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**MORPHOMETRIC CHARACTERISTIC OF THE SYSTEM
“MOTHER-PLACENTA-FETUS-NEWBORN” AT GESTOSIS OF PREGNANT SOWS**

**МОРФОМЕТРИЧЕСКАЯ ХАРАКТЕРИСТИКА СИСТЕМЫ МАТЬ-ПЛАЦЕНТА-
ПЛОД-НОВОРОЖДЕННЫЙ ПРИ ГЕСТОЗЕ СУПОРОСНЫХ СВИНОМАТОК**

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Abstract. It is established that in pig farms of various forms of ownership the number of animals with violation of reproductive function makes from 11.7 to 39.7%. As a result of the clinical examination of the basic herd of pigs revealed that obstetric pathology occurs on average 40.1 percent of broodstock, with 26.7% of the sows in the period of pregnancy registered gestosis with a classical triad — hyperhydration, hypertension and proteinuria.

Depending on the symptoms, there were 4 forms of pregnancy complications with gestosis with symptoms of anemia ($38.4 \pm 1.89\%$), hepatopathy ($27.8 \pm 1.2\%$), nephropathy ($34.5 \pm 1.7\%$) and paraplegia ($9.3 \pm 0.7\%$ of pregnant sows).

Diseases of pregnant sows were clinically manifested by events of oppression — loss of appetite, pallor of visible mucous membranes, soreness of palpable area of the liver, proteinuria, hypertension, disorders of the Central nervous system, calving mobility problems, yellowness of the eyeball.

Morphometric studies of the placenta in the gestosis of pregnant sows evidence that the length of the umbilical cord, the mass of the maternal part of the placenta, the thickness and volume of the child part of the placenta is reduced to a statistically reliable magnitude, compared with similar indicators in clinically healthy pregnant sows. Noted a significant fluctuation of fetus–placental ratio with an inverse of value. There was a significant fluctuation of the fetal–placental coefficient with the opposite value, in piglets born from clinically healthy mothers. The functional status of newborns depends on the forming processes of the maternal and child placenta, as well as the morphological and physiological properties of the development of fruits, which is confirmed by an authentic decrease in the body weight of newborns by 30.0–40.0% and weakly expressed motor–food reflexes.

Аннотация. Установлено, что в свиноводческих хозяйствах различных форм собственности количество животных с нарушением воспроизводительной функции составляет от 11,7 до 39,7%. В результате проведенной диспансеризации маточного стада свиней выявлено, что акушерская патология встречается в среднем у 40,1% маточного стада, при этом у 26,7% свиноматок в период супоросности зарегистрирован гестоз с классической триадой — гипергидротация, гипертензия и протеинурия.

В зависимости от симптомов выделили 4 формы осложнения беременности гестозом с симптомами анемии ($38,4 \pm 1,89\%$), гепатопатии ($27,8 \pm 1,2\%$), нефропатии ($34,5 \pm 1,7\%$) и параплегии ($9,3 \pm 0,7\%$ беременных свиноматок).

Заболевания супоросных свиноматок клинически проявлялись явлениями угнетения — потерей аппетита, бледностью видимых слизистых оболочек, болезненностью пальпируемой области печени, протеинурией, гипертензией, расстройствами центральной нервной системы, залеживанием, желтушностью глазного яблока.

Морфометрические исследования плаценты при гестозе супоросных свиноматок свидетельствуют о том, что длина пупочного канатика, масса материнской части плаценты, толщина и объем детской части плаценты уменьшена на статистически достоверную величину, в сравнении с аналогичными показателями у клинически здоровых супоросных свиноматок. Отмечено значительное колебание плод–плацентарного коэффициента с обратным значением, у плодов поросят, родившихся от клинически здоровых матерей. Функциональный статус новорожденных находится в зависимости от формообразовательных процессов материнской и детской плаценты, а также морфо–физиологических свойств развития плодов, что подтверждается достоверным снижением массы тела новорожденных на 30,0–40,0% и слабо выраженными двигательными–пищевыми рефлексами.

Keywords: gestosis of pregnant sows, placenta, fetus, newborns.

Ключевые слова: гестоз супоросных свиноматок, плацента, плоды, новорожденные.

Pig farming being an animal husbandry industry of precocious animal maturing plays an important part in providing the population with meat and meat products. The greatest effect in pig farming is achieved by intensification with maximum use of breeding stock [1, 4]. Currently, one of the most important areas of veterinary science is the development and perfection of means and methods of early prevention of metabolic disorders and creation on this basis a reliable system of protection from the so-called "technological" pathologies of pigs' reproduction [3, 5]. In addition, in recent years it was found that phase changes or critical periods in the development of immune system of pigs, which further define immunodeficiency states of animals, are recorded during postnatal growth and development of pigs [2, 6]. The problem of the mechanism of metabolic disturbances in the system "mother-placenta-fetus" at gestosis in pregnant sows is worthy of a special discussion, the consequence of the problem is the increased number of stillborns in the offsprings, live piglets with low birth weight and with a slightly pronounced orientation and sucking reflexes [7].

In connection with this, the problem of increasing of non-specific (natural) stability of the organism which is significant in protecting the body from diseases and in the process of immunological rearrangement at active immunity developing in gestation period is becoming very important.

The purpose of this researches to establish morphometric changes in the system "mother-placenta-fetus" in pregnant sows at gestosis.

Materials and methods

The study was conducted on 40 sows of large white breed weighing 185-235 kg by the second-fifth farrows and 20 replacement gilts weighing 125-135 kg. During the period of experiment (its duration was 4 months) the ration composition of the sows was: extruded barley and wheat, sunflower cake, premix 12-15-7/8, whey, calcined phosphate, salt, fodder chalk. Veterinary auto hematology analyzer of blood "Abacus Junior Pse 90 Vet" (Automatic Veterinary, production of Germany) and biochemical blood analyzer "Chem Well combi", models 2902 and 2910, (production of the USA, Florida) were applied to hematological studies. Morphological studies were conducted at the hotel of pathomorphological studies of NSU Russian Scientific Research Veterinary Institute of pathology, pharmacology and therapy of Russian Academy of Agricultural Sciences (RAAS).

Digital material was subjected to statistical processing on a PC Pentium with applied programs of Microsoft Office.

Results and discussion

Statistical data of the Saratov Region Veterinary Department indicate that the number of animals with impaired reproduction on pig farms of different forms of ownership is recorded from 11,7 to 39,7 per cent. Loss of pigs among different age groups of animals varies from 3,7 to 19,7 per cent, and forced slaughter is from 5,3 to 27,5 per cent. As a result of conducted screening of breeding sow stock it was revealed that the feeding ration of empty and pregnant sows mainly satisfies the pig body's need for feeding units, the exchange energy and dry substance, but is largely deficient in mineral metabolism (39,7%), acid-base status (59,8 per cent) and protein metabolism (37,8 per cent). Obstetric pathology occurs on average in 40,1 per cent of breeding stock, and it was registered that 26,7 per cent of the sows in the gestation period have gestosis with a classic triad – hyperhydratation, hypertension and proteinuria. Depending on the symptoms 4 forms of gestation complications from gestosis were detected. Thus, the symptoms of anemia were detected in 38,4±1,89 per cent of pregnant sows in the period from 49th till 77th days of gestation. The symptoms of hepatopathy were usually diagnosed in the second half of gestation in 27,8±1,2 per cent of sows, from 77th till 105th days nephropathy was registered in 34,5±1,7 per cent and 9,3±0,7 per cent of sows had paraplegia on 105th-114th days. Diseases of pregnant sows were clinically manifested by depression phenomena: the loss of appetite, pallor of visible mucous membranes,

tenderness at palpation of the liver, proteinuria, hypertension, disorders of the central nervous system, too long lying, icteritiousness of the eyeball.

Histological and histochemical studies of the maternal side of the placenta showed that the average thickness of the surface epithelium of the uterus is from 14,3±1,7 mkm to 27,9±1,9 mkm in the pigs of the control group, while the pigs of the experimental group have the average thickness from 15,5±1,9 mkm to 35,4±2,7 mkm, the difference is statistically valid ($p < 0,05$) (Table 1).

Table 1.

MORPHOLOGICAL INDICATORS OF MATERNAL SIDE OF THE PLACENTA IN CLINICALLY HEALTHY PREGNANT SOWS AND PREGNANTSOWS HAVING GESTOSIS

Indicators	The period of gestation, days			
	70-74		105-107	
	With gestosis	Clinically healthy	With gestosis	Clinically healthy
The weight of the uterus, kg	5,67 ± 0,65	6,47 ± 0,52	8,26 ± 0,38	10,44 ± 0,63 **
The area of the uterus, cm ²	554,1 ± 17,2	689,02 ± 19,3*	742,1 ± 37,2	813,1 ± 36,4*
%, the glands in the endometrium	10,6	12,3	14,4	15,7
The diameter of the glands, mkm	35,3 ± 1,2	41,7 ± 1,3*	49,9 ± 2,0	59,7 ± 1,7
The height of the glandular cells, mkm	14,8 ± 0,65	18,9 ± 0,75*	22,3 ± 1,9	24,5 ± 2,1

Notes: * $p < 0,05$, ** $p < 0,01$, here and further.

The maternal surface of the placenta has lobed cellular structure. The number of nodules - microcrypts reaches 17-23. Larger and thicker microcrypts are located in the center, lobules flatten to the periphery, and as a result, the placenta becomes spindle-shaped. The results of the measurement of the specific volume of the fetal side of the placenta showed that this indicator is in correlation with the volume of chorionic villi, which is 45,0 per cent in sows suffering from gestosis and 65,0 per cent of all fetal side of the placenta in clinically healthy sows (Table 2).

Table 2.

THE INDICATORS OF THE FETAL SIDE OF THE PLACENTA IN CLINICALLY HEALTHY PREGNANT SOWS AND PREGNANT SOWS HAVING GESTOSIS

Indicators	The period of gestation, days			
	70-74		105-107	
	With gestosis	Clinically healthy	With gestosis	Clinically healthy
The weight of the fetus membranes, kg	0,98 ± 0,04	0,70 ± 0,03*	1,85 ± 0,12	1,68 ± 0,45*
The length of the umbilical cord, cm	19,9 ± 1,2	17,5 ± 0,72	23,0 ± 1,1	19,2 ± 0,9*
The amount of allantoic fluid, ml	322,7 ± 12,7	521,0 ± 2,7**	235,6 ± 12,7	320,4 ± 13,4 **
The amount of amniotic fluid, ml	387,5 ± 7,2	437,3 ± 21,4 *	374,5 ± 11,1	269,1 ± 13,2
The volume of the placenta, ml	202,5 ± 9,7	215,8 ± 8,7*	323,5 ± 10,9	356 ± 11,7
The thickness of the fetal side of the placenta, cm	7,8 ± 0,7	7,5 ± 0,9	10,2 ± 2,1	15,3 ± 1,2*
The weight of the fetal side of the placenta, g	157,1 ± 9,2	195,0 ± 10,2 **	295,0 ± 11,5	379,8 ± 44,0*

Morphological study of the fetal part of the placenta demonstrates that the weight of the placenta in sows with gestosis was significantly lower compared to the weight of the placenta of clinically healthy pregnant sows, the data are statistically valid ($p < 0,05$).

When studying the umbilical cord, the presence of one vein and two arteries was marked. The length of the umbilical cord ranged from $7,3 \pm 0,71$ cm to $23,0 \pm 1,1$ cm, and the length of the umbilical cord in sows of the control group statistically is greater than that of sows of the experimental group which is a statistically valid value. The fluid content in the allantois changes with gestation. At early stages of development its amount varies from 85 to 320 ml, in the second month there is an increase to $520 \pm 12,7$ ml, and by the birth of the fetus, the amount of fluid gradually decreases to 35-120 ml or it is completely lacking. The length of the amnion on the 74th day of gestation is equal to $4,2 \pm 0,51$ cm, the width is $3,5 \pm 0,47$ cm, and by the end of the fourth month it respectively increases to $57,3 \pm 1,37$ and $26,7 \pm 1,52$ combat the beginning of the second month of gestation there is only $2,5 \pm 0,32$ ml of transparent, colorless fluid in the cavity of the amnion and by the beginning of the 74th day of gestation its quantity increases to $437,3 \pm 21,4$ ml and then decreases up to $163,1 \pm 13,2$ ml. The fluid becomes brown, mucous and contains large particles of meconium.

On the outer surface of the chorion there was an accumulation of villi. The villi form chorionic nodules of a round form, barely visible at the end of the first month. Their size increases by the birth of the fetus. Chorionic nodules are located on both sides of the great vessels in rows so that the entire surface of the chorion is broken into many small cells. The number of chorionic nodules of the right and left sides are different, there is also a difference in their size and shape.

In the amniotic region of the chorion, closer to the umbilical cord, chorionic nodules are larger, they are smaller towards the horns and there are no chorionic nodules in avascular areas. During the gestation the amount of chorionic nodules gradually increases and they implant deeply in the crypts of the endometrium in the second month. As a result, with every month the bond of fetal and maternal placentas is becoming stronger. However, the chorion is removed from the crypts of the mucosa of the endometrium without special efforts.

Pig's placenta has the form of oblong bag, tapering to the ends, with a diameter of $14,9 \pm 1,4$ cm. The thickness of the fetal side is on average $3,42 \pm 0,08$ cm, the weight is $367,1 \pm 13,6$ g, the volume (by displaced water in a measuring cup) is $330,4 \pm 13,4$ ml, the area of maternal surface is $203,8 \pm 14,7$ cm², and fetal-placental ratio is $3,17 \pm 0,72$.

The weight of the placenta also varied from $367,1 \pm 3,6$ to $319,7 \pm 10,4$ g, at the volume $330,4 \pm 13,4$ — $298,5 \pm 11,6$ ml, which characterizes the intrauterine conditions for the growth and development of fetus at various states of sows in the gestation period. The data analysis of the area of maternal surface of the placenta showed a significant variability of this indicator.

So, the area of maternal surface was $180,4 \pm 7,74$ cm² in sows with anemia, whereas in sows with nephropathy it was $165,3 \pm 8,27$ cm², in sows with hepatopathy it was $192,4 \pm 8,24$ cm² and in sows with paraplegia it was $172,5 \pm 9,12$ cm². While the area of maternal surface in clinically healthy sows during the period of gestation was $203,8 \pm 4,2$ cm². These figures are confirmed by the utero-placental ratio, which ranged from $3,11 \pm 0,74$ up to $3,35 \pm 0,51$ (Table 3).

Table 3.

THEMORPHOMETRIC CRITERIA OF THE FETUS STATE

Criteria	The period of gestation, days			
	70-74		105-107	
	With gestosis	Clinically healthy	With gestosis	Clinically healthy
Fetus-placenta ratio (FPR)	$4,23 \pm 0,12$	$3,90 \pm 0,17$	$7,61 \pm 0,35$	$6,27 \pm 0,22^*$
The weight of the fetus, g	$464,3 \pm 13,5$	$676,8 \pm 16,5^*$	$909,6 \pm 19,3$	$1123,4 \pm 32,5^{**}$
The weight of the liver, g	$11,9 \pm 0,15$	$16,7 \pm 0,09^{**}$	$26,7 \pm 0,19$	$30,1 \pm 0,15^*$
The weight of the lungs, g	$8,7 \pm 0,09$	$9,6 \pm 0,19^*$	$10,95 \pm 0,05$	$12,75 \pm 0,07^*$
The weight of the kidney, g	$3,67 \pm 0,10$	$4,15 \pm 0,12^*$	$8,21 \pm 0,23$	$9,37 \pm 0,17^*$
The weight of the spleen, g	$0,53 \pm 0,09$	$0,67 \pm 0,13$	$1,65 \pm 0,11$	$1,95 \pm 0,13^*$

As a result of our research, we have obtained the data describing the condition of the fetus in the united functional system in different periods of gestation. Thus, the dynamics of the absolute values of fetus-piglets weight ranged from $24,7 \pm 0,25$ g to $909,6 \pm 19,3$ in sows with gestosis, at a statistically valid difference in comparison with the values of fetus-piglets in clinically healthy sows, it was $33,6 \pm 0,29$ - $1123,4 \pm 32,5$ g. In addition, significant fluctuations of fetus-placental ratio in the fetus-piglets born by mothers suffering from gestosis were noted.

The statistical analysis of obtained data showed that birth weight of newborn piglets born by clinically healthy mothers is on average $1,165 \pm 0,05$ — $1,325 \pm 0,06$ kg. Such piglets are characterized by: moderate development of motor-food reflexes; good appetite; normal by frequency defecation and urination;

- timely and normal manifestation of static functions and freedom of movement; soft velvety skin with a well-developed subcutaneous fat layer, properly developed skeleton without rachitic deviations.

At the same time there is a valid reduction of newborn's body weight by 30,0-40,0 per cent in piglets born by mothers suffering from gestosis. Such piglets are characterized by: motor-food reflexes are poorly expressed; visible mucous membranes are pale; the hair is sparse, dry, short and hard; subcutaneous fat layer is absent; the skin in the neck and tail folds is pronouncedly folded; auricles are soft with ends hanging down; cortical bones are short; eyes are sunken due to thinning of the fat cushions of the eyeball and the fat bag itself; breathing is slow and superficial; heart sounds are weak, the pulse is arrhythmic, slow with decreasing pulse wave; the cardiac impulse is felt on both sides of the chest.

As a result of the conducted statistical analysis of the grouped according to the morphological and functional characteristics of newborn piglets it was found that there were: normotrophics — $69,8 \pm 3,5$ per cent; macrosoms — $6,3 \pm 1,3$ per cent; and hypotrophics — $24,6 \pm 1,3$ per cent, i.e. approximately 30,0 per cent of the amount of all newborns.

Thus, the functional status of the newborns is based on forming processes during antenatal period, as well as morpho-physiological properties of fetus development.

Conclusion

The results of our studies on morpho-functional changes in the system “mother-placenta-fetus-newborn” allow to make the following generalizations:

- morphometric studies of the placenta clearly show that the length of the umbilical cord and the weight of the maternal side of the placenta are increased, and the thickness and volume of the fetal side of the placenta are reduced by a statistically valid value in sows suffering from gestosis in comparison with the same indicators in clinically healthy pregnant sows;

- it follows from the data outlined in this article that the fetal-placental ratio for the birth in clinically healthy sows is more favorable than in sows suffering from gestosis. The absolute weight of the internal vital organs was more preferable in the fetus-piglets of clinically healthy pregnant sows.

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