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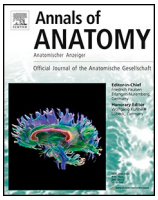

Research article

General Morphological Characteristics of the Results of Experimental Modeling of Aseptic Peritonitis

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ABSTRACT

Background: Aseptic peritonitis is a reaction of the local immune system aimed at rejection of a foreign body, which, having antigenic properties, does not (unlike a pathogen) counteract the immune system. The suture materials, namely catgut thread, used in intracavitary surgical operations possess xenogenic properties and can be used for antigenic stimulation of the immune system of the peritoneal cavity. Consequently, we decided to use a catgut suture for antigenic stimulation of the immune system of the peritoneal cavity and to study the morphological features of the results of experimental modeling of aseptic peritonitis in albino rats.

Method: The study involved 15 Wistar albino male rats, weighing 286,13 ± 6,26 g. To study the dynamics of destructive changes made by the catgut implant in the peritoneal cavity of the experimental animals, the animals were assigned into three groups in accordance with the time interval of their euthanasia at 3, 7, and 14 days of the experiment.

Results: After modeling an aseptic peritonitis, the investigation the abdominal cavity showed that in four out of five animals of the first group, that is, on day 3 of the experiment, the catgut implant had adhered to the greater omentum. The search for the fifth implant led to an unexpected discovery: we found it conjoined with the second derivative of the visceral peritoneum, similar in structure to the greater omentum, but related to the testes. On day 7, the implant embedded into the peritoneal cavity of the animals, had adhered to the serous formations of the testes in all five cases (100%, three of them – to the left epididymal omentum, and another two – to the right one). On day 14 (n = 5) it was found that in three cases it had adhered to the serous formations of the testes (60%, one of them to the left epididymal omentum, another two – to the right one) and in two cases it had adhered to the greater omentum (40%).

Conclusion: During the experiment on implantation of a xenogenic substrate in the form of flat bundles made from the catgut thread into the peritoneal cavity of sexually mature male rats, it was found for the first time that their acceptors were not only the greater omentum, but also two derivatives of the peritoneum, homeomorphic to it and associated with the epididymides, which we reasonably called epididymal omenta and described in details.

1. Background

During episodes of peritonitis, it is known that the greater omentum has a variety of functions. Current publications and literature have accumulated convincing data that shows that greater omentum of humans and white rats is a multifunctional organ, justifying the figurative name given to it as the "policeman of the peritoneal cavity" (Westenfelder, 2014; Meza-Perez and Randall, 2017; Wang et al., 2020).

First of all, the physiological properties of the greater omentum include its ability to change its shape and move within the peritoneal cavity, which some authors call migration (Di Nicola, 2019).

At the same time, it is believed that its plasticity depends on extraneous factors, such as a change in body position and peristaltic movements of the gastrointestinal tract. Of course, being a plastic structure that is located in the narrow space of the peritoneal cavity, the greater omentum cannot fail to be mechanically affected by the surrounding organs. But this cannot be explained by its inherent ability to purposefully respond to damage to one or another organ of the abdominal cavity. At the same time, the well-known fact that the greater omentum, having mobile properties, is able to purposefully implement not only the tamponade of various damaged organs of the abdominal cavity, but also to capture foreign substances that may enter the abdominal cavity

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(Liebermann-Meffert, 2000; Platell et al., 2000; Alagumuthu et al., 2005; Vernik and Singh, 2007; Collins et al., 2009; Di Nicola, 2019; Kroon and Mullen, 2021; Liu et al., 2021).

It is quite obvious that the ability to solve the problems can be shown at the present time only in an experiment on laboratory animals. As it is known, the validity of experimental modeling of a physiological or pathological state in laboratory conditions is achieved by previously establishing a sufficient degree of homology between the relevant functional systems of a person and an experimental animal. Therefore, the task comes down to choosing the most suitable species of laboratory animals, and the decisive factor is the minimal cost for their maintenance and for conducting experimental research on them in compliance with all requirements. According to literature, for the experimental modeling of peritonitis, the most suitable candidates are white rats, in which the greater omentum, is a miniature homologous of that of humans (Hryn et al., 2018a; Hryn et al., 2018b; Suzuki et al., 2019; Liu et al., 2021).

Issues related to the understanding of the mechanisms of development of aseptic inflammation of the peritoneum, which are widely known under the name of peritonitis, still remain topical problems of medicine. Peritonitis is a complication, or more precisely, an inevitable consequence or stage of development of various acute surgical diseases of septic and aseptic genesis, as well as injuries of abdominal organs (Hecker et al., 2019; Shepitko, 2019; Danyliv et al., 2022; Brown et al., 2023).

The analysis of the main provisions of contemporary immunology shows that aseptic inflammation is considered as a response of the immune system aimed at elimination of a foreign agent from the body, which, having antigenic properties, does not (unlike a pathogen) counteract the immune system (Chaplin, 2010; Chen and Nuñez, 2010; Chen et al., 2018; Hryn et al., 2022; Kostylenko et al., 2022; Nicholson, 2016; Savchenko et al., 2018; Bousquet et al., 2018).

Such agents include some used in medical practice, implants, as well as allo- and xenografts. Also, to simulate aseptic peritonitis, solutions of λ-carrageenan and γ-carrageenan are used, which are injected into the peritoneal cavity of an experimental animal (Shepitko, 2019; Danyliv et al., 2022).

Models with damage to both the parietal and visceral peritoneum were also used to reproduce aseptic peritonitis with ulceration (Melnychenko et al., 2019).

Attention is drawn to the fact that the suture material used in intracavity operations must possess antigenic properties so that in the process of wound healing, it is destroyed by means of an immune reaction to rejection. As is known, the leading role in this process belongs to cellular immunity, the effector elements of which are cytotoxic T-lymphocytes and macrophages, which means the development of aseptic inflammation. (Bilash et al., 2019; Kostylenko et al., 2022; Pronina et al., 2021; Titley-Diaz and De Cicco (2023); Caminero et al., 2021; Lock et al., 2017; Lovric et al., 2018; Muntjewerff et al., 2020).

One of the factors that lead to an inflammatory process during surgical interventions can be suture material, which later remains in the body, is a foreign agent for the body, and in the future can often be the cause of postoperative complications (Bilash et al., 2018, 2019; D'Cunha et al., 2022; Kim et al., 2020; Lovric et al., 2018).

Guided by these considerations, we decided (after a preliminary thorough analysis of many types of modern suture material) to use catgut thread for antigenic stimulation of the immune system of the peritoneal cavity. Catgut is widely used for suturing internal organs and tissues, it is not artificial, but bio-organic in nature, which is crafted out by collagen fibers from the submucosal layer of the small intestine of sheep (Bespalova, 2021; Kim et al., 2020).

Therefore, in the planned study, we expect to obtain more indicative morphological data about the specified properties of the greater omentum by experimental modeling of aseptic peritonitis with the intact state of the organs of the peritoneal cavity of white rats.

In this regard, our study distinguishes itself among the similar ones available in the literature. The purpose of our investigation is to study the morphological features of the results of experimental modeling of aseptic peritonitis in albino rats.

2. Methods and material

2.1. Experiment preparation

Prior the surgical procedures, we manufactured catgut implants, standardized in shape and size, for which a 2/0 size, 0.3 mm thick and 17 cm long catgut suture, was used, the segments of which were rolled into compact flat bundles with an area of 1 cm^2, after which they were subjected to sterilization through gamma radiation (Fig. 1).

2.2. Animals and experimental design

The experimental part of the study was started with involvement of 15 mature Wistar albino male rats, weighing 286,13 ± 6,26 g, supplied by Poltava State Medical University's vivarium (Poltava, Ukraine). The animals were housed at the experimental biological clinic (vivarium) of the Poltava State Medical University (Poltava, Ukraine) in the normal conditions, fed twice a day (morning and evening), with temperature of 20 ± 2 °C, 12 h light-dark cycle, humidity 40–60% and illumination 200 lux., in compliance with the regulations for keeping experimental animals adopted by the Directive of the European Parliament and Council (2010/63/EU), Order of the Ministry of Education and Science, Youth and Sports of Ukraine as of 01.03.2012 No. 249 "On Approval of the Procedure for Conducting Experiments on Animals by Scientific Institutions" and "General Ethical Principles of Animal Experiments", adopted by the Fifth National Congress on Bioethics (Kyiv, 2013), (Minutes No. 198 as of 21.10.2021 from the meeting of the Commission on Biomedical Ethics of the Poltava State Medical University.

Under general ether anesthesia, the cotton pad was moistened with a solution of ethyl ether in a dose of 3,5 ml/kg of body weight of a laboratory animal and placed in a special container with a rat for 2 min without air access. After anesthesia was achieved, the animal was fixed on the operating table. Then, a test tube with a cotton pad moistened with ether in the same dose was brought to the nose of the experimental animal, like a mask, in order to achieve complete anesthesia (Flecknell, 2016;). Keeping to the rules of sterile conditions and relevant regulations for the ethics of experimental research on animals, the abdominal cavity of the animals was dissected (the incision was no more than 1.5 cm long) along the linea alba (median laparotomy) and one of the

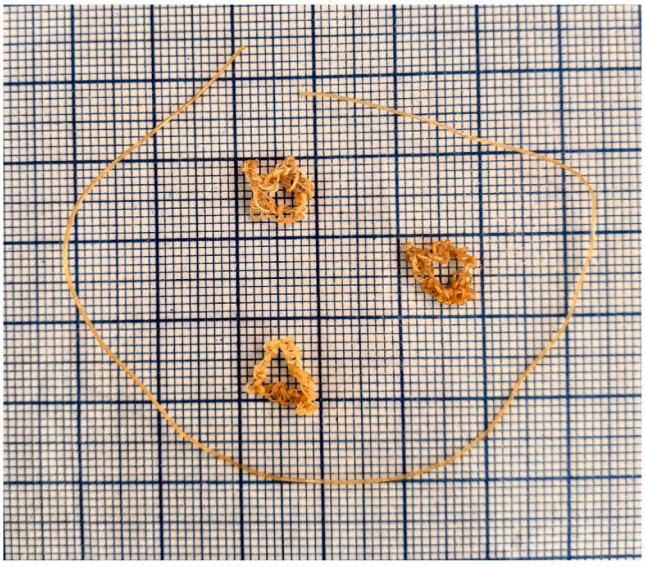

Fig. 1. Catgut suture randomly rolled into the bundles.

abovementioned catgut implants was carefully embedded internally. After that, the edges of the wound were sutured with a nonabsorbable polypropylene size 4/0 thread (Polypropylene; Ethicon, Somerville, NJ) with no antigenic properties.

To study the dynamics of destructive changes due to the catgut implant in the peritoneal cavity of the experimental animals, the animals were assigned into three groups in accordance with the time interval of their euthanasia that was achieved by ether anesthesia overdose 7 ml/kg of the body weight of a laboratory animal. (Flecknell, 2016;). The abdominal cavity of all animals was dissected following the euthanasia at 3, 7 and 14 days of the experiment.

To obtain statistically representative results, an additional group of Wistar albino male rats (n = 15) weighing from 312,86 ± 4,98 g. was added to the study.

2.3. Histological analysis

The findings of the study have been analyzed by the conventional histological methods and photography of the obtained specimens was made. The omentums were embedded in paraffin and divided into 4 μm thick tissue sections and Hematoxylin and Eosin (H&E) and Van Gieson stains were used. The specimens were then studied using a Konus light microscope equipped with the Sigeta DCM-900 9.0 MP digital microphotographic attachment with the Biorex 3 software adapted for these studies (serial number 5604). The morphometric characteristics of the tissue structures of the corresponding specimens were obtained using a system for visual analysis of histological specimens, as well as using the Sigeta X 1 mm/100 Div.x 0.01 mm object micrometer, the scale of which (equal to 1 mm, where the smallest division corresponds to 10 μm) was applied on the corresponding microimage obtained at an equivalent magnification.

2.4. Statistical analysis

All statistical analysis was carried out on a personal computer using the Prism 5 (version 5/03) and Microsoft Excel 2010 software packages, descriptive statistics and statistical analysis methods.

The descriptive statistics are presented as a mean and standard error of the mean (M±m). Qualitative indicators were presented in the form of absolute values (n) and percentages (%).

The values of the studied parameters between the groups were compared using the Kruskal-Wallis test (One-Way ANOVA).

The odds ratio (OR) was calculated to compare the preparations with implant absorbed by the serous structures of the testes and the greater omentum on day 3 and day 14 of the experiment.

Differences were considered statistically significant at $p < 0,05$.

3. Results

3.1. Results of the main group of experimental animal analysis

After opening the peritoneal cavity, its careful examination showed that in four out of five animals sacrificed on day 3 of the experiment, the catgut implant had adhered to the greater omentum (80%). The search for the fifth implant led to unexpected discovery: we found it conjoined with the second derivative of the visceral peritoneum, similar in structure to the greater omentum, but related to the testes (20%).

However, this phenomenon was not a single case. Thus, it was revealed that on day 7, the implant embedded into the peritoneal cavity of the animals, had adhered to the serous formations of the testes in all five cases (100%, three of them – to the left epididymal omentum and another two to the right one) and on day 14 (n = 5) in three cases it had adhered to the serous formations of the testes (60%, one of them to the left epididymal omentum and another two to the right one) and in two cases it had adhered to the greater omentum (40%) (Fig. 2).

While comparing the number of preparations with implant absorbed by the greater omentum and serous formations of the testes on day 3 and day 14 of the experiment the odds ratio was calculated: OR= 0.222; CI [0.012–3.979], $p < 0.05$.

At the same time, in five animals out of nine, the implants were located on the side of the left testicle (55.56%), while in four animals they had a right-sided connection (44.44%), indicating a completely random nature.

Eventually, out of 15 animals, only in six cases the catgut implant had adhered to the greater omentum (40%). In other animals (60%), the response to the implant was manifested by serous formations of the testes, which are fragmentary mentioned in the publications under different names that do not correspond to their essence, such as: “epididymal fat pad and epididymal fat”, “epididymal white adipose tissue”, “gonadal fat”, “gonadal depot of visceral white adipose tissue” (Bagchi and MacDougald, 2019; Chusyd et al., 2016; Dai et al., 2019; Lee, 2019).

Notably, regardless of the name no adequate comprehensible depiction of the structure of these formations, was found in literature, therefore, we conducted a thorough study of the abovementioned formations using an algorithm similar with that used for the study of the greater omentum (Maksymenko et al., 2022).

Therefore, to continue the analysis of the findings of the experimental studies, we would like to make a digression in order to fully familiarize with our resulting data on the morphological features of the serous formations of the testes of sexually mature albino male rats.

3.2. Results of analyses of the additional group of the experimental animals

After wide opening of the peritoneal cavity of the additional group the complete examination of its contents clearly showed that the target formations were localized naturally in different positions: in some cases, they were located superficially and could be clearly visualized, in other animals they were hidden among the loops of the small intestine, while in other cases we found them within the pelvic cavity and even immersed in the scrotum. Importantly, in all cases, they were easily extracted together with the testes, followed by the making of demonstrative total preparations (Fig. 3).

First of all, we have found that each testis of the albino rat has serous (peritoneal derivatives) formations of two types. One of them is a mesentery proper, with which each testis is solely attached to the posterior wall of the pelvic cavity, and the other is a free outgrowth of

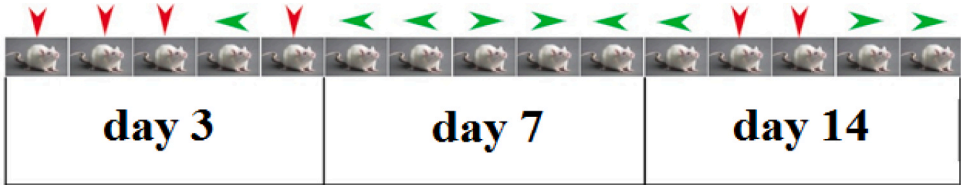

Fig. 2. The diagram of the assignment of animals over the time interval of the experiment with the designation of the omentum that absorbed the catgut implant. Red arrows indicate the absorption of the catgut implant by the greater omentum; green arrows indicate the absorption of the catgut implant by the epididymal omentum (arrow to the left – left testicle, arrow to the right – right testicle). *Note: p=0,3114

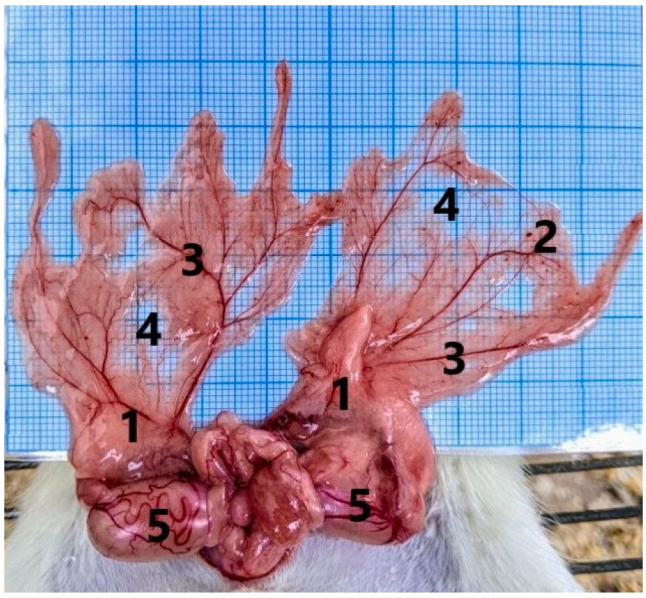

Fig. 3. Total preparation of the epididymal omentums of rat. Macroimage. 2 × magnification. 1 – the base of the omentum; 2 – free borders of the omentum; 3 – radial vascular-fatty tracts; 4 –serous-reticular membranes; 5 – testes.

reduplication of the serous membrane.

Generally, the above paired formation resembles a lobe, which has a narrow and short base, arising from the head of the epididymis. Blood vessels penetrate through this narrow base, which can be called a stem, starting from the head of the epididymis, branching radially in the reduplication of this serous lobe. At the same time, in each radially oriented blood tract there is an arterial vessel closely accompanied by a venous one. It`s completely notable that each radially oriented vascular tracts occupies an axial position in the marginiform adipose tissue with lobular distribution. Obviously, this image resembles the structural organization of the vascular-fatty arcades of the greater omentum. Notably, in the epididymal omentum, in contrast to the greater omentum, similar formations do not have an arcade, but a radial shape, which gives reason to call them radial vascular-fatty tracts. Generally, they are homeomorphic formations (Fig. 4).

This is also confirmed by the fact that in the fatty lobules of the radial vascular-fatty tracts of the epididymal omentum, separate milky spots have been found.

Herein, a marked similarity with the structure of the greater omentum is based on the presence in the latter of a laced structure of the intermediate zones between their radial vascular-fatty tracts, which we called serous-reticular membranes of the omentum. To confirm this, we present only some microimages of the intermediate zones of the serous lobes of the testes, which are similar to those of the greater omentum (Fig. 5).

Considering the findings of the previous studies (Hryn et al., 2022) it has been established that the area of the epididymal omentum exceeds the area of the greater omentum ($F=0.239; p = 0.006$) mainly due to the length ($r = 0.669$; $p = 0.006$), with their almost equal thickness ($F=1, 35; p = 0.291$) (Table 1).

3.3. Comparison of the results of the implant conjoin with the tissue structures of the greater and epididymal omentums

Eventually, a larger number of catgut implants were absorbed not by the greater omentum, but on its two (right and left) epididymal homologues, with an approximately equal distribution between them. However, the comparison between each of them individually shows that the overall number of the implants were absorbed by the greater omentum, which is presented in the diagram (Fig. 2), where it is shown that in the experimental animals, 6, 5 and 4 implants have been absorbed by the greater omentum, the left epididymal omentum, and the right epididymal omentum, respectively.

At the same time, it was established that the partial catgut threads rolled into flat bundles with an area of 1 cm^2, were adhered, generally, to the area of the free border either of the greater omentum or one of its two epididymal analogues. This tight adhesion of the implant to the marginal surface of the omenta occurred as soon as three days after its implantation into the peritoneal cavity of the experimental animals (Fig. 6).

Apparently, at this stage an organic adhesion of the implant to the tissue structures of the omenta occurs. In all cases, a morphological sign

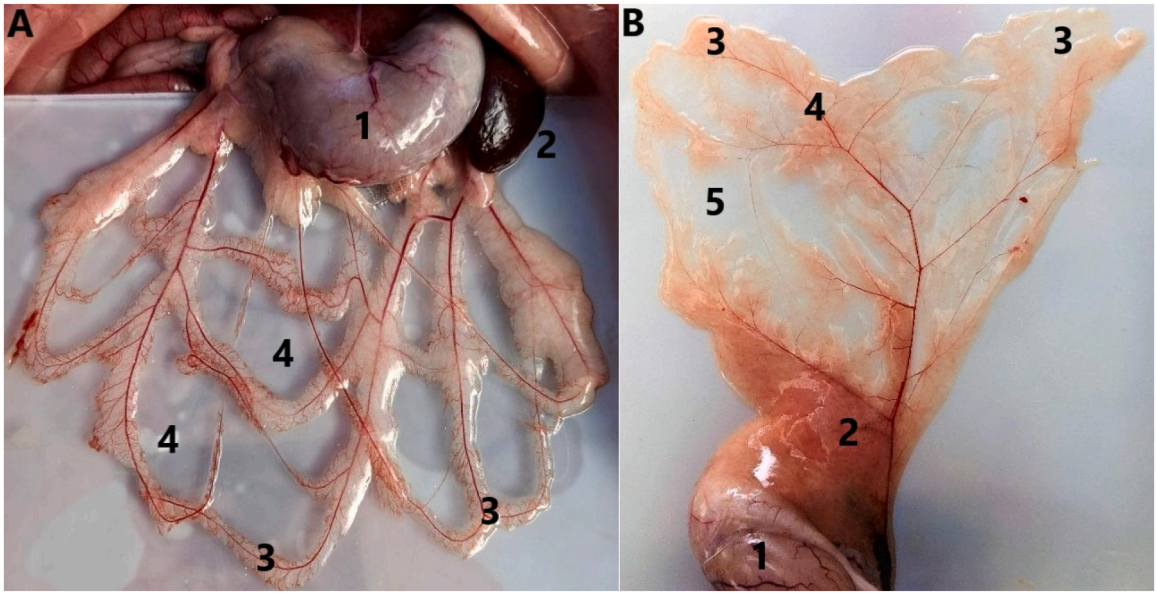

Fig. 4. Comparative demonstration of the total preparation of the greater omentum (A) with one of the epididymal omentum (B) of a mature male rat. Macroimage. A – 2 × magnification, B – 3 × magnification. A: 1 – stomach; 2 – spleen; 3 – vascular-fatty arcades; 4 – serous-reticular membranes. B: 1 – testis; 2 – the base of the omentum; 3 – free borders of the omentum; 4 – radial vascular-fatty tracts; 5 – serous-reticular membranes.

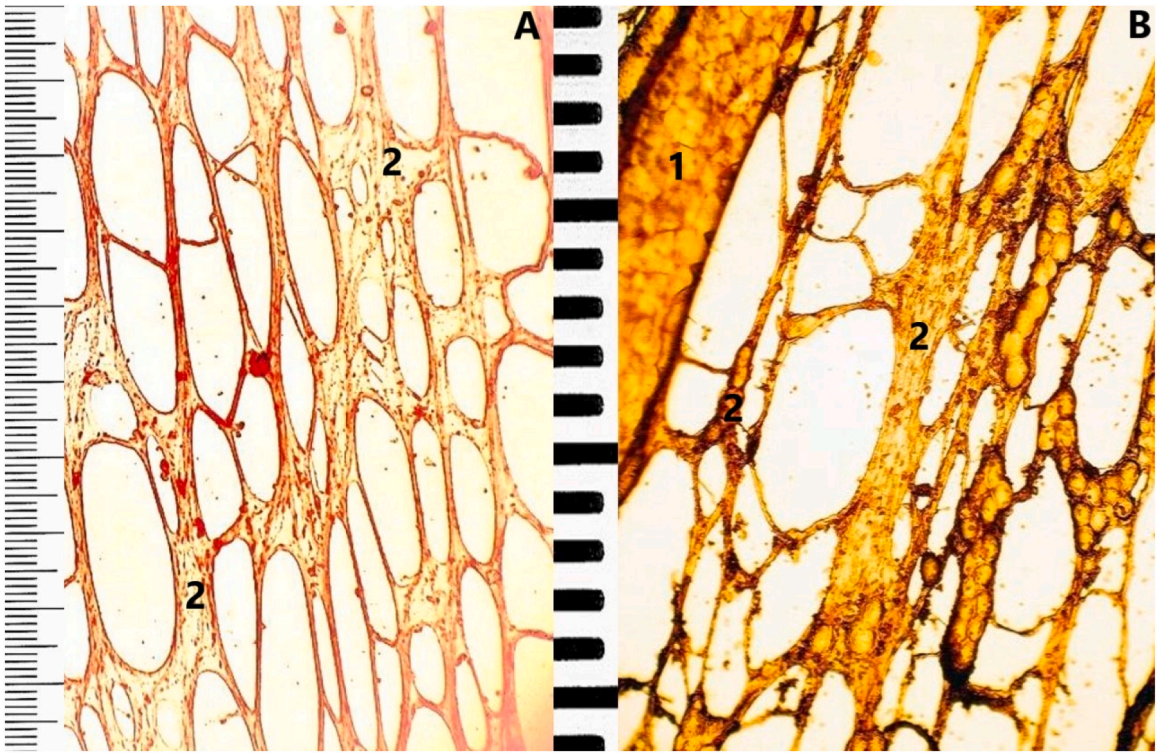

Fig. 5. Comparative demonstration of the serous-reticular membranes of the greater (A) and epididymal (B) omenta of a mature male rat. A - Objective lens 10 ×magnification, Van Gieson's stain. B – Objective lens 40 ×magnification H&E stain. The smallest division in the metric scale is 10 μm. 1 – tissue structures of the vascular-fatty tracts on the border with serous-reticular membranes; 2 – looped strands of serous-reticular membranes.

Table 1
General morphometric parameters of the greater and epididymal omenta (n = 15) M±m.

Morphometric parameters (M±m)	Greater omentum	Epididymal omentum
Length (mm)	43.61 ± 0.93	63.36 ± 2.52
Width (mm)	63.22 ± 1.52	69.54 ± 2.61
Area (mm^2)	2766.51 ± 103.73	4383.36 ± 212.09
Thickness (mm)	0.52 ± 0.02	0.58 ± 0.02

of a tight adhesion of the implant to the marginal zone of the omentum is growing of blood vessels into it, which starts from the omental vascular-fatty arcades and tracts (Fig. 6), indicating that the greater omentum and similar epididymal formations are homeomorphic derivatives of the peritoneum.

4. Discussion

4.1. Discussion on the analysis of the omenta

Noteworthy, it was totally unexpected for us to discover the presence of formations similar to greater omentum, involved in the absorption of the implants.

It is known that the gonadal white adipose tissue in male rats is associated with the epididymis and the testis itself and is called epididymal white adipose tissue, and in female rats, the gonadal white adipose tissue surrounds the uterus and ovaries and is called ovarian and parametrial tissue (Cinti, 2012; Rosen and Spiegelman, 2014).

A distinct description of the normal structure of serous formations of the epididymides, regardless of nomenclature, was not found in any source of literature, which made us to conduct a thorough study of them using the algorithm similar to the study of the greater omentum (Maksymenko et al., 2022; Hryn et al., 2022).

It should be noted that presently there is no clear data in the literature on the comparison between the greater omentum and epididymal fat. The only mention of it was by Chen et al. who report that the structure of the adipose tissue of the epididymides is similar to the adipose tissue of the greater omentum, which is also perfectly vascularized, located in the peritoneal cavity and varies in size. The findings of our study revealed absolute similarity of the elements comprising their morphological structure. Based on the findings, it would be more appropriate to call the above serous epididymal formations the "epididymal omenta" as compared to its existing terminology in the literature (Chen, 2007).

Bagchi and MacDougald (2019), have found that the epididymal white adipose tissue is associated with the epididymis and blood vessels, which is also confirmed by our research. At this point, there may be several visible blood vessels and they are oriented and branched radially, occupying an axial position, therefore, we call them radial vascular-fatty tracts, and no data on this phenomenon could be found in previous literature.

The findings of the morphometric analysis have established that the area of the epididymal omentum exceeds the area of the greater omentum mainly due to the length, which is confirmed by the studies of other authors, as well who consider epididymal fat as the largest representative of the white visceral fat in rodents (Chusyd et al., 2016; Sakata et al., 2020).

In addition, according to various authors, epididymal fat performs the function of a dynamic insulator, being the protective tissue of the epididymis, as well as energy function, produces cytokines and macrophages, and also provides transport for lipids and fatty acids, regulating metabolic homeostasis, which makes it possible to use this tissue in conducting various studies with insulin activity and modeling obesity (Chen et al., 2007; Dai et al., 2022; Sárvári et al., 2021; Villa et al., 2017).

As previously illustrated, the epididymal omentum contains milky spots similar to, but less common than those found in the greater omentum.

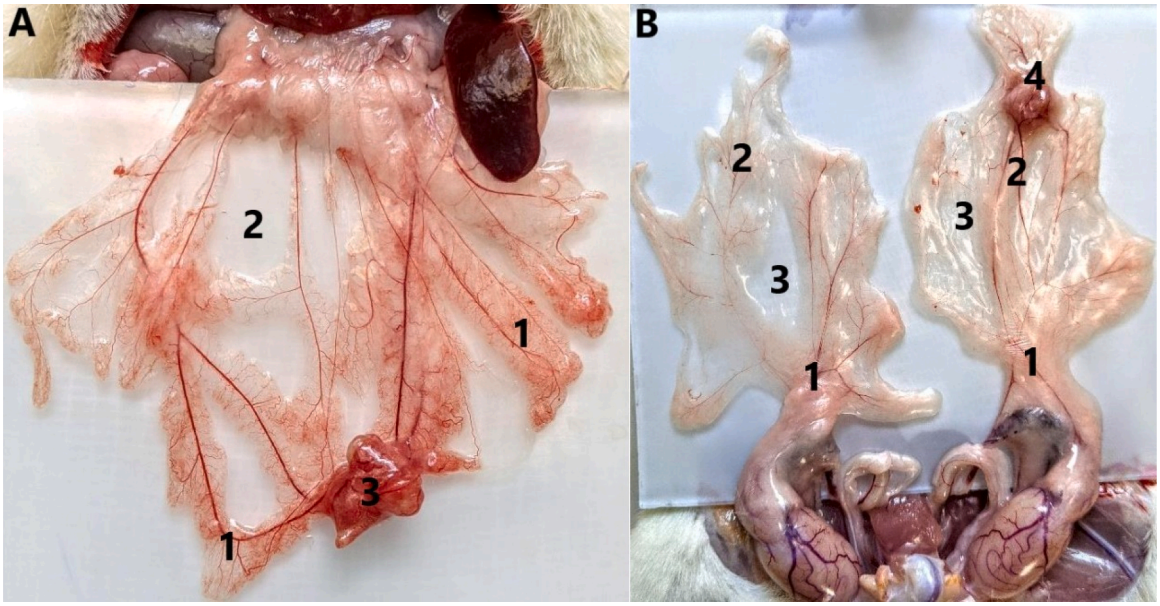

Fig. 6. Catgut implant associated with the greater (A) and the epididymal omenta of albino male rats within 3 days of the experiment. Macrophotography. A – 2 × magnification, B – 2 × magnification. A: 1 – vascular-fatty arcades; 2 – serous-reticular membranes; 3 – blood vessels, ingrown into the implant. B: 1 – the base of the omentum; 2 – radial vascular-fatty tracts; 3 – serous-reticular membranes; 4 – blood vessels, ingrown into the implant.

Consequently, our brief, but quite sufficient, comparative analysis between the structure of the greater omentum and the serous formations of the testes of albino rats shows that they, by the combination of similar tissue components in them, can be considered as homologous derivatives of the peritoneum. Based on this, we consider that it could be more correctly to call these testicular serous formations "epididymal omenta" as compared to the existing terms in the literature.

4.2. *Discussion on the experimental peritonitis models*

Peritonitis remains a serious clinically complex problem of the healthcare system. Despite the achieved success in its treatment, the mortality rate of peritonitis and its complications is growing (Montravers et al., 2021).

Currently, laboratory albino rats are one of the most popular experimental models for studies because they are easy of access (Mascena et al., 2018; Shepitko, 2019).

To date, a laboratory rat is the most widely used animal model in the simulation of peritonitis and in the studies of diseases of the gastrointestinal tract. Moreover, the anatomical structure of the internal organs of laboratory rats is similar to the human one (Hryn et al., 2018b; Mascena et al., 2018; Shepitko, 2019; Hryn et al., 2018a; Redondo-Calvo et al., 2022).

Various methods of simulating peritonitis have been proposed, which can be assigned into several groups according to the characteristics of reproduction of the purulent-inflammatory process in the abdominal cavity. The first group includes the methods of introduction of foreign bodies or chemical substances into the abdominal cavity; the second group involves methods of bacterial contamination of the abdominal cavity with various cultures of pathogenic microorganisms or fecal suspension through a puncture or incision through the abdominal wall, or by perforation of any part of the gastrointestinal tract; the third group can be represented by the combined methods of modeling acute experimental peritonitis, which include elements of the above mentioned methods in various combinations (Redondo-Calvo et al., 2021; Chen et al., 2017; Ito et al., 2017; Liu et al., 2021).

Liu et al. (2021), classify peritonitis, according to its cause, into aseptic peritonitis, bacterial peritonitis, peritoneal dialysis-associated peritonitis, and LPS (lipopolysaccharide)-induced peritonitis. An experimental peritonitis model can be created by intraperitoneal injection of LPS (10 mg/kg).

Shepitko (2019), Shepitko (2015), in his study modeled experimental aseptic inflammation of the rat peritoneum by intraperitoneal injection of 5 mg of λ-carrageenan (Sigma, USA) in 1 ml of physiological saline solution per animal, which caused acute aseptic inflammation. Subsequently, acute aseptic inflammation of the peritoneum caused by a single intraperitoneal injection of λ-carrageenan led to general changes in the membranes of the wall of the jejunum.

Siplyvyi et al. (2013) also experimentally modeled aseptic general peritonitis on Wistar mature albino rats by administration of 5 ml γ-carrageenan (Sigma, USA) per 1 ml of isotonic saline solution. On the basis of the conducted research, the staging of the course of experimental peritonitis with the hemomicrocirculatory changes characteristic for each stage has been confirmed.

One of the main conditions for the development of experimental peritonitis is the reproducibility and uniformity of the development of the disease, which undoubtedly affects the findings of the conducted experimental study.

The greater omentum is considered a barrier to bacterial invasion and, as a result, can convert the source of a possible development of peritonitis into a local abscess (Liu et al., 2021; Wang et al., 2020).

It has been found that the structures of the greater omentum are able to encapsulate foreign bodies (Forooghi et al., 2021; Vernik and Singh, 2007), that was revealed during our study. However, the data presented in our publication on the adhesive properties of the epididymal serous formations to foreign bodies in the abdominal cavity are not present in the literature and neither are comprehensive, systematic and morphometric description of the above structures.

5. Conclusion

During the experiment on implantation of a xenogenic substrate in the form of flat bundles at catgut thread, into the peritoneal cavity of sexually mature male rats, it was found for the first time that their acceptors were not only the greater omentum, but also two derivatives of the peritoneum, homeomorphic to it, associated with the epididymides, which we reasonably called epididymal omenta and described in details.

Thus, our study has found that the peritoneal cavity of sexually

mature male rats, unlike in humans, contains more than one omentum, to be more specific, three omenta (the lesser omentum, which appears in anatomy manuals, does not, in our opinion, belong to such formations). Therefore, in 60% of cases, it was not the greater omentum that absorbed most of the catgut implants, but two of its epididymal homologues (in 4 cases (44.44%) by the right one and in 5 cases (55.56%) by the left one).

Noteworthy, we have established that in all cases, without exception, the catgut implant was adhered to the border of one or another omentum, accompanied by invasion of blood vessels into it.

The details about the further development of the immune response of the omenta to the catgut implant are currently still being analyzed and will be presented at a later date.

Ethical statement

The authors are accountable for all aspects of this work in ensuring that questions related to the accuracy or integrity of any part of this work are appropriately investigated and resolved.

CRediT authorship contribution statement

Volodymyr Hryn: Conceptualization, Writing – review & editing, Methodology. **Yuriy Kostylenko:** Methodology, Writing – original draft. **Oleksandr Maksymenko:** Data curation, Resources, Investigation, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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