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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии
საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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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 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 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 ВИНТИ 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.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx**. Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

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).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - <http://www.spinesurgery.ru/files/publish.pdf> и http://www.nlm.nih.gov/bsd/uniform_requirements.html В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректур авторам не высылаются, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or computer-printed on a single side of standard typing paper, with the left margin of 3 centimeters width, and 1.5 spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - 12 (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

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.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf

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).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned
Requirements are not Assigned to be Reviewed.**

ავტორთა საქურაღებოლ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

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.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

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 შედეგის 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 ფხიხლებში 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.

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DYNAMICS OF THE MECHANICAL FUNCTION OF THE LEFT ATRIUM IN PATIENTS WITH ISCHEMIC MITRAL VALVE REGURGITATION

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Abstract.

Aim: To assess the left atrium (LA) mechanical function in patients with ischemic mitral regurgitation (IMR) using technologies of vector analysis of endocardium movement rate.

Materials and methods: The study enrolled 107 patients aged $56 \pm 7,5$ among which 96 men (89,7 %). The entry criteria: I-III degree of ischemic mitral regurgitation on echocardiography, angiography revealing coronary artery disease requiring surgical revascularization, sinus rhythm with the heart rate ranging from 60 to 89 per minute, superior echocardiography visualization of LA endocardium. We hypothesize that atrial changes in deformation and deformation rate can be associated with severity of regurgitation. The scientific study is prospective and cohort non-randomized study.

Results: Values of left atrium mechanical function decline proportionally to IMR severity. Longitudinal deformation and LA deformation rate reflect link with IMR greater than conventional indices used for estimation of LA geometry.

Key words. Left atrium, ischemic mitral valve, regurgitation.

Introduction.

The issues of ischemic mitral regurgitation (IMR) remain most relevant in the treatment of patients with coronary heart disease (CHD), since even a small degree of IMR is associated with an increased risk and poor prognosis [1]. Potentially, the assessment of the hemodynamic significance of varying degrees of insufficiency in a particular patient and the study of its influence on the remodeling of the heart can help in the choice of treatment approach. At the same time, heart chambers or hemodynamic characteristics, which change due to the direct impact of IMR, can be considered effectors of regurgitation [2]. One of the main effectors of chronic IMR is the left atrium (LA). It is known that an increase in the volume of LA is a powerful predictor of mortality, but it is unclear how its mechanical function changes, which depends on the overload with a regurgitating volume and thus may become an important component in assessing the effects of regurgitation [3]. In study by Wang Y et al., it has been shown that strain indicators and strain rate of LA are earlier and more sensitive indicators of volume overload than geometric changes in the atria [4]. There are number of studies regarding the changing strain in patients with arterial hypertension, CHD, and atrial fibrillation, while the contribution of mechanical LA function to the process of global heart remodeling in patients with IMR has not been practically evaluated. In the literature, there are few data on the mechanics of LA in patients with MR during the reservoir and systolic phase of the LA [5]. Features of the strain indicators in the other phases of the atrium (absorption phase and conduit period) have not been evaluated. The features of the functional volumetric and mechanical parameters of the LA depending on the severity

of MR in all phases of the LA activity are not yet described. We assume that atrial strain and strain rate may be associated with the severity of IMR. The aim of the study is to evaluate the mechanical function of the LA in patients with IMR using the vector analysis of the movement rate of the endocardium.

Materials and methods.

The study included 107 patients aged 56 ± 7.5 years old, of which 96 (89,7%) are men, hospitalized with coronary artery disease at our clinic between 2016-2020. The Ethics Committee of the Scientific Center for Surgery approved this study with registration number 18 / 12.08. 2016 of the year and all patients provided written informed consent. The investigators vouch for the accuracy and completeness of the data and for the fidelity of this report to the trial protocol, which is available with the full text of this article.

The scientific study is prospective and cohort non-randomized study. Inclusion criteria were echocardiography showing III-IV degree of MR, the presence of coronary artery disease showed by angiography requiring surgical revascularization, sinus rhythm with the heart rate ranging from 60 to 89 per minute, superior echocardiography visualization of LA endocardium. The comparison group consisted of 20 healthy volunteers, of which men - 10 (50%), aged between 38 to 65 ($52.6 \pm 13,4$) years old.

The study group included 12 (11.2%) patients with functional class II angina pectoris, 69 (64.5%) patients with functional class III angina pectoris and 26 (24.3%) patients with functional class IV angina pectoris. The time from the onset of symptoms of IHD was 4.5 ± 3.3 years. The number of patients who underwent a Q-wave myocardial infarction was - 68 (63.6%), anterior with a Q-wave - 21 (19.6%), repeated myocardial infarction - 18 (16.8%). Symptoms of heart failure of II functional class were registered in 12 (11.2%) patients, III functional class in 64 (59.8%) patients and IV functional class in 31 (29.0%) patients. 21 patients (19.6%) had concomitant diabetes mellitus type 2, and arterial hypertension was detected in 60 (56%) patients.

Patients received conservative therapy that complies with current guidelines for treatment of IHD such as acetylsalicylic acid, statins, beta-blockers, angiotensin-converting enzyme inhibitors [6]. All patients underwent a complex of clinical, laboratory and instrumental examinations (ECG, general and biochemical blood tests, coagulation parameters, chest X-ray, 24-hour ECG monitoring, echocardiography, coronary angiography). All the patients underwent echocardiography examination using Accuson S2000 equipped with a 4V1c probe.

The severity of the IMR was assessed by several quantitative parameters, including the measurement of the width of the proximal regurgitation jet (vena contracta, VC, average 0.52 ± 0.21 cm for the group), the index of the area of the regurgitation

flow (percentage of the jet relative to the area of the LA, the average MR value is $28.7 \pm 11.5\%$), [7]. The mean end-diastolic volume (EDV) in the study group was 116.3 ± 26.2 ml, the LV ejection fraction (EF) – $43.0 \pm 11.2\%$, the maximum volume of LA – 78.5 ± 26.5 ml, the average pressure in the pulmonary artery was 26.5 ± 10.2 mmHg. All the patients in the comparison group had no MR as shown in echocardiography and all the echocardiographic data corresponded to the normal [8]. For echocardiographic examination of the LA following indicators were evaluated characterizing the geometry (volumes), the function (volume change), and the mechanics of the LA (longitudinal deformation and strain rate). To study the function of the LA, the fraction of passive emptying as a characteristic of the conductor function, the fraction of active emptying (as a characteristic of the pumping function), and also the expansion index of the LA as an indicator of the reservoir function were evaluated [9]. Vector analysis of the longitudinal strain (strain, S %) and strain rate (SR) of the LA was carried out on the basis of a dynamic assessment of a two-dimensional echocardiographic image using the patented Speckle Tracking Syngo VVI technology.

SR and S were studied during the four phases of the LA activity: 1) the reservoir phase or the accumulation period, characterizes the flow of blood from the pulmonary veins during LV systole, when the mitral cusps are still closed; data acquisition was performed from the opening of the aortic valve cusps to the opening of the cusps of the mitral valve synchronously with the ECG: from the beginning of the ST segment to the end of the T wave; 2) conduit phase associated with the flow of blood from the LA to the LV during its early diastole, the values were recorded from the opening of mitral valves until the end of the diastasis, synchronously with the ECG: from the end of the T wave to the beginning of the P wave; 3) the contractile phase or the period of atrial systole, displays the active flow of blood from the LA to the late LV diastole, measurements were performed from the beginning of the P wave to the R wave on the ECG; 4) the absorption phase reflects the flow of blood from the pulmonary veins and the filling of the LA in the early LV systole, estimated from the closing of mitral cusps to the opening of the aortic valve cusps, which corresponds to the period from the peak of the R wave to the end of the S wave on the ECG [10].

Statistical analysis of the data was carried out using Statistica 8.0. Correlation analysis was carried out. For the description of quantitative data, the values of mean M and standard deviation SD were used. The evaluation of the statistical significance of differences p between the groups was carried out using parametric criteria with a normal distribution of the trait — the two-sample Student's t-test for comparisons of means ($M \pm SD$).

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Results.

Maximum (78.5 ± 26.5 ml), minimum (53.4 ± 22.2 ml) and P-volumes of the left atrium (66.3 ± 24.6 ml) significantly differed in the patients of the study group and in the comparison group (47.6 ± 10.2 ml, 31.4 ± 8 ml, 38.8 ± 8.1 ml, respectively). Only a moderate direct correlation was found between the

volumes of the LA and the MR area index of the flux ($R_s = 0.46$ for the MR and the maximum volume of the LA, $R_s = 0.5$ for the minimum, $R_s = 0.45$ for the P-volume of the LA). The fraction of passive emptying of the LA in the comparison group was significantly higher than in patients with MR, which indicates a decrease in atrial conduction function in patients with IMR ($26.5 \pm 10.3\%$ versus $15.3 \pm 8.2\%$). A moderate inverse correlation was found between the index of the area of the flow of the MR and the fraction of passive emptying of the LA ($R_s = -0.55$). The larger is MR, the smaller the volume of fluid flowing through the LA into the LV during the conduit phase of the atria, thereby reducing the contribution of the atrium to the LV stroke volume, therefore, to the LV systolic function. A moderate direct correlation was found between the fraction of passive emptying and LVEF ($R_s = 0.46$), which indicates a moderate association between LA and LV dysfunction.

The fraction of passive emptying which reflects pumping function of LA was significantly reduced in patients with MR compared with the control group ($22.4 \pm 9.9\%$ versus $28.1 \pm 7.3\%$). There was a mild inverse correlation between the fraction of active emptying of the LA and MR ($R_s = -0.27$). The LA expansion index characterizing the atrial reservoir function was significantly higher in the comparison group (patients with MR 0.8 ± 0.5 versus 2.47 ± 0.8 in the comparison group). There was a strong inverse correlation between the LA expansion index and the index of the area of the flow of the MR ($R_s = -0.76$) which confirms the deterioration of the atrial reservoir function. When analyzing differences in the functional parameters of the LA depending on the degree of MR we found the absence of a significant difference in the fraction of passive emptying of LA between patients with moderate and severe MR (with second degree MR $13.9 \pm 8\%$, with third degree MR $14.8 \pm 7.2\%$).

However, when indexing the obtained data to the corresponding volume of the LA, significant differences were found (S in the group with MR $-2.8 \pm 0.7\%$ / 10 ml of the maximum volume of the LA, in the comparison group $-7.5 \pm 1.2\%$ / 10 ml of the maximum volume of LA), which confirms the hemodynamic significance of chronic overload with regurgitating volume of blood of LA. Longitudinal systolic deformation of LA was significantly reduced in the contractile phase (in patients with MR $-3.6 \pm 2.3\%$ versus $-12.4 \pm 1.8\%$ in the comparison group) and in the absorption phase (in patients with MP $-1.2 \pm 0.3\%$ versus $-0.44 \pm 0.7\%$ in the comparison group, $p < 0.05$). In the conduit phase, the deformation was minimal both in patients with MR and in the comparison group, but paradoxically larger values were recorded in patients with MR than normal (-0.37 ± 0.2 and $-0.1 \pm 0.17\%$, respectively). A pronounced direct correlation of S in the systolic phase of the LA and MR ($RS = 0.88$), moderate S in the conduit phase and MR ($RS = 0.5$) and inverse correlation S in the phase of absorption and MR ($RS = -0.58$), S in the reservoir phase and MP ($RS = -0.5$).

We analyzed indicators S of LA depending on MR. The maximum differences were found in individuals without MR and in patients with minor MR during the systole of LA ($-12.4 \pm 1.8\%$ vs. $-6.5 \pm 2.2\%$, $p < 0.05$, respectively) and during the absorption phase ($-0.44 \pm 0.7\%$ vs. $-1.1 \pm 0.07\%$, $p < 0.05$, respectively), as well as between patients with mild and

moderate MR (S during the period of LA systole in patients with MR Grade I $-12.3 \pm 2.8\%$ versus $-6.5 \pm 1.4\%$ with MR of Grade II; S during the absorption phase with MP of the I degree $-1.8 \pm 0.07\%$ versus -1.4 ± 0.07). Similarly, to the indicators of SR between patients with moderate and severe MR, no differences in S values were found in all phases.

In contrast to previous studies of mechanical function of LA, which evaluated only the peak positive longitudinal S and SR (as indicators of the accumulation period) and the peak negative S and SR (as indicators of the systolic phase of the LA), we attempt to give a comprehensive assessment of the atrial activity along with the contribution of the conduit and suction phase. Thus, the deformation values obtained during the period of blood flow from the LA to the LV in the normal state more reflect LV function than the LA function. But, as demonstrated in our study, the presence of chronic IMR significantly changes the deformation rate of LA in the conduit period proportionally to the severity of regurgitation (which is confirmed by a direct correlation of MR and SR during this phase). Deformation in patients with minor MR in the conduit phase are minimal, and in patients with moderate and severe MR, they are close to zero during the entire phase. Consequently, the LA in the conduit period in patients with moderate and severe MR in terms of deformity functions as a “passport” with minimal S and SR values even during the early filling of the left ventricle. With inhibition of the deformity in the systolic phase of the LA, it becomes clear that the mechanical contribution to the filling of the LV is significantly reduced, despite the increase in the maximum volume of the LA. Perhaps these changes are related to the processes of structural remodeling of the atrium and loss of elastic properties due to chronic overload with the regurgitated blood volume. The changes of the deformation we detected in the absorption phase were multidirectional in the control group, patients with minor regurgitation and patients with III – IV degree of MR. Deformation in this phase is close to zero, which is normal (in the control group $S -0.44 \pm 0.7$). The presence of more negative results of deformation in patients with MR ($-1.3 \pm 0.07\%$) during this period remains unclear. In patients with III and IV degree of MR, the deformation values were even lower than in patients with mild MR. It is possible that due to atrial remodeling caused by MR, since the deformation was recorded synchronously with the ECG (from the R-wave to S), from the view of electrical processes, this was already the phase of LA absorption, and from the point of view of mechanics, the end of the LA systole period. It is because of the complexity of differentiation of the onset of the phases most researchers prefer to ignore this phase and not to study its features.

Normally, during the phase of the LA reservoir (towards the end of the LV systole), the maximum (among all LA phases) positive deformity is recorded, which is accompanied by the greatest increase in atrial volume. The reservoir period depends on the preload conditions and is fundamentally volume dependent. This means that the deviation of the mechanical characteristics from the normal range is related to the additional volume appearing in the atrium during this period (i.e., directly from the MR). The data obtained by us can be explained by taking into account the mechanical and functional changes

along with all phases of the LA. With a mild degree of MR, there was an increase in the active volume of the LA, due to which, in patients with stage I of MR, the fraction of active emptying remained within normal limits and compensated for the mechanical synergy. But with a moderate and pronounced degree of IMI, indicators characterizing contractility were decreased. Similarly, to the classical Frank – Starling curve after a certain “threshold” volume of chambers further growth of contractility does not occur: it begins to decrease. In our study, this “threshold” was not the atrial volume, but the LA expansion index, which functionally characterizes the reservoir phase. A correlation was found between the expansion index and the fraction of active emptying of the LA ($R_s = 0.70$), the expansion index and the deformation rate of the LA in the reservoir phase ($R_s = 0.63$).

In this study, we demonstrated the importance of analyzing mechanical data (SR and S in patients with IMR) for complex assessment of the function of LA, along with traditional geometric parameters. Atrial activity can be interpreted not only from the standpoint of changes in atrial size and volume, but also on the basis of the evaluation of the mechanical properties of LA. Particularly noteworthy is the identification of a significant difference in SR inhibition between patients with mild and moderate MR and uncertain differences in SR indices in patients with moderate and severe MR. The results obtained probably indicate comparable ultrastructural changes in the atria that occur with chronic volume overload of MR from grade II and higher. Further detailed study of the dynamics of the mechanical function of the LA in patients with MR may be a promising and useful tool in assessing its hemodynamic significance and in the choice of surgical approach for additional intervention on mitral valve with IMR.

Discussion.

The novel metric of ECG PL identifies patients with fewer (≤ 3) or greater numbers of stable rotors/focal sources for AF, validated by intracardiac FIRM mapping, and localized them to right or left atria. These data open the possibility of using 12-lead ECG analyses to classify AF mechanistically and plan procedures for right-or left-sided FIRM ablation. At the same time, the obtained data allow the normal reference ranges for the three components of left atrial function to be demonstrated. The between-study heterogeneity is explained partly by heart rate, body surface area, and sample size.

The qualitative assessment of LA deformation and its practical value has been the subject of discussion in the last decade. Pathan F, et al showed that LA deformation is reciprocally associated with LV deformation, in other words, all mechanical processes in the atrium are only a mirror reflection of LV deformation and are more dependent on movement of the annular plane of LV systolic and diastolic functions [11].

However, further studies showed significant limitations of these data, demonstrating the significance of atrial contribution (systolic negative deformation) in the formation of an adequate preload of the LV and the contribution of reservoir phase (diastolic positive deformation of the LA) in the formation of the LV stroke volume [12]. In addition, the conduit function of LA depends on afterload, largely determined by the pressure

in the receiving chamber which is LV, which increases as the diastolic stiffness and systolic dysfunction of the LV increases [13]. Of course, the conduit period is difficult to evaluate, since it is biphasic: during the beginning of early filling of the LV, atrial deformity is minimal, but the deformation rate is highest, however in the second period, we witness the plateau, when both the deformation and the deformation rate are close to or equal to 0. As well as other authors was good interobserver agreement of LA strain values between novice and expert. SR values also demonstrated good interobserver agreement. Of all parameters, SR-LA had the best interobserver and intraobserver agreement. Global LA strain and SR values were highly reproducible by novice strain reader using multi-vendor analysis software. Interobserver reproducibility between novice and experts was good and acceptable within limits of agreement. Lau DH, et al., showed that a decrease in S and SR is an independent predictor of ultrastructure changes in LA, in particular interstitial fibrosis [14]. Consequently, a decrease in deformity into the conduit phase of LA may be considered an effector of hemodynamic significance of MR. Several authors indicated the reduced SR and S in the atrial systole are associated with the severity of regurgitation [15].

Conclusion.

Echocardiographic parameters of the mechanical function of the left atrium change in accordance with the severity of the ischemic mitral regurgitation. Indicators of strain rate and strain of the atrium mainly depend on the degree of mitral regurgitation, while conventional indicators of geometry and function of left atrium are less dependent on the magnitude of regurgitation. In proportion to the severity, ischemic mitral regurgitation is associated with mechanical remodeling of the atrium, concomitant with changes in strain and strain rate values in left atrium activity. In terms of the degree of changes in strain and strain rate against the background of moderate and pronounced ischemic mitral regurgitation, there are no special differences; this confirms the significance of even a moderate degree of regurgitation for the processes of mechanical left atrium remodeling.

Conflict of interest.

The authors declare no conflict of interest.

REFERENCES

- Girdauskas E, Pausch J, Harmel E, et al. Minimally invasive mitral valve repair for functional mitral regurgitation. *Eur J Cardiothorac Surg.* 2019;55:17-25.
- Sakaguchi T, Hiraoka A, Ryomoto M, et al. Papillary Muscle Reorientation for Systolic Anterior Motion After Mitral Valve Repair. *Ann Thorac Surg.* 2021;111:305-307.
- Nenna A, Nappi F, Spadaccio C, et al. Systolic Anterior Motion (SAM) Complicating Mitral Valve Repair: Current Concepts of Intraoperative and Postoperative Management. *Surg Technol Int.* 2020;37:225-232.
- Wang Y, Zhang Y, Ma C, et al. Evaluation of Left and Right Atrial Function in Patients with Coronary Slow-Flow Phenomenon Using Two-Dimensional Speckle Tracking Echocardiography. *Echocardiography.* 2016;33:871-80.
- Garsse L, Gelsomino S, Lucky F.C, et al. *Cardiovas. Imaging.* 2013;14:534-543.
- Rakhshan M, Toufigh A, Dehghani-Firouzabadi A, et al. Effect of Cardiac Rehabilitation on Hope Among Cardiac Patients After Coronary Artery Bypass Graft Surgery. *Risk Manag Health Policy.* 2020;13:1319-1326.
- Nenna A, Nappi F, Spadaccio C, et al. Systolic Anterior Motion (SAM) Complicating Mitral Valve Repair: Current Concepts of Intraoperative and Postoperative Management. *Surg Technol Int.* 2020;37:225-232.
- Kron IL, Hung J, Overbey JR, et al. Predicting recurrent mitral regurgitation after mitral valve repair for severe ischemic mitral regurgitation. *J Thorac Cardiovasc Surg.* 2015;149:752-61.e1.
- Campbell B, Robinson S, Rana B. The evolution from cardiac physiologists to clinical scientists in the UK: a guide to attaining equivalence. *Echo Res Pract.* 2019;6:R99-R105.
- Bokeria O.L, Averina I.I, Glushko M.A. Important aspects of preoperative diagnosis and preparation of patients for cardiac surgery. *Bulletin of the Scientific Center for Cardiovascular Surgery. A.N. Bakulev of the Russian Academy of Medical Sciences.* 2018;19:327-337.
- Pathan F, D'Elia N, Nolan MT, et al. Normal Ranges of Left Atrial Strain by Speckle-Tracking Echocardiography: A Systematic Review and Meta-Analysis. *J Am Soc Echocardiogr.* 2017;30:59-70.e8.
- Charron P, Elliott PM, Gimeno JR, et al. EORP Cardiomyopathy Registry Investigators. The Cardiomyopathy Registry of the EUR Observational Research Programme of the European Society of Cardiology: baseline data and contemporary management of adult patients with cardiomyopathies. *Eur Heart J.* 2018;39:1784-1793.
- Hope KD, Wang Y, Banerjee MM, et al. Left atrial mechanics in children: insights from new applications of strain imaging. *Int J Cardiovasc Imaging.* 2019;35:57-65.
- Lau DH, Linz D, Schotten U, et al. Pathophysiology of Paroxysmal and Persistent Atrial Fibrillation: Rotors, Foci and Fibrosis. *Heart Lung Circ.* 2017;26:887-893.
- Li B, Wu H, Sun H, et al. Predicting functional mitral stenosis after restrictive annuloplasty for ischemic mitral regurgitation. *Cardiol J.* 2019;26:350-359.