

**HEALTH, ENVIRONMENT, DEVELOPMENT****MORPHO-FUNCTIONAL STATE OF PERINEUM AND BEHAVIORAL CHANGES IN RATS OF THE OLDER AGE GROUP DURING THE ADHESION PROCESS****Natalia Novosad**

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**Summary**

Age-related changes, the use of antibiotics and chemotherapeutic agents, food with preservatives and stabilizers, physical inactivity as a physical factor, surgical interventions, inflammatory processes are the consequences of the action of various physical and chemical factors leading to changes in the structure and functioning of all components of the peritoneum with subsequent remodeling of its individual histological structures. The consequence of the restructuring of the histological structure of the intestine and peritoneum most often, according to the literature, is the development of adhesive disease. The study of the behavior of rats was carried out using the "Open Field" observation method, which allows assessing motor activity, exploratory behavior, emotionality and anxiety of animals both at the individual and species levels. The morphological study included macroscopic, histological and morphometric assessment of the peritoneal tissues of its components in rats of the older age group. A macroscopic study of the visceral and parietal peritoneum was carried out, the number of adhesions in the abdominal cavity was counted, and their thickness was measured. The detected adhesive process in rats of the older age group is characterized by gradual remodeling of the tissues of the parietal and visceral peritoneum and the formation of connective tissue neoplasms. The detected adhesions were small, mobile and elastic, but also hard and dense, localized on the surface of the peritoneal tissue. The peritoneal tissues during the adhesive process lose elasticity and mobility, thicken and compact. As a result of the formation and spread of adhesions, the mobile segments of the small and large intestine are clamped and fixed in an unnatural position, which leads to acute intestinal obstruction. The total number of adhesions in the abdominal cavity of rats of the older age group was found to be  $4.03 \pm 0.15$  per studied area. Their total diameter was  $1.12 \pm 0.03$  mm.

**Key words:** peritoneum, gastrointestinal tract, histological changes, rats, morphometry, adhesions, adhesion disease.

DOI <https://doi.org/10.23856/6916>

## 1. Introduction

Currently, most changes in the functioning of the gastrointestinal tract are associated with a violation of the tissue barrier during the penetration of pathogenic species of microorganisms and the absorption of toxic substances, which is one of the effects of a biological factor on the intestine (*Stepanchuk et al. 2021: 33*). Violation of immunological tolerance to one's own microflora is one of the common pathologies of the gastrointestinal tract by an autoimmune mechanism, which is a consequence of the use of poor-quality food, impaired nutritional hygiene and age-related changes in the immune system of the organism itself; which is also one of the biological factors of violation of the histological barrier: external environment - intestine - internal environment (*Murando et al., 2019: 10*).

There are several hypotheses regarding the causes of adhesion formation: the theory of the body's sensitivity to the intestinal microbiota, ischemia, insufficient protective reaction to limit the focus of inflammatory pathologies, mitochondrial dysfunction (*Daisuke et al., 2019: 443*).

Age-related changes, the use of antibiotics and chemotherapeutic agents, food with preservatives and stabilizers, physical inactivity as a physical factor, surgical interventions, inflammatory processes are the consequences of the action of various physical and chemical factors, leading to changes in the structure and functioning of all components of the peritoneum with subsequent remodeling of its individual histological structures (*Kim et al., 2012: 104*).

According to the literature, the most common consequence of the restructuring of the histological structure of the intestine and peritoneum is the development of adhesive disease (*Schurink et al., 2019: 429*).

The aim of the work is to study the morpho-functional changes of the peritoneum and behavioral changes in rats of the older age group.

## 2. Materials and methods

The study was conducted at the laboratory named after Professor Yeshchenko V. A. of the Department of Physiology, Immunology and Biochemistry with a course of civil defense and medicine of the Faculty of Biology of the Zaporizhzhia National University.

For the study, white rats weighing 170-220 g ( $n = 20$ ) aged 2.5 - 3 years were selected. Laboratory animals were kept in standard conditions of a vivarium with a 12-hour lighting regime at a temperature of  $(22 \pm 2)^\circ \text{C}$ , relative humidity of air  $(55 \pm 5)$ . During the experiment, animals were kept in a vivarium with a natural light-dark cycle, the temperature and humidity of the environment were regulated on a standard diet with free access to food and drinking water.

Experimental studies on animals were carried out under sterile conditions as part of the scientific work of the Department of Physiology, Immunology and Biochemistry with a course in civil defense and medicine on the topic "Morpho-functional state of organs and their lymphoid components under the influence of internal and external factors" (state registration number: 0123U103988).

Dissection and collection of biological material for further analysis were carried out under anesthesia with strict adherence to ethical standards defined by the 1997 Council of Europe Convention on Bioethics, the European Convention (*Strasbourg, 1986*), the Law of Ukraine No. 3447-IV "On the Protection of Animals from Cruelty" and the Council of Europe Directive 86/609/EEC (1986).

The study of rat behavior was conducted using the Open Field observation method, which allows assessing motor activity, exploratory behavior, emotionality, and anxiety of animals at both the individual and species levels (*Cleypool et al., 2020: 165*).

Morphological study included macroscopic, histological, and morphometric evaluation of peritoneal tissues and their components in older rats.

A macroscopic study of the visceral and parietal peritoneum was performed, the number of adhesions in the abdominal cavity was counted, and their thickness was measured using calipers (Krishnan *et al.*, 2020: 154).

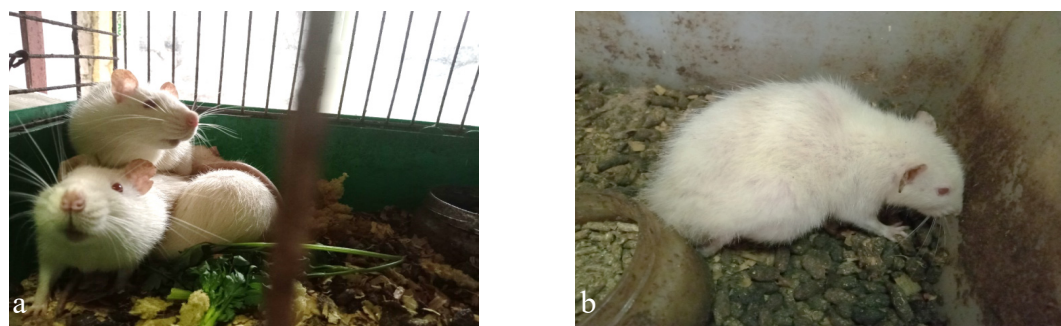
### 3. Research results

During the study, it was found that white rats that did not have adhesions usually adapted well and actively explored the territory, were active and mobile. The animals had a normal grooming intensity. A feeding and drinking schedule with a normal periodicity characteristic of healthy individuals was noted.

In animals in which adhesions were recorded, significant changes in the life cycle were observed. It was noted that the rats had a sedentary lifestyle, they became sleepy, lethargic and mainly stayed in dark corners.

Due to the reduced energy level, most of the experimental rats began to take care of themselves less, losing their usual cleanliness (Fig. 1). A sloppy, dirty appearance of the rats was noted.

Increased thirst is noted. The above symptoms are accompanied by bloating, accompanied by asymmetry of the abdomen. Some of the rats either refused to eat or significantly reduced the amount of food they consumed, which is likely a result of abdominal pain and general discomfort in the gastrointestinal tract.



**Fig. 1. Appearance of the studied rats: a) in which no adhesions were detected in the abdominal cavity; b) with adhesions in the abdominal cavity.**

Certain changes were observed in the postures of the rats studied, as well as in the intensity of their breathing. Thus, some of the animals were often in a position with a slightly raised abdomen, as in the case of pain or bloating, breathing more heavily and several times more often than the group of rats in which no adhesions were detected. The reason for this may be pain and spasms.

Changes were observed in the feces of animals in which adhesions were detected: in most rats, hard or dry fecal masses prevailed; and only in a few rats - liquid stools.

It is noted that rats in which digestive disorders were detected became less social, avoiding interaction with other rats. Thus, most of the animals studied preferred isolation, probably due to pain or stress.

During the macroscopic analysis of the abdominal cavity of rats with detected age-related adhesions, it was found that the peritoneal surface was characterized by a significantly denser structure. A decrease in the elasticity of the mesentery of the large intestine during stretching was noted.

The detected adhesions of the abdominal cavity are rigid and dense, which reduce the ability of internal organs to move. As a result of the formation and spread of high-density tissue in the abdominal cavity, the mobile segments of the small and large intestine are clamped and fixed in an unnatural position, which leads to the occurrence of acute intestinal obstruction. Macroscopically, this phenomenon was confirmed by massive widespread edema and hyperemia of the vessels around the affected area. The accumulation and obstruction of fecal masses and gases in the large intestine disrupts its peristalsis and causes bloating.

The number of visceral adhesions in the abdominal cavity of the experimental animals was calculated to be  $3.00 \pm 0.11$ , while the number of visceral-parietal adhesions was significantly lower and reached  $1.3 \pm 0.05$  units per studied area of the peritoneum. Thus, a statistically significant ( $p < 0.001$ ) difference is observed between these indicators. The total number of intra-abdominal (visceral and visceral-parietal) adhesions in rats of the older age group was  $4.03 \pm 0.15$ . Загальна товщина спайок, які виявили у щурів старшої вікової групи становила  $1,12 \pm 0,03$  мм. Досліджувані спайки були дрібні рухливі і пружні, локалізувалися на поверхні тканини очеревини, мали рівні краї.

The peritoneum is a continuous layer of mesothelial cells. These cells cover the sub-mesothelial space formed by a thin layer of connective tissue, which contains fibroblasts, macrophages, dendritic cells and various subpopulations of lymphocytes (Maksimenko et al., 2023: 29).

Many scientists have noted that adhesions are connective tissue formations. Scientific studies have confirmed the important role of connective tissue remodeling factor in their formation (Murando et al., 2019: 10; Schurink et al., 2019: 429). At the histological level, adhesions are composed of mononuclear cells, fibroblasts, adipocytes, vascular endothelial cells, and collagen fibers, which are in a well-defined ratio (Murando et al., 2019: 10; Solass et al. 2016: 193).

It is important to note that adhesions in the abdominal cavity are not simply scar tissue. Instead, they are considered active vascular structures that ensure adequate blood supply to the damaged organ and the peritoneum surrounding it. In this case, the key factor is not the damage to the peritoneum itself, but to the blood vessels in the tissues located under it (Struller et al., 2017: 153).

A significant number of scientific works are devoted to the study of individual components of the peritoneum. The results of these studies indicate the presence of numerous features not only in its anatomical and histological organization, but also in the lymphoid component of its derived structures (Nurov et al., 2021: 66).

In view of this, the study of the peritoneum as an immunocompetent organ remains an extremely relevant direction for further scientific research. The knowledge obtained may have important practical significance, in particular, in determining the factors that regulate the immune response in the body (Maksimenko et al., 2023: 29; Solass et al. 2016: 193; Nurov et al., 2021: 66).

#### 4. Conclusions

1. The detected adhesive process in rats of the older age group is characterized by gradual remodeling of the parietal and visceral peritoneal tissues and the formation of connective tissue neoplasms. The detected adhesions were small, mobile and elastic, but also hard and dense, localized on the surface of the peritoneal tissue.

2. During the adhesive process, the peritoneal tissues lose their elasticity and mobility, thicken and compact. As a result of the formation and spread of adhesions, the mobile segments of the small and large intestine are clamped and fixed in an unnatural position, which leads to acute intestinal obstruction.

3. The total number of adhesions in the abdominal cavity of rats of the older age group was established to be  $-4.03 \pm 0.15$  per studied area. Their total was  $1.12 \pm 0.03$  mm.

#### References

1. Stepanchuk AP, Fedorchenko IL, Tarasenko YaA. (2021) [Histostructure of the human cap in normal and peritonitis]. *Ukrainian Journal of Medicine, Biology and Sports*. 6:5–33. Ukrainian.
2. Murando F, Peloso A, Cobiauchi L. (2019) *Experimental Abdominal Sepsis: Sticking to an Awkward but Still Useful Translational Model. Mediators of Inflammation*. 3:8–10.
3. Daisuke S, Ji HK, Shunichi S, Gen M, José FR. (2019) *Topographical anatomy of the greater omentum and transverse mesocolon: a study using human fetuses. Anatomy and Cell Biology*. 52:443–454.
4. Kim JH, Han EH, Jin ZW, Lee HK, Fujimiya M, Murakami G, Cho BH. (2012) *Fetal topographical anatomy of the upper abdominal lymphatics: its specific features in comparison with other abdominopelvic regions. The Anatomical Record*. 295:91–104.
5. Schurink B, Cleypool CGJ, Bleys RL. (2019) *A rapid and simple method for visualizing milky spots in large fixed tissue samples of the human greater omentum. Biotechnic&Histochemistry*. 94(6):429–434.
6. Cleypool CGJ, Schurink B, Horst DE, Bleys R. (2020) *Sympathetic nerve tissue in milky spots of the human greater omentum. Journal of Anatomy published by John Wiley&Sons Ltd on behalf of Anatomical Society*. 236(1):156–164.
7. Krishnan V, Tallapragada S, Schaar B, Kamat K, Chanana AM, Zhang Y. (2020) *Omental macrophages secrete chemokine ligands that promote ovarian cancer colonization of the omentum via CCR. Communications Biology*. 223(1):524–529.
8. Maksimenko OS, Gryn VG. (2023) [Big cap of white rats: structural and functional characteristics and its role in peritonitis]. *Ukrainian Journal of Medicine, Biology and Sports*. 8:22–29. Ukrainian.
9. Solass W, Struller F, Horvath P, Königsrainer A, Sipos B, Weinreich FJ. (2016) *Morphology of the peritoneal cavity and pathophysiological consequences. Pleura and Peritoneum*. 1(4):193–201.
10. Struller F, Weinreich FJ, Horvath P, Kokkalis MK, Beckert S, Königsrainer A, Reymond MA. (2017) *Peritoneal innervation: embryology and functional anatomy. Pleura and Peritoneum*. 2(4):153–161.
11. Nurov JR, Ahmadova MA. (2021) *Features of Anatomy of the Greater Omentum. International journal on orange technology*. 3(9):66–68.