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MORPHOLOGY OF THE HUMAN CARDIAC VALVES OF INFLAMMATORY AND NON-INFLAMMATORY GENESIS OF THE ACQUIRED HEART DEFECTS

Morphology of the human cardiac valves of inflammatory and non-inflammatory genesis of the acquired heart defects

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Summary. The prosthetics of the heart valves was and remains one of the main parts of cardiac surgery. Reliable information about the nature of valve heart defects will be useful for developing the most effective treatment regimens for patients.

The aim of the study – to investigate morphological peculiarities of the heart valves, which were removed during the surgical replacement of their prostheses.

Materials and Methods. The material for the morphological study of the valves was taken in the Institute of Cardiovascular Surgery named after M. M. Amosov. There were studied the main structural components of 855 valves (377 mitral and 478 aortic ones). Out of the cusps, chordae and papillary muscles, according to the generally accepted method, there were made histological specimens, which were stained with hematoxylin-eosin, with picrofuchsin according to Van Gieson method, Weigert resorcin-fuchsin method and also according to MSB method in Zerbino-Lukasevich modification. Frozen sections were processed by means of Sudan to identify adipose cells.

Results. There was revealed the predominance of lesions of the aortic valve. The frequency of pathological processes causing acquired heart defects has been clarified. The analysis of structural changes revealed the predominance of lipoidosis in the group of non-inflammatory valve damage. When estimating the specific gravity of lipoidosis in 46.4 %, it was combined with rheumatism, infectious endocarditis, dysplasia, and myxomatous degeneration.

Conclusions. Morphological analysis of the surgical specimen showed that acquired heart defects are some polymorphic pathologies. In the foreground among the causes of defects there is rheumatic valvulitis (49.7 %), in the second place – non-inflammatory valve damage (38.4 %), in the third place – infective endocarditis (10.4 %). Acquired heart defects, caused by one of the above-mentioned reasons, are often complicated as a result of the

Морфологічні прояви набутих вад клапанів серця людини запального і незапального генезу

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Резюме. Протезування клапанів серця було і залишається одним з основних розділів у кардіохірургії. Достовірна інформація про природу клапанних вад серця буде корисна для розробки найефективніших схем лікування пацієнтів.

Мета дослідження – вивчити морфологічні особливості клапанів серця, які були видалені під час хірургічної заміни їх протезами.

Матеріали і методи. Матеріал для морфологічного дослідження клапанів узяли в Інституті серцево-судинної хірургії імені М. М. Амосова. Вивчили основні структурні компоненти 855 клапанів (377 мітральних і 478 аортальних). З місць перетину хорд і сосочкових м'язів за загальноприйнятою методикою були отримані гістологічні зрізи, які фарбували гематоксиліном та еозином, пікрофуксином за методом Ван Гізона, резорцин-фуксином за методом Вейгерта, а також за методом MSB у модифікації Лукасевича – Зербіно. Заморожені зрізи обробляли суданом для виявлення жирових клітин.

Результати. Виявлено ураження переважно аортального клапана. З'ясовано частоту патологічних процесів, що викликають набуті вади серця. Аналіз структурних змін показав переважання ліпоїдозу в групі ушкоджень клапана незапального генезу. При оцінці питомої ваги ліпоїдозу в 46,4 % він поєднувався із ревматизмом, інфекційним ендокардитом, дисплазією та міксоматозною дегенерацією.

Висновки. Результати морфологічного аналізу зрізів показали, що набуті вади серця являють собою поліморфні патології. На першому місці серед причин набутих вад клапанів серця є ревматоїдний вальвуліт (49,7 %), на другому – незапальне ураження клапанів (38,4 %), на третьому – інфекційний ендокардит (10,4 %). Набуті вади серця, викликані однією з вищезазначених причин, часто ускладнюються в результаті нашарування змін, які пов'язані з гемодинамічною

layering of changes that are associated with hemodynamic trauma of the endocardium or lipoidosis. Cholesterol necrosis of the cusps is the basis for the development of infective endocarditis.

Key words: heart; endocardium; valves; endothelial function; structural changes.

INTRODUCTION

The prosthetics of the heart valves was and remains one of the main sections of cardiac surgery [3, 4, 8, 10]. In previous years, these operations have been performed in rheumatic valve failures. However, as the literature data show, the prevalence of rheumatic heart disease hasn't decreased so far [1, 9]. Rheumatic heart disease is one of the most critical form of acquired heart diseases in children and young adults living in developing countries. Rheumatic heart disease accounts for approximately 15 to 20 percent of all patients with heart failure in endemic countries [1]. A study of rheumatic heart disease cases estimated – there were globally 33.4 million cases of rheumatic heart disease and 319,400 deaths due to rheumatic heart disease in 2015 [9]. The incidence of rheumatic heart disease is highest in Oceania, central sub-Saharan Africa, and South Asia. In 2015, there were noted to be 3.4 cases per 100,000 population in nonendemic countries and 444 cases per 100,000 population in endemic countries [9]. Therefore, the surgical correction of affected heart valves remains high enough [3, 7, 8]. Heart valve diseases are common disorders with five million annual diagnoses being made in the United States alone [6]. Data from a clinical examination of patients do not always allow the exact differentiation of the nature of changes in the valve apparatus of the heart. Since the beginning of the twenty-first century, the field has been rapidly changing with the introduction of transcatheter heart valve implantation and repair [4, 6, 10].

Reliable information about the nature of valve heart defects will be useful for developing the most effective treatment regimens for patients [2].

The aim of the study – to investigate morphological peculiarities of the heart valves, removed during the surgical replacement of their prostheses.

травмою ендокарда або ліпоїдозом. Холестериновий некроз стулок є основою для розвитку інфекційного ендокардиту.

Ключові слова: серце; ендокард; клапани; ендотеліальна функція; структурні зміни.

MATERIALS AND METHODS

For the morphological study of the valves the material was taken in the Institute of Cardiovascular Surgery named after M. M. Amosov. There were studied the main structural components of 855 valves (377 mitral and 478 aortic ones). Out of the cusps, chordae and papillary muscles, according to the generally accepted method, there were made histological specimens, which were stained with hematoxylin-eosin, with picrofuchsin according to Van Gieson method, Weigert resorcin-fuchsin method and also according to MSB method in Zerbino-Lukasevich modification. Frozen sections were processed by means of Sudan to identify adipose cells.

RESULTS AND DISCUSSION

Microscopic examination of the valves has shown (Table 1) that in 49.7 % of the observations, the defect of the valves had rheumatic genesis. At the same time, in 30 % of cases, the changes resulted in more or less sclerotic deformation of the valve structures, which was accompanied by an increase in their volume and the formation of dense calcium. The last one was located mainly in the area of the adherent commissures and along the closure of the cusps. There were no signs of active rheumatic inflammation.

However, there were detected: damage to endothelial deprivation, organized fibrin layers and manifestations of continuous chronic non-specific cell infiltration, usually – with a significant number of fibroblasts in 125 out of the 424 valves of this group in deformed cusps, especially in the commissure site, as well as at the base and on the surface of the capsulated calcifications. These changes may be due to hemodynamic trauma of the deformed, rigid valve structures. In 33.5 % of patients (142 valves), pronounced tissue manifestations of active rheumatoid process were revealed. In two aortic valves, a fibrinoid necrosis of collagen fibers with a macrophage reaction

Table 1. The frequency of pathological processes causing acquired heart defects

Valves	Total number of valves	Rheumatism		Infectious endocarditis		Non-inflammatory damage
		inactive	active	primary	secondary	
Mitral	377	131	56	18	16	156
Aortic	478	152	86	26	42	172
In total	855	283	142	44	58	328
	100 %	425 49.7 %		102 11.9 %		38.4 %

was observed against the background of sclerotic changes, which led to the formation of the Aschoff-Talalaev granuloma or some larger disorganization foci, surrounded by macrophage infiltrate with admixture of lymphocytes. In these patients, the cusps of the valve were vascularized and the manifestations of productive-destructive vasculitis were recorded in the vessels. In other observations, the rheumatic lesion of the valves was less acute; in the preparations there were signs of the organization of necrosis foci with macrophage dystrophy, as well as with active fibroblastic reactions and calcification.

There were 102 patients (10.4 %) operated on for infectious endocarditis. The aortic valve was damaged in 68 of them, the mitral valve – in 34 patients. In 44 cases, infective endocarditis was interpreted as primary, while macroscopically, manifestations of enzymatic tissue lysis in the form of destruction of the edges of the cusps or perforations in the center dominated in the valve cusps and commissures. Loose vegetation was present in the areas of destruction of valve structures. Rarely, the edges of perforative openings were smooth, thinned or slightly perforated. The tissue surrounding them was thin, elastic and partially swollen. However, a significant increase in the volume of cusps and commissures in primary infective endocarditis was not observed. In 58 observations (57.1 %), infectious endocarditis was considered secondary, as it developed against the background of post-rheumatic deforming sclerosis of the valves.

38.4 % of the valves were not assigned to either rheumatism or infectious endocarditis (see Table 1). Table 2 shows the decoding of this group. Out of 328 observations, 123 (37.5 %) valves had signs of various dysplastic changes. In the mitral valves, these changes mostly related to the papillary-chordal apparatus with valve prolapse (Table 2). In the aortic valves, one of the commissures was missing as a result of the fusion of one of the cusps (bicuspid valve).

4 % of the valves of this group had signs of myxomatous degeneration: expansion and swelling of the spongy layer of the cusps, local fragmentation of connective tissue bundles of dense surface layers with damage to the endothelium and zones of reactive fibrogenesis.

However, the largest number of observations in this group – 50.3 % (165 valves) was due to lipid

damage of the valves, which was macroscopically manifested by three main options: 1 – flat sub-endothelial plaques of light-orange colour, which were localized mainly in the peri-anular part of the cusps; 2 – voluminous, clearly delimited calcifications, which protruded in relief above relatively thin cusps; 3 – thinning, micro-aneurysms and linear perforations in the cusps without signs of fibrosis.

According to the microscopic structure, sub-endothelial plaques differed little from cholesterol granulomas, which are observed in vessels in atherosclerosis. On the surface of the cusps, flat foci of necrosis were revealed, which gave a positive reaction to fats, often with the presence of cholesterol crystals. Infiltration with monocyte cells was noted around these foci, among which there were groups of lipophages and drops of freely located fat stained with Sudan in a bright-orange colour.

Calcifications, which were formed as a result of lipid damage to the valves, contained cholesterol crystals, as well as plaques. Their fibrous capsule was markedly sudanophilic, but lipophages and free Sudan-positive material were absent.

A variant of lipoidosis with acute destruction of cusps in macroscopic examination can be mistaken for infectious endocarditis. However, when staining for fats around the tissue defect, numerous light-yellow drops of fat are observed, which merge with each other, as well as many foam cells of the same colour. Cholesterol crystals, calcium and polymorphonuclear leukocytes were not detected in these areas.

When processing all the material with Sudan (106 valves), it was found (Table 3) that in 26.4 % of cases, the lipid damage of the valves is superimposed on the post-rheumatic changes, complicating the deformation of the cusps, and in 4.8 % of observations, the lipid damage is present when the rheumatic process is activated.

In 5 (4.8 %) valves, cholesterol necrosis became the basis for the development of infectious endocarditis. Lipoidosis complicated valve dysplastic changes in 3 patients and myxomatous degeneration in 8 patients. In 23 cases, atherosclerotic lesion of the valves appeared as an independent disease, and only in 32.1 % of observations, the valve preparations were Sudan-negative. These were mostly patients younger than 30 years old.

Table 2. Non-inflammatory valve damage

Valves	Total number of valves	Type of pathology			
		Dysplasia	Myxomatous degeneration	Lipoidosis	Other types of pathology
Mitral	156	78	2	64	12
Aortic	172	45	11	101	15
In total	328 (100 %)	123 (37.5 %)	13 (4 %)	165 (50.3 %)	27 (8.2 %)

Table 3. Specific gravity of lipoidosis of the heart valves in all the operating material (n = 106 valves)

Valve	The nature of valve damage						
	Lipoidosis	Inactive rheumatism + lipoidosis	Active rheumatism + lipoidosis	Infectious endocarditis + lipoidosis	Dysplasia+ lipoidosis	Myxomatous degeneration + lipoidosis	Absence of lipoidosis
Aortic	17	11	1	4	2	7	19
Mitral	6	17	4	1	1	1	15
In total	23 (21.6 %)	28 (26.4 %)	5 (4.8 %)	5 (4.8 %)	3 (2.8 %)	8 (7.6 %)	34 (32.1 %)

The results of our study are consistent with the data of other authors, which indicate the dominance of degenerative valve lesions [2] and the key role of hemodynamic trauma [5, 6].

CONCLUSIONS

Morphological analysis of the surgical specimen showed that acquired heart defects are some polymorphic pathologies. In the foreground among the

causes of defects there is rheumatic valvulitis (49.7 %), in the second place – non-inflammatory valve damage (38.4 %), in the third place – infective endocarditis (10.4 %). Acquired heart defects, caused by one of the above-mentioned reasons, are often complicated as a result of the layering of changes that are associated with hemodynamic trauma of the endocardium or lipoidosis. Cholesterol necrosis of the cusps is the basis for the development of infective endocarditis.

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