

## COMPARISON OF PULSATILITY INDEX (PI) AND RESISTIVE INDEX (RI) BETWEEN FETAL LEFT AND RIGHT MIDDLE CEREBRAL ARTERIES

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### ABSTRACT

As the origins of the common carotid arteries and consequently middle cerebral arteries (MCAs) are different on the left and right side, we hypothesized that whether there is any difference in the pulsatility index (PI) and resistive index (RI) of left and right MCAs of fetuses suspected to have intrauterine growth restriction (IUGR). To compare the PI and RI between fetal proximal sites of the right and left MCAs. A total of 50 pregnant women with mean ( $\pm$ SD) age of 27 ( $\pm$ 6.12) years, mean ( $\pm$ SD) gestational age of 35.1 ( $\pm$ 2.8) weeks were included. RI and PI of both left and right MCAs (proximal location) were measured. The correct technique for MCA peak systolic volume (PSV) was done with long axis of the fetal head parallel to the scanner probe with in sonation angle as close as possible to 0°. Mean ( $\pm$ SD) PI in the right and left MCAs were respectively 1.67 ( $\pm$ 0.33) and 1.63 ( $\pm$ 0.32),  $P= 0.2$ . Mean ( $\pm$ SD) RI in the right and left MCAs were respectively 0.79 ( $\pm$ 0.06) and 0.78 ( $\pm$ 0.07),  $P= 0.68$ . No significant difference existed regarding the PI and RI values between right and left MCAs. Either left or right MCA can be imaged during color Doppler ultrasound examination of fetuses suspected to have IUGR.

**KEYWORDS:** *Middle cerebral artery; color Doppler ultrasonography, fetus*

### INTRODUCTION

Doppler ultrasonography velocimetry of fetal vessels is a non-invasive method of monitoring fetal hemodynamic and abnormal blood flow. Most ultrasound examinations are done on umbilical artery. However, middle cerebral arteries (MCAs) are also being studied commonly. MC Asare the most accessible arteries for fetal ultrasound examination. In the transverse plane they can be imaged by color Doppler ultrasound<sup>1</sup>. Doppler examination of the MCA is a well-established method by radiologists in fetal assessment and antenatal care<sup>2</sup>. In several conditions such as fetal hypoxemia, asphyxia, anemia, etc the blood flow alters in the MCA. This occurs because of central redistribution of blood flow to critical organs such as brain and heart and decreased flow to peripheral tissues<sup>1,3</sup>. This flow alteration results in increased end-diastolic flow velocity which is reflected by a low MCA PI (pulsatility index) on Doppler ultrasound and decreased resistance measured by resistive index (RI)<sup>1,3</sup>. Color Doppler ultrasound of MCAs is used in some conditions. One of the

mostly reported and studied fetal conditions where Doppler ultrasound is most useful, as a non-invasive method, is in the assessment of intrauterine growth restriction (IUGR)<sup>4-6</sup>. When IUGR exists, a progressive reduction in MCA PI is measured by ultrasound<sup>7</sup>. Even the location of MCA where PI and RI are measured has been noted to be important<sup>8</sup>. Usually, when color Doppler ultrasound is done, the left or right MCA which is closer to the probe is examined. It is supposed that PI and RI are similar in left and right side MCAs. Regarding the origins of left and right common carotid arteries and consequently left and right MCAs (left common carotid artery stemming from the aortic arch and right common carotid artery stemming from brachiocephalic artery) as well as unequal distance of left and right MCAs from the left ventricle, we hypothesized that PI and RI may be different in these two arteries. Since correct measurement of PI and RI are important when color Doppler ultrasound is done for assessment of suspected IUGR, if a significant difference existed between left and right MCAs, the interpretation of

the results may be distorted. Therefore, we decided to compare PI and RI between left and right MCAs.

## MATERIALS AND METHODS

### *Study population and sampling*

In this cross-sectional study, the study population consisted of women with singleton pregnancy referred to our radiology department for assessment of suspected IUGR by color Doppler ultrasound of the fetal MCAs. The sampling method was convenient method. A total of 50 cases were included.

### *Doppler ultrasound examination*

Doppler ultrasound was done by Siemens Sonoline G40 ultrasound system. RI and PI of both left and right MCAs (proximal location) were measured. Gestational age was calculated by ultrasound. The ultrasound was done while the mother was in supine position. The correct technique for MCA peak systolic volume (PSV) was done with long axis of the fetal head parallel to the scanner probe with insonation angle as close as possible to 0°. The fetus was in rest without any respiratory movements for at least 2 minutes. The circle of Willis was imaged and zooming was done with visualization of the MCA full length. The volume sample (1 mm) was superimposed on MCA originating from internal carotid artery (ICA) with angle between blood flow and the wave as close as possible to 0°. The waveforms should be similar to each other and the highest PSV was measured. The

described method was repeated for 3 times. All examinations were done by an attending radiologist.

RI = PSV - end diastolic velocity/PSV

PI = PSV - end diastolic velocity/mean velocity

## STATISTICAL ANALYSES

The data gathered were entered into the SPSS software (ver. 19.0) and using descriptive indices, and paired sample t test for PI and the Wilcoxon test for RI, the statistical analyzes were done. The significance level was set at 0.05.

### *Ethics*

The participation in the study was on voluntary basis. The objectives of the study were explained to the participants. The informed consent was obtained. The protocol of the study was approved by the Ethics Committee of our medical university.

## RESULTS

A total of 50 pregnant women were studied with mean ( $\pm$ SD) age of 27 ( $\pm$ 6.12) years, mean ( $\pm$ SD) gestational age of 35.1 ( $\pm$ 2.8) weeks, and mean ( $\pm$ SD) parity of 1.9 ( $\pm$ 1.14) deliveries. Table 1 presents mean (SD) RI and PI in left and right MCAs. As shown, no significant difference was observed between left and right MCAs regarding PI and RI.

Table 1

*Comparison of pulsatility index (PI) and resistive index (RI) between left and right middle cerebral arteries (MCAs) of 50 fetuses suspected to have intrauterine growth restriction (IUGR)*

		Min. to Max.	Mean ( $\pm$ SD)	P value
Pulsatility index	Right MCA	1.3 to 2.18	1.67 ( $\pm$ 0.33)	0.2
	Left MCA	1.05 to 2.16	1.63 ( $\pm$ 0.32)	
Resistive index	Right MCA	0.62 to 0.88	0.79 ( $\pm$ 0.06)	0.68
	Left MCA	0.62 to 0.9	0.78 ( $\pm$ 0.07)	

## DISCUSSION

According to our findings, mean values of PI and RI were slightly higher in the right MCA compared to left MCA. However, this difference was not statistically significant. The reason that why we decided to compare the left and right MCA PI and RI, as stated previously, is the fact that these two arteries have different origins and different distances from the left ventricle. So there might be

a difference in PI and RI. Here, we measured MCA PI and RI at proximal location. This location is usually measured both in clinical practice and in research studies. In previous studies, one of the factors studied is the location of the MCA where PI and RI are measured. In other words, the authors assessed proximal, mid, and distal locations of both MCAs in 42 women five times throughout the pregnancy<sup>2</sup>. They reported mean ( $\pm$ SD) PI in the right and left MCAs as 1.49 ( $\pm$ 22) and 1.51 ( $\pm$ 0.19), respectively at gestational age range of 35 to 39

weeks (mean= 37 weeks). The focus of the mentioned study was to compare PI and RI values between three regions of the MCA. No direct comparison was performed between right and left MCAs. They did not find significant difference between three regions where PI and RI measurements were done. The mean ( $\pm$ SD) RI value at proximal MCA in the right MCA (at gestational age range of 35-39 weeks) was 0.76 ( $\pm$ 0.09) and in the left MCA it was 0.75 ( $\pm$ 0.14). Roughly speaking, although no direct comparison between right and left MCA PI and RI values were reported by the authors, it seems that similar to what we found, no difference existed between right and left MCA PI and RI measurements. They reported that both PI and RI were lower in the proximal MCA when compared to mid and distal regions, but it was not statistically significant. We were not able to follow the sample throughout pregnancy. It may be useful to consider this in future studies to follow the cases over pregnancy to

see whether any difference exists between left and right MCA PI and RI measurements. Also, to eliminate the inter-observer errors, all ultrasound examinations were done by a single radiologist. It would also be good idea to consider the examinations by 2 radiologists in the future studies to find any disagreement between measurements and to have more accurate values.

## CONCLUSION

In conclusion, we did not find any significant difference between right and left MCA PI and RI values. Either of these arteries can be measured while Doppler ultrasound is done for assessment of fetuses suspected to have IUGR.

## CONFLICT OF INTEREST

Conflict of interest declared none.

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