

# AGE-RELATED STRUCTURAL CHANGES IN APONEUROSES OF THE RECTUS ABDOMINAL MUSCLES IN PATIENTS WITH POSTOPERATIVE VENTRAL HERNIAS

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## Key words:

morphological study, age classification, aponeurosis, microscopy, postoperative ventral hernia.

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**Objective of the study** - to determine the structural differences of aponeuroses in different age groups of patients with postoperative ventral hernias.

**Material and methods.** Comparative morphological studies of aponeuroses in 36 patients aged 40-76 years, operated by reason of postoperative ventral hernias in hospitals 1, 2 of Samarkand State Medical Institute for postoperative ventral hernias, were conducted by us. Patients are divided into 3 groups according to the WHO age classification: Group I included patients at the age of 45-59 years old; Group II 60-74 years old; and the Group III included patients aged 75-90 years old. The biopsy specimens of the anterior abdominal wall, obtained during hernioplasty were subjected to histological examination. Standard pieces of aponeurotic abdominal wall tissues taken during surgery were fixed in a 10% formalin solution on phosphate buffered saline for light microscopy examinations. Paraffin sections were stained with hematoxylin and eosin (H&E).

**Results.** Investigation of biopsy specimens of aponeuroses and adjacent muscle tissue in patients of different age groups have revealed significant structural differences that can determine the frequency of hernias of the anterior abdominal wall and their recurrences.

**Conclusions.** The studies have shown that with advancing age significant structural disturbances occur at aponeurosis of the abdominal rectus muscles. The nature of these changes, especially the disruption of the collagen fiber arrangements, suggests that these structural changes are responsible for the weakening of the aponeurosis.

## Ключові слова:

морфологічні дослідження, вікова класифікація, апоневроз, мікроскопія, післяопераційні вентральні грижі.

Клінічна та експериментальна патологія Т.17, №3 (65), С.74-79.

## ВІКОВІ СТРУКТУРНІ ЗМІНИ АПОНЕВРОЗІВ ПРЯМИХ М'ЯЗИВ ЖИВОТА У ХВОРИХ З ПІСЛЯОПЕРАЦІЙНИМИ ВЕНТРАЛЬНИМИ ГРИЖАМИ

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**Мета роботи** - виявити структурні відмінності апоневрозів у різних вікових групах пацієнтів з післяопераційними вентральними грижами.

**Матеріал і методи.** Нами проведено порівняльні морфологічні дослідження апоневрозів 36 хворих, оперованих 1 і 2 клініках Самаркандського державного медичного інституту з приводу післяопераційних вентральних гриж у віці від 40 до 76 років. Хворі розподілені на 3 групи за віковою класифікацією ВООЗ: I. Середній вік 45-59 років; II. Похилий вік 60-74 років; III. Старечий вік 75-90 років. Дослідженню піддавалися біоптати передньої черевної стінки, отримані під час герніопластики. Для світлової мікроскопії стандартні шматочки апоневротичної тканини передньої черевної стінки, взяті під час операції, фіксували в 10% розчині формаліну на фосфатному буфері. Парафінові зрізи фарбували гематоксином і еозином.

**Результати.** Проведені дослідження біоптатів апоневрозів і прилеглої м'язової тканини у пацієнтів різних вікових груп дозволили виявити суттєві структурні відмінності, які можуть визначати частоту гриж передньої черевної стінки та їх рецидиви.

**Висновки.** Проведені дослідження показали, що з віком мають місце суттєві порушення структури апоневроза прямих м'язів живота. Характер цих змін, а саме порушення впорядкованості розташування колагенових волокон, дозволяє припускати, що саме ці структурні зміни є основою порушення міцності апоневроза.

## ВОЗРАСТНЫЕ СТРУКТУРНЫЕ ИЗМЕНЕНИЯ АПОНЕВРОЗОВ ПРЯМЫХ МЫШЦ ЖИВОТА У БОЛЬНЫХ С ПОСЛЕОПЕРАЦИОННЫМИ ВЕНТРАЛЬНЫМИ ГРЫЖАМИ

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**Цель работы** - выявить структурные различия апоневрозов в различных

возрастных группах пациентов с послеоперационными вентральными грыжами.

**Материал и методы.** Нами проведены сравнительные морфологические исследования апоневрозов 36 больных, оперированных в 1 и 2 клиниках Самаркандского государственного медицинского института по поводу послеоперационных вентральных грыж в возрасте от 40 до 76 лет. Больные разделены на 3 группы по возрастной классификации ВОЗ: I. Средний возраст 45-59 лет; II. Пожилой возраст 60-74 лет; III. Старческий возраст 75-90 лет. Исследованию подвергались биоптаты передней брюшной стенки, полученные вовремя герниопластики. Для световой микроскопии стандартные кусочки апоневротической ткани передней брюшной стенки, взятые во время операции, фиксировали в 10% растворе формалина на фосфатном буфере. Парафиновые срезы окрашивали гематоксилином и эозином.

**Результаты.** Проведенные исследования биоптатов апоневрозов и прилегающей мышечной ткани у пациентов различных возрастных групп позволили выявить существенные структурные различия, которые могут определять частоту грыж передней брюшной стенки и их рецидивы.

**Выводы.** Проведенные исследования показали, что с возрастом имеет место существенные нарушения структуры апоневроза прямых мышц живота. Характер этих изменений, а именно нарушения упорядоченности расположения коллагеновых волокон, позволяет предполагать, что именно эти структурные изменения являются основой нарушения прочности апоневроза.

**Ключевые слова:** морфологические исследования, возрастная классификация, апоневроз, микроскопия, послеоперационные вентральные грыжи.

Клиническая и экспериментальная патология Т.17, №3 (65), С.74-79.

## Introduction

Hernias of the anterior abdominal wall are the common surgical diseases. Life-time occurrence in general the population is about 3-7%. A hernia can form anywhere in the abdominal wall, but more often it occurs in the so-called weak areas [2]. According to the recent data, 2-15% of laparotomy is complicated by postoperative ventral hernia (POVH), while patients with POVH account for 20-27% of the total number of patients with ventral hernias [3, 4, 7].

The leading causes to the formation of hernias are diverse. One of the reasons for the formation of POVH is the disruption of the connective tissue formation in the postoperative scar area in combination with other etiologic factors that are divided into predisposing and generating factors. Predisposing factors include: the age of the patient, excessive or lack of subcutaneous fat, pregnancy and multiple birth, decreased regenerative capacity of tissues and overall decrease in the reactivity of the organism [5, 6].

It can be assumed that the frequency and especially, recurrence of the hernias in the anterior abdominal wall is due to age-related changes in the corresponding abdominal wall structures and, first of all, structural changes in aponeurosis [1]. However, morphological studies of aponeurosis of the anterior abdominal wall in the age aspect have not been studied.

## Objective

To determine structural differences of aponeuroses in different age groups of patients with postoperative ventral hernias.

## Material and methods

We conducted comparative morphological studies of aponeuroses from 36 patients operated in 1st and 2nd hospitals of the Samarkand State Medical Institute (SamMI) for postoperative ventral hernias in patients at the age of 40 to 76 years old. Patients were divided into 3

groups according to the WHO age classification: Group I included patients aged 45-59 years old; Group II consisted of patients at the age of 60-74 years old; and Group III included patients at the age of 75-90 years old. Morphological studies were conducted in the pathologic anatomy laboratory of the Republican Specialized Center of Surgery named after academician V. Vakhidov (RSCS) based on the scientific contracts between the Pediatric Surgery Department and 1st surgical disease department of SamMI and the pathologic anatomy laboratory of the RSCS. The biopsy specimens (mainly aponeuroses) of the anterior abdominal wall, received during the hernioplasty, were analysed. For light microscopy, standard pieces (0.3?0.3 cm) of aponeurotic tissue of the abdominal wall taken during the operation were fixed in a 10% formalin solution on phosphate buffered saline. Paraffin sections were stained with hematoxylin and eosin. Light-optical micrographs were obtained on Zeiss Axioskop 40 microscope coupled with a digital camera. All photomicrographs were processed and stored on a computer using the Microsoft-Windows XP-Professional application software.

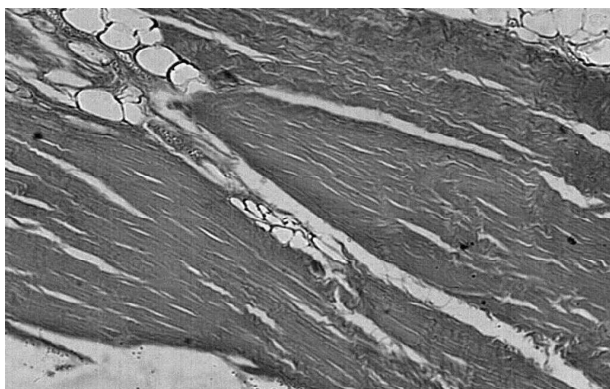
## Results and discussion

Studies of the biopsies of aponeuroses and adjacent muscle tissues in patients of different age groups have revealed significant structural differences that can determine the frequency of hernias of the anterior abdominal wall and their recurrences.

In the first age group (patients age 45-59 y.o.), muscle tissue adjacent aponeurosis revealed that muscle fibers are closely adhere to each other. With interlayers of fatty and loose connective tissue with vessels (Fig. 1).

In the group of elderly patients (60-74 years), the interlayers of connective tissue between the muscle fibers were wider, there were more adipose cells. Hemorrhages were identified in the interlayer of connective tissue, (Fig.2)

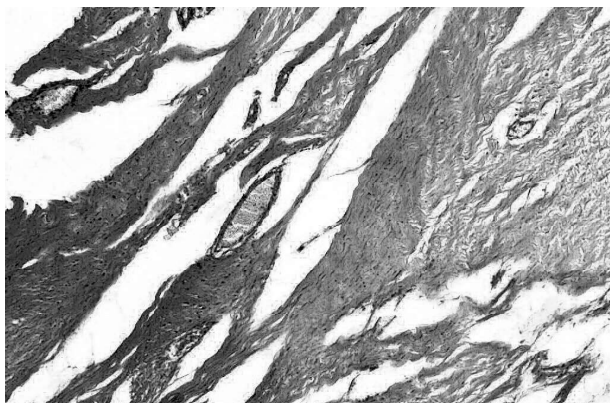
In the senile age group (75-90 years.) large gaps were



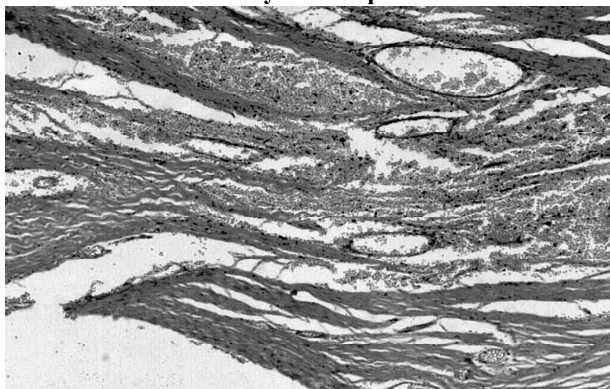
**Figure 1. Muscle tissue of the anterior abdominal wall. Tight adherence of muscle bundles to each other. Thin layer of adipose tissue. The patient is 45 years old. H&E 10 x 10**

determined between the bundles of muscle fibers. Muscle fibers were atrophic. There was a proliferation of connective tissue with the phenomena of circular cell infiltration. Often there were blood and lymphatic vessels with enlarged lumens. Muscle fibers were located chaotically. Significant volume is occupied by "structureless" zones (Fig. 3.4).

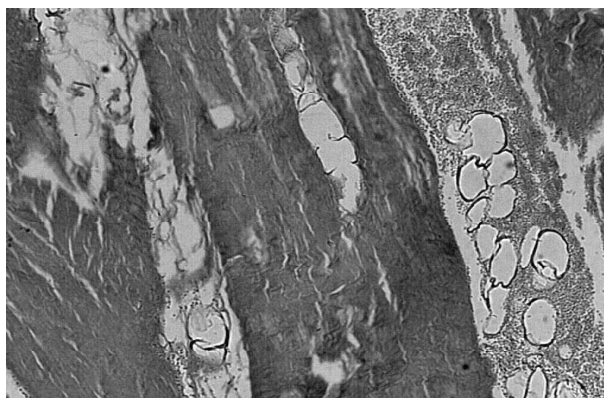
Along with the vessels with enlarged lumens numerous blood cells inside the lumen, mainly red blood



**Figure 3. Muscle tissue of the anterior abdominal wall. Wide gaps between muscle fascicles ("non-structural" zones). Vessels with enlarged lumens with accumulated erythrocytes inside. The 10x10 specimen from 75 years old patient**



**Figure 5. Muscle tissue of the anterior abdominal wall. Wide gaps between muscle fascicles ("non-structural" zones). Enlarged blood vessels, extravascular erythrocytes. The 10x10 specimen from 77 years old patient**

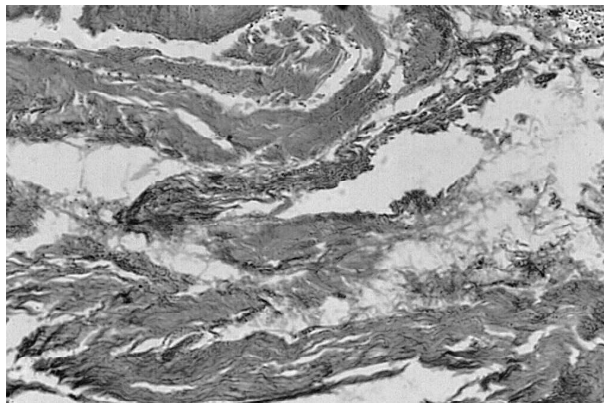


**Figure 2. Muscle tissue of the anterior abdominal wall. Well-developed layers of adipose and loose connective tissues. The 10 x 10 specimen from 61 years old patient**

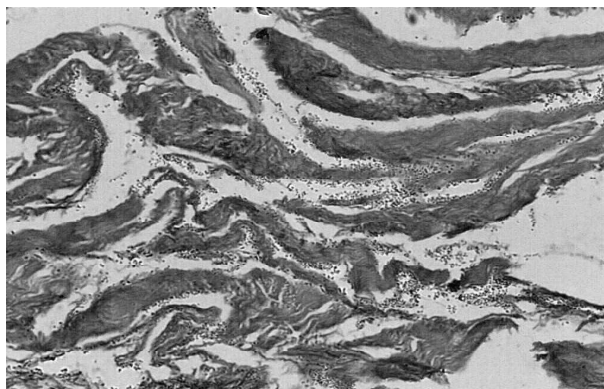
cells, were found with the predominance of pathological forms of extravascular erythrocytes (Fig. 4-6).

Aponeurosis of the anterior abdominal wall (rectus abdominis) is a wide tendon plate, formed from dense collagen and elastic fibers, with few vessels. This aponeurosis is one of the most solid formations that determines the success of hernioplasty and prevents the hernia recurrences.

However, with advancing age certain structural



**Figure 4. Muscle tissue of the anterior abdominal wall. Wide gaps between muscle fascicles ("non-structural" zones). Enlarged lymphatic capillaries. The 10x10 specimen from 75 years old patient**



**Figure 6. Muscle tissue of the anterior abdominal wall. Wide gaps between the muscle fascicles ("non-structural" zones), extravascular erythrocytes. The 10x10 specimen from 77 years old patient**

changes in the aponeuroses weakens it.

In patients aged 45-59 years, the fascicles of collagen fibers were thick, closely adjacent to each other and were arranged in several layers. The fibers were wavelike curved and run in the same direction parallel to each other, along the long axis of the aponeurosis. They were rather monomorphic with tinctorial properties (Fig. 7-8).

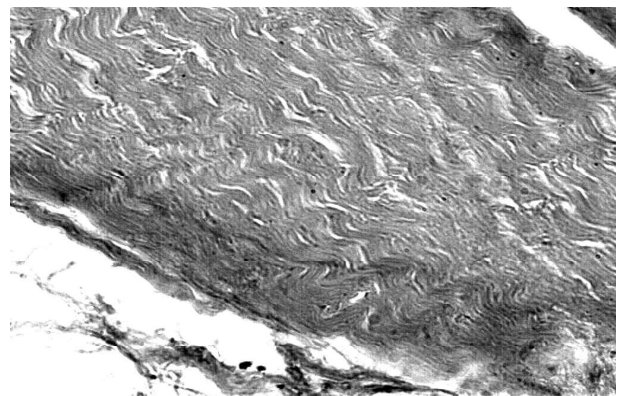
The general histoarchitectonics of collagen beams of



**Figure 7. The aponeurosis from a 45 years old patient. Dense location of collagen fibers with characteristics of tortuosity. H&E 10 x 40**

aponeurosis in individuals under 60 years of age persists. The bundles of collagen fibers have the correct orientation. However, rather wide gaps appear between the bundles of collagen fibers, in which free erythrocytes were determined. There was a pronounced twisting of the beams (Fig. 9)

At the operated patients at the age of 60-74 years (elderly age) in aponeuroses more serious changes were



**Figure 8. The aponeurosis from a 45 years old patient. Dense location of the collagen fibers with a characteristics of tortuosity. H&E 10 x 40**



**Figure 9. The aponeurosis from 57 years old patient. The appearance of gaps between the fascicles of collagen fibers, the characteristic tortuosity is preserved. H&E 10 x 40**

revealed, bundles of fibers branch, into separate fibers. The arrangement of the fibers characterizes randomness. The pattern of the beams varies, their characteristic tortuosity is smoothed out. In large spaces, a large number of erythrocytes is determined. The bundles of collagen

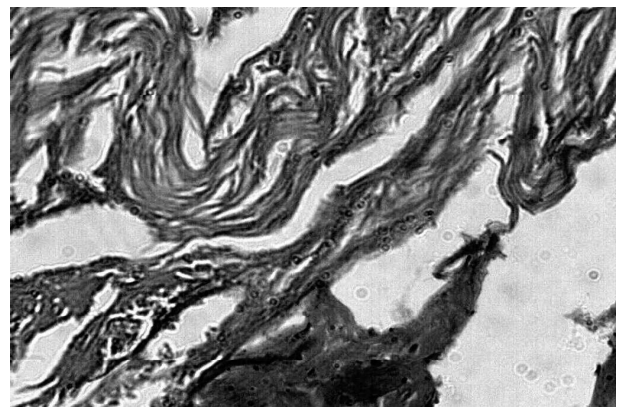


**Figure 10. The aponeurosis of 66 years old patient. Large gaps between the bundles of fibers with red blood cells in them. H&E 10 x 10**

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fibers lose contact with each other (Fig. 10,11).

Variability of the collagen fibers sizes, locations and shapes was revealed; their tinctorial properties. The interfiber spaces increased in size. The most characteristic



**Figure 11. The aponeurosis of 66 years old patient. Large gaps between the bundles of fibers with a loss of tortuosity. H&E 10 x 40**

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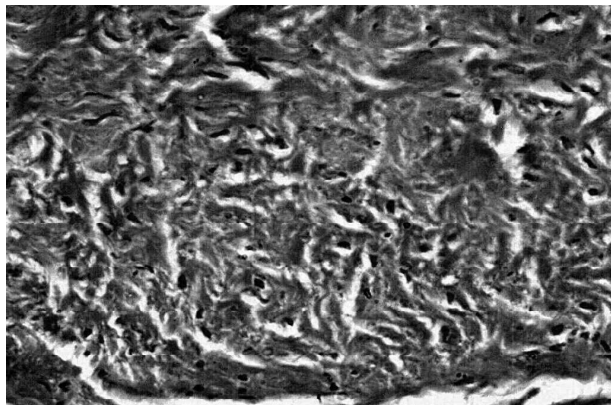


is the chaotic arrangement of the fibers (Fig. 11 -13).

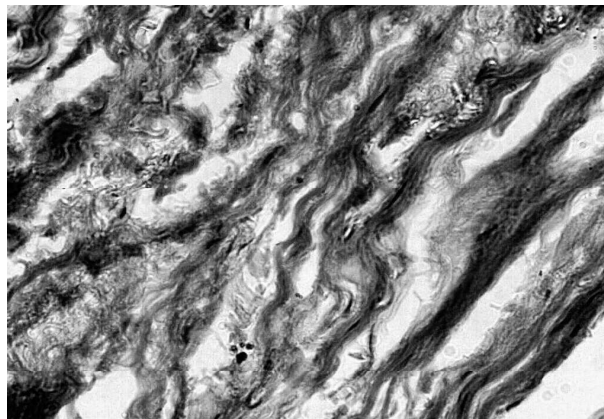
The greatest changes in the structure of aponeuroses of the abdominal rectal muscles were revealed in patients of the oldest age group of 75-90 years (old age).

Collagen fibers, as a rule, were scattered with a weakly expressed tendency to form bundles. Free erythrocytes are located in the expanded spaces between the fibers (Fig.14).

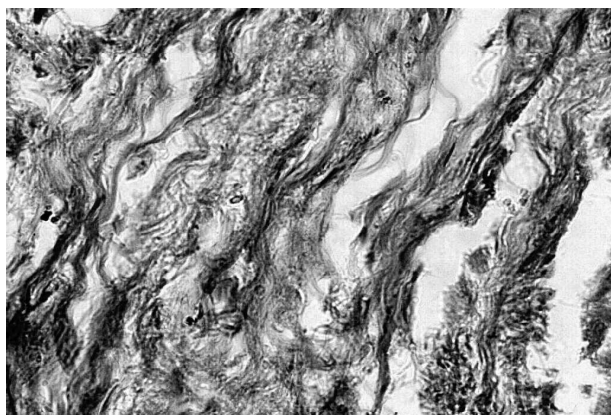
It is often observed that the collagen fibers are separated by a kind of loose network, with a large volume



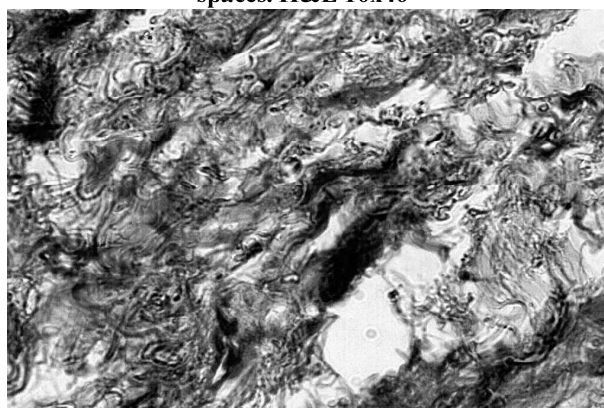
**Figure 12.** The aponeurosis of 66 years old patient. Chaotic arrangement of fiber bundles. H&E 10 x 40



**Figure 13.** The aponeurosis of 66 years old patient. Chaotic arrangement of fiber bundles with extended spaces. H&E 10x40



**Figure 14.** The aponeurosis of 77 years old patient. Chaotic arrangement of scattered fibers with extended spaces between them, without pronounced formation of bundles. H&E 10x40.



**Figure 15.** The aponeurosis of the 77 year old patient. Chaotic arrangement of disparate fibers with extended spaces between them, without the formation of bundles. H&E 10x40

### Conclusions

The study shows that with advancing age there are significant structural derangements in aponeurosis of the abdominal rectal muscles. The nature of these changes, namely the disruption of the collagen fibers arrangement suggests that these structural changes were the basis for the weakening of the strength of aponeurosis. Appearance of free erythrocytes in the zones between fascicles, as well as widening the lumen of the vessels with accumulations of erythrocytes in them indicates increased permeability of the vascular walls and the disturbance of microcirculation. All these structural changes affect the strength of the anterior abdominal wall, reduce its adaptation to mechanical stress and ultimately contribute to the formation of postoperative ventral hernias.

of "structureless" zones (Fig. 15). Our postoperative observations showed that such patients had hernia recurrence in the late period.

Therefore, in elder age group patients with postoperative ventral hernia remodeling of the muscle and connective tissue occurs in the aponeurosis structure as a result of dystrophic and regenerative processes. These changes are considered as compensatory processes in response to partial death of the aponeurosis tissue.

### Prospects for the future research

Further researches will be conducted in this scientific direction.

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