GEORGIAN MEDICAL NEWS

ISSN 1512-0112

No 3 (312) Март 2021

ТБИЛИСИ - NEW YORK

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

No 3 (312) 2021

Published in cooperation with and under the patronage
of the Tbilisi State Medical University

Издается в сотрудничестве и под патронажем
Тбилисского государственного медицинского университета

გამოიცემა თბილისის სახელმწიფო სამედიცინო უნივერსიტეტთან
თანამშრომლობითა და მისი პატრონაჟით

ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

ТБИЛИСИ - НЬЮ-ЙОРК

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board and The International Academy of Sciences, Education, Industry and Arts (U.S.A.) since 1994. **GMN** carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

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GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией и Международной академией наук, образования, искусств и естествознания (IASEIA) США с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения.

Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

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Ежемесячный совместный грузино-американский научный электронно-печатный журнал
Агентства медицинской информации Ассоциации деловой прессы Грузии,
Международной академии наук, индустрии, образования и искусств США.
Издается с 1994 г., распространяется в СНГ, ЕС и США

Website:
www.geomednews.org

The International Academy of Sciences, Education, Industry & Arts. P.O.Box 390177,
Mountain View, CA, 94039-0177, USA. Tel/Fax: (650) 967-4733

Версия: печатная. **Цена:** свободная.
Условия подписки: подписка принимается на 6 и 12 месяцев.
По вопросам подписки обращаться по тел.: 293 66 78.
Контактный адрес: Грузия, 0177, Тбилиси, ул. Асатиани 7, IV этаж, комната 408
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По вопросам размещения рекламы обращаться по тел.: 5(99) 97 95 93

GEORGIAN MEDICAL NEWS
Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press; International Academy of Sciences, Education, Industry and Arts (USA).
Published since 1994. Distributed in NIS, EU and USA.

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При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

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2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

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In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

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ავტორთა საყურადღებოდ!

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1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

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6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

Содержание:

MORPHOMETRIC ASSESSMENT OF STRUCTURAL CHANGES IN THE VASCULAR BED OF DUODENUM IN ANIMALS WITH OBSTRUCTIVE CHOLESTASIS

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Despite the significant achievements of modern hepatology, obstructive cholestasis remains one of the most common human diseases in Ukraine and in the world. The duodenum, as part of a single hepatopancreatoduodenal system, is naturally involved in the pathological process in the disease of one of the organs of the same zone. [1-4]. Changes in the duodenum in mechanical jaundice and liver dysfunction have been studied by many authors. The main focus of these studies was on the detection of changes in the duodenal wall. The structure of the vascular bed of the organ, without which it is impossible to assess the condition and function of the duodenum, remained unnoticed. There is no doubt that the basis of pathological changes in the duodenum in mechanical jaundice plays a major role in the structural reorganization of the vascular bed, especially changes in their structural and spatial organization. [5-7]. And also requires in-depth study of the restructuring in the microcirculation system affected by obstructive cholestasis of the duodenum, because in the smallest blood vessels and especially capillaries, through the histohematogenous barrier is realized transport function of the circulatory system and transcapillary exchange, which causes causes tissue hemostasis.

Aim of the research – comprehensive morphometric assessment of the structural and spatial organization of the circulatory system of the duodenum in obstructive cholestasis in intact animals.

Material and methods. The experiments were carried out on 12 sexually mature (6-12 months) male Vietnamese pigs weighing 30.5-48.4 kg with different pedigree lines. Distribution into groups was carried out on the basis of the timing of obstructive cholestasis (3,7,14,28 days).

In these pathological conditions, the change in the cross section of the vascular trunks was accompanied by a restructuring of the symmetry of the vascular bed (H2). The latter changed significantly in the vessels of the IV order (Table 1). It should also be noted that in mechanical jaundice already in this short period the angles of branching of arteries and fusion of veins (φ0, φ1, φ2) changed. Branching angles tended to increase (Table 2). Increased branching angles and their asymmetry adversely affect blood circulation and total vascular capacity. All this indicates a deterioration in the blood supply to the walls of the duodenum in obstructive cholestasis [11–13].

Table 1. Morphometric characteristics of the vascular bed of the duodenum of intact male pigs (M±m)

Order	Type of vessels	Indices								
		D_0, μm	D_1, μm	D_2, μm	φ_0, °	φ_1, °	φ_2, °	L, mm	H_2, %	K_3, %
I	A	152,30±6,90	126,60±6,30	75,10±3,30	38,18±2,10	14,45±0,60	26,32±1,50	43,60±3,42	27,30±1,20	88,10±4,80
	V	276,40±9,30	239,20±9,45	192,90±4,26	54,22±4,20	14,10±0,90	43,58±3,12	48,34±3,54	19,10±1,14	98,20±5,10
II	A	75,60±3,60	68,30±3,36	41,60±4,56	69,27±4,80	24,32±1,50	45,90±3,20	16,40±0,90	22,30±1,20	88,30±3,60
	V	197,70±9,90	167,50±9,42	99,80±3,84	38,70±3,30	12,60±0,90	27,64±1,47	34,20±2,70	24,40±1,32	106,30±5,04
III	A	38,90±1,80	33,15±2,10	26,27±2,19	83,60±4,44	37,26±3,30	47,30±3,36	6,90±0,60	26,30±1,44	102,32±5,40
	V	106,10±3,90	84,60±4,14	49,30±3,60	67,28±3,60	22,40±2,10	47,36±3,45	20,40±1,20	24,80±1,38	109,30±4,20
IV	A	24,50±1,50	23,90±1,20	19,10±1,20**	109,54±5,10	43,40±3,90	48,40±3,60	2,30±0,36	30,60±1,50	110,50±3,30
	V	49,30±3,30	24,80±2,10	26,50±2,70	76,58±4,80	28,90±2,46	42,80±3,27	6,96±0,45	32,20±1,56	108,40±1,92
V	A	19,50±0,90	19,12±0,93	16,70±1,10	87,40±4,86	42,10±3,72	32,70±2,40	1,80±0,09	36,30±2,40	115,30±0,72
	V	26,60±1,80	24,10±2,16	20,70±1,80	72,58±4,20	31,70±2,94	36,44±2,52	3,60±0,21	38,50±2,55	85,90±3,90

note: * - p< 0,05 compared to control. A- arteries; V - veins*

Table 2. Morphometric characteristics of the vascular bed of the duodenum of male pigs with 3-day mechanical jaundice (M±m)

Order	Type of vessels	Indices								
		D_0, μm	D_1, μm	D_2, μm	φ_0, °	φ_1, °	φ_2, °	L, mm	H_2, %	K_3, %
I	A	151,30±0,30	107,80±8,60	74,20±6,40	42,50±3,12	16,512±1,320	25,87±1,80	44,95±3,90	29,90±2,40	88,10±3,51
	V	281,20±11,70	272,40±12,10	193,10±10,20	61,18±3,30	16,20±1,08	43,90±3,30	44,40±3,20	24,10±1,30	81,28±2,31
II	A	74,60±7,80	69,20±3,60	37,40±2,25	79,520±2,210*	28,360±2,090	51,20±2,10	18,30±1,17	25,50±2,40	84,20±4,80
	V	202,80±10,20	170,40±11,30	108,90±8,60	44,320±2,820	18,210±1,203	28,10±1,50	35,10±2,31	25,30±2,61	98,70±4,50
III	A	37,60±2,60	30,50±2,70	25,50±1,80	83,36±2,07	39,14±2,40	49,20±1,23	7,81±0,63	29,70±3,03	94,80±3,12
	V	110,90±9,70	88,70±9,30	61,07±3,80	77,250±3,400*	27,36±2,10	50,70±3,30	21,30±2,10	27,20±1,80	102,30±5,70
IV	A	24,20±1,40	23,70±2,80*	19,60±1,40	122,30±4,20*	48,10±2,40*	61,14±3,10*	3,70±0,21	30,10±2,70	109,60±6,10
	V	61,30±3,90*	37,90±4,20*	33,60±2,10*	84,20±3,60	41,30±2,70*	53,40±3,03*	12,48±1,80	26,48±1,80*	103,40±4,80
V	A	19,40±1,20	19,20±0,72	16,30±1,10	99,30±2,40*	48,02±2,40	51,30±2,10*	2,70±0,18	30,60±1,50*	120,38±6,60
	V	34,30±1,90*	29,90±1,10*	26,50±1,80*	81,80±3,06	38,30±2,10	42,80±2,40	6,30±1,05	31,20±2,10*	81,04±3,30

*note: * - p<0.05 compared to control. A-arteries; V - veins*

Table 3.Morphometric characteristics of vessels of different caliber of the duodenum of male Vietnamese pigs with 3-day mechanical jaundice (M±м)

Level	Indices	
	KI	MT, μm
Large arteries	0,153±0,015	24,80±1,50
Middle arteries	0,197±0,018	20,40±1,20
Small arteries	0,260±0,012*	14,90±0,66

*note: KI – Kernoghan's index, MT – media thickness, * - p<0,05 compared to control*

Morphometry of large, medium and small arteries of the studied organ showed that in these vessels there is a tendency to thicken their wall and narrow the lumen (Table 3). However, the Kernogan index was statistically significant only in the small arteries of this organ [14–16].

After 7 days from the start of simulation of experimental mechanical jaundice, changes in the duodenum of the studied animals were more pronounced changes compared with the previous group. At the same time growth of section of vascular trunks of veins is established. Especially there was an increase in the diameters of the veins in the vessels of IV and V order (Table 4). The arteries are narrowed throughout. During this period, there was a tendency to increase the length of vascular trunks, significantly changed the ratio of this value to D0. This phenomenon was especially pronounced in vessels of IV and V orders [17,18]. In these pathological conditions, the asymmetry also changed. It should be noted that the angles of departure of the branches from the main trunks of the vascular order significantly increased. The latter statistically significantly outweighed similar values in intact animals. The branching rate in higher order vessels tended to increase. In the higher orders of the vessels there was a similar dynamics of this parameter, which indicated a certain order in these vessels of the branching coefficient. Vascular morphometry also showed that their narrowing had already been observed in the large arteries. The latter was confirmed by the growth of the Kernogan index. The arteries of medium caliber were even more changed (Table 5). In small arteries, the Kernogan index increased from 0.220±0.09 to 0.289±0.015 (p<0.01), and the thickness of the media - from 13.30±0.72 to (15.80±0.63) μm 0.05) [19,20]. The above changes indicate a significant structural adjustment of the vascular bed of the duodenum with weekly obstructive cholestasis.

Morphometry of the microcirculatory tract showed that in animals with weekly cholestasis, all parts of the microcirculatory tract tended to expand (Table 4). However, the most dilated was the venous part of the microcirculatory tract (Table 6). Thus, the thickness of the arterioles in the mucous membrane in experimental animals with weekly obstructive cholestasis reached 20.80±0.75 μm, which was 4.2% higher than the similar control indicator [21,22].

Table. 4. Morphometric characteristics of the vascular bed of the duodenum of male Vietnamese pigs with weekly obstructive cholestasis (M±m)

Order	Types of vessels	Indices								
		D_0, μm	D_1, μm	D_2, μm	φ_0, °	φ_1, °	φ_2, °	L, mm	H_2, %	$К_3$, %
I	A V	150,90±11,80 282,30±11,40	105,70±7,80 273,10±12,60	73,50±6,90 205,10±11,70	70,42±4,20 64,90±2,10	30,20±2,10** 18,70±1,50*	42,20±2,10 48,03±3,30	45,10±3,60 51,40±4,20	30,30±2,10 26,40±1,80*	106,10±3,30* 97,90±2,10
II	A V	73,60±7,50 210,90±12,60	67,30±3,90 171,42±12,40	37,20±4,41 109,80±7,26	81,30±4,20* 62,20±3,30**	33,30±2,40* 21,90±1,80*	52,20±3,60 39,80±1,80*	18,90±1,80 36,42±2,40	27,50±2,10* 26,80±2,40	96,30±3,30 97,40±4,80
III	A V	37,70±3,30 112,80±9,60	30,40±4,20 99,80±8,70	25,20±1,92 65,80±3,90	91,40±4,80 87,50±2,40*	43,90±3,30 34,70±2,10**	49,90±1,77 54,60±3,30	8,30±1,20 21,90±1,50	29,90±1,80 28,10±2,10	116,30±4,50 103,10±4,20
IV	A V	24,20±1,50* 66,10±5,40*	23,50±2,10* 50,20±4,80**	19,20±1,60* 36,20±2,40*	124,50±5,40* 92,40±2,30*	51,60±3,30 37,31±2,40*	66,90±3,60* 54,20±3,30*	3,60±0,24* 13,30±0,90*	34,30±2,40 27,70±2,10	97,40±2,30 99,20±2,70
V	A V	18,10±1,02* 36,40±1,80*	16,82±1,20* 30,90±1,92*	15,90±1,17 27,80±1,50*	107,70±6,30* 88,60±4,20*	53,80±3,30* 39,90±3,60	50,30±3,60* 43,90±2,10*	2,80±0,19** 6,10±0,90*	29,80±2,04 31,60±2,10*	137,20±5,10* 95,56±3,60

*note: * - p< 0,05 compared to control. A- arteries; V – veins; ** - p<0,01, in other cases - p >0,05*

Table 5. Morphometric characteristics of arteries of different caliber of the duodenum of pigs with weekly obstructive cholestasis (M±m)

Level	Indices	
	KI	MT, μm
Large arteries	0,170±0,018*	25,10±1,50
Middle arteries	0,230±0,015*	20,90±1,08
Small arteries	0,289±0,015**	15,80±0,63*

*notes: IR - Kernogan index, MT - media thickness, * - p<0,05 in comparison with control values, ** - p<0,01*

Table 6. Morphometric characteristics of the microcirculatory tract of the duodenum in pigs with weekly obstructive cholestasis M±m)

Part of duodenum	Arterioles			Precapillares			Capillares			Postcapillares			Venulae			Density of capillares
	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	
Upper	20,80±0,75	21,80±0,81	22,03±0,84	11,57±0,72	11,92±0,54	11,80±0,45	7,11±0,44	7,25±0,39	7,20±0,42	13,90±0,42	14,30±0,33*	14,40±0,36*	32,95±0,83*	31,40±0,81*	30,80±0,72*	(343,12) x10

*note: M - mucous; S - submucous; Ms - muscular, * - p<0,05*

Precapillaries and capillaries had the same tendency to expand. It should be noted that the postcapillaries and venules differed statistically significantly from the previous values. Thus, the diameter of the postcapillaries in the muscular layer of the upper part of the duodenum reached 14.40±0.36 μm. This numerical value was statistically significantly different from the similar control (13.28±0.30 μm, P<0,05). It is also worth noting that the latter parameter was lower than the above by 8.4%. Venules in the mucous, submucosal and muscular membranes of the duodenum also had an almost similar tendency to expansion [23]. Thus, the diameter of the venules in the mucous membrane of the studied organ reached 32.95±0.83

μm. This morphometric index was statistically significantly different from the similar control parameter (30.05±0.96 μm, p<0.05). The last digital value was 9.6% lower than the previous one. The diameter of venules in a submucous membrane of experimental animals exceeded control size in 1,1 times, and in a muscular layer - on 8,7%. The density of capillaries per unit area tended to expand, but did not statistically significantly exceed the last morphometric parameter in intact animals. It should also be emphasized that up to a week (3 days) the above morphometric parameters did not differ significantly from the control (Table 1).

Under these experimental conditions, the microcirculatory tract of others - the duodenum was changed less significantly, so we did not present these data in the tables.

During this period of mechanical jaundice, deeper changes in the structural and spatial organization of the vascular bed of the duodenum were observed, which were already observed on the review radiographs of arteries and veins of the studied organ (Fig. 1, 2).

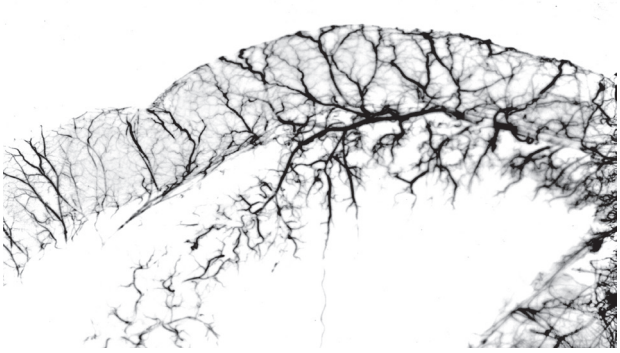

Fig. 1. Arterial bed of the duodenum with two-week mechanical jaundice. Depletion of vascular pattern in the wall of the duodenum in pigs. Photo from radiograph

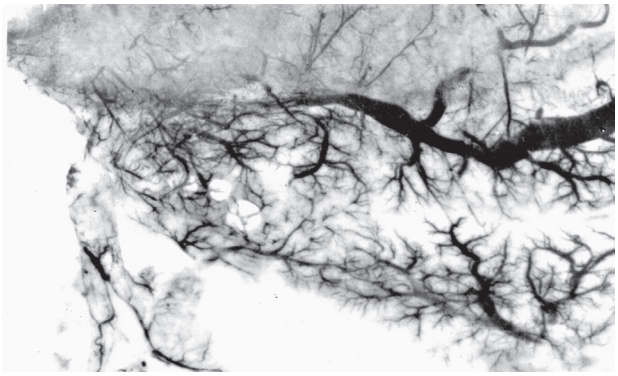

Fig. 2. Dilation of the venous bed and loss of asymmetry in pigs 14 days after the onset of surgical cholestasis. Photo from radiograph

Table 7. Morphometric characteristics of the vascular bed of the duodenum in pigs with two-week obstructive cholestasis (M±m)

Order	Types of vessels	Indices								
		D_0, μm	D_1, μm	D_2, μm	φ_0, °	φ_1, °	φ_2, °	L, mm	H_2, %	K_3, %
I	A V	150,10±12,30 283,40±13,20	104,90±8,10 275,21±13,50	73,60±7,20 206,40±12,30	81,20±4,20** 75,80±3,60*	40,10±2,40* 21,90±1,50*	51,80±3,30* 53,70±3,60*	45,15±3,70 50,30±4,50	29,10±2,40 24,51±1,80*	90,70±9,30 97,30±5,40
II	A V	73,82±7,80 211,50±12,90	67,50±6,30 172,50±13,80	36,70±5,40 110,10±12,60	82,40±4,50* 66,90±3,60	35,70±2,10* 24,30±1,70	51,10±3,30 43,80±2,70*	16,90±1,80 34,60±2,70	26,40±2,10 25,10±1,90	98,12±8,10 97,90±5,70
III	A V	36,60±3,30* 116,90±7,20*	30,10±3,30* 105,12±8,10*	24,90±2,70* 66,10±4,20*	92,30±4,80 88,60±3,30**	44,50±3,10* 34,60±1,80*	50,30±1,80 55,20±3,10*	7,40±0,90 18,80±1,20	26,60±1,80 27,80±1,50	118,50±10,20 104,32±9,30
IV	A B	23,30±1,90** 69,90±4,50**	20,70±2,10** 56,10±4,50*	18,30±1,90** 40,45±2,70*	125,60±5,70* 94,30±3,60*	50,90±3,30 37,92±2,07*	64,50±3,60* 56,70±3,30*	2,70±0,81 10,20±0,90*	33,21±2,10 28,40±3,30	98,50±4,60 100,11±8,10
V	A V	18,40±1,20** 39,80±2,10**	16,03±10,10** 34,60±2,10**	15,90±1,20** 31,70±1,50**	108,50±6,60* 92,40±3,60**	54,70±3,03* 41,20±2,40	51,20±3,27* 50,70±3,10*	1,70±0,09 3,10±0,21	17,56±1,90* 26,40±1,50**	138,30±5,10* 98,80±3,30

*note: * - p<0,05; ** - p<0,01 in comparison with the control. A-arteries; V - veins*

After 14 days from the beginning of modeling of mechanical jaundice, deeper changes in the structural and spatial organization of the vascular bed of the duodenum were observed, which were already observed on review radiographs of arteries and veins of the studied organ (Fig. 1, 2).

A detailed analysis of the morphometric parameters of the vascular bed of the duodenum showed that during this period of the experiment, the absolute values of the diameters of the veins increased. The arteries are narrowed (Table 7). It should be noted that starting from the vessels of the III order, the diameters of

the veins significantly exceeded the control values. Thus, D0 arteries of the third order in these pathological conditions reached 49.80±3.30 μm, which is almost 1.3 times lower than the values in the intact group of animals. The D0 of the third-order vein was 126.90±7.20 μm, which was 1.2 times higher than the same morphometric parameter of the duodenum of control male pigs of the Vietnamese breed. A similar pattern in the dynamics of changes in diameters was observed in the arteries and veins of the studied organ of IV and V orders. Almost the same changes were observed when comparing D1 and D2 with control values [24,25].

The change in the diameters of arteries and veins in the studied organ was accompanied by a loss of asymmetry of vascular orders (H2), especially in arteries and veins of the 5th order (Table 7). The angles of branching of the arteries in most cases increased compared to the previous observation period. At the same time the angles of formation of venous trunks also increased. It should be noted that the latter values were statistically significantly changed in comparison with control values in almost all studied vascular orders. The coefficient of vascular branching (K3) in comparison with a similar parameter of the previous group has not changed. It should be noted that in arteries of the V order it reached 138.30±5.10%. The given value was statistically significantly different from the same in intact animals (85.90±3.90%, p<0.05). The length of vascular orders in these simulated pathological conditions tended to decrease (Table 7).

The Kernogan index increased in arteries of all orders (Table 8). The thickness of the media tended to increase significantly. It increased statistically significantly in the arteries of medium and small calibers. Such changes in the Kernogan index and media thickness indicated a deterioration in the blood supply to the duodenum in simulated obstructive cholestasis [26].

Table 8. Morphometric characteristics of arteries of different caliber of the duodenum in pigs with two-week obstructive cholestasis (M±m)

Level	Indices	
	KI	MT, μm
Large arteries	**0,190±0,017***	**26,20±1,20**
Middle arteries	0,250±0,012*	21,80±0,90*
Small arteries	0,300±0,015*	17,20±0,60*

*notes: IR - Kernogan index, MT - media thickness, * - p<0,05 in comparison with control values, ** - p<0,01*

Table 9. Morphometric characteristics of the microcirculatory tract of the duodenum in pigs with two-week obstructive cholestasis (M±m)

Part of dudenum	Arterioles			Precapillares			Capillares			Postcapillares			Venulae			Density of capillares
	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	
Upper	31,40±0,90**	32,10±1,20**	31,50±0,90**	15,30±0,60*	14,90±0,72*	15,40±0,63*	10,30±0,36**	11,20±0,33**	11,50±0,30**	19,40±0,51**	19,10±0,48**	19,60±0,54**	48,10±3,30**	47,90±3,10**	48,60±3,30*	(285±9) x 10*

*note: M - mucous; S - submucous; Ms - muscular, * - p<0,05*

Morphometry of all parts of the microcirculatory tract showed that almost all of them tended to change significantly. Thus, the diameter of the arterioles in the upper part of the studied organ in the mucous membrane was equal to 31.40±0.90 μm. This value was statistically significantly different from that in the previous group of observations (20.80±0.75 μm, p<0.01) and exceeded the latter by 1.5 times. The same tendency to changes was observed also at the analysis of morphometric characteristics of arteries in a submucosal and muscular layers of the investigated part of a duodenum. Significant changes took place in the morphometric assessment of the structural rearrangement of the precapillaries. Thus, in the mucous membrane of this organ with 14-day obstructive cholestasis, the diameter of the precapillaries reached 15.30±0.60 μm. This morphometric parameter was statistically significantly different from the same in the previous group of observations, ie with 7-day obstructive cholestasis. In the specified terms this diameter of precapillaries reached 11,57±0,72 microns. These values were statistically significantly different. Similarly, the dynamics was observed with the structural rearrangement of the precapillaries in the submucosal and muscular membranes of the studied part of the duodenum. Thus, with 14-day obstructive cholestasis, the diameter of the precapillaries in the submucosal membrane of the studied organ exceeded a similar parameter in animals with 7-day mechanical jaundice 1.25 times, and in the muscular layer - 1.3 times.

The diameters of capillaries in the mucous, submucosal and muscular membranes of the upper part of the studied organ also increased significantly. Thus, the diameter of the capillaries in the mucous membrane in these experimental conditions reached the value of 10.30±0.36 μm. This parameter was statistically significantly different from that in the previous group of observations (7.11±0.45 μm, p<0.01) and exceeded the latter by almost 44.8%. Almost similar tendency to increase in diameters of postcapillaries was observed in submucosal and muscular covers of the investigated body. During this period of obstructive cholestasis, the diameter of postcapillaries and venules also increased (Table 9).

Thus, the diameter of the venules in the mucous membrane of the upper part of the duodenum in these simulated pathological conditions reaches 48.10±3.30 μm, when in animals with 7-day obstructive cholestasis - 32.95±0.83 μm. It should be noted that the above morphometric parameters were statisti-

cally significantly different (p<0.01) and the previous parameter was 1.46 times higher than the last. A similar phenomenon was found in the study of the structural rearrangement of the venules in the submucosal and muscular layers of the studied organ. Under these pathological conditions, the density of capillaries significantly decreased (Table 9), which indicated a significant deterioration in the blood supply to the duodenum with 14-day obstructive cholestasis. Morphometric parameters of all parts of the microcirculatory tract of other parts of the duodenum in this period of mechanical jaundice are not presented in the tables, because the dynamics of their changes was the same as in the upper part of this organ.

Visual examination of angiograms of pigs with 28-day obstructive cholestasis revealed significant changes in the structural and spatial organization of the vessels of the duodenum.

Arterial vessels were narrowed, deformed and twisted. Thus, during this period, D0 in the arteries of the first order reached 183.20±12.60 μm. This presented value (Table 10) was statistically significantly different from similar intact pigs (152.30±6.90 μm, p<0.05-0.001). The veins were ectasized, the diameter of their lumen increased. However, statistically significant, this parameter did not differ from the control. Thus, the diameter (D0) of the first order veins in this period was 284.50±13.80 μm, and in intact animals - 276.40±9.3 μm (p>0.05). Almost similar dynamics was observed in the analysis of the given in vessels of the II order (Table 10).

The same processes were observed in vessels of the III-th, IV-th, V-th orders. D1 values of arteries and veins in 28-day obstructive cholestasis also tended to change. This parameter in the arteries of the first order was reduced, but did not differ statistically significantly from that in intact animals. It should be noted that in the veins of this order, the difference between these values was significant (p<0,05, Table 8). Similar changes were found in vessels of the II order. In vessels of the III order the specified parameter statistically significantly differed from control indicators both in arteries, and in veins. The same dynamics of the studied morphometric index was observed in arteries and veins of IV and V orders.

Table 10. Morphometric characteristics of the vascular bed of the duodenum in male pigs with 28-day obstructive cholestasis (M±m)

Order	Types of vessels	Indices								
		D_0, μm	D_1, μm	D_2, μm	φ_0, °	φ_1, °	φ_2, °	L, mm	H_2, %	K_3, %
I	A	143,20±12,60*	103,10±8,40	70,80±7,40	82,10±4,10*	41,40±2,50*	52,30±3,20*	45,90±3,80	29,20±2,50	91,10±9,40
	V	284,50±13,80	276±13,70*	207,20±12,60	76,20±3,70*	22,50±1,60*	54,10±3,56*	50,80±4,60	24,60±1,70*	97,60±5,70
II	A	71,40±7,90	66,30±3,36	36,20±5,60	82,90±4,40*	36,10±2,08*	51,60±3,40	16,70±1,90	26,80±2,20	98,50±8,40
	V	212,60±13,10	193,62±9,24*	112,30±12,70	67,20±3,50*	24,80±1,60*	44,20±3,30*	34,40±2,80	25,30±2,10	97,40±6,30
III	A	36,40±3,60*	29,90±3,30*	24,80±2,60*	92,90±1,80*	45,10±3,09*	50,90±1,96	7,20±0,97	26,66±1,90	118,90±11,70
	V	117,40±7,10*	106,20±8,20*	67,21±4,10*	89,30±3,20	34,90±1,70*	55,80±3,10*	18,10±1,30	27,60±1,80	105,30±10,50
IV	A	22,90±1,80**	19,12±1,60*	17,80±1,80*	126,10±5,60*	51,40±3,10	65,10±3,50*	2,70±0,90	33,42±2,40	97,30±4,90
	V	68,20±4,60**	57,30±4,60*	40,42±2,60*	95,40±3,50	38,20±2,04	57,22±3,20*	101,10±0,81*	28,46±3,70	96,20±3,96
V	A	17,90±1,10**	15,80±1,60*	14,03±1,10*	108,84±6,42*	55,40±3,10*	51,90±3,10*	1,66±0,12	27,40±1,80*	136,20±10,50
	B	40,50±2,20**	35,20±1,90**	32,40±1,50**	93,20±3,40**	41,60±2,30	50,80±3,06*	3,09±0,24	26,90±4,10	98,98±10,20

*note: M - mucous; S - submucous; Ms - muscular, * - p<0,05*

Table 11. Morphometric characteristics of arteries of different caliber of the duodenum in pigs with 28-day obstructive cholestasis (M±m)

Level	Indices	
	KI	MT, μm
Large arteries	0,194±0,016*	26,22±1,30
Middle arteries	0,256±0,013*	22,10±0,96*
Small arteries	0,326±0,015*	17,30±0,57*

*notes: IR - Kernogan index, MT - media thickness, * - p<0,05 in comparison with control values, ** - p<0,01*

Table 12. Morphometric characteristics of the microcirculatory tract of the duodenum in pigs with 28-day obstructive cholestasis (M±m)

Part of duodenum	Arterioles			Precapillares			Capillares			Postcapillares			Venulae			Density of capillares
	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	M	S	Ms	
Upper	31,50±0,80*	32,40±1,10*	31,80±0,90*	15,36±0,57	15,10±0,69*	15,66±0,60*	10,37±0,33*	11,40±0,33*	11,80±0,30*	19,60±0,48*	19,30±0,51*	19,80±0,48**	48,20±3,30**	48,40±3,06**	48,90±3,09**	(297±8)*10*

*note: M - mucous; S - submucous; Ms - muscular, * - p<0,05*

On day 28 of mechanical jaundice, there was a tendency to increase the total angle of branching of the vascular order due to the greater deviation of the daughter branch. The angle of discharge of the latter (φ2) in all orders of arteries and veins significantly exceeded the control values. It should be noted that the angle of discharge of the parent branch was less pronounced (Table 8).

The increase in the transverse diameter of the venous vessels was accompanied by a decrease in their relative length, which indicated the predominant dilatation and loss of asymmetry of the vascular bed. The tendency to decrease the branching coefficient of vascular orders (K3) indicated a decrease in the capacity of the arterial bed [27,28].

Thickening of the arterial wall was observed in 28-day obstructive cholestasis. This was evidenced by the dynamics of the Kernogan index and media thickness. Thus, the Kernogan index of the large arteries of the duodenum in pigs with 28-day obstructive cholestasis reached 0.194±0.016, which is 1.5 times higher than in intact animals. In the middle arteries, this parameter was 1.6 times higher than in the control group, and in the small arteries - 1.5 times. At the same time, the thickness of the media also increased. In large arteries it increased by 11.1%, in medium vessels - by 17.5%, and in small - by 30.0% (Table 11).

Data on the morphometry of the microcirculatory tract of the duodenum in pigs with 28-day obstructive cholestasis showed that changes in all its parts continued to grow. At the same time, the spatial characteristics of arterioles, precapillaries, capillaries, postcapillaries and venules significantly increased. The number of capillaries also decreased significantly (Table 12).

At light optical research of microdrugs of a duodenum at experimental pigs plethora of both arteries, and veins is established. The walls of the vessels are somewhat thickened with the phenomena of edema. Stasis, as well as perivascular diapades hemorrhages were found in small vessels [29–31]. The internal elastic membrane in the arteries with the phenomena of edema, stratification, disorganization of its fibers. In some places there were gaps in the latter. Smoothing of this membrane was observed in most vessels. The inner lumen of the vessels narrowed and was deformed. In most cases, the deformation of the lumen of the arteries was found in the places of their branching. In a wall of these vessels between muscular myocytes increase in a connecting fabric was observed. Perivascular sclerosis was also detected. Alternative and infiltrative processes were also observed in the mucous membrane of the studied organ [32,33].

On injectable micropreparations in vessels of a microcirculatory channel various forms of expansion and bulging were observed. The vascular density of the microcirculatory tract was reduced. There was also a significant deformation of the studied structures. Endothelial cell proliferation was observed in some vessels, which indicated hypoxia. Infiltrative and sclerotic processes took place in the muscular membrane.

Thus, obstructive cholestasis was accompanied by a significant structural and spatial rearrangement of the vascular bed of the duodenum. The latter correlated with the duration of mechanical jaundice. The most pronounced changes in the vascular bed of the duodenum of pigs occurred during 28-day mechanical jaundice [34].

Conclusions. The degree of circulatory disorders, disorders of the microcirculatory tract is accompanied by an increase in the angles of arteries and fusion of veins, increased asymmetry of the vascular bed of the duodenum, narrowing of the lumen of arteries and thickening of their walls are objective criteria for assessing the degree of mechanical jaundice, predicting the reversibility of their changes.

REFERENCES

1. Apostu, RC, Ciuce CC, Făgărăşan V, Scurtu RR, Ciuce C. Hepatoportoenterostomy in selective obstructive cholestasis - an new experimental model in the rat chirurgia. 2020;115(2):252-60. doi:10.21614/chirurgia.115.2.252.

2. Yokota S, Ono Y, Nakao T, Zhang P, Michalopoulos GK, Khan Z. Partial bile duct ligation in the mouse: a controlled model of localized obstructive cholestasis. // J Vis Exp. 2018;28(133):56930. doi: 10.3791/56930.

3. Fu H, Li Y, Bai G, Yin R, Yin C, Shi W, et al. Persistent cholestasis resulting from duodenal papillary carcinoma in an adolescent male: a case report. // Medicine (Baltimore). 2019;98(22):e15708. doi:10.1097/MD.0000000000015708.

4. Шошенко КА. Кровеносные капилляры. Новосибирск, 1985. 374 с.

5. Jian Y, Haisu T, Chihua F, Yingfang F, Nan X, Ning Z, et al. Clinical applications of three-dimensional visualization model of arteries supplying the extrahepatic bile duct for patients with biliary obstruction.// AM. SUR. 2017;83(1):8-15.

6. Cho MK, So H, Jung K, Lee JH, Park DH. Percutaneous transhepatic biliary drainage-assisted, endoscopic ultrasound-guided hepaticoduodenostomy for isolated complete right intrahepatic duct obstruction.// Endoscopy. 2016;48(S01):E317-18. doi:10.1055/s-0042-117223.

7. Dai J, Wu X-F, Chun Y, Li H-J, Chen Y-L, Liu G-Z, et al. Study of relationship between the blood supply of the extrahepatic bile duct and duct supply branches from gastroduodenal artery on imaging and anatomy. //Chin Med J (Engl). 2015;128(3):322-6. doi:10.4103/0366-6999.150097.

8. Delhove JMKM, Buckley SMK, Perocheau DP, Karda R, Arbuthnot P, Henderson NC, et al. Longitudinal in vivo bio-

imaging of hepatocyte transcription factor activity following cholestatic liver injury in mice. // Sci Rep. 2017;7:41874. https://doi.org/10.1038/srep41874.
9. Lobeck IN, Dupree P, Tiao GM, Dupree P, Tiao GM, Bove KE. Cystic biliary atresia and choledochal cysts are distinct histopathologic entities.// Am J Surg Pathol. 2017;41(3):354-64.
10. Куприянов ВВ. Пути микроциркуляции. Кишинев: Картя Молдовеняска, 1969. 260 с.
11. Bharathy KGS, Borle D, Kumar N. Acute calculous cholecystitis with intrahepatic gallbladder perforation. // JAMA Surg. 2017;152(4):403-4.
12. Gupta K, Li Q, Tang H, Li Shan Fong E, Song Z, Mo S, et al. Actomyosin contractility drives bile regurgitation as an early response during obstructive cholestasis. // J Hepatol. 2017;66(6):1231-40.
13. Sutton AJ, Vohra RS, Hollyman M, Marriott PJ, Buja A, Alderson D, et al. Cost-effectiveness of emergency versus delayed laparoscopic cholecystectomy for acute gallbladder pathology.// British J Surg. 2017;104(1):98-107.
14. Russo P, Magee JC, Anders RA, Bove KE, Chung C, Cummings OW. Key histopathologic features of liver biopsies that distinguish biliary atresia from other causes of infantile cholestasis and their correlation with outcome: A multicenter study.// Am J Surg Pathol. 2016;40(12):1601-15.
15. Evans AT, Hockenbery DM, Ioannou GN, Hassan S, Qiu WC, Hockenbery DM. Fibrosing cholestatic hepatitis C after hematopoietic cell transplantation: Report of 3 fatal cases. // Am J Surg Pathol. 2015;39(2):212-20.
16. Tag CG, Weiskirchen S, Hittatiya K, Tacke F, Tolba RH, Weiskirchen R. Induction of experimental obstructive cholestasis in mice. // Lab Anim. 2015;1 Suppl:70-80. doi:10.1177/0023677214567748.
17. Chai J, Cai S-Y, Liu X, Lian W, Chen S, Zhang L. Canalicular membrane MRP2/ABCC2 internalization is determined by Ezrin Thr567 phosphorylation in human obstructive cholestasis. // J Hepatol. 2015;63(6):1440-48.
18. Jorge AM, Keswani RN, Veerappan A, Gawron AJ, Soper NJ. Non-operative management of symptomatic cholelithiasis in pregnancy is associated with frequent hospitalizations. // J Gastrointest Surg. 2015;19(4):598-603.
19. Mishra T, Lakshmi KK, Peddi KK. Prevalence of cholelithiasis and choledocholithiasis in morbidly obese south indian patients and the further development of biliary calculus disease after sleeve gastrectomy, gastric bypass and mini gastric bypass. // Obes Surg. 2016;26(10):2411-17.
20. Wagner M, Fickert P, Zollner G. Secretin and cholestasis, two sides of a coin. // Hepatol. 2016;64(3):714-6.
21. Babu CSR, Sharma M. Biliary tract anatomy and its relationship with venous drainage. // J Clin Exp Hepatol. 2014;4(Suppl 1): S18-26. doi: 10.1016/j.jceh.2013.05.002.
22. Heinrich S. Partial bile duct ligation in mice: a novel model of acute cholestasis. // Surg. 2011;149(3):445-51.
23. Yang M, Ramachandran A, Yan H-M, Woolbright BL, Copple BL, Fickert P, et al. Osteopontin is an initial mediator of inflammation and liver injury during obstructive cholestasis after bile duct ligation in mice. // Toxicol Lett. 2014;224(2):186-95. doi:10.1016.
24. Ansaloni L, Pisano M, Coccolini F, Peitzmann AB, Fingerhut A, Catena F. 2016 WSES Guidelines on acute calculous cholecystitis. // World J Emerg Surg. 2016;11:25. doi:10.1186/s13017-016-0082-5.
25. Tag CG, Sauer-Lehnen S, Weiskirchen S, Borkham-Kamphorst E, Tolba RH, Tacke F, Weiskirchen R. Bile duct ligation in mice: induction of inflammatory liver injury and fibrosis by obstructive cholestasis. // J Vis Exp. 2015;(96):52438. doi:10.3791/52438.
26. Гнатюк МС, Татарчук ЛВ, Грабчак СО. Особливості структурної перебудови судин гемомікроциркуляторного русла дванадцятипалої кишки при обтураційному холестазі. // Здобутки клініч. і експерим. медицини. 2016;4: 36-9. DOI: https://doi.org/10.11603/1811-2471.2016.v0.i4.7073.
27. Пилипчук ВІ. Варіанти операційних втручань на жовчовивідних протоках при хронічному панкреатиті з ознаками біліарної гіпертензії. Шпитальна хірургія. // Журнал імені Л. Я. Ковальчука. 2016;2:27-31. DOI: https://doi.org/10.11603/2414-4533.2016.2.6406.
28. Logoyda L. A HPLC-MS/MS method development and validation for the simultaneous determination of nifedipine and enalapril in human plasma. Int J Appl Pharm. 2018;10:35-42.
29. Sobazstiano P, di Molat F. Pathophysiology of Chronic Damage. // Acute and chronic pancreatitis. Turin: Editioni minerva modica. 2013:63-9.
30. Гоpальський ЛП, Хомич ВП, Кононський ОІ. Основи гістологічної техніки і морфофункціональні методи дослідження у нормі та при патології. Житомир: Полісся, 2011. 288 с.
31. Патент UA78273, МПК G 09B23/28(2006/01) Спосіб моделювання механічної жовтяниці / М. С. Гнатюк – NoU201211327; заявл.01.10.2012; опубл.11.03.2013, Бюл. No 5.
32. Vandenabeele LAM, Dhondt E, Geboes KP, Defreyne L. Percutaneous stenting in malignant biliary obstruction caused by metastatic disease: clinical outcome and prediction of survival according to tumor type and further therapeutic options. // Acta Gastroenterol Belg. 2017;80(2):249-55.
33. van Golen RF, Olthof PB, de Haan LR, Coelen RJ, Pechlivanis A, de Keijzer MJ, et al. The pathophysiology of human obstructive cholestasis is mimicked in cholestatic Gold Syrian hamsters. // Biochim Biophys Acta Mol Basis Dis. 2018;1864(3):942-51. doi:10.1016/j.bbadis.2017.11.022.
34. Thoguluva Seshadri C, Ramanathan S, Thoguluva Chandrasekar V, Bollu Janakan G, Kalamegam RY, Suriyanarayanan S. Obstructive jaundice is not always surgical! ACG Case Rep J. 2019;6(9):e00179. doi:10.14309/crj.0000000000000179.

SUMMARY

MORPHOMETRIC ASSESSMENT OF STRUCTURAL CHANGES IN THE VASCULAR BED OF DUODENUM IN ANIMALS WITH OBSTRUCTIVE CHOLESTASIS

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Aim of the research – comprehensive morphometric assessment of the structural and spatial organization of the circulatory system of the duodenum in obstructive cholestasis in intact animals.

Three days after the simulated obstructive cholestasis in 3 experimental animals, on examination of radiographs there is a tendency to reorient the arterial and venous bed of the duodenum. Analysis of morphometric parameters also showed a tendency to constriction of arteries and varicose veins. Some narrowing of the arteries was evidenced by a decrease in the diameters of the main trunks of the vascular order (D0) almost throughout the

period of the studied vascular bed. The same trend was observed in the morphometric assessment of daughter branches (D1, D2).

The degree of circulatory disorders, disorders of the microcirculatory tract are accompanied by an increase in the angles of arteries and fusion of veins, increased asymmetry of the vascular bed of the duodenum, narrowing of the lumen of arteries and thickening of their walls are objective criteria for assessing the degree of mechanical jaundice, predicting the reversibility of their changes.

Keywords: obstructive cholestasis, duodenum, microcirculatory tract.

РЕЗЮМЕ

МОРФОМЕТРИЧЕСКАЯ ОЦЕНКА СТРУКТУРНЫХ ИЗМЕНЕНИЙ СОСУДИСТОГО РУСЛА ДВЕНАДЦАТИПЕРСТНОЙ КИШКИ ЖИВОТНЫХ ПРИ ОБТУРАЦИОННОМ ХОЛЕСТАЗЕ

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Цель исследования – комплексная морфометрическая оценка структурно-пространственной организации системы кровообращения двенадцатиперстной кишки при обтурационном холестазе в эксперименте.

Эксперименты проведены на 12 половозрелых (6-12 мес.) самцах свиней вьетнамской породы массой 30,5-48,4 кг с разными линиями родословной. Распределение по группам осуществлялось на основе сроков обтурационного холестаза (3,7,14,28 дни).

Спустя три дня после моделирования обструктивного холестаза у 3 из 12 экспериментальных животных при исследовании рентгенограмм наблюдается тенденция к изменению ориентации артериального и венозного русла двенадцатиперстной кишки. Анализ морфометрических данных выявил склонность к сужению артерий и варикозному расширению вен. О сужении артерий свидетельствует уменьшение диаметров основных стволов сосудистого порядка (D0) практически на протяжении всего периода исследуемого сосудистого русла. Подобная тенденция наблюдалась при морфометрической оценке дочерних ветвей (D1, D2).

Результаты проведенных исследований выявили, что степень нарушения кровообращения и микроциркуляторного русла, сопровождающееся увеличением углов артерий и сращением вен, повышенная асимметрия сосудистого русла двенадцатиперстной кишки, сужение просвета артерий и утолщение их стенок являются объективными критериями оценки степени механической желтухи и прогнозирования обратимости их изменений.

რეზიუმე

თორმეტგოჯა ნაწლავის სისხლძარღვთა კალაპოტის სტრუქტურული ცვლილებების მორფომეტრიული შეფასება ობტურაციული ქოლესტაზის დროს

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კვლევის მიზანს წარმოადგენდა თორმეტგოჯა ნაწლავის სისხლძარღვთა სისტემის სტრუქტურულ-სივრცითი ორგანიზების კომპლექსური მორფომეტრიული შეფასება ობტურაციული ქოლესტაზის დროს ექსპერიმენტში.

კვლევა ჩატარდა 30,5-48,4 კგ მასის და სხვადასხვა ხაზის ვიეტნამის ჯიშის 12 ზრდასრულ (6-12 თვის ასაკის) მამრ ღორზე. ჯგუფებად განაწილების პრინციპს წარმოადგენდა ობტურაციული ქოლესტაზის ვადა (3, 7, 14 და 28 დღე).

ობტურაციული ქოლესტაზის მოდელირებიდან სამი დღის შემდეგ 12 ექსპერიმენტული ცხოველიდან სამს რენტგენოლოგიურად აღენიშნა ტენდენცია თორმეტგოჯა ნაწლავის არტერიული და ვენური კალაპოტის ორიენტაციის ცვლილებებისკენ. მორფომეტრიული მონაცემების ანალიზით გამოვლინდა მიდრეკილება არტერიების შევიწროებისა და ვენების ვარიკოზული გაგანიერებისაკენ. არტერიების შევიწროების შესახებ მიუთითებდა სისხლძარღვების ძირითადი ღეროების (D0) დიამეტრის შემცირება მთლიანად სისხლძარღვთა კალაპოტში. ასეთივე ტენდენცია აღინიშნა სისხლძარღვთა განტოტებების (D1, D2) მორფომეტრიული შეფასების დროსაც.

ჩატარებული კვლევის შედეგებით გამოვლინდა, რომ სისხლის მიმოქცევის და მიკროცირკულაციური კალაპოტის დარღვევის ხარისხი - არტერიების კუთხეების და ვენების შეზრდის მატება, თორმეტგოჯა ნაწლავის სისხლძარღვთა კალაპოტის მომატებული ასიმეტრია, არტერიების სანათურის დავიწროება და მათი კედლების გასქელება, წარმოადგენს მექანიკური სიყვითლის ხარისხის შეფასების და განვითარებული ცვლილებების შექცევადობის პროგნოზირების ობიექტურ კრიტერიუმს.