working. Some people say that this way the baby protest to be taken out from the warm, pleasant maternal nest, they protest to arrive in the cold air, into the real world."

„It is a good signal if you can hear the crying of your baby in the delivery room. The cry helps him to get rid of liquid in his lung, in his nose and in his mouth. This is why the doctors encourage the little baby to cry."

3.2 There is a strong meaning of the first cry for the parents. It was collected by personal interview during another research project.

"The fear gripped my heart when I heard his voice"

"I had a slight fear that he did not start crying immediately in the moment when he came out"

"This baby started to cry at once, with the previous child I felt immediately that something went wrong when I heard the first cry"

"I was scared that they would not let me know whether he had a good first cry, whether he lost points in the evaluation"

"He had a good cry and I knew that everything was OK"

"I could hear that they had good cries even through the closed door"

"She did not want to cry she just had two groaning sounds"

"I asked why she did not have first cry yet, I was told that they did not let her to swallow the fie-fie amniotic fluid"

3.3 *The condition and the first cry of the newborn after the birth for the professionals*

The professionals involved in deliveries used the Apgar score to evaluate the actual condition of newborn babies 5 and 10 minutes after delivery. The first crying sounds have been the components of two criteria: the respiratory effort and the response to stimulation (reflex irritability). It was given 5 point in case of the good, powerful first cry and the newborn got 0 point who did not have a first cry or have just a whining.

Even recently the observation of the physiological components of the Apgar score represents key importance though it has got different role in the newest guidelines.

3.4 *Crying or not crying*

It is possible to be born without crying and to be a healthy newborn according to the oral, unwritten tradition of certain midwifes.

There can be nearly unconscious gestures by the staff after delivery which may promote the first cry of the babies to fulfil the expectations.

On the other hand there is an everyday practice to prevent the start of breathing and the first cry before suction of the upper respiratory tract in case of meconium stained amniotic fluid.

4. HOW THE SCIENTIFIC RESEARCHES CONTRIBUTED TO OUR MAP ABOUT THE FIRST CRY?

4.1 *From audible to visible*

The first cry of the newborn represented a significant category among the signals of being alive after delivery even centuries ago.

Even before the appearance of technical devices the specialists involved in infant care were able to record when the cry sounded different from the healthy ones owing to the damage of central nervous system, or the respiratory system, like high pitched cry sound, irregular crying after delivery.

W. Gardiner used the musical notes to make visible the baby's cry in his book "The music of nature" in 1832.

The need and expectation by the analysis of cry sounds focused on

• to create so called objective parameters which can be a good basis for analysis, evaluation and comparison,

•to help the manifestation of certain characteristics which may not appear by the auditory perception,

•the gained data are suitable to describe and differentiate the physiological conditions, discomforts, like hunger, sleepiness, dirty nappy, fear,

•to gain data which can be specific to certain pathological conditions,

•to create a device that may be applicable in everyday life situation like EKG, EEG or apnea alarm.

During the previous decades the data provided by spectrograph got the closest to the requirements and expectations. The short events in the sound signals can disappear extremely quickly. The careful study of spectrograms can focus on details in higher resolution in time

and frequency domain compared to the human ear but spectrogram reading is very complex. Usually it needs several years of experience for specialists to read it properly.

Since the 1960-s the Scandinavian research group (Sweden, Finland) in various combination of the researchers produced the most data on cry signal analysis by using spectrograph in broad range of physiological and pathological condition of infants. They examined the following parameters in the spectrograms: duration, fundamental frequency, melody type, other features related to the fundamental frequency, like gliding.

The application of this method proved to be so successful that it led to develop an automatic cry analysis on the bases by a group of Mexican researchers to support the differentiation between normal and pathological cry.

4.2 *Analysis of first cry in case of delivery by natural way and by caesarean section*

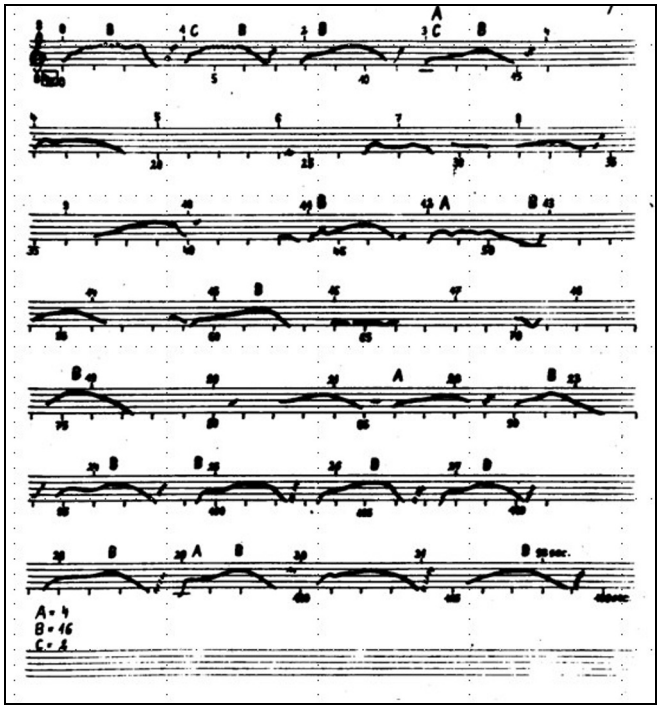

Fig. 2. Sound microscopy (F0 plot on traditional music note system). An example of baby cry in the case of vaginal delivery.

In 1974 Makói and her colleagues compared the first cry of 10 newborns born vaginally and 10 newborns born by caesarean section. Their gestational weeks were between 38-42 weeks. The caesarean sections were carried out under general anesthesia. The significance of the topic came from the everyday experience. It happened many times years ego that babies born by caesarean section could not have first cry or just had a feeble groan. It was said "He had been overcome by sleep," though the scientific data were not without doubt about the effect of maternal anaesthesia to the infant. The cry analysis happened by sound microscopy method. The method itself was invented by Peter Szőke, a Hungarian ornithologist who applied it for studying the sound of birds. The samples were significantly different in the babies born by vaginally or by caesarean section See Fig. 2. and 3.)

The differences have been considered as an early sign of the different adaptation to the extrauterin life.

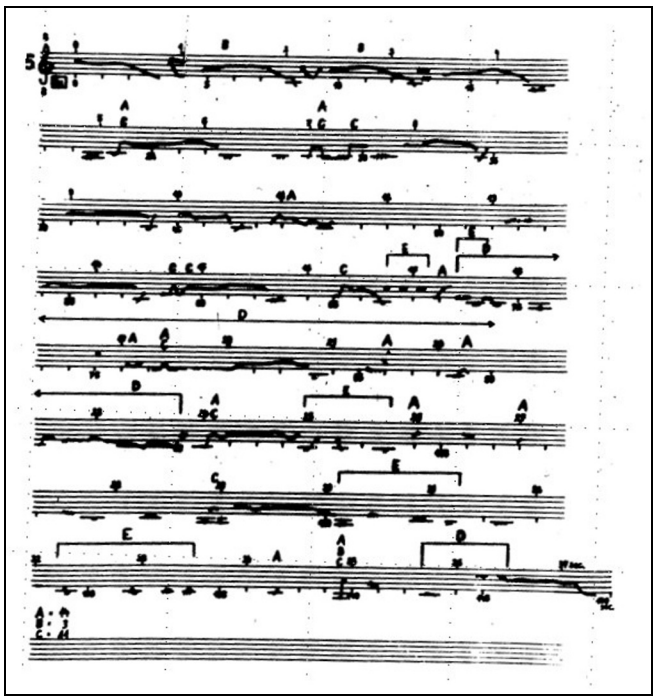

Fig. 3. Sound microscopy (F0 plot on traditional note system). An example of baby cry in the case of caesarean section.

In 2007 S. Höing and her colleagues presented a poster during the 10th International Cry Research Workshop in Denmark with the title "Does the mode of delivery influence cry properties in newborns' crying?" They compared the cry of 13 infants born by vaginal delivery and 16 infants born by elective and 12 by emergency caesarean section. It was used local (spinal) anaesthesia in the elective group and two cases got general anaesthesia in the emergency caesarean section group. They recorded the cry samples within the first three days. They focused on the development of cry during this early period not mainly to the first cry. They found that the cry samples of babies born vaginally showed increase of complex melody structure, clear development in cry pattern. They meant multiple-arc and segmented multiple-arc as complex melody structure. They considered this result as a possible sign of their quicker adaptation.

5. OUR NEW TEST MATERIALS AND METHODS

In the A test group 10 first cry samples were recorded. The newborns born by spontaneous vaginal delivery, gestational weeks between 37-42 weeks, Apgar score were normal, birthweight was between 2770-3960g

In the B test group also 10 first cry samples were recorded. The newborns born by caesarean section (elective, except one) under spinal anaesthesia, gestational weeks between 38-

42 weeks, Apgar score were normal, birthweight was above 3000 g, except one twins.

In both tests the first 2-5 minutes of newborn cry signals were recorded.

The recorder equipments were Olympos (VN-300PC) digital voice-recorder and Panasonic mini cassette recorder (RQ - 11). The recording happened in SOTE II. Department of Obstetrics. One of the parents signed a consent to the recording.

5.1 Subjective tests

In each cry record a representative subsection has been selected for detailed analysis and tests. Such subsections consist of 3-4 cry period about 10 s. The selection targeted the beginning of the regular baby cry.

For subjective tests a complete record was composed by digital editing. The sampling rate was 22050/s. It was started with an introduction announcement concerning the test. An identification announcement was recorded before the cry signal subsections to make sure the synchrony with the test sheets. The cry signals were followed by 10s break for the test persons to evaluate the cry signal and express their subjective opinion on the test sheet. The complete record has 25 cry subsections in random order of vaginal and caesarean section delivery. The rules of double blind tests were consequently applied. Both the test persons, and even the researchers directing the tests and evaluating the test sheets, were free from any information concerning the origin of cry subsections. Three of cry subsections were repeated in the composed test program to check the consistency of opinions.

The task of the test persons was to express their opinion on three scales after listening each cry subsection. The scales were: irregular-rhythmic, weak-powerful, unclear-clear. The responses of the test persons were to put a mark graphically on the test sheet scales. Instead of the number based scoring, we selected the graphical response to reduce the transformation levels in the subjective opinion expression and to have a finer scaling. Such expression of opinions can avoid the unnecessary transformation to a numeric scale.

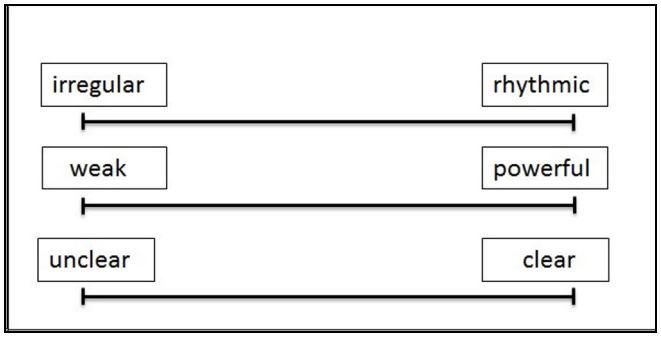

Fig. 4. An element of the test sheet to evaluate subjectively one cry subsection.

The graphical scale was converted into linear numeric scale during the processing phase of results. The left end of the line was fixed to 0 and the right end of the graphical scale equalled to 100.

32 specialists in newborn care (paediatricians, midwifes, staff nurses) were asked to participate in the assessment process.

5.2 Objective measurements based on signal analysis

In the objective tests the target features tried to calculate physical parameters, which are closely related to the rhythmic, powerful and clear subjective scales. The same composed cry signal record was used as in the subjective tests. The WaveSurfer free software tools were used to analyse the cry signals. In the first step the energy maximum positions were appointed in each cry elements. The beginning and end of cry elements were determined at time moments having 12 dB energy level below the maximum. The time duration (TD) of a cry element is the time difference between the beginning and end time. The repetition time (RT) is the time difference between two subsequent cry element beginnings. The absolute energy level values of cry signal do not carry relevant information because of the automatic volume control features of the used recorder devices. An example plot of the cry waveform and energy plot is illustrated in Fig 5.

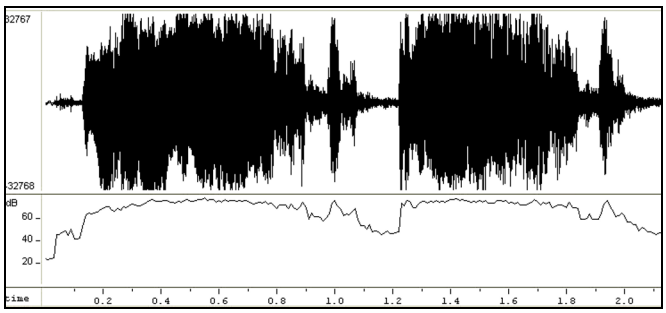

Fig. 5. Waveform and energy plot of two cry elements.

The spectral features of the cry signals were analysed only at the energy maximum moments of cry elements. The spectrum was calculated by the following parameters: Hamming window by 2048 samples, pre-emphasis value 0,9. Such parameter values are very common in speech signal processing tasks. This window size is wide enough to a fine spectrum resolution and can follow the dynamic changes of the vocal tract movements. An example can be seen in Fig 6. On the spectrum plot the fundamental frequency (F0) value can be seen as the first relevant peek and the can be checked by the existence of peaks at double, triple frequency values. Further important spectral derivative feature parameters characterising the shape and conditions of the vocal tract are the formant parameters. The spectrum envelope was calculated using linear prediction (LPC) method. The order of LPC analysis was 12. Fig. 7 demonstrates the LPC based envelope in the case of a really clear voicing cry element. Using the phonetic terminology at the first maximum of envelope is the first formant frequency (F1). Similarly the second peak determines the second formant frequency (F2). The formant frequency values are considerably higher compared to the adult speech parameters due to the small size of the baby vocal organs. The level differences of peaks and

the minimum of the envelope curve represent well the clearness of the cry elements (D1,D2)

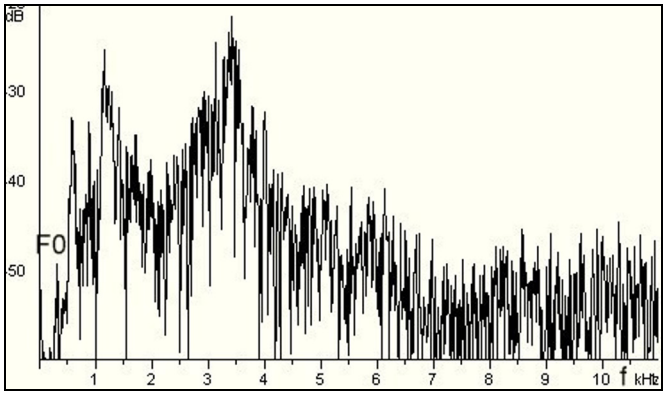

Fig. 6. Spectrum example of a cry element at energy maximum.

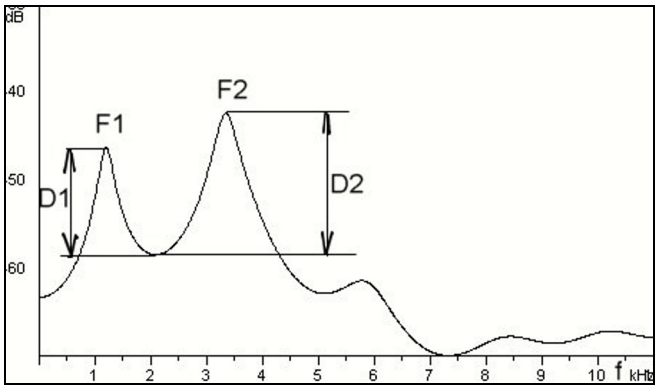

Fig. 7. LPC based spectrum envelope of a cry element at energy maximum.

6. RESULTS

6.1 Results of the subjective assessment tests

The average opinion values on the irregular-rhythmic, weak-powerful, unclear-clear scales were calculated. The group of babies born by vaginally has definitely higher average values and lower standard deviation values on both scales compared to the group born by caesarean section (see Fig. 8.).

The complex opinion is expressed in three dimensions which are more or less independent. The healthy newborn's crying is typically more rhythmic, more powerful and clearer. They also able to produce such regular cry signals nearly immediately. Newborns suffering from different problems typically are not able to produce such rhythmic, powerful and clear cry signals. Babies delivered by caesarean section need to face quicker adaptation to the extrauterin life. May be this fact is reflected in the cry parameters.

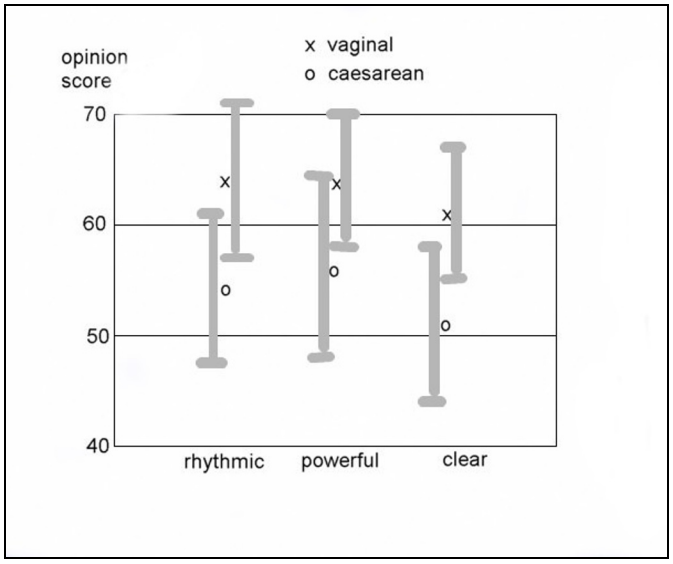

Fig. 8. The average opinion score values at different delivery mode. The grey lines show standard deviation values.

6.2 Objective figures based on cry signal analysis

The same composed test signals were analysed as were used in the subjective tests. The results are summarised in Table 1.

Table 1. 5Average values of the signal processing based cry parameters

Parameter	Unit	Vaginal (v)	Caesarean (c)	v/c
Peak energy level	dB	76.50	75.20	1.01
Duration (TD)	s	0.68	0.64	1.07
Repetition time (RT)	s	1.53	1.31	1.17
Fundamental frequency (F0)	Hz	451.57	503.04	0.90
First formant frequency (F1)	Hz	1817.00	1403.00	1.30
Second formant frequency (F2)	Hz	3133.00	2774.00	1.13
Formant level and minimum level difference (D)	dB	13.69	7.52	1.82

The average values of RT, F0, F1, F2, D parameters are significantly better in the case vaginal delivery then in case of caesarean section. The potential relations of the subjective opinion values and the analysis parameters need further investigations.

7. DISCUSSION

The research works investigated the first cry in different mode of delivery also found differences in the cry samples. They used spectrography which measured the physical, acoustical parameters of cry samples as we did in our recent research.

Makói's results 30 years ago gave more striking differences in case of the different mode of deliveries, most probably owing to the general anaesthesia of the mothers.

Branco's and S. Höing's results show also subtle differences in case of different mode of delivery like our recent results. The lack of robust deviation most probably due to the local (spinal) anaesthesia of the mothers and the subtle differences may refer to the differences of in some parts of complex process of delivery.

Our new simplified subjective and objective test methods also can differentiate the newborn condition based on the analysis of cry signals in case of different mode of delivery.

8. CONCLUSIONS

Probably it is fairly obvious for a group a people including specialists that the newborns gain different experience born by vaginally or by caesarean section. It has been certain processes, parameters which has been already proved this expectation but there are some issues open to further research. The indication to leave the natural way of delivery has been beyond the original conception for a long time: to save the life of mother or the newborn.

The first cry of the newborn can deliver the wholeness of information about his condition. It can carry the important messages about a crossing point, what experiences the newborn has just went over and whether he is well equipped to face to the adaptation process to new circumstances. The past and future are together.

Our cry analysis could clearly show the differences in the different ways of delivery by both the acoustical parameters and by the subjective test though the cry samples were within the normal range. The cry as an information entity can be put into the box of the soft, subtle parameters relating to the importance of the cardio-respiratory parameters but it can be a factor in the decision making process about the way of delivery in the future. It can be ranked in similar category the changes of neonatal EEG complexity depending on the delivery modes and how the early stage of intestinal bacterial colonisation is altered by by the mode of delivery. The road can be built to carry this information to the families as well besides the scientific community.

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