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Morphofunctional Peculiarities of the Arteries in General Deep Hypothermia

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Abstract. The objective of the work is to study the dynamics of peculiarities of morphophunctional changes in structural elements of arteries' walls of muscular type under the influence of the general deep hypothermia. There were used 20 white mature adult outbred rats weighing 160-180 g. Cooling was performed in accordance with the patented methods. Euthanasia of the rats was carried out by an overdose of ether anesthesia. Collection of the material was performed during the 7th, 14th and 30th days of post-hypothermic period. Pieces of humeral, femoral, renal, superior mesenteric arteries and celiac trunk were carried to paraffin blocks according to the conventional methods. With the help of sliding microtome there were received sections of 5-8 microns thick with subsequent staining with hematoxylin and eosin, fuchsin according to the Hart (identification of elastic fibers), trichrome staining according to Masson (identification of collagenous fibers), alcian blue after Stidman (definition of glycosaminoglycans). Ultrastructural study of the material was performed on the electron microscope PEM-125K. During the 7th day degenerative changes of the vascular wall structural components predominate, which during the 14th day are combined with compensatory-adaptive manifestations. During the 30th day after the action of general deep hypothermia there are expressed intracellular regenerative processes. The perspective is to study further changes which occur in the main arteries of elastic and mixed types at different terms of post-hypothermic period with the purpose to find ways of their prevention and correction, which is dictated by medical and social value of this problem.

Keywords: ***muscular type arteries, general deep hypothermia***.

Problem statement and analysis of the latest research. According to literature data, the structure of arteries is based on the concept of functional unit, structural components of which are closely related [2]. In experiment on animals and studied human material the patterns of structural adjustment of intima, media and adventitia of the main arteries due to their functional activity, influenced by various factors [1, 3, 4, 9, 13]. One of the most common factors of influence experienced by most living creatures is cold [6, 12]. Subject of study of its effect on internal organs is widely processed [12]; however, there are only a few data about the impact on extra-organic arteries [7]. According to our information, at the height of the cold factor action and during the first, third day of post-hypothermic period there is some swelling and partial destruction of certain cellular and extracellular elements of the arterial wall.

Objective of the work – is to study the dynamics of peculiarities of morphofunctional changes in structural elements of arterial wall of muscular type under the influence of the general deep hypothermia.

Materials and methods

To achieve this goal there were used 20 mature white adult outbred rats weighing 160-180 g. Test animals were divided into two groups: experimental (15) and control (5). Cooling was carried out in accordance with a patented technique [8]. Euthanasia of the rats was performed by an overdose of ether anesthesia. Collection of the material was performed during the 7th, 14th and 30th day of post-hypothermic period. Animal management, their nutrition and manipulations were performed in compliance with ethical and legal standards. After fixation in 10% neutral formalin, the pieces of brachial, femoral, renal, superior mesenteric arteries and celiac trunk were carried to paraffin blocks according to the conventional methods. At sliding microtome there were received sections of 5-8 microns thick with subsequent staining with hematoxylin and eosin, fuchsin after Hart (identification of elastic fibers), trichrome staining according to Masson (identification of collagenous fibers), alcian blue after Stidman (definition of glycosaminoglycans). Ultrastructural study of the material was performed on the electron microscope PEM-125K. The diameter of the lumen of the arteries and their average thickness of the membrane were measured. Processing of the received results is performed by means of PC using the software package MicrosoftExcel-2000.

Results of the study and their discussion

During the 7th day of post-hypothermic period there is marked dilatation of studied arteries, that is why their lumen exceeds even benchmarks. It results in thinning of the arterial wall, although the swelling phenomena still remain, that's why membranes are not fully differentiated. Internal elastic membrane is somewhere smoothed, fragmented, exfoliated from the medial shell. Smooth myocytes of this membrane are disoriented. Adventitial shell has no clear visualization. In the ultrastructural study endothelial nuclei are deformed, chromatin granules are placed marginally. Somewhere there is nucleolemma destruction. The cytoplasm contains a large number of micropinocytotic vesicles and vacuoles. Mitochondria swell, their matrix is lumenized, and cristae are partially destroyed. The membranous structures of granular endoplasmic reticulum and Golgi apparatus are fragmented. Luminal plasmolemma forms numerous vacuolated protrusions into the lumen of blood vessels, somewhere their integrity is violated. There are phenomena of microclasmatosis. Internal elastic membrane is smoothed. The nuclei of smooth myocytes of medial membrane are of small size, deformed, chromatin is placed unevenly. Tubules and cisterns of granular endoplasmic reticulum are swollen and fragmented. Golgi apparatus is represented by individual flattened vesicles. There are mitochondria, completely devoid of cristae. Myofilaments are placed compactly. Structural elements of adventitial membrane are not clearly manifested.

During the 14th day after exposure to the general deep hypothermia there is decrease of endothelial edema of the studied arteries, their nuclei contours become clearer. The structure of internal elastic membrane is restored, but somewhere it is thickened due to the accumulation of collagenous fibers. Smooth myocytes of medial membrane are located spiral. Along with this, there are phenomena of hyperelastosis of media. The external elastic membrane is contoured clearly. Ultrastructurally there are features of compensatory-adaptive phenomena. The nuclei of endothelial cells become oval, chromatin granules are placed evenly. The nuclear envelope has convoluted contours. Granular endoplasmic reticulum consists of long tubules, on their external surface there is a large number of ribosomes. Golgi apparatus is represented by small vesicles and isolated vacuoles. In the cytoplasm there are polysomes. The number of mitochondria with matrix of average electron density and arranged cristae increases. Smooth myocytes of medial membrane have clear contours; their nuclei are oval in shape. The number and volume of tubules and cisterns of granular endoplasmic reticulum and Golgi apparatus elements increases. The vast majority of mitochondria are filled with electron-dense matrix, and their internal membrane forms ordered cristae. Sarcoplasm is filled with well-structured myofilaments. Internal and external elastic membranes are more clearly contoured.

During the 30th day of post-hypothermic period the structural organization of studied arterial walls closes to normal. Elongated endothelial cells with brightly coloured nuclei are on the uniformly convoluted inner elastic membrane. Smooth myocytes of the medial membrane are placed spiral. Among them there are collagenous and elastic fibers. The external elastic membrane surrounds the vessel around the perimeter. Morphometric data indicate a decrease in the lumen of the arteries, compared with the previous period, however, the control values they do not reach yet. Ultrastructurally endothelial nuclei are oval in shape, chromatin is distributed evenly. In tubules and cisterns of granular

endoplasmic reticulum there are numerous ribosomes. Last ones occur also in the free condition. Golgi apparatus is characterized by normal structure. Mitochondria are oval in shape and have clearly arranged cristae. In the cytoplasm there are micropinocytotic vesicles. Internal elastic membrane creates uniform folds. Smooth myocytes of the medial membrane are without peculiarities. Structural components of adventitial shell are within normal limits.

Dilated phenomena noted on the 7th day indicate paralysis of innervation of muscular membrane as a result of complex reaction of vasomotor nerve endings is a sequential change of phase of their arousal in paresis of vasoconstrictors, until their complete paralysis. Steady expansion of blood vessels is in the basis of pre-static condition, which is accompanied by formation of protein coagulates on the luminal surface of endothelial cells [5, 14, 15]. During the 14th day there is a combination of degenerative changes with compensatory-adaptive ones. As it is known, up to the twenty-first day vessels undergo compensatory changes, which are the evidence of proliferative activity in vascular wall structural elements [11]. Formation of collagenous fibers along the internal elastic membrane causes decrease of elasticity and resiliency, that is compensated by hyperelastosis of the medial membrane [2]. During the 30th day of the observation there are expressed restorative processes. It is known that functional needs of organs and tissues are the stimulus of regeneration [10].

Prospects for further research

The perspective is to study further changes which occur in the main arteries of elastic and mixed types during different terms of post-hypothermic period with the aim to find the ways of their prevention and correction, which is dictated by medical-social value of this problem.

Conclusions

During the 7th day the degenerative changes of the vascular wall structural components predominate, which during the 14th day are combined with compensatory manifestations. During the 30th day after the action of general deep hypothermia there are expressed intracellular regenerative processes.

References

1. Babak OYa, Lisova HV. Morphological changes of the vascular wall of carotid arteries in patients with chronic glomerulonephritis. Medytsyna sohodni i zavtra. 2011; 4 (53): 45-48.

2. Bahriy MM, Slyvka VI. Obliterate thromboangitis (Buerger's disease): pathomorphological changes in the vessels of the amputated lower limbs. Patolohiya. 2007; 4 (2): 76-80.

3. Voronkov LH, Shkurat IA, Besaha YeM. Structural changes of main arteries in patients with chronic heart failure. Krovoobih ta hemostaz. 2005; 3-4: 15-19.

4. Kuzminova NV. Morphological changes of the vascular wall in hypertensive patients depending on the nature of complications. Visnyk morfolohiyi. 2009; 15 (1): 150-154.

5. Loktionova SA, Kabakov AE. Phosphatase inhibitors prevent the dephosphorylation of HSP27, destruction of stress fibrils and change of morphology of endothelial cells in the depletion of ATP. Bulleten ekperimentalnoy biologii i meditsiny. 2001; 9: 350-353.

6. Makhanova NA. The effect of stress caused by cooling in an early postnatal ontogenesis, on the blood pressure and heart function in normal and hypertensive rats. Bulleten ekperimentalnoy biologii i meditsiny. 2000; 12: 660-663.

7. Nikishkova IN, Kutikov AE. Peculiarities of general moderate periodic cooling modeling in Wistar rats. Problemy kriobiologii. 2000; 2: 113-114.

8. Shutka BV, Popadynets OH, Zhurakivska OYa inventors; Shutka BV, Popadynets OH, Zhurakivska OYa assignee. Method for modeling general deep hypothermia in experiment. Ukaine patent UA 65225. 2004 Mar 15.

9. Slabyy OB, Hnatiuk MS, Kovalchuk LF. Morphometric evaluation of arterial remodeling characteristics of myocardium in toxic lesions. Ukrayinsky medychny almanakh. 2009; 12 (4): 176-179.

10. Strukov AI, Puchkov VS, Kaufman YaYa. Inflammation. In: Obshchaya patologiya cheloveka. Moscow: Meditsyna; 1990. p. 3-74.

11. Gansburgskiy AN, Yaltsev AV, Ovchinnikov NL, et al. Structure of a population of smooth myocytes of various parts of aorta. Morfologiya. 2006; 129 (4): 36.

12. Shutka BV, editor. General deep hypothermia. Ivano-Frankivsk; 2006. 300 p.

13. Yuryk II, Holovata TK. Histological changes of major vessels of the lower limbs of rats of immature and reproductive age under the conditions of hyperuricemia depending on the duration of the experiment. Visnyk VDNZU "Ukrainian Medical Dental Academy". 2015; 4 (52): 286-290.

14. Aird WC. Endothelial cell heterogeneity. Crit Care Med. 2003; 31(4): 221-230. doi: 10.1097/01.CCM.0000057847.32590.C1 PMid:12682444

15. Uzhan H, Yazici M, Albayrak S, Erbilen E, Bulur S, Akdemir R, Uyan C. Elastic properties of the ascending aorta and left ventricular function in patients with hypothyroidism. Echocardiography. 2005; 22 (8): 649-656. doi: 10.1111/j.0742-2822.2005.00189.x PMid:16174118

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Морфофункціональні особливості артерій при дії загальної глибокої гіпотермії

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Резюме. Мета роботи – вивчити в динаміці особливості морфофункціональних змін у структурних елементах стінки артерій м'язового типу під впливом дії загальної глибокої гіпотермії. Використано 20 білих дорослих безпородних статевозрілих щурів масою 160-180 г. Охолодження проводили відповідно до запатентованої методики. Евтаназія щурів здійснювалася методом передозування ефірного наркозу. Забір матеріалу проводили на 7-му, 14-ту і 30-ту доби постгіпотермічного періоду. Шматочки плечової, стегнової, ниркової, верхньої брижової артерій та черевного стовбура проводили до парафінових блоків за загальноприйнятою методикою. На санному мікротомі отримували зрізи товщиною 5-8 мкм із подальшим фарбуванням гематоксиліном і еозином, фукселіном за Хартом (виявлення еластичних волокон), трихромним забарвленням за Масоном (ідентифікація колагенових волокон), альціановим синім за Стідменом (визначення глікозаміногліканів). Ультраструктурне вивчення матеріалу проводили на електронному мікроскопі ПЭМ-125К. На 7-у добу превалюють дистрофічні зміни структурних компонентів судинної стінки , які на 14-у добу поєднуються з компенсаторно-пристосувальними проявами. На 30-у добу після дії загальної глибокої гіпотермії виражені внутрішньоклітинні регенераторні процеси. Перспективним є вивчення в подальшому змін, які виникають в магістральних артеріях еластичного та змішаного типів у різні терміни постгіпотермічного періоду з метою пошуку шляхів їх профілактики і корекції, що продиктовано медико-соціальним значенням даної проблеми.

Ключові слова: артерії м'язового типу, загальна глибока гіпотермія.

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