UDK 616.071+616.002.16+616.45+616.18

Kniazevych-Chorna T.V., Shutka L.A., Dutchak U.M.

Morphological Restructuring of Hemomicrocirculatory Channel of Adrenal Glands after the Action of the Cold Factor

Department of human anatomy, operative surgery and topographic anatomy
Ivano-Frankivsk National Medical University, Ivano-Frankivsk, Ukraine, knyaz_tv@mail.ru

Abstract. For investigation of adrenal glands of 20 mature white breedless rat-males we used complex of morphological methods of investigations to study the hemomicrocirculatory flow after the effect of general deep hypothermia. The contraction of arteries and dilatation of veins have been established in the adrenal glands capsule and parenchyma. Under the electron microscope the swelling of the endotheliocytes of the arterial stream, resulting in their crossing over into the lumen are observed. The nuclei of these cells are elongated, with condensed chromatin located under the invaginated karyolema**.** The tubules and cisterns of the rough endoplasmic reticulum widen and form vacuoles. On their outer membrane we can observe a large amount of ribosomes. The components of the Golgi complex become wider. The mitochondria increase in size, their matrix is transparent containing fuzzy crysta. A lot of vacuoles are seen in the cytoplasm. The lumenal surface of the cell membrane of endotheliocytes is fragmented in some areas. The basal membrane is dilated and together with the inner elastic membrane forms an uneven fold. Its folds are considerably deeper than those of the control group. The smooth myocytes of the middle layer of the blood vessel wall and their organelles have poorly defined boundaries due to the swelling.

All these changes in the hemomicrocirculatory channels lead to tension of the cells of the paremchyma of the adrenal glands corresponding to the period of the reactive-swelling changes.

Key words: adrenal gland, hemomicrocirculatory channel, the general deep hypothermia.

Formulation of the problem and analysis of recent researches. Diseases or any pathological processes of the adrenal glands lead to changes of the internal environment of the human organism. Regardless of the etiological factors, the first place of the pathogenesis of these diseases or processes is appears as changes in the hemomicrocirculation channel (P. A. Doriot, [2003]. One of the main factors that affect the morphology of the adrenal glands is stress, in this case cold temperatures. Slight and frequent impact of cold will not only damage the organism, but can even make it stronger. But, the long lasting impact of very cold temperatures will lead to irreversible changes (K.P. Ivanov, [2002]. First of all, the impact of cold will be reflected in the morphological changes of cellular components and microcirculatory system.

The aim of research. The aim of our research was to study morphofunctional changes of the blood stream of the adrenal glands with morphometric parameters after the general deep hypothermia.

Materials and methods

The experiment was performed on the 20 mature white breedless male rats, with weight 160-200 grams each, which were divided into two groups: the experimental (16 rats) and control (4 rats). The animals from the experimental group were put into the freezing camera with the constant temperature of about -32°C in order to reach the desirable rectal temperature of about +12-+13°C (Pat. 65225A Shutka B.V. et al. [2004].

Sections of the adrenals glands were dyed with hematoxylin-eosin and fuksin-picrofuksin in order to perform the histological investigation. In order to study the adrenal vessels, they were injected with the ether chloroform mixture of paris blue paint through the abdominal aorta and subsequently dyed with hematoxylin-eosin (Pat. 91377 Levitsky V.A., [2010]. Electromicroscopic investigation was performed in the conventional way.

Pets and manipulation of them carried out in accordance with Appendix 4 to the "Rules for work with experimental animals", approved by the Ministry of Health of Ukraine № 755 of 12 August 1997., "On measures for further improvement of forms of work with experimental animals" and the "General ethical principles of animal experiments ", approved by the first National Congress on Bioethics (Kyiv, 2001).

Results

After the general deep hypothermia the contraction of the arterial and dilation of the venous blood vessels of the circulatory system of the capsule and parenchyma can be observed. In certain places, the blood vessels were not uniformly filled with the injected dye mixture. The diameter of the arterioles of the capsule is about 4 mcm on average ($p < 0,05$) (in control 22,10±1,11 mcm). The internal elastic membrane is uneven, forming deep folds on the top of which the swollen nuclei of the endotheliocytes can be observed. The smooth myocytes of the middle layer have veiled nuclei, which are situated deep between folds of the inner elastic membrane. The external elastic membrane has no outlines, and the dilatation of the perivascular space is observed.

Under the electron microscope we can observe the swelling of the endotheliocytes of the arterial stream, resulting in their crossing over into the lumen. The nuclei of these cells are elongated, with condensed chromatin located under the invaginated karyolema**.** The tubules and cisterns of the rough endoplasmic reticulum widen and form vacuoles. On their outer membrane we can observe a large amount of ribosomes. The components of the Golgi complex become wider. The mitochondria increase in size, their matrix is transparent containing fuzzy crysta. A lot of vacuoles are seen in the cytoplasm. The lumenal surface of the cell membrane of endotheliocytes is fragmented in some areas. The basal membrane is dilated and together with the inner elastic membrane forms an uneven fold. Its folds are considerably deeper than those of the control group. The smooth myocytes of the middle layer of the blood vessel wall and their organelles have poorly defined boundaries due to the swelling. Invagination is seen in the adventitial layer. Same occurrences can be seen in the structural components of the precapillaries, causing the contraction of their lumen: 12,26±0,45 mcm ($p < 0,05$) (in the control group 14,42±0,72 mcm).

In the capillaries of the capsule and the cortex of the adrenal glands, we can see the destruction of the fenestral areas of endotheliocytes and the formation of protrusions of their lumenal membrane into the cavity of capillaries. The nuclei of these cells are deformed and the boundaries of the nucleosome become convoluted. The granules of chromatin combine for form larger structures and are located under the nuclear membrane. Widening and vacuolization of the structural components of the rough endoplasmic reticulum and the Golgi apparatus is observed. The mitochondrial matrix becomes transparent/lighter, the crysta undergo destruction. The basal membrane becomes thicker and uneven. In the lumen of the capillaries erythrocyte sludge can be observed along with leukocytes and thrombocytes.

Under morphometric analysis, the diameters of glomelular fasciculate and reticular zones are the following: 4,21±0,25 mcm ($p < 0,01$), 4,70±0,16 mcm ($p < 0,001$) and 9,07±1,02 mcm ($p < 0,05$) in comparison with 5,48±0,21 mcm, 6,97±0,23 mcm and 13,28±1,31 mcm in control.

The sinusoidal capillaries of the medullary substance have an irregular shape, due to the uneven filling by the injected dye mixture, their diameter increases to 27,07±1,25 mcm ($p < 0,05$).

On the basis of morphometric analysis the dilatation of the postcapillaries, venules, veins and the central vein of the medullary substance are observed. The diameter of these vessels is 42,71±1,54 mcm ($p < 0,05$), 61,27±2,29 mcm ($p < 0,05$), 93,35±1,55 mcm ($p < 0,01$) та 129,73±2,26 mcm ($p < 0,01$) respectively, witch is bigger than in control group.

The endotheliocytes of the sinusoids and the venous part of

blood stream elongate and become thinner. The nuclei of the cells also become elongated and the amount of cell components decreases.

Discussion

When talking about the spasm of the arterial part of the blood stream, its reflex origin should be noted. It is known that the reaction of the organism to the changes of the ambient temperature is going through the activation of the sympathoadrenal system (Shutka B. Et al. [2006], V.M. Lapsha, V. N. Bocharov [1991], the terminal fibers of witch are located near the vessels and smooth muscle elements and through the ±-adrenoreceptors it influences microcirculation (O. Chabre et al. [1995]. In this manner, hypothermia can lead to the spasm of smooth myocytes of arterial blood vessels (A. Y. Kudryashov, M. S. Tabarov, B. I. Tkachenko [1993]. The dilatation of the venous stream is caused of the weakening and destruction of the elastic components of the venous wall under the influence of the biologically active substances circulation of which is increased in the blood stream under the cold factor (V. Kumar, A. Abbas, N. Fausto [2004].

Conclusions

1. After the total deep hypothermia we can observe the spasm of the arterial stream and the dilatation of the venous stream, swelling of the components of the cellular wall and changes their morphometric parameters.

2. All these changes lead to tension of the cells of the paremchyma of the adrenal glands corresponding to the period of the reactive-swelling changes caused by compensatory adaptation phenomena.

Prospects for future research in this direction are unquestioned, because it is unknown what changes we will observe in other terms after the total deep hypothermia and how the regeneration of the organ will be held.

References

1. Total deep hipotermiya / [Shutka B., Sagan O., Dutchak U. et al.] Ed. B. Jokes. Ivano-Frankivsk: Galician printing, 2006. - 300 p.

2. Ivanov K.P. The problem of recovery of physiological functions in humans during deep hypothermia (to the question of the limits of physiological adaptation) / K.P. Ivanov // Human Physiology. - 2002. - T. 28, № 3. - P. 123-130.

3. Kudryashov Y.A. Paired organ vascular function during hypothermia against hypoxia / A. Y. Kudryashov, M. S. Tabarov, B. I. Tkachenko // Pathological physiology and experimental therapy. - 1993. - № 2. - P. 20-23.

4. Lapsha V.M. Morphofunctional changes in the sympathoadrenal system under the influence of temperature and emotional factors / V.M. Lapsha, V. N. Bocharov // The endocrine system of the body and harmful environmental factors: the works of all-Union Conf. conference. : Sept. 25-27. 1991: Proc. - Leningrad, 1991. -P. 133.

5. Pat. 65225A Ukraine, IPC A 61 B 5/01. The method of modeling the general deep hipotermia experiment / Shutka B.V., Popadynets O.G., Zhurakivska O.Y.; patent Ivano-Frankivsk State Medical University. - № 2003065678; appl. 19.06.03, publ.15.03.04, Bull. Number 3.

6. Pat. 91377 Ukraine, IPC A 61 B 10/00, G 01 N 1/30. A way of combined detection of hemomicrocirculatory flow and parenchyma tissue by injection of blood vessels and staining hematoxylin and eosin / Levitsky V.A., Popadynets O.G., Knyazevich-Chorna T. V., Kolinko J. O.; patent Ivano-Frankivsk State Medical University. - № a200804032; appl. 03/31/2008, publ. 26.07.2010, Bull. Number 14.

7. Doriot P. A. Some unusual consideration about vessel walls and wall stresses / P. A. Doriot // J. Theor. Biol. – 2003. – Vol. 221, № 1. – P. 133–141.

8. Hormonal regulation of mitogen activated protein kinase activity in bovine adrenocortical cells: cross- talk between phosphoinositides, adenosine 30,50-monophosphate and tyrosine kinase receptor pathways / O. Chabre, F. Cor-nillon, S. Bottari [et al.] // Endocrinology. – 1995. – Vol. 136. – P. 956–964.

9. Kumar V. Robbins and Cotran Pathologic basis of disease / V. Kumar, A. Abbas, N. Fausto. – [7-th Edition]. – Saunders, 2004. – 1525 p.

Князевич-Чорна Т.В., Шутка Л.А., Дутчак У.М.

Морфологічна перебудова гемомікроциркуляторного русла надниркових залоз на висоті дії холодового фактора

Кафедра анатомії людини, оперативної хірургії та топографічної анатомії, Івано-Франківський національний медичний університет, м.Івано-Франківськ, Україна

Резюме. У дослідах на надниркових залозах 20 білих безпородних статевозрілих щурів-самців, використовуючи комплекс морфологічних методів дослідження, вивчено стан їх гемомікроциркуляторного русла на висоті дії загальної глибокої гіпотермії. Встановлено, що при дії холодового фактора спостерігається звуження артеріальної та розширення венозної ланок кровоносного русла капсули і паренхіми наднирників. На ультраструктурному рівні виявляється набряк ендотеліоцитів артеріол, у результаті чого вони значно випинаються в їх просвіт. Ядра таких клітин набувають видовженої форми, каріолема інвагінується, під нею конденсується хроматин. Канальці та цистерни гранулярної ендоплазматичної сітки розширюються, вакуолізуються, на їх зовнішній поверхні візуалізується невелика кількість рибосом. Апарат Гольджі представлений розширеними пухирцями і мішечками. Мітохондрії збільшуються у розмірах, мають просвітлений матрикс та нечіткі кристи. У цитоплазмі наявна велика кількість вакуолей. Люменальна поверхня плазмолеми ендотеліоцитів місцями фрагментується. Базальна мембрана потовщується і разом із внутрішньою еластичною мембраною формує нерівномірну складчастість. Складки цієї мембрани є значно глибшими, ніж у контролі. Гладкі міоцити середньої оболонки та їх органели через набряк набувають нечітких контурів.

Така перебудова гемомікроциркуляторного русла веде до функціонального напруження клітин паренхіми надниркових залоз та відповідає стадії реактивно-набрякових змін.

Ключові слова: надниркова залоза, гемомікроциркуляторне русло, загальна глибока гіпотермія.

Князевич-Чорна Т.В., Шутка Л.А., Дутчак У.М.

Морфологическая перестройка гемомикроциркуляторного русла надпочечников на высоте воздействия холода

Кафедра анатомии человека, оперативной хирургии и топографической анатомии, Ивано-Франковский национальный медицинский университет, г.Ивано-Франковск, Украина

Резюме. В опытах на надпочечниках 20 белых беспородных половозрелых крыс-самцов, используя комплекс морфологических методов исследования, изучено состояние их гемомикроциркуляторного русла на высоте воздействия общей глубокой гипотермии. Установлено, что при воздействии холода наблюдается сужение артериального и расширение венозного отделов кровеносного русла капсулы и паренхимы надпочечников. На ультраструктурном уровне оказывается отек эндотелиоцитов артериол, в результате чего они значительно выпячиваются в их просвет. Ядра таких клеток приобретают удлиненной формы, кариолема инвагинируется, под ней конденсируется хроматин. Канальцы и цистерны гранулярной эндоплазматической сети расширяются, вакуолизируются, на их наружной поверхности визуализируется небольшое количество рибосом. Аппарат Гольджи представлен расширенными пузырьками и мешочками. Митохондрии увеличиваются в размерах, имеют просветленный матрикс и нечеткие кристи. В цитоплазме имеется большое количество вакуолей. Люменальна поверхность плазмолеми эндотелиоцитов местами фрагментируется. Базальная мембрана утолщается и вместе с внутренней эластичной мембраной формирует неравномерную складчатость. Складки этой мембраны значительно глубже, чем в контроле. Гладкие миоциты средней оболочки и их органеллы из-за отека приобретают нечетких контуров.

Такая перестройка гемомикроциркуляторного русла ведет к функционального напряжения клеток паренхимы надпочечников и соответствует стадии реактивно-отечных изменений.

Ключевые слова: надпочечники, гемомикроциркуляторное русло, общая глубокая гипотермия.

Received 22.06.2015.