

MORPHOMETRIC REMODELING OF THE UTERUS IN FEMALE RATS AFTER EXPERIMENTAL LIVER INJURY

Olimova Aziza Zokirovna

*Associate Professor, Department of Preclinical Sciences,
Asian International University*

ABSTRACT

The study aimed to assess structural and morphometric remodeling of the uterus in female albino rats after experimental liver injury. Female rats aged 3 and 9 months were examined, with intact age-matched animals serving as controls. Liver injury was induced by a single subcutaneous injection of heliotrine at a dose of 25 mg/100 g body weight. Uterine specimens were fixed in 10% neutral formalin, processed routinely, and stained with hematoxylin and eosin. Morphometric measurements were performed on digital microphotographs using QuPath 0.5.1. Experimental liver injury produced reductions in the thickness of the uterine wall and its structural components, as well as decreases in epithelial height, stromal thickness, uterine gland diameter and gland density. In 3-month-old rats, uterine wall thickness decreased from 950 ± 18 to 875 ± 17 μm , endometrial thickness from 181 ± 4 to 158 ± 4 μm , and stromal thickness from 156 ± 3 to 138 ± 3 μm . Myometrial thickness decreased to 690 ± 11 μm , while muscle fiber diameter decreased to 12.8 ± 0.3 μm . In 9-month-old animals, uterine wall thickness decreased to 925 ± 19 μm , endometrial thickness to 171 ± 4 μm , and stromal thickness to 148 ± 3 μm . Myometrial thickness and muscle fiber diameter decreased to 731 ± 13 and 13.7 ± 0.3 μm , respectively. Uterine gland diameter and density decreased to 23.8 ± 0.6 μm and 17.6 ± 0.7 glands/ mm^2 in 3-month-old animals and to 25.7 ± 0.7 μm and 15.2 ± 0.6 glands/ mm^2 in 9-month-old animals. In contrast, vascular diameter increased to 46.8 ± 1.2 and 53.6 ± 1.4 μm , respectively. The findings demonstrate that hepatic injury is accompanied by pronounced morphometric remodeling of the uterus, with greater changes in older animals.

Keywords: experimental liver injury, uterus, morphometric remodeling, endometrium, myometrium, uterine glands, vascular changes, female rats, heliotrine, histology.

МОРФОМЕТРИЧЕСКОЕ РЕМОДЕЛИРОВАНИЕ МАТКИ У САМОК КРЫС ПОСЛЕ ЭКСПЕРИМЕНТАЛЬНОГО ПОВРЕЖДЕНИЯ ПЕЧЕНИ

Олимова Азиза Зокировна

Доцент кафедры доклинических наук, Asian International University

АБСТРАКТ

Целью исследования явилась оценка структурно-морфометрической перестройки матки у самок белых крыс после экспериментального повреждения печени. Исследование проведено на самках крыс в возрасте 3 и 9 месяцев, при этом соответствующие интактные животные использовались в качестве контрольных групп. Повреждение печени моделировали однократным подкожным введением гелиотрина в дозе 25 мг/100 г массы тела. Маточный материал фиксировали в 10% нейтральном формалине, подвергали стандартной гистологической обработке и окрашивали гематоксилином и эозином. Морфометрические измерения выполняли на цифровых микрофотографиях с использованием программы QuPath 0.5.1. После экспериментального повреждения печени выявлено уменьшение толщины стенки матки и ее структурных компонентов, а также снижение высоты эпителия, толщины стромы, диаметра и плотности маточных желез. У 3-месячных животных толщина стенки матки уменьшилась с 950 ± 18 до 875 ± 17 мкм, эндометрия — со 181 ± 4 до 158 ± 4 мкм, стромы — со 156 ± 3 до 138 ± 3 мкм. Толщина миометрия снизилась до 690 ± 11 мкм, а диаметр мышечных волокон — до $12,8 \pm 0,3$ мкм. У 9-месячных животных толщина стенки матки составила 925 ± 19 мкм, эндометрия — 171 ± 4 мкм, стромы — 148 ± 3 мкм. Толщина миометрия и диаметр мышечных волокон снизились соответственно до 731 ± 13 и $13,7 \pm 0,3$ мкм. Диаметр и плотность маточных желез у 3-месячных животных уменьшились до $23,8 \pm 0,6$ мкм и $17,6 \pm 0,7$ желез/мм², а у 9-месячных — до $25,7 \pm 0,7$ мкм и $15,2 \pm 0,6$ желез/мм². В то же время диаметр кровеносных сосудов увеличился соответственно до $46,8 \pm 1,2$ и $53,6 \pm 1,4$ мкм. Полученные результаты свидетельствуют о выраженной морфометрической перестройке матки при экспериментальном повреждении печени, причем наиболее значительные изменения наблюдаются у животных старшего возраста.

Ключевые слова: экспериментальное повреждение печени, матка, морфометрическая перестройка, эндометрий, миометрий, маточные железы, сосудистые изменения, белые крысы, гелиотрин, гистология.

EKSPERIMENTAL JIGAR SHIKASTLANISHIDAN KEYIN URG'OCHI KALAMUSHLAR BACHADONINING MORFOMETRIK QAYTA QURILISHI

Olimova Aziza Zokirovna

Asian International University, Klinik oldi fanlar kafedrası dotsenti

ANNOTATSIYA

Tadqiqotning maqsadi eksperimental jigar shikastlanishidan keyin urg'ochi oq kalamushlar bachadonidagi strukturaviy va morfometrik qayta qurilishlarni baholashdan iborat bo'ldi. Tadqiqot 3 va 9 oylik urg'ochi kalamushlarda olib borildi, tegishli yoshdagi intakt hayvonlar nazorat guruhi sifatida olindi. Jigar shikastlanishi 25 mg/100 g tana vazniga miqdorda geliotrinni bir martalik teri ostiga yuborish orqali modellashtirildi. Bachadon to'qimalari 10% neytral formalinda fiksatsiya qilindi, standart gistologik usulda qayta ishlanib, gematoksilin va eozin bilan bo'yaldi. Morfometrik o'lchovlar QuPath 0.5.1 dasturi yordamida raqamli mikrofotosuratlarda amalga oshirildi. Eksperimental jigar shikastlanishidan so'ng bachadon devori va uning asosiy strukturaviy qismlari qalinligining, shuningdek, epiteliy balandligi, stroma qalinligi, bachadon bezlari diametri va zichligining kamayishi aniqlandi. 3 oylik hayvonlarda bachadon devorining umumiy qalinligi 950 ± 18 mkm dan 875 ± 17 mkm gacha, endometriy qalinligi 181 ± 4 mkm dan 158 ± 4 mkm gacha, stroma qalinligi esa 156 ± 3 mkm dan 138 ± 3 mkm gacha kamaydi. Miometriy qalinligi 690 ± 11 mkm gacha, mushak tolalari diametri esa $12,8 \pm 0,3$ mkm gacha pasaydi. 9 oylik hayvonlarda bachadon devori qalinligi 925 ± 19 mkm, endometriy qalinligi 171 ± 4 mkm, stroma qalinligi esa 148 ± 3 mkm ni tashkil etdi. Miometriy qalinligi va mushak tolalari diametri mos ravishda 731 ± 13 va $13,7 \pm 0,3$ mkm gacha kamaydi. 3 oylik hayvonlarda bachadon bezlarining diametri va zichligi mos ravishda $23,8 \pm 0,6$ mkm va $17,6 \pm 0,7$ bez/mm² gacha, 9 oylik hayvonlarda esa $25,7 \pm 0,7$ mkm va $15,2 \pm 0,6$ bez/mm² gacha kamaydi. Aksincha, qon tomirlari diametri mos ravishda $46,8 \pm 1,2$ va $53,6 \pm 1,4$ mkm gacha oshdi. Olingan natijalar eksperimental jigar shikastlanishida bachadonning yaqqol morfometrik qayta tuzilishini ko'rsatdi; bunda o'zgarishlar katta yoshdagi hayvonlarda kuchliroq namoyon bo'ldi.

Kalit so'zlar: eksperimental jigar shikastlanishi, bachadon, morfometrik qayta tuzilish, endometriy, miometriy, bachadon bezlari, tomir o'zgarishlari, urg'ochi kalamushlar, geliotrin, gistologiya.

Introduction

The structural condition of the uterus is closely associated with systemic metabolic regulation, hormonal balance, tissue perfusion, and the functional state of other organs. Since the liver participates in metabolic and endocrine regulation, its injury may result in secondary structural changes in reproductive organs. However, the morphometric characteristics of uterine remodeling following hepatic injury require further experimental characterization. Quantitative assessment of the individual uterine layers and their structural components makes it possible to identify the predominant morphological changes associated with liver damage.

Aim

The aim of this study was to evaluate the structural and morphometric remodeling of the uterus in female albino rats following experimental liver injury, with particular attention to the endometrium, myometrium, perimetrium, uterine glands, and blood vessels.

Materials and Methods

Female albino rats aged 3 and 9 months were included in the experiment. Experimental hepatic injury was modeled by a single subcutaneous injection of heliotrine at a dose of 25 mg/100 g body weight. Intact animals of corresponding ages served as controls. Uterine specimens were fixed in 10% neutral formalin, processed using standard histological methods, embedded in paraffin, and sectioned at 4–5 μm . Sections were stained with hematoxylin and eosin. Digital microphotographs were analyzed using QuPath 0.5.1. The following parameters were measured: total uterine wall thickness, endometrial, myometrial and perimetrial thickness, epithelial height, stromal thickness, uterine gland diameter and density, myometrial muscle fiber diameter, and vascular diameter.

Results

The analysis demonstrated substantial remodeling of all major structural compartments of the uterus following experimental liver injury. In 3-month-old animals, total uterine wall thickness decreased from the control value of 950 ± 18 to 875 ± 17 μm . Endometrial thickness decreased from 181 ± 4 to 158 ± 4 μm , while epithelial height decreased from 20.1 ± 0.3 to 17.8 ± 0.3 μm ($p < 0.001$). Stromal thickness decreased from 156 ± 3 to 138 ± 3 μm . The diameter and density of uterine glands decreased from 27.4 ± 0.7 to 23.8 ± 0.6 μm ($p < 0.001$) and from 21.3 ± 0.8 to 17.6 ± 0.7 glands/ mm^2 ($p < 0.01$), respectively. Myometrial thickness decreased to 690 ± 11 μm and muscle fiber diameter to 12.8 ± 0.3 μm . Perimetrial thickness decreased to 27.1 ± 0.7 μm . At the same time, vascular diameter increased from 40.6 ± 1.1 to 46.8 ± 1.2 μm ($p < 0.01$).

In 9-month-old animals, the same general pattern was observed but with greater changes in several parameters. Uterine wall thickness decreased from 1045 ± 20 to 925 ± 19 μm , while endometrial thickness decreased from 202 ± 5 to 171 ± 4 μm . Epithelial height decreased from 21.5 ± 0.4 to 18.2 ± 0.3 μm ($p < 0.001$), and stromal thickness decreased from 170 ± 4 to 148 ± 3 μm . The diameter of uterine glands decreased from 30.4 ± 0.8 to 25.7 ± 0.7 μm ($p < 0.001$), and gland density decreased from 19.8 ± 0.7 to 15.2 ± 0.6 glands/ mm^2 ($p < 0.001$). Myometrial thickness decreased from 798 ± 14 to 731 ± 13 μm , muscle fiber diameter from 15.6 ± 0.3 to 13.7 ± 0.3 μm , and perimetrial thickness from 32.1 ± 0.8 to 28.4 ± 0.7 μm . Conversely, vascular diameter increased from 45.3 ± 1.2 to 53.6 ± 1.4 μm ($p < 0.001$).

Conclusion

Experimental liver injury produces multidirectional morphometric remodeling of the uterus, characterized predominantly by thinning of the uterine wall and its structural layers, reduction of epithelial and stromal parameters, regression of uterine glandular characteristics, and enlargement of vascular diameter. These findings demonstrate that hepatic injury is accompanied by structural alterations throughout the uterine wall rather than being limited to a single tissue compartment. The changes were more pronounced in 9-month-old animals, indicating that age modifies the uterine morphological response to experimental liver injury.

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