Usmanov Ravshan Jakhongirovich – D.Sc. professor
Rasulov Hamidulla Abdullaevich – D.Sc. professor
Eshonkulova Bakhriniso Dustmurodovna – Ph.D., professor
Mirzarahimov Husan Abduganievich – assistant
Tashkent State Medical University (Tashkent, Uzbekistan)
Chirchik Branch of Tashkent State Medical University (Tashkent, Uzbekistan)

EXPERIMENTAL MODELING OF CHRONIC INFLAMMATION OF LEG APOPHYSIES

Abstract. *Chronic inflammation of the apophyses of the foot tendons is a pressing problem in orthopedics and sports medicine. In this study, an experimental animal model of apophysitis was created and morphological changes were evaluated. Chronic inflammation in the apophysis area was induced by repeated mechanical loading and local inflammatory factors. Histological analyses revealed inflammatory infiltration, disorganization of tendon fibers, and dystrophic and resorptive changes in bone tissue.*

Research objective: *To create an experimental animal model of chronic inflammation of the foot tendon apophyses and evaluate morphological changes.*

Materials and methods. *The research was conducted in 30 laboratory rats. Rats were kept in experimental conditions, their age, sex and weight were standardized. Control and experimental groups were formed. Animals were euthanized by decapitation on the 7th, 14th, 21st, 30th days of life. Repeated mechanical impact and inflammatory factors were applied to the apophyses in the experimental group.*

Keywords: *apophysitis, chronic inflammation, experimental model, tendon, morphology.*

Усманов Равшан Жахангирович – д.м.н., профессор
Расулов Хамидулла Абдуллаевич – д.м.н., профессор
Эшонкулова Бахринисо Дустмуродовна – Ph.D., доцент
Мирзарахимов Хусан Абдугани угли – ассистент
Ташкентский государственный медицинский университет (Ташкент, Узбекистан)
Ташкентский государственный медицинский университет, Чирчикский филиал (Ташкент, Узбекистан)

ЭКСПЕРИМЕНТАЛЬНОЕ МОДЕЛИРОВАНИЕ ХРОНИЧЕСКОГО ВОСПАЛЕНИЯ АПОФИЗОВ СУХОЖИЛИЙ СТОПЫ

Аннотация. *Хроническое воспаление апофизов сухожилий стопы представляет актуальную проблему в ортопедии и спортивной медицине.*

Целью данного исследования явилась разработка экспериментальной модели хронического апофизита у лабораторных животных и оценка сопутствующих морфологических изменений. Повторяющаяся механическая нагрузка в сочетании с локальными воспалительными факторами приводила к формированию хронического воспаления в апофизарной зоне. Гистологический анализ выявил клеточную воспалительную инфильтрацию, дезорганизацию сухожильных волокон, а также дистрофические и резорбтивные изменения костной ткани. Предложенная модель может быть использована для изучения патогенеза апофизита и апробации терапевтических подходов.

Ключевые слова: *апофизит, хроническое воспаление, экспериментальная модель, сухожилие, морфология.*

Usmanov Ravshan Jaxongirovich – t.f.d., professor
Rasulov Hamidulla Abdullaevich – t.f.d., professor
Eshonkulova Baxriniso Do'stmurodovna – Ph.D., professor
Mirzarahimov Husan Abdug'anievich – assistent
Toshkent Davlat Tibbiyot Universiteti (Toshkent, O'zbekiston)
Toshkent Davlat Tibbiyot Universitetining Chirchiq filiali (Toshkent, O'zbekiston)

OYOQ APOFIZIYALARINING SURUNKUCHLI YALLIG'LANISHINI EKSPERIMENTAL MODELLASHTIRISH

Annotatsiya. *Oyoq paylarining apofizlarining surunkali yallig'lanishi ortopediya va sport tibbiyotida dolzarb muammo hisoblanadi. Ushbu tadqiqotda apofizitning eksperimental hayvonlar modeli yaratildi va morfologik o'zgarishlar baholandi. Apofizit sohasidagi surunkali yallig'lanish takroriy mexanik yuklanish va mahalliy yallig'lanish omillari tomonidan qo'zg'atildi. Gistologik tahlillar yallig'lanish infiltratsiyasini, pay tolalarining disorganizatsiyasini va suyak to'qimasida distrofik va rezorbtiv o'zgarishlarni aniqladi.*

Tadqiqot maqsadi: *Oyoq payining apofizlarining surunkali yallig'lanishining eksperimental hayvonlar modelini yaratish va morfologik o'zgarishlarni baholash.*

Materiallar va usullar. *Tadqiqot 30 ta laboratoriya kalamushida o'tkazildi. Kalamushlar eksperimental sharoitlarda saqlandi, ularning yoshi, jinsi va vazni standartlashtirildi. Nazorat va eksperimental guruhlar tuzildi. Hayvonlar hayotning 7, 14, 21, 30-kunlarida boshlarini kesish orqali evtanaziya qilindi. Eksperimental guruhdagi apofizlarga takroriy mexanik ta'sir va yallig'lanish omillari qo'llanildi.*

Kalit so'zlar: *apofizit, surunkali yallig'lanish, eksperimental model, pay, morfologiya.*

Relevance: Apophyses The apophyses in the foot are anatomical structures where bones are connected by tendons and ligaments, and are exposed to high mechanical loads. The apophyses in the foot are prone to repeated microtrauma, leading to the development of chronic inflammation. Injury and disease of the Achilles tendon is a serious pathology of the human musculoskeletal system. The difficulty of choosing the optimal type of treatment and the long duration of incapacity for work indicate that this problem is of social importance [1].

Subcutaneous rupture of the Achilles tendon is more common among young people, which is associated with the high demands placed on their bodies, and in some cases, the injury is bilateral. Timely treatment of patients and their return to training is an urgent problem of modern traumatology and orthopedics. Misdiagnosis of Achilles tendon injuries and diseases is quite common, and it makes up 40-75% [2, 4].

Efforts to reduce diagnostic errors in Achilles tendon injuries and to more accurately analyze clinical indicators have led to the introduction of additional examination methods. This indicates the need to study the functional state of the neuromuscular apparatus at different periods after Achilles tendon injury, which will allow us to determine the extent of pathological changes in the injured muscle.

During treatment, new methods are being developed that allow dynamic monitoring and evaluation of muscle functional status [5].

When the Achilles tendon is torn, the loss of normal muscle tone leads to hypotrophy of the muscle fibers. The above pathological changes lead to a decrease in the function of the triceps muscle of the calf. This leads to a long-term, sometimes irreversible impairment of the foot support function.

Mirinova S.P. and others believe that further improvement of methods of treatment of subcutaneous rupture of the Achilles tendon continues. The research of many scientists is aimed at developing new surgical methods or improving existing ones. However, the methods of caring for patients in the postoperative period continue as before [7, 10]. Scarring injuries of the calf and heel in the Achilles tendon area can be complicated by trophic ulcers that do not heal for a long time. Scars in the Achilles tendon area are constantly injured by shoes when walking, and as a result, the scar becomes rough and sore.

Research objective: To create an experimental animal model of chronic inflammation of the foot tendon apophyses and evaluate morphological changes.

Materials and methods. The research was conducted in 30 laboratory rats. Rats were kept in experimental conditions, their age, sex and weight were standardized. Control and experimental groups were formed. Animals were euthanized by decapitation on the 7th, 14th, 21st, 30th days of life. Repeated mechanical impact and inflammatory factors were applied to the apophyses in the experimental group. To study the process of aseptic inflammation, the collected materials were fixed in a 10% neutral formalin solution, and paraffin slices were prepared from the tissues. 5-8 μm thick histological preparations were prepared from paraffin blocks and stained with hematoxylin-eosin method. The prepared sections were subjected to hematoxylin-eosin and Vag Gizon to study the connective tissues, and to study the connective tissue, cells and its intermediate elements, a histochemical reaction was carried out using Toluidine blue and Azan dye. Prepared micropreparations were viewed under the microscope of SARL Zeiss Microscopy GmbH and photographed on the Axio Lab.A1 (Germany) camera.

Most of the prepared sections were stained with hematoxylin and eosin, the main method of staining histological preparations. In this case, staining was carried out with two components: the main dye hematoxylin - staining cell nuclei, and eosin - an acidic dye, staining cell protoplasm and, to a lesser extent, various intercellular structures. The resulting micrographs revealed that the cell nuclei were blue, and the cytoplasm and intercellular substance were pink.

Results. In the experimental group, inflammatory infiltration, disorganization of ligament fibers, resorption of bone tissue, and vascular reactions were detected. Early (5–7 days) signs of an acute inflammatory reaction were detected in the area of biomaterial implantation. A high cellular density was observed due to macrophages, lymphocytes, mast cells, and segmented neutrophils. Small and medium lymphocytes were detected among immunocompetent cells.

The xenogeneic biomaterial particles were intensively infiltrated by eosinophils and neutrophils. The cells that had accumulated at the border of the xenogeneic biomaterial particles formed a relatively wide cellular wall that confined the material that was foreign to the body.

Electron microscopic examination revealed neutrophil-macrophage, macrophage-macrophage and lymphocyte-macrophage contacts. Ultrastructure of macrophages showed that they were functionally impaired. Their cytoplasm was filled with phagosomes and residual bodies, and the cytomembrane was smoothed. Signs of decreased biosynthetic activity were observed in the cell nuclei, and organelles involved in energy metabolism (mitochondria) and structures associated with secretory activity (lysosomes, Golgi complex) were damaged or underdeveloped.

The biomaterial particles themselves were swollen and stained grayish when stained by the Van Gieson method, indicating the onset of necrotic processes. When stained by the Hale method, blue staining of xenogeneic biomaterial particles was not detected. A pronounced vascular reaction was observed in the surrounding tissues, which was expressed in the dilation of blood vessels and stasis of erythrocytes. Small foci of hemorrhage were also found in the surrounding tissues.

After 7 days, along with some necrotic biomaterial particles and the above-mentioned cells, a large number of mesenchymal and poorly differentiated cells were detected around them. These were stellate-shaped cells, indicating the activation of regenerative processes.

Infiltration of macrophages, neutrophils and lymphocytes around the implanted material (↑) 2 days after injection of xenogeneic biomaterial. Hematoxylin-eosin stain. Magnification ×50.

Macrophage with signs of functional impairment 7 days after xenogeneic biomaterial administration. Phagosomes and residual bodies (↑). Electron micrograph. No pathological changes were observed in the control group.

Discussion. After the biomaterial was injected into the connective tissue of rats, various cellular elements were detected, among which inflammatory and immunocompetent cells occupied the main place [1, 4]. In the early stages of the experiment, neutrophil-macrophage infiltration was quickly joined by lymphocytic infiltration, which indicated the development of an immune response due to the high antigenicity of the implanted biomaterial [2]..

Xenogenic biomaterial grafting induced an iron reaction: blood iron expansion, blood stasis, micro-thrombi were formed and blood vessels were destroyed. These abnormalities indicated that stasis hyperemia was present in the zonasida [3, 5]. These signs are generally defined by the Cheklovchi Val Shakllanishida, who is responsible for the development of these signs.

Many researchers argue that the amino acid composition of the biomaterial is a decisive factor in the nature of the induced inflammation [6, 9,10]. Histochemical studies on the detection of free glycosaminoglycans in tissues have shown that a large part of the xenogeneic biomaterial is not degraded in the "foreign" organism. Without repetition, xenogeneic biomaterial particles remained at the injection site for about two months, provoking an immune-inflammatory reaction [8, 11].

The experimental results are consistent with the morphological changes observed in clinical chronic apophysitis and confirm the leading role of mechanical loading and inflammation.

Conclusion. The proposed experimental model is effective for studying the pathogenesis of apophysitis and testing new treatment methods. Thus, the introduction of xenogeneic biomaterial reduces the functional capacity of macrophages, resulting in the development of chronic inflammation of the slow-acting type in tissues. During the recovery of the damaged focus, as a result of a decrease in cytotoxic activity and an increase in the ability to stimulate cell growth, uneven fibrosis processes develop and a layered, very dense fibrous scar is formed.

The introduction of dispersed xenogeneic biomaterial into the skin of animals can be used as an experimental model for the formation of chronic inflammation or fibrosis (scar) in tissues. The proposed experimental model is very simple and easy to repeat.

REFERENCES

1. Kutina S.N., Mayansky D.N. Features of the development of liver cirrhosis at rats at stimulation liver macrophages // Bull. Exp. Biol., 1981, No. 9, pp. 366-369.

2. Mayansky D. N. Role macrophages in reparative processes. – In the book: Mechanisms of

pathological reactions. Tomsk, 1991, pp. 56–62. (a).

3. Ivanov A.A. Inflammatory diseases of the apophyses. Moscow, 2018.

4. Muslimov S. A. Morphological aspects regenerative surgery. – Ufa: Bashkortostan, 2000, 168 p.

5. Shekhter A.B., Rozanova I.B. Fabric reaction on implant. IN book: Biocompatibility. Ed. V.I. Sevastyanova.-M., 1999, With. 174-211.

6. Rasulov H.A., Isaeva N.Z., Eshonkulova B.D., Ibrokhimova L.I. Morphological changes in paraarticular tissues in children with congenital dislocation of the hip on the background of hypothyroidism // "Nazarium and Clinical Medical Journal". Tashkent, 2018. - #2. -C.124-125.

7. Rasulov H.A., Mahmadaliyev H.J. Temirova N.T. Maghribov Sh.G. Morphological description of rat foot joints in experimental hypothyroidism //"A new day in medicine". Tashkent. 2018. No. 3 (23). Pages 225-228.

8. Mirsharapov U.M., Rasulov H.A., Eshonkulova B.D., Ibrohimov Sh.F. Morphological changes of elements of the knee joint under the influence of experimental hypothyroidism // "Eurasian journal of Academic research" // Tashkent 2020. -№3 (11) pages 18-23.

9. Mirsharapov U.M., Rasulov H.A., Eshonkulova B.D., Khusanova E.S., Ibrohimov Sh.F.// "Morphological and morphometric changes of knee joint elements in experimental hypothyroidism"// Tashkent 2023. No. 4. Pages 346-352

10. Rasulov H.A., Isaeva N.Z., Eshonkulova B.D., Ibrokhimova L.I. Morphological changes in paraarticular tissues in children with congenital hip dislocation against the background of hypothyroidism // «Nazariy va klinik tibbiyot zhurnali». Tashkent, 2018. - №2. – P.124-125.

11. Rasulov H.A. State of morphology and metabolism of the apophyseal-tendon complex in rats with experimental hypothyroidism // "Pediatrics". Tashkent. 2018. - No. 4. - P. 263-266.

ИНФОРМАЦИЯ ДЛЯ АВТОРОВ СТАТЕЙ
«Вестник Ассоциации пульмонологов Центральной Азии»

Журнал предназначен для пульмонологов, терапевтов, фтизиатров, врачей общей практики и смежных специальностей.

Для публикации принимаются статьи по проблемам респираторной медицины, организации пульмонологической и фтизиатрической помощи больным, медицинской реабилитации, фундаментальным исследованиям.

В журнале можно публиковать оригинальные статьи, обзоры, лекции, материалы съездов, конференций, диссертаций, а также информацию для практических врачей.

Материал должен содержать новые, ранее не опубликованные данные и соответствовать профилю журнала.

Редакционная коллегия журнала рецензирует все полученные материалы. Решение о включении статей и других материалов в очередной номер журнала принимает редакционная коллегия, которая оставляет за собой право производить сокращение и редакционные изменения рукописей.

Работы принимаются на русском и английском языках.

Требования к тексту:

- шрифт- Times New Roman, кегль 12;
- междустрочный интервал 1,15;
- поля: левое – 3 см, правое, верхние и нижнее – по 2 см;
- абзацный отступ – 1 см;
- нумерация страниц внизу и посередине;
- все аббревиатуры и сокращения автор должен расшифровать при первом употреблении в тексте.

Порядок оформления статьи:

- УДК, название (заглавными буквами) статьи, с новой строки – фамилия и инициалы автора(ов), с новой строки – полное название учреждения, город, страна;
- аннотации на русском, узбекском и английском языках (не более 150-200 знаков каждая), ключевые слова (5-10 слов);
- основной текст статьи – введение, цель исследования, материалы и методы, результаты, обсуждение, выводы и библиографический список;
- ссылки на авторов в тексте указываются в круглых скобках (Ф.И.О., год);
- статистическая обработка цифровых данных обязательна;
- графики и схемы не должны быть перегружены текстовыми надписями и должны иметь надписи;
- микрофотографии и фото могут быть черно-белыми;
- таблицы должны иметь название, быть компактными, наглядными, заголовки глав должны соответствовать их содержанию. Цифры должны соответствовать цифрам в тексте и быть обработаны статистически.

Объем оригинальных статей, включая таблицы, рисунки, литературу и резюме, не должен превышать 8-10 страниц, обзоров и лекций – 10-15 страниц.

Список цитируемой литературы прилагается на отдельном листе и должен быть оформлен следующем образом:

- Источники приводятся в алфавитном порядке с указанием фамилий авторов и инициалов, вначале отечественные, затем иностранные.
- Полностью указываются названия книг, статей, журналов, место издания, год, тома и номера выпуска, страницы «от» и «до».
- За точность библиографии ответственность несет автор.
- Список цитируемой литературы не более 15, за исключением обзорных статей.

Статья должна быть отредактирована, представлена в двух экземплярах на одной стороне стандартного листа формата А-4, без рукописных вставок и помарок, а также в электронном варианте.

Необходимо предоставить акт экспертного заключения и **направление** учреждения. 2-ой экземпляр статьи, представляемой к публикации, должен быть с визой руководителя и подписан автором(ми).

При несоблюдении перечисленных правил статьи возвращаются авторам без рассмотрения.

Автор(ы) должен предоставить сведения для контакта: фамилия, имя, отчество, ученая степень, ученое звание, основное место работы, должность, контактные телефоны, e-mail, почтовый адрес.

Автор(ы) несет полную ответственность за достоверность приведенных фактов, цитат и прочих сведений, а также за использование данных, не предназначенных для открытой печати.

Редакция журнала надеется на плодотворное сотрудничество.

По всем вопросам обращаться к ответственному секретарю журнала …

*Журнал включен в перечень рецензируемых научных изданий,
рекомендованных Высшей аттестационной комиссией Республики Узбекистан
для публикации основных научных результатов диссертаций
по медицинским наукам доктора философии и доктора медицинских наук*

ВЕСТНИК

**АССОЦИАЦИИ ПУЛЬМОНОЛОГОВ
ЦЕНТРАЛЬНОЙ АЗИИ**

Выпуск 13 (№18) 2026

Главный редактор: *А.М.Убайдуллаев*
Заместитель главного редактора: *И.В.Ливерко*
Компьютерная верстка: *Р.Р.Усманова*
Корректоры: *Ш.Ш.Массавиров, Н.В.Гафнер*

*Журнал зарегистрирован в Государственном комитете печати
Республики Узбекистан 5 декабря 2003 г.
(удостоверение №135)*

*Все права защищены.
Перепечатка материала возможно только с разрешения редакции.
Мнение редакционной коллегии может не совпадать с мнением автора.
Ответственность за достоверность результатов и содержание рекламных материалов
несут авторы и рекламодатели.*

Сдано в набор 09.03.2026 | Подписано в печать 29.03.2026 | Формат 60x84$^{1/8}$ | Цена свободная
Печать ризографическая | Тираж 100 экз заказ 35