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PHYSIOLOGICAL PECULIARITIES OF HEMOSTASIS IN PIGLETS EXPOSED TO UNFAVORABLE HYDROINFLUENCE

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Abstract:
Environmental influences can affect all systems of the body, including blood and mechanisms that ensure its liquid state. At the same time, the influence of physical factors has not been fully evaluated with regard to hemostasis activity. The aim of the work: to trace changes in the activity of hemostasis components in piglets that have undergone an episode of hypothermia due to anthropogenic hydro-impact. A group of 33 2-month-old piglets of the Large White breed was formed, which were exposed to cold water for 2.5 hours due to a technogenic accident. A control group of 35 two-month-old healthy piglets, which did not experience negative environmental influences, was collected from 35 two-month-old healthy piglets kept in the same farm as the group after the negative impact. Activation of platelet aggregation was found in piglets that underwent negative hydro-exposure. Also in these animals there was noted an increase in the functional capabilities of plasma hemostasis with a decrease in the capabilities of fibrinolysis. This situation aggravated the phenomena of microcirculation in the organs of animals. The coming slowdown of hemorheology in microvessels inhibited metabolism and weakened their organism as a whole. In piglets that experienced an episode of hypothermia, a functional biologically disadvantageous strengthening of hemostasis work is formed, which can impede the processes of microcirculation and, consequently, the phenomena of anabolism in their tissues. In this regard, it seems important to evaluate in future studies the effect of various optimizing influences on the activity of individual components of hemostasis in piglets that have undergone negative hydroexposure.
Keywords: piglets, hydroexposure, hypothermia, hemostasis, coagulation, platelets, physiology.

Introduction

Modern pig breeding in Russia is a very important branch of actively developing agriculture, producing meat food products for the population of different age groups (Maksimov *et al*., 2018a; V.I., Glagoleva *et al*., 2018). For its further successful development, it is important to maintain the health of young animals, their intensive growth in optimal environmental conditions and rapid treatment in case of any pathology (Fomina *et al*., 2024).

There is no doubt that the organism reacts quickly to changes in the external environment by changes in biochemical processes and synthesis of macroergens (Zavalishina *et al*., 2018; Tkacheva & Zavalishina, 2018a). First of all, the effects of physical factors, nutrients (Maksimov *et al*., 2018; Mandal *et al*., 2021), biologically active substances and muscle activity (Tkacheva & Zavalishina,

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2018b) are biologically significant.

It becomes clear that for the solution of all these issues, the optimum state of animals' internal fluid medium - blood - plays an important role (Maden et al., 2018; Tkacheva, E.S., & Zavalishina, S.Yu. (2018c). Being a liquid internal medium of the organism, blood is a reliable indicator of the functional capabilities of the organism, capable of reacting to any environmental influences (Culler *et al*., 2017; Zavalishina, 2018a). The stronger under their influence the vital processes change, the brighter the changes in blood can be (Zavalishina, 2018b). The composition of blood can change with changes in its hemostatic characteristics, affecting the functional features of the whole organism (Smedt & Hemker, 2011). Hemostatic parameters of blood strongly affect the level of tissue perfusion (Zavalishina, 2018c), regulating the intensity of anabolism in all tissues of the animal and the level of its productivity (Zavalishina, 2018d; Burhans *et al*., 2022). Taking into account, undoubtedly, the great importance for the work of the whole organism and potentially possible negative changes in it under the influence of various negative influences, it is very important to evaluate the components of hemostasis when the organism enters different conditions of the environment of existence (Xu *et al*., 2022).

Purpose of the work: to trace changes in the activity of hemostasis components in piglets suffering from an episode of hypothermia due to anthropogenic hydro-impact.

Materials and methods

The study is based on the observation of 33 healthy piglets aged 2 months, both sexes of the Large White breed, reared in a pig farm located in central Russia. A group of these piglets was formed after a mechanical failure of the water supply system with partial flooding of the room where they were kept. As a result, during 2.5 hours the piglets were immersed half of their bodies in water with a temperature of 10°C. This group of animals became known as the post-impact group in the work performed. Another group, the control group, consisting of 35 two-month-old piglets, completely healthy, not exposed to any negative influences during their life and kept in stable optimal conditions, was observed. Feeding of both groups of piglets was comparable and standardized.

In animals observed in the study, the amount of fibrinogen in blood was estimated using the modified Claus method (Barkagan & Momot, 2008). Plasminogen concentration was determined using chromogenic substrates ("Dade Behring", Germany) on the FP-901 apparatus ("LabSystems", Finland). The level of fibrin-monomer complexes able to dissolve in blood was detected in piglets by visual method using reagents from Technologia-Standard (Russia) (Barkagan & Momot, 2008). Using a coagulometer ("HUMAN GmbH", Germany), activated partial thromboplastin time was recorded using a standard set of reagents HemoStat aPTT-EL. The value of the international normalized ratio in animals was determined using the Quick's method (Barkagan & Momot, 2008). The severity of platelet aggregation ability was determined using a laser analyzer of aggregation process ("Biola", Russia), the operation of which is based on the turbodimetric method. The aggregation stimulant in the study was 0.5 μM adenosine diphosphate (ADP) solution.

Statistical calculations based on the recorded numerical results consisted in the determination of Student's t-criterion.

Results of the study

There were some peculiarities of hemostasis-related indicators taken into account in this study (Table). In piglets experiencing negative environmental effects, the indices acquired functionally unfavorable changes.

Table. Hemostatic indices of piglets

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Hemostasis parameters	Post-impact group, n=33	Group in consistently optimal conditions, n=35
Platelet aggregation 0.5 μM ADP, units	2.39±0.19*	2.05±0.25
Spontaneous platelet aggregation, units	1.19±0.16*	1.02±0.12
Activated partial thromboplastin time, s	28.2±0.84**	36.9±0.73
International normalized ratio	1.09±0.23*	1.23±0.15
Fibrinogen, g/l	3.3±0.33**	2.6±0.19
Soluble fibrin-monomer complex, mg/ml	3.2±0.38**	2.4±0.71
Plasminogen, %	88.1±0.74*	96.7±0.57

Note: reliability of differences of monitored indicators between the observation groups * - $p<0.05$, ** - $p<0.01$.

In piglets that underwent negative hydro-exposure, there was an increase in platelet aggregation, which occurred spontaneously (by 16.7%) and developed under the influence of the inducer adenosine diphosphate (by 16.6%), which is a standard physiological agonist of this process.

In piglets that experienced cooling in aqueous medium, a significant reduction in the value of activated partial thromboplastin time (by 30.8%) and a decrease in the level of international normalized ratio by 12.8% were found. In these animals, blood plasminogen was reduced by 9.8% while fibrinogen (by 26.9%) and soluble fibrin-monomer conglomerates (by 33.3%) were increased.

Discussion

The influence of the environment is very important at all stages of organism development (Zavalishina, 2018e). Its influence can regulate many phenotypic manifestations of many of its qualities (Bouchama *et al*., 2005). For this reason, there is a close attention of researchers to all aspects of the physiology of animals exposed to unfavorable environmental conditions and to the evaluation of the consequences of these influences on the organism at any age (Zavalishina, 2018f). Continued thoughtful research on aspects of pig physiology is intended to form the scientific basis for the development of technologies for their breeding, housing and fattening (Bruchim *et al*., 2017). The generalization of the resulting data can help the operation of pig farms in practice (Zavalishina, 2018g).

In earlier observations, it was firmly established in different mammalian species that hemostasis is a system responsive to everything that happens to the organism and, first of all, in case of unfavorable influences on it from the outside in the form of the appearance of undesirable dysfunctions and signs of pathology (Zavalishina, 2018h; Proctor *et al*., 2020). At the same time, any dynamics of lipid peroxidation activity affects the state of the organism quite pronouncedly (Corte *et al*., 2008). The dynamics of functional readiness of elements of the hemostasis system, which is of different degrees of activity, affects the state of rheological characteristics of blood (Zavalishina, 2018i). These changes in the blood are rightly associated with the realization of microcirculation phenomena, providing metabolism in all its cells against the background of all kinds of environmental effects associated with

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prooxidant manifestations in the blood (De Stoppelaar *et al*., 2014).

Activation of hemostasis components was found in piglets against the background of negative hydroinfluence. Apparently, it should be associated with the fact that it is caused by intensification of hemocoagulation mechanisms along both its pathways. Undoubtedly, this phenomenon is determined by intensification of functional characteristics of many hemocoagulation factors involved in it in piglets. Apparently, in the plasma of piglets after hypothermia there is excessive formation of thromboplastin and increased activation of factor XII. Probably, this situation is also caused by the increase in the blood of piglets after hypothermia of fibrinogen and fibrin monomers able to dissolve. This indicates the coming intensification of fibrin polymerization phenomena, poorly inhibited by fibrinolysis mechanisms.

According to the accumulated data in science, it is clear that the depression of antioxidant mechanisms in the organism, necessarily leads to the activation of platelets participation in hemostasis processes and primarily due to their aggregation (Zavalishina, 2018j). We can think that the main reason for this in animals is a decrease in the formation of cyclic adenosine monophosphate in the cytoplasm of platelets and an increase in the generation of thromboxane A_2 in them (Dorsam *et al*., 2004). This situation enhances the formation of platelet aggregates in blood (Zavalishina, 2018k).

There is a growing opinion among researchers about the dependence of the physical status of the animal and the level of its productive capacity on the parameters of their blood (Freedman & Loscalzo, 2005). Based on this opinion, a small fragment of the early ontogenesis of piglets was considered in the course of the work. In this regard, it is premature to consider an episode of short-term hypothermia in water environment as a negative environmental factor, which in piglets obligatorily causes activation of hemostasis processes (Zavalishina, 2018l). However, the revealed changes in hemostasis activity associated with unfavorable external influences on the organism can be a powerful impetus for a detailed study of various aspects of regulation of their parameters in piglets. In addition, we can think that there is an undoubted connection between the work of all components of hemostasis and the development of productive qualities of piglets.

Conclusion

At the onset of hypothermia in water environment in piglets at the age of 2 months there comes undesirable activation of hemostasis system, which negatively affects the phenomena of microcirculation. In the piglets exposed to cooling hydro-influence there is an increase in the work of hemocoagulation inhibition of fibrinolysis and increase in the ability of thrombocytes to develop aggregation. This situation can have a very negative effect on the trophics of the whole organism of animals and eventually can inhibit the processes of their growth and formation of productive qualities.

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