

ELECTROIMPEDANCE MEASUREMENTS OF PREGNANT WOMEN WITH BIG AND HYPOTROPHIC FETUS

N.I.Uljanova, A.J.Karpov, I.I.Iljjin, M.E.Korotkova

Clinical hospital №9, Yaroslavl

e-mail: sim-tech@net76.ru

Abstract. We are of the opinion that the opportunity of forecasting the weight of the newborns on the 28th-32th weeks of gestation with the help of the current electroimpedance measurements of central and peripheral hemocirculation is worthy of interest and can be implemented in practical activity. The survey was based on examination of 263 pregnant women. The estimation of central and peripheral hemocirculation was carried out on the 10, 16, 20-22, 28-32 and 36th weeks of gestation. The state of the central hemocirculation was determined utilizing the method of impedance cardiography according to Kubitchek, the peripheral circulation (an index finger of the right hand) – by the impedance method in the tetra-polar mode. It was possible to allocate the complex of the impedance parameters containing information in diagnostics of the newborns' weight. All the changes of parameters of the central and peripheral circulation of pregnant women with small and large fetus are being observed beginning from the 27th week of gestation. It is typical, that pregnant women with large fetus has more intensive peripheral blood circulation; besides, contraction of their myocardium of the left ventricle increased and its postloading is reduced.

Index Terms – impedance cardiography, periferal circulation, obstetrics..

Pregnancy causes diverse changes in the woman's organism, the aim of which is to provide normal development of the foetus. No major factors influencing weight of the foetus and the newborn have been formulated until present day. Once the mechanisms determining weight of the foetus are establish, it will be possible to carry out pathogenetic treatment of the foetal hypotrophy, thus having an opportunity to influence weight of the foetus at birth. The purpose of the present work is to study particularities of the central and peripheral hemodynamics of pregnant women with various weight of the foetus during uncomplicated pregnancy.

Material and methods. Hemodynamic parameters of 269 healthy pregnant women, divided into two clinical groups and comprising 153 pregnant women with weight of the newborn exceeding 3800 grams and 116 pregnant women with the weight of the newborn below 3000 grams, have been analysed. The examination was carried out at various stages of gestation - before 22 weeks, during 22 - 26 weeks, 27 - 31 weeks, 32 - 36 weeks, and 37 - 41 weeks. The state of the central hemodynamics was determined utilizing the method of impedance cardiography (according to Kubitchec), the state of the peripheral circulation (an index finger of the right hand) - an impedance method in a tetrapolar mode. The study was performed with the help of the impedance analyzer "RA - 5 - 01" as well as the applied computer program «System Hemocirculation». The results were processed with the help of variational statistics methods utilizing Student's criterion.

Results. 1. Central hemodynamics. In order to estimate the central hemodynamics we used the following parameters: stroke volume (SV, ml), cardiac output (CO, l/min), total peripheral vascular resistance (TPVR), aorta valve vibration spread time (AVVST, msec), amplitude of systolic rheogram (ASR, mm). As one can see from the table, only AVVST among all the other parameters of the central hemodynamics of pregnant women with big and hypotrophic foetuses differs significantly beginning from the 27th weeks of gestation.

Table 1. Parameters of the central hemodynamics of pregnant women (1st and 2nd groups)

Stages of gestation		SV		CO		AVVST		ASR		TPVR	
		1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 gr	2 gr
<20 weeks	X	60,1	61	4,69	4,64	151.3	147.3	2.82	3,13	1557,5	1532
	σ	10,04	9,9	0.89	0.77	12,17	12,9	0.63	0.71	300,3	209
22-26 weeks	X	52,58	51,3	4,37	3,91	155*	143	2.47	2.46	1661,5	1856
	σ	10,16	12,7	0.86	0.83	24,06	9,54	0.75	0.83	326,5	536

27-31 weeks	X	50,4	52	4,47	4	158.6*	150	2.53	2.6	1673,7	1773
	σ	11,13	12	0.89	0.9	14,68	20	0.78	0.76	389,6	498
32-36 weeks	X	44,5	45	3,8	3,52	154*	141.1	2.15	2.26	2026,9	2235
	σ	9,64	11	0.83	0.86	17,44	14,2	0.55	0.61	451,7	540
37-41 weeks	X	38,4	42,4	3,36	3,16	143.5	135	1.75	1.99	2485,2	2527,3
	σ	13,6	12,3	1.12	0.81	15,67	11,78	0.46	0.79	768,4	559,5

Note. * $p < 0,05$.

2. Cardiodynamics. In order to estimate the cardiodynamics of the pregnant women under survey the following parameters were determined: left ventricle work (LVW, kgm/min), double and threefold product, velocity of the maximal systolic blood filling (VMSBF, cm/sec), Left Cardiac Displacement Volumetrical Speed (LCDVS, ml/sec).

Table 2. Parameters of cardiodynamics in the groups under examination.

Stages of gestation		LVW		DP		TP		VMSBF		LCDVS	
		1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 rgr	2 gr
<20 weeks	X	5,9	5,8	83,8	83	2116,9	2145	1,65	1,65	235,6	237
	σ	1,35	1,31	13.66	10.5	301,4	251	0,31	0,32	36,61	35
22-26 weeks	X	5,6	4,83	93,4	88	2285,9	2167	1,54	1,54	212,4	195
	σ	1,41	1,09	16.86	19.4	301,8	251	0,38	0,37	37,63	39,6
27-31 weeks	X	5,8*	4,9	100,4*	85	2370,9*	2211	1,64	1,46	210,3	203
	σ	1,31	1,31	14.22	15	229,4	298	0,43	0,5	37,91	42
32-36 weeks	X	5,04	4,54	99,6*	87,9	2310,4*	2167	1,39	1,48	188,8	178
	σ	1,29	1,36	18.78	15.5	325,7	301	0,33	0,46	34,12	39,6
37-41 weeks	X	4,4	4,4	99,4*	89,5	2374,2*	2283,8	1,14	1,24	152,2	163,1
	σ	1,44	1,33	12.72	18.83	326,1	350,4	0,28	0,53	41,16	40,18

Note. * $p < 0,05$.

As one can see from the table, only left ventricle work (LVW), double and threefold product differ significantly starting from the 27th weeks of gestation. The higher parameters of LVW, double and threefold product are connected with the greater heart rate of pregnant women with large foetuses.

3. Systolic time intervals. The systolic time intervals are characterized by the following parameters: time of blood discharge from the left ventricle (TBDLV, msec), mechanical systole (SM, msec), heart rate (HR).

Table 3. Systolic time intervals.

Stages of gestation		TBDLV		MS		HR	
		1 gr	2 gr	1 gr	2 gr	1 gr	2 gr
<20 weeks	X	254,3	259	325,8	330	78,2	76
	σ	12,8	10,8	14,897	13	8.83	6.57
22-26 weeks	X	247,7	257*	316,7	324	83,6	79
	σ	22,55	27,8	23,53	26	9.69	11.9
27-31 weeks	X	238,4	254*	304,9	331*	89,7*	80
	σ	21,65	22	22,6	25	9.79	9
32-36 weeks	X	235,3	250*	309,6	329,8*	86,1*	77,1
	σ	32,03	18,4	23,03	21,58	11.62	8.9
37-41 weeks	X	240,6	258,5*	310,2	332,6*	86,4*	76,1

weeks	σ	18,84	25,16	21,37	27,93	7.39	13.77
-------	----------	-------	-------	-------	-------	------	-------

Note. * $p < 0,05$.

Significant distinctions of all parameters can be observed starting from 27th weeks of pregnancy and indicate a greater myocardial contractility of the left ventricle of pregnant women with large foetuses.

4. Peripheral circulation. The following parameters describe peripheral circulation: finger impedance (FI, om), finger minute volume (FMV, ml/min), pulse finger volume (PFV? ml), peripheral differential amplitude of a rheogram (PDAR, mm), dicrotic index (DI, %), rheographic factor (RF), rheographic index (RI), systolic period (SP, %).

Table 4. Parameters of peripheral circulation.

Index		<22 weeks		22-26 weeks		27-31 weeks		32-36 weeks		37-41 weeks	
		1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 gr	2 gr	1 gr	2 gr
FI	X	151,7	151	130,1	133	126,5	142*	117,5	140*	113,3	125,1
	σ	17,34	21,9	22,9	22,9	18,87	26	20,88	27,6	18,16	23,05
FMV	X	1,56	1,29	2,49*	1,91	3,19*	1,83	3,03*	1,73	2,61	2,01
	σ	0,66	0,53	1,32	1,29	1,71	1,11	1,87	0,93	1,41	1,39
PFV	X	0,019	0,017	0,029	0,024	0,04*	0,024	0,037*	0,022	0,029	0,026
	σ	0,007	0,006	0,015	0,01	0,019	0,014	0,023	0,013	0,016	0,017
PDAR	X	3	2,74	3,5	3,3	3,88*	3,34	3,42	3,22	2,85	3,3
	σ	0,89	0,94	1,18	1,08	1,03	1,29	1,17	1,15	1,27	1,33
DI	X	31,8	43	37,4	42	36	43	40,3	50,5	44,9*	57,9
	σ	14,24	14,68	14,57	18,6	15,11	13	13,87	15,6	14,55	11,57
RF	X	14,3	13	16,8	15,2	19,6*	16	19,9*	17	21,7	19,7
	σ	3,47	3,61	4,14	3,94	4,62	5	4,98	5,66	6,28	5,69
RI	X	0,995	0,986	1,733	1,343	2,11*	1,545	1,986	1,806	1,786	2,115
	σ	0,477	0,527	0,886	0,553	0,734	0,955	0,813	1,527	0,923	1,095
SP	X	40,26	36	40,55	40	41,9*	38	40,69*	37	39,4*	35,14
	σ	4,29	3,84	5,17	5,35	4,71	4	6,32	4,36	3,21	3,44

Note. * $p < 0,05$.

It is necessary to point out the significant distinctions in peripheral circulation of the pregnant comprising the survey groups: pregnant women with large foetuses have higher parameters of systolic period (SP), finger minute volume (FMV), pulse finger volume (PFV), rheographic factor (RF), rheographic index (RI). It indicates more expressed peripheral vasodilation of pregnant women with large foetuses. It is typical that all the differences become prominent from 27th weeks of gestation.

Conclusions. The following changes, based on the received data of the central and peripheral circulation of the pregnant women under examination, were recorded:

1. Differences in peripheral hemodynamics can be observed practically in all parameters and are expressed more considerably, than in central hemocirculation. Peripheral blood circulation of pregnant women with large foetuses is more intensive.
2. Differences in central hemodynamics are applied to increase of contractility and reductions of afterloading of the left ventricular myocardium of pregnant women with large foetuses.

3. Differences of parameters of the central and peripheral circulation of pregnant women with hypotrophic foetuses and large foetuses are observed beginning from the 27th weeks of gestation. This phenomenon was observed simultaneously with substantial increase of the rate growth from the same period of gestation as well.

We were able to distinguish a set of impedance parameters, which supply additional information and facilitate weight forecasting of the newborn: parameters of peripheral circulation, parameters of systolic time intervals, AVVST, left ventricle work (LVW), double and three-fold product.