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QUANTITATIVE INDICATORS AND METHODS FOR MODELING STRUCTURAL UNITS IN PLACENTAL INSUFFICIENCY

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Summary

Placental insufficiency is a violation of the morphofunctional state of the placenta, which is based on the immaturity of tissue structures to one degree or another, which leads to disruption of the mother-placenta-fetus system and an insufficient supply of nutrients to the fetus. With placental insufficiency, the growth and development of the fetus slows down. The study of morphological changes in the placenta at the anatomical and histological level is of great importance.[6,7] Since the determination of the size, area and volume of various tissue structures is an important task in the study of morphofunctional and pathological changes in organs.[1,2,3,4,5] It is known that since the shape of the placenta is mainly round, its diameter was measured in a ruler, and the maternal surface was determined by the following formula:

$S = p \times d2 / 4.$

To assess the degree of placental insufficiency, we used a morphometric study of terminal chorionic villi using a program to calculate the morphological function of the placenta, i.e. to evaluate the important structural features of terminal villi and their occupied area, which is an important main morphofunctional feature.

When examining the placenta using histometry, clinical and morphological data are first determined whether the condition of placental insufficiency is primary or secondary. Then, a list of morphological features characteristic of the two types of placental insufficiency is determined. Primary and secondary placental insufficiency, each of which is calculated using the method of "point counting", selected in histological samples and studied in percent for ease of comparison.

The area occupied by structural changes in the placenta was calculated using G. G. Avtandilov's "multipoint test" system, that is, how many of the 200 points in the test system correspond to all structural changes in the placenta and how many points correspond to each change. To ensure a high level of reliability of the results obtained in each group, 10 objects of histological preparations were selected.

When counting points, the area is selected by moving the microscope object, regardless of histological preparation, and points are counted in several areas from each section. It is known that in the "multipoint test" of Avtondilov points are randomly distributed over the surface of the histological section, and the points corresponding to the calculated structural unit Vv are equal in size and area. This is calculated based on the criteria of probability theory.

Based on the data obtained, the area or volume occupied by each of the structural units in the same fabric is calculated. If it is assumed that the area occupied by all structural units in the tissue is 100 percent, the area and volume of each structural unit Vv is calculated using the following formula using the rule of descent of one point into the structural unit under study,1)

$P = Vv / 100$

The probability that the points correspond to other structural units that need to be calculated is calculated using this formula:

2) $Q = 100 - Vv / 100$

All points corresponding to the calculated structural unit are taken as x, and its error,

3) If x / z is equal to P,

The absolute error calculated as a percentage is determined by this formula:

4) $e = (x / z - P) \times 100 = 100\ x / z - Vv$,

According to the well-known probability theory, this formula also has the following form:

5) $x / z - P = t \times \sqrt{} Pq / z$

In this case: x - points corresponding to the structural unit under study; z is the total number of points of the test system; R is the probability of points falling on the calculated structural unit; q is the probability of points corresponding to other structural units in a histological section; t is the normalized difference.

The absolute error is found by this formula,

6) $e = t\sqrt{Vv}\ (100 - Vv) / z$

In this study, we initially took histological preparations from 14 women in labor, the uncomplicated pregnancy, as a rule, calculated their structural units. The main studies were divided into two groups: in group 1, primary placental insufficiency; in group 2, secondary placental insufficiency.

Initially, the main structures of placental tissue and the area of secondary compensatory changes in the following group were calculated: control group, the following structural units in groups 1 and 2 were calculated:

Rsv - stem villi;

Ptv - terminal villi;

Rpp is an intermediate space;

Rvpi- was the point at which secondary pathological and involutive changes occurred.

Further, in 3 groups, structural changes in terminal villi were calculated separately:

Pk5tv - terminal villi with 5 or more capillaries;

Pk3tv - terminal villi, with less than 3 capillaries;

Rntvbk - undifferentiated terminal villi without capillaries;

Rntv-undifferentiated terminal villi;

Rstv - sclerotic terminal villi;

Points corresponding to terminal villi were counted.

To assess the degree of placental insufficiency in the control and two main groups, secondary pathological and involutive changes in it were calculated separately:

RFF - fibrinoid foci;

Ron - foci of necrosis;

Moat - foci of inflammation;

Rock - points corresponding to foci of calcification.

1) Calculation of the area of the main structures and secondary compensatory changes in the composition of the control group of placental tissue.

Morphometry of the control group of structural units, placental tissue.

n = 10	*The number of points in structural units*				*Total*
	Рсв	**Ртв**	**Рпп**	**Рвпи**	200
1	33	102	43	22	
2	31	104	41	24	
3	34	99	45	22	
4	32	103	44	21	
5	34	100	44	22	
6	30	105	41	24	
7	32	100	45	23	
8	33	101	43	23	
9	31	103	44	22	
10	30	100	46	24	
	320	1017	436	227	2000
M±m(ε)	16,0±1,64	50,8±2,24	21,8±1,55	11,4±1,41	100%

Vсв = Рсв/Р × 100 = 320 /2000 ×100=16,0; ε св =2,0 × √ 16(100-16)/2000 = 1,64 (P<0,01)

Vтв = Ртв/Р × 100 = 1017/ 2000 × 100 = 50,8; ε тв = 2,0 × √ 50,8(100-50,8) / 2000 = 2,24 (P<0,05)

Vпп = Рпп/Р × 100 = 436/ 2000 × 100 = 21,8; ε пп = 2,0 × √ 13,6(100-13,6) / 2000 = 1,55 (P<0,05)

Vвпи = Рвпи/Р ×100 = 227/ 2000 ×100 =11,3; ε тер.вор.=2,0 × √ 11,3(100-11,3) / 2000 = 1,41 (P<0,05)

2. Calculation of the area of the main structures and secondary compensatory changes in placental tissue in the first group.

Morphometry of placental tissue, structural units of group 1.

n = 10	The number of points in structural units				Total
	Рсв	**Ртв**	**Рпп**	**Рвпи**	200
1	41	82	62	15	
2	44	78	60	18	
3	39	83	64	14	
4	42	80	59	19	
5	40	83	63	14	
6	36	85	61	18	
7	42	80	60	18	
8	43	83	59	15	
9	41	83	60	16	
10	40	81	61	18	

Total	408	818	609	165	2000
M±m(ε)	20,4±1,81	40,9±2,19	30,5±2,05	8,21±1,23	100%

Vсв = Рсв/Р × 100 = 408 /2000 ×100=20,4; ε св =2,0 × √ 20,4(100-20,4)/2000 = 1,81 (P<0,01)

Vтв = Ртв/Р × 100 = 818/ 2000 × 100 = 40,9; ε тв = 2,0 × √ 40,9(100-40,9) / 2000 = 2,19 (P<0,05)

Vпп = Рпп/Р × 100 = 609/ 2000 × 100 = 30,5; ε пп = 2,0 × √ 30,5(100-30,5) / 2000 = 2,05 (P<0,05)

Vвпи = Рвпи/Р ×100 = 165/ 2000 ×100 =8,21; ε тер.вор.=2,0 × √ 8,21(100-8,21) / 2000 = 1,23 (P<0,05)

3) Calculation of the area of the main structures and secondary compensatory changes in the placental tissue in the second group.

Morphometry of placental tissue in the structural units of the second group.

n = 10	**The number of points in structural units**				**Total**
	Рсв	**Ртв**	**Рпп**	**Рвпи**	200
1	37	77	26	60	
2	34	78	26	62	
3	39	75	24	62	
4	36	78	25	61	
5	40	74	25	61	
6	35	78	25	62	
7	42	72	26	60	
8	39	75	25	61	
9	36	78	24	62	
10	40	74	24	62	
Total	378	759	250	613	2000
M±m(ε)	18,9±1,75	37,9±2,17	12,5±1,47	30,7±2,06	100%

Vсв = Рсв/Р × 100 = 378 /2000 ×100=18,9; ε св =2,0 × √ 18,9(100-18,9)/2000 = 1,75 (P<0,01)

Vтв = Ртв/Р × 100 = 759/ 2000 × 100 = 37,9; ε тс = 2,0 × √ 37,9(100-37,9) / 2000 = 2,17 (P<0,05)

Vпп = Рпп/Р × 100 = 250/ 2000 × 100 = 12,5; ε пп = 2,0 × √ 12,5(100-12,5) / 2000 = 1,47 (P<0,05)

Vвпи = Рвпи/Р ×100 = 613/ 2000 ×100 =30,65; ε впи=2,0 ×√30,65(100-30,65)/2000 = 2,06 (P<0,05)

4) Calculation of structural changes in the composition of terminal villi in 3 groups:

Control group.

	The number of points in structural units					Total
	Рк5тв	**Рк3тв**	**Рнтвбк**	**Рнтв**	**Рств**	200
1	161	23	10	0	6	
2	154	26	13	0	7	
3	157	24	11	0	8	
4	158	21	12	0	9	
5	160	22	11	0	7	
6	156	24	12	0	8	
7	158	22	11	0	9	
8	159	22	11	0	8	
9	162	22	11	0	5	
10	162	22	11	0	5	
Total	1587	228	113	0	72	2000
M±m(ε)	79,4±1,8	11,4±1,42	5,6±1,03	0	3,6±0,83	100%

Vк5тв = Рк5тв/Р × 100 = 1587 /2000 ×100=79,4; εк5с =2,0 × √ 79,4(100-79,4)/2000 = 1,8 (P<0,01)

Vк3тв = Рк3тв/Р × 100 = 228/ 2000 × 100 = 11,4; εк3тв= 2,0 × √ 11,4(100-11,4) / 2000 = 1,42 (P<0,05)

Vнтвбк = Рнтвбк/Р×100 = 113/2000 ×100 = 5,65; εнтвбк=2,0 ×√5,65(100-5,65) / 2000 =1,03 (P<0,05)

Vств = Рств/Р ×100 = 72/ 2000 ×100 =3,6; εств=2,0 ×√3,6(100-3,6)/2000 = 0,83 (P<0,05)

Group 1.

	The number of points in structural units					Total
	Рк5тв	**Рк3тв**	**Рнтвбк**	**Рнтв**	**Рств**	200
1	53	76	17	39	15	
2	49	78	19	40	14	
3	50	74	21	40	15	
4	56	71	19	41	13	
5	54	76	19	37	14	
6	56	74	16	38	16	
7	55	75	15	41	14	
8	59	71	18	36	16	
9	58	72	16	39	15	

10	54	76	17	39	15	
Total	544	743	177	390	146	2000
M±m(ε)	27,2±1,98	37,2±2,16	8,8±0,97	19,5±1,77	7,3±0,83	100%

Vк5тв = Рк5тв/Р × 100 = 544 /2000 ×100=27,2; εк5тв =2,0 × √ 27,2(100-27,2)/2000 = 1,98 (P<0,01)

Vк3тв = Рк3тв/Р × 100 = 743/ 2000 × 100 = 37,2; εк3тв= 2,0 × √ 37,2(100-37,2) / 2000 = 2,16 (P<0,05)

Vнтвбк = Рнтвбк/Р×100 = 177/2000 ×100 = 8,8; εнтвбк=2,0 ×√8,8(100-8,8) / 2000 =0,97 (P<0,05)

Vнтв = Рттс/Р ×100 = 390/ 2000 ×100 =19,5; εнтв=2,0 ×√19,5(100-19,5)/2000 = 1,77 (P<0,05)

Vств= Рскл/Р ×100 = 146/ 2000 ×100 =7,3; εств=2,0 ×√7,3(100-7,3)/2000 = 0,83 (P<0,05)

	The number of points in structural units					**Total**
	Рк5тв	**Рк3тв**	**Рнтвбк**	**Рнтв**	**Рств**	200
1	83	51	14	7	45	
2	80	52	13	8	47	
3	81	50	12	9	48	
4	83	51	15	7	44	
5	83	50	13	8	46	
6	81	52	13	8	46	
7	83	51	14	7	45	
8	79	53	18	8	42	
9	81	52	16	7	44	
10	84	49	17	8	42	
Total	818	511	145	77	449	2000
M±m(ε)	40,9±2,19	25,6±1,95	7,3±0,86	3,7±0,83	22,5±1,86	100%

Group 2.

Vк5тв = Рк5тв/Р × 100 = 818 /2000 ×100=40,9; εк5тв =2,0 × √ 40,9(100-40,9)/2000 = 2,19 (P<0,01)

Vк3тв = Рк3тв/Р × 100 = 511/ 2000 × 100 = 25,6; εк3тв= 2,0 × √ 25,6(100-25,6) / 2000 = 1,95 (P<0,05)

Vнтвбк = Рнтвбк/Р×100 = 145/2000 ×100 = 7,3; εнтвбк=2,0 ×√7,3(100-7,3) / 2000 =1,16 (P<0,05)

Vнтв = Рнтв/Р ×100 = 77/ 2000 ×100 =3,7; εнтв=2,0 ×√3,7(100-3,7)/2000 = 0,83 (P<0,05)

Vств= Рств/Р ×100 = 449/ 2000 ×100 =22,5; εств=2,0 ×√22,5(100-22,5)/2000 = 1,86 (P<0,05)

5) Control to assess the degree of placental insufficiency in 2 main groups, to calculate the secondary pathological and involutive changes in it.

RFF - fibrinoid foci;

Rno - foci of necrosis;

Moat - foci of inflammation;

Rok - points corresponding to foci of calcification.

Control group

	The number of points in structural units				Total
	Рфо	**Рно**	**Ров**	**Рок**	200
1	146	5	0	49	
2	145	6	0	49	
3	146	4	0	50	
4	144	6	0	50	
5	145	7	0	48	
6	146	5	0	49	
7	146	6	0	48	
8	145	7	0	48	
9	146	5	0	49	
10	147	6	0	47	
Total	1456	57	0	487	2000
M±m(ε)	72,8±1,98	2,85±0,74	0	24,35±1,91	100%

Vфо = Рфо/Р × 100 = 1456 /2000 ×100=72,8; ε фо =2,0 × √ 72,8(100-72,8)/2000 = 1,98 (P<0,01)

Vно = Рно/Р × 100 = 57/ 2000 × 100 = 2,85; εно= 2,0 × √ 2,85(100-2,85) / 2000 = 0,74 (P<0,05)

Vок = Рок/Р×100 = 487/2000 ×100 = 24,35; εок=2,0 ×√24,35(100-24,35) / 2000 =1,91 (P<0,05)

Group 2.

	The number of points in units				Total
	Рфо	**Рно**	**Ров**	**Рок**	200
1	53	63	47	37	
2	56	60	45	39	
3	55	61	44	40	
4	54	59	49	38	
5	54	62	46	38	
6	51	65	46	38	
7	56	61	45	39	
8	54	62	46	38	
9	56	60	46	38	
10	53	64	46	37	
Total	542	617	459	382	2000
M±m(ε)	27,1±1,98	30,85±2,06	22,95±1,88	19,1±1,76	100%

Vфо = Рфо/Р × 100 = 542 /2000 ×100=27,1; ε фо =2,0 × √ 27,1(100-27,1)/2000 = 1,98 (P<0,01)

Vно = Рно/Р × 100 = 617/ 2000 × 100 = 30,85; εно= 2,0 × √ 30,85(100-30,85) / 2000 = 2,06 (P<0,05)

Vов = Ров/Р×100 = 459/2000 ×100 = 22,95; εов=2,0 ×√22,95(100-22,95) / 2000 =1,88 (P<0,05)

Vок = Рок/Р×100 = 382/2000 ×100 = 19,1; εок=2,0 ×√19,1(100-19,1) / 2000 =1,76 (P<0,05)

Morphometric indicators of the structural units of the control, primary and secondary placental insufficiency,%

Groups	**Vсв**	**Vтв**	**Vпп**	**Vвпи**
Control group	16,0±1,64	50,8±2,24	21,8±1,55	11,4±1,41
Group 1	20,4±1,81*	40,9±2,19*	30,5±2,05*	8,21±1,23*
Group 2	18,9±1,75**	37,9±2,17**	12,5±1,47**	30,7±2,06**

* -P≤0.05 The confidence level of the first group relative to the indicators of the control group

** - R≤0.01 Reliability level of group 2 relative to the indicators of the control group

Morphometric parameters of structural units in the control, primary and secondary placental insufficiency, %

	Vк5тв	Vк3тв	Vнтвбк	Vств	Vств	Total
Control	79,4±1,8	11,4±1,42	5,6±1,03	0	3,6±0,83	100%
Group 1	27,2±1,98	37,2±2,16	8,8±0,97	19,5±1,77	7,3±0,83	
Group 2	40,9±2,19	25,6±1,95	7,3±0,86	3,7±0,83	22,5±1,86	

Morphometric parameters of secondary pathological and involutive changes in the placenta in the control and 2 main groups.

	Vфо	Vно	Vов	Vок
Control	72,8±1,98	2,85±0,74	0	24,35±1,91
Group 2	27,1±1,98	30,85±2,06	22,95±1,88	19,1±1,76
P	0,01	0,01		0,01

CONCLUSION

The results of morphometric calculations showed that the area occupied by the structural units in the placenta in the control group had the following parameters. Stem villi averaged 16.0% of the total placental area, while terminal villi made up the largest area, 50.8%.

Secondary involutive changes in the structure of the placenta averaged 11.4%. The distance between the placental villi was 21.8% of the norm.

In group 1, i.e. in primary placental insufficiency, the area of the main villi increased by 4%, the area of the terminal villi decreased by 10%, and the secondary invasive changes also decreased in size. It was found that another significant change was a significant expansion of the space between the villi, an average of about 10%. It follows that with primary placental insufficiency, their area decreases due to morphologically underdeveloped terminal villi, the space between the villi decreases, due to the decrease in the number of villi, the intervillous space and the area of the stem villi expand. Significant changes in secondary placental insufficiency were the following: a sharp decrease in area, terminal villi, the space between the villi; 3-fold increase in the area occupied by secondary involutional changes, compared with the control group.

The results of morphometric calculations of the manifestations of specific changes in the composition of the terminal villi showed that in the control group, the bulk of the terminal villi (79.4%) was occupied by villi with 5 or more capillaries. A very small amount of villi with 3 or less capillaries and villi without capillaries was found. The number of villi with multiple sclerosis was only 3.6%. The morphometric amount of 5-capillary villi in primary placental insufficiency was 3 times higher than in the control group, that is, only 27.2%. Instead, the number of 3-capillary, without capillary and undifferentiated villi increased

sharply, and their occupied area was 37.2%, 8.8% and 19.5%, respectively. The number of sclerotic villi was also 2 times higher than in the control group.

It was noted that the results of morphometric calculations with secondary placental insufficiency have completely different indicators than with primary placental insufficiency. It was found that the number of villi with 5 capillaries is many, that is, 40.9%, and 3 capillary villi occupied less with primary placental insufficiency, that is 25.6%. However, in the absence of secondary placental insufficiency, the area of sclerotic villi was 7 times larger than in the control group, and 3 times larger than in primary placental insufficiency.

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