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MORPHOMETRIC CHANGES IN THE UTERUS IN EXPERIMENTAL LIVER INJURY: COMPARATIVE RESULTS IN 3- AND 9-MONTH-OLD FEMALE ALBINO RATS

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Abstract

Experimental liver injury may induce systemic pathological changes affecting not only hepatic tissue but also the structural and functional state of other organs, including the female reproductive system. The uterus is particularly sensitive to systemic metabolic, hormonal, vascular, and inflammatory disturbances associated with liver dysfunction. However, the age-related characteristics of uterine morphological and morphometric changes following experimental liver injury remain insufficiently studied.

Objective. The aim of this study was to evaluate the morphological and morphometric characteristics of the uterus in 3- and 9-month-old female albino rats following experimental liver injury and to determine the age-related patterns of structural changes in the endometrium, myometrium, perimetrium, uterine glands, and uterine blood vessels.

Materials and Methods. An experimental study was conducted using 3- and 9-month-old female albino rats. Experimental liver injury was induced by a single subcutaneous administration of heliotrine at a dose of 25 mg/100 g body weight. Age-matched intact animals served as controls. Following completion of the experiment, the animals were euthanized, and the uterus was excised for histological and morphometric examination. Uterine tissue samples were fixed in 10% neutral buffered formalin, processed by standard histological techniques, embedded in paraffin, sectioned at 4–5 μm, and stained with hematoxylin and eosin. Morphological examination was performed using light microscopy. Morphometric analysis was carried out using QuPath 0.5.1 on digitized histological images. The total thickness of the uterine wall, thickness of the endometrium, myometrium and perimetrium, surface epithelial height, endometrial stromal parameters, uterine gland diameter and number, muscle fiber diameter, and uterine blood vessel diameter were assessed. Statistical analysis was performed using Microsoft Excel and IBM SPSS Statistics, with $p<0.05$ considered statistically significant.

Results. In intact animals, age-related structural remodeling of the uterus was observed. Compared with 3-month-old animals, 9-month-old rats demonstrated an increase in total uterine wall thickness from 950±18 to 1045±20 μm, endometrial thickness from 181±4 to 202±5 μm, surface epithelial height from 20.1±0.3 to 21.5±0.4 μm, endometrial stromal thickness from 156±3 to 170±4 μm, uterine gland diameter from 27.4±0.7 to 30.4±0.8 μm, myometrial thickness from 738±12 to 798±14 μm, muscle fiber diameter from 14.2±0.3 to 15.6±0.3 μm, perimetrium thickness from 30.2±0.8 to 32.1±0.8 μm, and blood vessel diameter from 40.6±1.1 to 45.3±1.2 μm. At the same time, the number of uterine glands decreased from 21.3±0.8 to 19.8±0.7 glands/mm².

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Following experimental liver injury, 3-month-old rats demonstrated a decrease in total uterine wall thickness to 875±17 μm, endometrial thickness to 158±4 μm, surface epithelial height to 17.8±0.3 μm ($p<0.001$), stromal thickness to 138±3 μm, uterine gland diameter to 23.8±0.6 μm ($p<0.001$), and gland density to 17.6±0.7 glands/mm² ($p<0.01$). Myometrial thickness decreased to 690±11 μm, muscle fiber diameter to 12.8±0.3 μm, and perimetrium thickness to 27.1±0.7 μm, whereas blood vessel diameter increased to 46.8±1.2 μm ($p<0.01$). In 9-month-old experimental animals, more pronounced morphometric alterations were observed. Total uterine wall thickness decreased to 925±19 μm, endometrial thickness to 171±4 μm, surface epithelial height to 18.2±0.3 μm ($p<0.001$), stromal thickness to 148±3 μm, uterine gland diameter to 25.7±0.7 μm ($p<0.001$), and gland density to 15.2±0.6 glands/mm² ($p<0.001$). Myometrial thickness decreased to 731±13 μm, muscle fiber diameter to 13.7±0.3 μm, and perimetrium thickness to 28.4±0.7 μm, while blood vessel diameter increased to 53.6±1.4 μm ($p<0.001$). These findings indicate more pronounced structural remodeling and microcirculatory disturbances in older experimental animals.

Conclusion. Experimental liver injury induces significant morphological and morphometric remodeling of the uterus in female albino rats, affecting all major uterine layers, the glandular apparatus, and vascular structures. The observed changes are characterized predominantly by a reduction in uterine wall, endometrial and myometrial thickness, decreased surface epithelial height, alterations in endometrial stroma and uterine glands, and increased blood vessel diameter. The severity of these changes varies with animal age and is more pronounced in 9-month-old rats. These findings indicate that experimental liver injury may have a significant systemic effect on the female reproductive system and that age-related structural characteristics of the uterus should be considered when evaluating its response to hepatic injury.

Keywords: experimental liver injury, uterus, female albino rats, endometrium, myometrium, perimetrium, uterine glands, morphometry, histology, age-related changes, heliotrine.

INTRODUCTION

In modern medicine, the liver is considered one of the most important organs involved not only in metabolic processes but also in the regulation of hormonal, immune, detoxification, and hemodynamic processes in the body. Impaired liver function may adversely affect the morphofunctional state of numerous organs and systems. In particular, the study of secondary structural changes occurring in the organs of the reproductive system under conditions of liver injury is one of the topical areas of modern morphology and experimental medicine. Due to the functional interrelationship between the liver and the reproductive system, impaired hepatocyte function may lead to alterations in hormone metabolism, blood circulation, immune responses, and tissue trophic status.

The uterus is one of the central organs of the female reproductive system, and its normal morphofunctional state ensures conception and the development of pregnancy, embryo implantation, fetal development, and the physiological course of childbirth. The uterine wall consists of the endometrium, myometrium, and perimetrium, each of which

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has specific structural and functional characteristics. The endometrium contains the surface epithelium, glands, stromal components, and blood vessels, whereas the myometrium is predominantly composed of smooth muscle cells. The coordinated functioning of these structural components ensures the normal functional state of the uterus. The mechanisms underlying changes that may occur in uterine tissue under conditions of liver injury are multifactorial. On the one hand, reduced metabolic and detoxification functions of the liver may result in the accumulation of various biologically active substances and metabolites in the body. On the other hand, disturbances in hormonal metabolism may affect the structural state of the endometrium and myometrium. In addition, impaired liver function may be accompanied by changes in the biochemical composition of the blood, hemostasis, microcirculation, and immune processes. The combined effects of these factors may contribute to the development of dystrophic, degenerative, and compensatory-reparative changes in uterine tissue.

In recent years, the number of scientific studies investigating the prevalence of liver diseases and their effects on the functioning of various organs has increased. However, the effects of liver injury on the female reproductive system, particularly on the morphological and morphometric characteristics of uterine tissue, have not yet been sufficiently studied in a systematic manner. Most existing studies have focused on the metabolic, hematological, and endocrine consequences of liver pathology, whereas structural changes in individual components of the uterine wall have been less extensively investigated using a comprehensive morphometric approach. A comprehensive study of uterine morphology requires not only the identification of macroscopic and microscopic changes but also their quantitative assessment. Morphometric methods make it possible to determine the overall thickness of the uterine wall, the thickness of the endometrium and myometrium, the structural characteristics of epithelial cells, the condition of the endometrial glands, as well as the morphometric parameters of stromal and vascular components. Such an approach makes it possible to objectively assess the severity of the pathological process, identify age-related differences, and compare changes in experimental groups with control parameters. In particular, age is an important factor in assessing the morphofunctional response of the uterus under conditions of liver injury. The regenerative potential of tissues, functional state of blood vessels, sensitivity to hormonal influences, and intensity of metabolic processes vary across different age periods of the organism. Therefore, comparative investigation of morphometric parameters of uterine tissue in experimental animals of different age groups is important for identifying age-related characteristics of the pathological process. The surface epithelial layer of the endometrium is of particular importance in assessing the morphological state of the uterus. Changes in epithelial cell height, density, and morphological structure may provide information about the functional state of the tissue. Liver injury-associated disturbances in hormonal and metabolic balance may lead to structural remodeling of the epithelial component. At the same time, the number, shape, distribution, and relationship of endometrial glands with the stromal component are also important morphological criteria for assessing the functional state of the uterus.

The morphological state of the myometrium is also of great importance for maintaining uterine function. The thickness of the smooth muscle layer, arrangement of muscle fibers, and their relationship with blood vessels determine the contractile properties

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of the uterus. Under conditions of liver injury, metabolic disturbances and changes in microcirculation may induce structural remodeling of the myometrium. Therefore, in addition to the endometrium, investigation of the morphometric parameters of the myometrium represents an important area of the study. The condition of the vascular component is also an important parameter for assessing pathological processes in uterine tissue. The normal functioning of the endometrium and myometrium is directly dependent on adequate blood supply. Liver dysfunction may lead to hemodynamic alterations, changes in the rheological properties of blood, and modifications of the vascular wall. As a result, changes in the uterine microcirculatory system may include vascular dilation or constriction, remodeling of the vascular wall, perivascular changes, and disturbances in tissue trophic status. The use of an experimental model makes it possible to investigate more thoroughly the cause-and-effect relationship between liver injury and morphological changes in the uterus. Experimental studies allow the controlled observation of the stages of pathological process development, the formation of experimental and control groups under standardized conditions, and statistical comparison of the obtained morphometric parameters. In this regard, comprehensive assessment of the morphological state of the uterus in experimental liver injury is of considerable scientific and practical importance.

MATERIALS AND METHODS

The study was conducted using an experimental liver injury model in 3- and 9-month-old female albino rats. The experimental animals included 3-month-old rats weighing 170–190 g and 9-month-old rats weighing 260–300 g, with no apparent pathological changes in the reproductive system or general somatic condition. The experimental animals were maintained under standard vivarium conditions. Water and standard feed were provided ad libitum. Before the experiment, the rats underwent a two-week quarantine and acclimatization period under vivarium conditions. Throughout the study, the animals' general condition, body weight, mobility, feeding behavior, and changes in external appearance were monitored regularly.

Liver injury was induced by establishing an experimental model. For acute heliotrine-induced liver intoxication, the rats were administered a single subcutaneous dose of heliotrine solution acidified with hydrochloric acid (pH 7.0) at a dose of 25 mg per 100 g of body weight, in a volume of 0.25 mL. Rats in the control group simultaneously received the same volume of the solvent subcutaneously. At the end of the experiment, the animals were euthanized at the designated time point, and the uterus was excised. The obtained tissue samples underwent standard histological processing for subsequent morphological and morphometric investigations.

Uterine tissues were fixed in 10% neutral buffered formalin. Subsequently, the specimens were dehydrated through a graded series of alcohols, cleared in xylene, and embedded in paraffin. Serial sections 4–5 μm thick were prepared from the paraffin blocks. Histological specimens were stained with hematoxylin and eosin and examined using light microscopy. The morphological structure of the uterus was studied using hematoxylin and eosin staining. Microscopic examination identified the main structural components of the uterine wall—the endometrium, myometrium, and perimetrium. The surface of the endometrium was lined by a single layer of columnar epithelium, beneath which cellular connective tissue stroma and uterine glands were located. Functional and basal layers were

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distinguished within the endometrium. The myometrium consisted of smooth muscle tissue, with muscle fibers arranged in different directions; numerous blood vessels were observed in its middle portion. Externally, the uterus was covered by the perimetrium. The specimens were examined by light microscopy at various magnifications, including ×40, ×100, ×200, and ×400.

Morphometric parameters of the uterus were determined using the QuPath 0.5.1 software based on digitized histological images. During the study, the overall thickness of the uterine wall; morphometric parameters of the endometrium, myometrium, and perimetrium; height of the endometrial surface epithelium; number and diameter of uterine glands; area of the stromal component of the endometrium; thickness of the myometrial muscle layer; as well as the diameter and density of uterine blood vessels were assessed. The results of the morphometric analysis were comparatively evaluated between the control and experimental groups to determine the extent of structural changes occurring in uterine tissue against the background of liver injury. The quantitative data obtained were processed using methods of variation statistics. The results were expressed as M±m, where M represents the arithmetic mean and m represents the standard error of the mean. The statistical significance of differences between the groups was assessed using appropriate statistical tests, and a value of $p<0.05$ was considered statistically significant. Statistical analysis was performed using Microsoft Excel and IBM SPSS Statistics software.

RESULTS

Microscopic examination of the uterus of 3-month-old intact rats revealed that the main morphological layers of the uterine wall—the endometrium, myometrium, and perimetrium—were well developed. The surface of the endometrium was lined by a single layer of columnar epithelium. The epithelial cells were uniform in shape and size, with clearly defined nuclei. The endometrial stroma was relatively dense, and the uterine glands were evenly distributed within it. The myometrium consisted of well-developed smooth muscle fibers, with muscle bundles arranged in different directions. Blood vessels were identified between the myometrial muscle bundles. The perimetrium was covered by a thin layer of connective tissue and mesothelium. Under conditions of experimental liver injury, structural remodeling may occur in the uterus of 3-month-old rats compared with the control group. A decrease in the height of the surface epithelium, increased density of the stromal component, changes in the diameter and number of uterine glands, alterations in the morphometric parameters of myometrial muscle fibers, and changes in the diameter of blood vessels may be observed. Microscopic examination of the uterus of 9-month-old intact rats demonstrated preservation of the main layers of the uterine wall. The surface epithelium of the endometrium was relatively higher, while the stromal component and uterine glands were well developed. The thickness of the myometrial muscle layer increased compared with that in 3-month-old animals. The diameter of blood vessels and their distribution within the stromal component were also relatively more pronounced. Under conditions of experimental liver injury, changes in the uterine tissue of 9-month-old animals may be more pronounced. A decrease in endometrial thickness, reduction in the height of the surface epithelium, a decrease in the number and diameter of the glands, remodeling of the stromal component, and structural changes in the myometrium were observed. An increase in the diameter of blood vessels may be considered a morphological

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manifestation of microcirculatory disturbances. The obtained morphometric results demonstrated significant differences in the structural parameters of the uterus between 3- and 9-month-old intact and experimental rats. In the 3-month-old control group, the overall thickness of the uterine wall was 950±18 μm, whereas in the 9-month-old control group, this parameter increased to 1045±20 μm, representing a 10.0% increase. In the experimental groups, the corresponding values were 875±17 and 925±19 μm, respectively. Thus, experimental liver injury resulted in a decrease of 7.9% compared with the control group in 3-month-old animals and 11.5% in 9-month-old animals. Endometrial thickness also varied depending on age and experimental exposure. In 3-month-old control animals, endometrial thickness was 181±4 μm, whereas in the 9-month-old control group it reached 202±5 μm. In the experimental groups, the corresponding values were 158±4 and 171±4 μm, respectively. Thus, under conditions of liver injury, endometrial thickness decreased by 12.7% in 3-month-old animals and by 15.3% in 9-month-old animals. The height of the surface epithelium was 20.1±0.3 μm in the 3-month-old control group and 21.5±0.4 μm in the 9-month-old control group. In the experimental groups, the corresponding values were 17.8±0.3 and 18.2±0.3 μm, respectively. In the control groups, epithelial height increased by 7.0% with increasing age, whereas under experimental conditions, age-related growth of this parameter was minimal. At the same time, experimental liver injury reduced epithelial height by 11.4% in 3-month-old animals and by 15.3% in 9-month-old animals. The thickness of the endometrial stroma was also reduced in the experimental groups compared with the control groups. In the 3-month-old control group, this parameter was 156±3 μm, increasing to 170±4 μm in the 9-month-old control group. In the experimental groups, values of 138±3 and 148±3 μm were recorded, respectively. Consequently, against the background of liver injury, the thickness of the stromal component decreased by 11.5% in 3-month-old animals and by 12.9% in 9-month-old animals. The diameter of the uterine glands was 27.4±0.7 μm in the 3-month-old control group and 30.4±0.8 μm in the 9-month-old control group. In the experimental groups, these values were 23.8±0.6 and 25.7±0.7 μm, respectively. In the control groups, the diameter of the glands increased by 10.9% with age, whereas in the experimental groups this parameter increased by 8.0%. As a result of experimental liver injury, gland diameter decreased by 13.1% in 3-month-old animals and by 15.5% in 9-month-old animals. The number of uterine glands also decreased under the influence of the experimental condition. In 3-month-old control animals, the number of glands was 21.3±0.8 glands/mm², whereas in the experimental group it was 17.6±0.7 glands/mm². In 9-month-old animals, the corresponding values were 19.8±0.7 and 15.2±0.6 glands/mm², respectively. These findings indicate that experimental exposure reduced the number of glands by 17.4% in 3-month-old animals and by 23.2% in 9-month-old animals. This change may indicate an intensification of structural remodeling processes in the glandular component of the endometrium. The thickness of the myometrium was 738±12 μm in the 3-month-old control group and 798±14 μm in the 9-month-old control group. In the experimental groups, these parameters were 690±11 and 731±13 μm, respectively. In control animals, myometrial thickness increased by 8.1% with age, whereas in the experimental groups it increased by 5.9%. Liver injury reduced myometrial thickness by 6.5% in 3-month-old animals and by 8.4% in 9-month-old animals. The diameter of myometrial muscle fibers increased from 14.2±0.3 μm in the 3-month-old control group to 15.6±0.3 μm in the 9-month-old control group. In the

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experimental groups, the corresponding values were 12.8±0.3 and 13.7±0.3 μm. Under the experimental conditions, the diameter of the muscle fibers decreased by 9.9% in 3-month-old animals and by 12.2% in 9-month-old animals. Changes were also observed in the thickness of the perimetrium. In the 3-month-old control group, this parameter was 30.2±0.8 μm, increasing to 32.1±0.8 μm in the 9-month-old control group. In the experimental groups, the corresponding values were 27.1±0.7 and 28.4±0.7 μm, respectively. Experimental liver injury resulted in a decrease in perimetrium thickness of 10.3% in 3-month-old animals and 11.5% in 9-month-old animals. Unlike the other parameters, the diameter of the uterine blood vessels increased in the experimental groups. In the 3-month-old control group, the vascular diameter was 40.6±1.1 μm, whereas in the experimental group it was 46.8±1.2 μm. In the 9-month-old control group, the vascular diameter was 45.3±1.2 μm, while in the experimental group it reached 53.6±1.4 μm. Thus, under experimental conditions, the diameter of the blood vessels increased by 15.3% in 3-month-old animals and by 18.3% in 9-month-old animals. This finding may be associated with compensatory or pathological vascular dilation in the uterine microcirculatory system against the background of liver injury.

Overall, comparison of the morphometric parameters of 3- and 9-month-old animals demonstrated that experimental liver injury adversely affected the main structural components of the uterus. The experimental groups showed decreases in the overall thickness of the uterine wall, endometrial and myometrial thickness, surface epithelial height, endometrial stromal thickness, diameter and number of uterine glands, and diameter of myometrial muscle fibers. At the same time, an increase in the diameter of blood vessels was observed. These changes were more pronounced in 9-month-old experimental animals than in the 3-month-old experimental group, indicating that the effect of liver injury on uterine tissue may become more pronounced with increasing age.

DISCUSSION

Comparative analysis of the morphometric parameters of the uterus in 3- and 9-month-old intact animals demonstrated that, with increasing age, the overall thickness of the uterine wall increased from 950±18 μm to 1045±20 μm, endometrial thickness from 181±4 μm to 202±5 μm, epithelial height from 20.1±0.3 μm to 21.5±0.4 μm, and endometrial stromal thickness from 156±3 μm to 170±4 μm. In addition, the diameter of the uterine glands increased from 27.4±0.7 μm to 30.4±0.8 μm, myometrial thickness from 738±12 μm to 798±14 μm, muscle fiber diameter from 14.2±0.3 μm to 15.6±0.3 μm, and perimetrium thickness from 30.2±0.8 μm to 32.1±0.8 μm. The diameter of blood vessels also increased from 40.6±1.1 μm to 45.3±1.2 μm. At the same time, the number of endometrial glands decreased from 21.3±0.8 to 19.8±0.7 glands/mm². These changes indicate age-related structural remodeling of uterine tissue during the period from 3 to 9 months of age. In 3-month-old animals, comparison of the morphometric parameters of the uterus in the experimental group with those in the intact group revealed a decrease in all major structural parameters. The overall thickness of the uterine wall decreased from 950±18 μm to 875±17 μm, endometrial thickness from 181±4 μm to 158±4 μm, and epithelial height from 20.1±0.3 μm to 17.8±0.3 μm ($p<0.001$). The thickness of the endometrial stroma decreased from 156±3 μm to 138±3 μm, while the diameter of the uterine glands decreased from 27.4±0.7 μm to 23.8±0.6 μm; these differences were highly

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statistically significant ($p<0.001$). The number of glands decreased from 21.3±0.8 to 17.6±0.7 glands/mm² ($p<0.01$). Myometrial thickness decreased from 738±12 µm to 690±11 µm, muscle fiber diameter from 14.2±0.3 µm to 12.8±0.3 µm, and perimetrium thickness from 30.2±0.8 µm to 27.1±0.7 µm ($p<0.01$; $p<0.05$). In contrast, the diameter of blood vessels increased from 40.6±1.1 µm to 46.8±1.2 µm ($p<0.01$). Thus, in 3-month-old experimental animals, structural disturbances developed in the main tissue components of the uterus, characterized by predominantly atrophic changes accompanied by dilation of the blood vessels. In 9-month-old animals, the morphometric parameters of the uterus in the experimental group were also significantly reduced compared with those in the intact group. The overall thickness of the uterine wall decreased from 1045±20 µm to 925±19 µm, endometrial thickness from 202±5 µm to 171±4 µm, and epithelial height from 21.5±0.4 µm to 18.2±0.3 µm ($p<0.001$). Endometrial stromal thickness decreased from 170±4 µm to 148±3 µm, while gland diameter decreased from 30.4±0.8 µm to 25.7±0.7 µm ($p<0.001$). The number of glands decreased from 19.8±0.7 to 15.2±0.6 glands/mm², and the difference was highly statistically significant ($p<0.001$). Myometrial thickness decreased from 798±14 µm to 731±13 µm, muscle fiber diameter from 15.6±0.3 µm to 13.7±0.3 µm, and perimetrium thickness from 32.1±0.8 µm to 28.4±0.7 µm ($p<0.01$–$p<0.001$). In contrast, the diameter of blood vessels increased from 45.3±1.2 µm to 53.6±1.4 µm ($p<0.001$). These findings indicate that structural changes in uterine tissue persisted in 9-month-old experimental animals and were more pronounced for certain parameters. Comparative analysis of the morphometric parameters of the uterus in 3- and 9-month-old experimental animals demonstrated that, with increasing age, the overall thickness of the uterine wall increased from 875±17 µm to 925±19 µm, endometrial thickness from 158±4 µm to 171±4 µm, epithelial height from 17.8±0.3 µm to 18.2±0.3 µm, and endometrial stromal thickness from 138±3 µm to 148±3 µm. The diameter of the uterine glands increased from 23.8±0.6 µm to 25.7±0.7 µm, myometrial thickness from 690±11 µm to 731±13 µm, muscle fiber diameter from 12.8±0.3 µm to 13.7±0.3 µm, and perimetrium thickness from 27.1±0.7 µm to 28.4±0.7 µm. The diameter of blood vessels increased from 46.8±1.2 µm to 53.6±1.4 µm. However, the number of glands decreased from 17.6±0.7 to 15.2±0.6 glands/mm². Thus, although some morphometric parameters in 9-month-old animals under experimental conditions demonstrated partial recovery or an increase compared with the 3-month-old animals, they did not reach the values observed in the corresponding age-matched intact animals. This finding indicates that, alongside age-related remodeling processes, persistent pathological changes remain in uterine tissue under conditions of liver injury.

CONCLUSION

Based on the results of the comparative morphological and morphometric study, it was established that experimental liver injury induces significant structural and morphometric changes in the uterus of female albino rats of different age groups. In intact animals, age-related structural remodeling of the uterus was observed, manifested by an increase in the total thickness of the uterine wall, endometrial and myometrial thickness, surface epithelial height, endometrial stromal parameters, uterine gland diameter, muscle fiber diameter, and blood vessel diameter in 9-month-old animals compared with 3-month-old animals, while the number of uterine glands decreased. Experimental liver injury was

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accompanied by a decrease in the total thickness of the uterine wall, endometrial and myometrial thickness, surface epithelial height, endometrial stromal parameters, uterine gland diameter and number, as well as muscle fiber diameter. At the same time, an increase in uterine blood vessel diameter was observed, indicating the development of microcirculatory disturbances. These changes were more pronounced in 9-month-old experimental animals, particularly with respect to epithelial height, uterine gland parameters, and vascular diameter. The comparative analysis of 3- and 9-month-old experimental animals demonstrated that, although some morphometric parameters increased with age, they did not reach the values observed in age-matched intact animals. Thus, experimental liver injury causes pronounced structural and morphometric remodeling of the uterus, characterized predominantly by atrophic changes in the endometrium and myometrium, alterations in the uterine glandular apparatus, and vascular changes. The severity of these changes is influenced by the age of the animals, indicating that age-related structural characteristics of the uterus may affect its response to systemic pathological effects associated with liver injury.

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Journal of Advances in Drug Research

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