

## THE APPLICATION BY SOVILJ - LJUBIC METHOD OF PRENATAL HEARING SCREENING (PHS)

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### Abstract

Previous researches in the field of auditory perception gave reliable proofs that auditory perception is developed in prenatal period.

The aim of this work was to determine which of Doppler indexes (Pi and Ri) is more reliable in the assessment of the fetal reaction to a defined sound stimulus by Sovilj-Ljubic method.

This paper introduces Sovilj-Ljubic method of prenatal hearing screening (PHS).

Fetal brain circular changes are shown through the assessment of the blood flow velocity in aa. cerebri media, through the values of Pulsatility index (Pi) and Resistance index (Ri). The research comprised N=24 pregnant women with normal pregnancies, in the period from 27 to 31 gestation week.

The results of comparative analysis of the values of Pi and Ri are presented, with the aim of establishing which of the mentioned measuring parameters is more susceptible to the assessment of the fetal reaction to sound stimulus.

The initial results indicated that Pi and Ri values increase or decrease after the defined sound stimulation, which confirmed that fetus reacts to the mentioned sound stimulus, and that Pi changes are more reliable compared to Ri changes ( $p < 0.05$ ).

*Key words:* fetal auditory perception, aa. cerebri media, prenatal auditory detection

### 1. Introduction

Previous researches of fetal development proved that in the 20th gestation week human cochlea reaches the size that it has in an adult (1), and the developmental state similar to other mammals, when the reaction to sound can be provoked (2), sounds can be encoded, and messages can be sent along auditory paths (3). In human fetus, this happens when the reaction to speech is detected by behavioral or electrophysiological methods (4,5).

based on the similar researches, it proceeded that reactive hearing appears in the 16th week (6), whereas active hearing commences in the 24th week when the ear is structurally formed and when hearing becomes the main informational channel.

In our country, fetal reaction to sound stimulus was examined by M. Sovilj and A. Ljubic in 1992 (7). The aim of this experiment was to establish whether fetus reacted to acoustic stimulus, guided by the fact that most frequent causes of childhood deafness were congenital infections by different microorganisms (it is established that *Rubella* and *Cytomegalovirus*, *Treponema pallidum* and *Toxoplasma gondii* have harmful effects on hearing). Their results showed that immediately after acoustic stimulation blood flow is increased by 30% in the observed artery, which confirms that it is sonographically possible to register the reaction to defined sound stimulus in normal fetus.

## 2. Aim

The aim of this work was to determine which of Doppler indexes (Pi and Ri) is more reliable in the assessment of the fetal reaction to a defined sound stimulus by Sovilj-Ljubic method.

## 3. Method

Examination of brain circular changes through fetal aa. cerebri media provoked by the defined sound stimulus was carried out by Sovilj – Ljubic method, in the following procedure (8):

- Establishing of the documenttion and obtaining heteroanamnestic data.
- Procedure of a standard ultrasound examination.
- Placing of antiphones on pregnant woman's ears in order to exclude the influence of sound stimulus via mother's auditory system.
- Establishing of the position of fetus' head.
- Determination of fetus' auricle, which is turned towards mother's abdomen.
- Placing of the loudspeakers according to the vertical axis, 5cm from pregnant woman's abdomen in the direction of fetus' ear.
- Positioning of fetus' a.cerebri media or a.cerebri anterior.
- Reading of basic RI and/or PI values.
- Generating of digitalized defined sound stimulus.
- Reading of RI and/or PI Peak values.
- Measuring of the time needed for RI and/or PI values to get back to basic value.
- Measuring of the appearance time of the movement of bulbosa, and/or body parts.

The research comprised N=24 pregnant women with normal pregnancies, in the period from 27th to 31st gestation week in order to obtain reliable fetal reactions to the defined sound stimulus. All pregnancies were normal, without complications of any kind, thus eliminating the factors that might influence fetal response.

The research was carried out in Belgrade, at the Gynecology Obstetric Clinic "Narodni front" (N1=12 pregnant women) in which fetal Pulsatility index (Pi) value was measured, and at Gynecology Obstetric Clinic of the University Clinical Centre (N2=12 pregnant women) in which fetal Resistance index (Ri) value was measured. The obtained index values were analyzed according to the gender of the fetus, and according to the significance of the differences of basic and Peak values after the stimulation.

For the ultrasound examination and measurement we used Siemens Sienna and Aloka SSD-680 (Aloka Co, Tokyo, Japan) ultrasound apparatuses with convex and sector probe of 3.5 MHz frequency with the possibilities of doppler-a and color doppler techniques.

Defined sound stimulus is digitally generated sound of 90 dB intensity, of the frequency range of 1500-4500 Hz, and the duration of 0.2 seconds.

We examined circular changes in aa. cerebri media, based on the assessment of blood flow velocity, through Pi values (Gynaecology Obstetric Clinic "Narodni front") and Ri values (Gynaecology Obstetric Clinic, Clinical Hospital Centre of Serbia). Doppler indexes measure the resistance of peripheral circulation. If the index value is increased, blood flow velocity in that blood vessel is decreased, and vice versa.

## 3. Results and discussion

By monitoring brain circular changes in a fetus as the reaction to the stimulation by defined sound, the research of fetal auditory perception in the period of 27- 31 gestation week, indicated the presence of two types of fetal reaction: type 1 – by increasing Pi and Ri values and type 2 – by decreasing the values of these indexes. These two types of fetal reactions are most probably related

to deeper psychophysiological structures of a genetic type, which points to the need for further subtle researches on psychophysiology of fetal reaction and its causes.

Table 1 Pi values in N1 group

Statistical parameters	Pi	
	Basic values before	PEAK value after stimulation
Number of patients	12	12
Minimal value	1.4	1.28
Maximal value	2.6	2.38
Average value	1.99	1.80
Standard deviation	0.34	0.29
Coefficient of variation in %	16.99	16.36
Significance of the differences	<b>t=2.675; p&lt;0.02</b>	

Graph 1 Pi values in N1 group

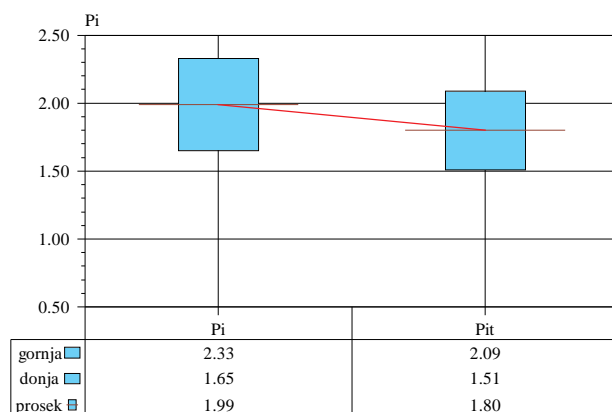


Table 1 and Graph 1 present the changes of Pulsatility index (Pi) values in N1 group. Statistically significant difference was established between basic Pi values before stimulation and Pi Peak values

after the stimulation on the level of  $p < 0.05$ . On the basis of the obtained Pi values it was established that the average basic Pi value before the stimulation is  $1.99 \pm 0.34$ , and Peak Pi value after the stimulation is  $1.80 \pm 0.29$ .

These findings confirm that stimulation by defined sound stimulus leads to statistically significant changes of the blood flow velocity in aa. cerebri media indicated by the change of Pi value of Doppler-index, whose values are decreased or increased, which reliably confirms the presence of fetal reaction to the mentioned sound stimulus.

There were no statistically significant differences in Pi values, according to the gender of the fetus.

Table 2 Ri values in N2 group

Statistical parametres	Ri	
	Basic values before stimulation	PEAK values after stimulation
Number of patients	12	12
Minimal value	0.73	0.53
Maximal value	0.93	0.93
Average value	0.81	0.80
Standard deviation	0.07	0.12
Coefficient of variation in %	8.19	14.44
Significance of differences	t=0.154; p>0.05	

Graph 2 Ri values in N2 group

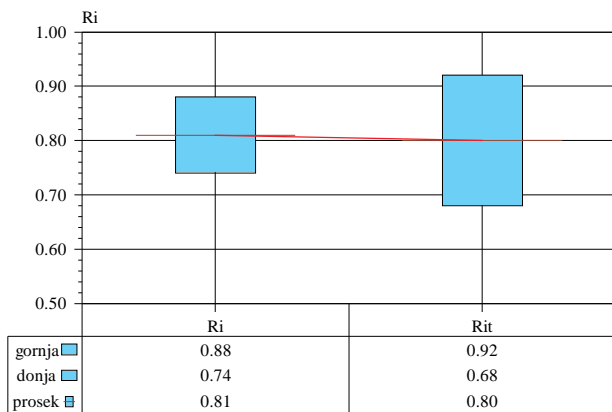


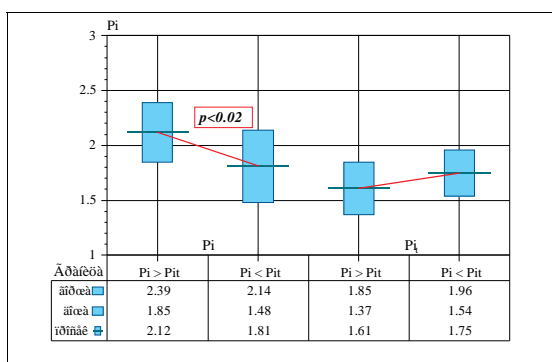
Table 2 and Graph 2 present the changes of Ri values in N2 group. The analysis of Ri values before the stimulation and Ri Peak values after the stimulation did not establish any statistically significant differences ( $p>0.05$ ).

Basic Ri values before the stimulation were  $0.81\pm 0.07$ , and Ri Peak values after the stimulation were  $0.80\pm 0.12$ . However, although Ri Peak values did not show statistical significance in relation to the basic values, there was a tendency of a change in the form of the increase and the decrease of Ri peak values that are related to the increase or the decrease of the blood flow velocity in the observed artery, which indicates that the actual changes of the observed Ri index in N2 group are less reliable and sensitive susceptible compared to the observed changes stated by Pi index in N1 examined group.

There were no statistically significant differences in Ri indexes according to the gender of the fetus.

Observing the relation of basic and Peak values of both Doppler indexes (Pi and Ri) we note physiological reaction to sound stimulus was present in every examined fetus, but this reaction had two directions: decreasing or increasing the blood flow velocity in the examined brain artery.

Graph 3. Change of Pi values according to the direction of fetal reaction

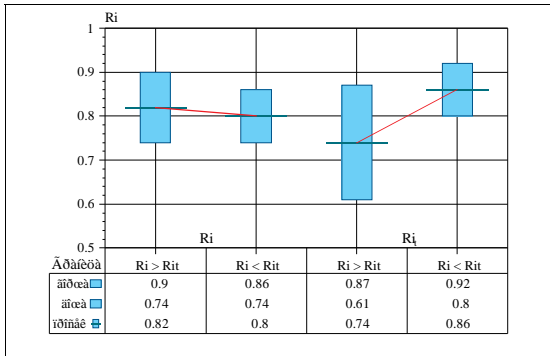


Graph 3 presents the change of Pi values in N1 group according to the direction of fetal reaction. The result analysis indicated that in 75 % fetuses, the blood flow velocity in a.a cerebri media increased, and in 25 % the blood flow velocity decreased. We established statistically significant difference between basic Pi values before the stimulation and Pi Peak values after the stimulation in fetuses with decreased Pi values as a reaction to defined sound stimulus on the level of  $p<0.02$ .

In fetuses with the decreased blood flow velocity in aa. cerebri media, there were no statistically significant differences in relation to Pi basic and Peak values ( $p>0.05$ ), probably due to the small

sample.

Graph 4 Changes of Ri values according to the direction of fetal reaction



Graph 4 presents changes of Ri values in N2 group according to fetal reaction. The result analysis indicated that in 50 % of fetuses the blood flow velocity is increased, and in 50 % of fetuses the blood flow velocity is decreased in the observed blood vessel. Ri values did not show statistical significance in relation to the basic and Peak values in N2 group ( $p < 0.05$ ).

The results of this pilot research indicate the necessity of further monitoring of newborns in which, during the fetal period, there were no statistical significances compared to the observed basic and Peak values of Doppler index, with the aim of possible prevention and overcoming the difficulties that might occur in the prelingual and later speech-language development.

#### 4. Conclusions

The results of our pilot research indicate:

- fetus of a defined gestation age reacts to defined sound stimulus by changes in the blood flow velocity in aa. cerebri media.
- by the application of Sovilj-Ljubic method of prenatal hearing skreening(PHS) it is possible to reliably establish fetal reaction to defined sound stimulus by monitoring Pi values.
- peak values of Pulsatility index (Pi) are statistically significantly decreased in relation to the basic values on the level of  $p < 0.02$  in fetuses whose direction of reaction is the decrease of P i Peak.
- Resistance index (Ri) values are not statistically significant in relation to basic and Peak values, but they do show the tendency of the change of fetal reaction in both directions.
- doppler Pi index is a more reliable parameter for the assessment of fetal reaction to the defined sound ( $p < 0.05$ ).
- in the examined gestation period, the examined fetuses indicated two types of psychophysiological reactions to defined sound stimulus. These researches are continued on the population of pathological pregnancies, which will provide reliable values of the detection of normal and pathological fetal reactions to defined sound stimulus.

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