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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.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

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 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.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ 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. Корректура авторам не высылается, 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 compu-ter-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 საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ 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 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.

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CHRONIC HEART FAILURE WITH PRESERVED LEFT VENTRICLE EJECTION FRACTION (HFPEF) AND RIGHT VENTRICLE INVOLVEMENT IN PATIENTS WITH NORMAL SINUS RHYTHM AND ATRIAL FIBRILLATION; A SMALL OBSERVATIONAL STUDY: RELEVANCE OF THE PROBLEM, DIAGNOSTIC APPROACH, ECHOCARDIOGRAPHIC EVALUATION OF RIGHT VENTRICLE

Sergo Kobalava*, Mikheil Tsverava, Eteri Tsetskhladze.

David Aghmashenebeli University of Georgia Faculty of Medicine, Georgia.

Abstract.

Chronic Heart Failure (CHF) is a complex syndrome that affects at least 6.5 million adults in the USA. The preserved left ventricle ejection fraction was met in at least 50% of patients. The data were published by the Center of Heart and Stroke Statistics in 2020. Right ventricle (RV) involvement in the pathological process of patients with chronic heart failure with preserved left ventricle ejection fraction is a common problem. The pathogenesis, mechanisms, and prognosis of RV dysfunction in patients with HFpEF have not yet been fully evaluated. Several questions have been raised regarding these aspects.

Methods: We investigated 26 patients with documented and confirmed HFpEF diagnoses. Patients were divided into two separate groups: patients with normal sinus rhythm and those with atrial fibrillation. For all subjects, the right ventricle (RV) systolic and diastolic functions were assessed using transthoracic ultrasound. We studied the RV measurements and volume, Tricuspid Annular Plane Systolic Excursion (TAPSE), Fractional Area Change (FAC), Right Ventricular Index of Myocardial Performance (RIMP), pulse Doppler S-wave, and Eccentricity Index (EI). Additionally, we evaluated the secondary echocardiographic parameters for RV dysfunction such as pulmonary hypertension using the following markers: systolic pulmonary artery pressure (sPAP), s pulmonary artery pressure (mPAP), tricuspid regurgitation (TR) velocity, pulmonary velocity acceleration time (PVAT) and SPAP/ TAPSE ratio.

We searched for selected echocardiographic parameters that might better indicate both RV systolic and diastolic deterioration in patients with HFpEF.

Results: None of the parameters evaluated during transthoracic echocardiography that were proposed to assess RV function revealed specificity for patients with HFpEF, except for the Right Ventricular Index of Myocardial Performance (RIMP). We did not observe the significant statistical correlation between FAC, TAPSE and S` and the severity of RV deterioration or patients` subjective symptoms. Only the RIMP plays an important role in the assessment of RV contractility and diastolic dysfunction. Meanwhile, RIMP values were not correlated with pro-BNP levels, severity of pulmonary hypertension, or heart failure NYHA class.

Conclusions: 1. HFpEF is widespread, especially among elderly women with concomitant arterial hypertension, overweight status, and acquired valvular disease. 2. In patients with HFpEF, the RV is mainly involved in the pathological process, regardless of the cardiac rhythm. In our trial, RV involvement was observed in all 26 patients. Its involvement might have occurred based on subjective, objective, and echocardiographic findings. 3. In patients with HFpEF, the minimal essential echo parameters that should be examined for better evaluation of the RV functions are the following: RV and RVOT linear and volumetric measurements, TAPSE, FAC, Tissue Doppler S`, RIMP. 4. RIMP itself was found to be a sensitive marker for the description of RV dysfunction, including both systolic and diastolic function, in patients with HFpEF despite age, sex, and cardiac rhythm. 5. The value of RIMP was not linked to either the severity of HF, level of pro-BNP or degree of pulmonary hypertension.

Key words. Chronic heart failure with preserved left ventricle ejection fraction, right ventricle, transthoracic echocardiography, right ventricular index of myocardial performance (RIMP).

Introduction.

Chronic heart failure with preserved left ventricular ejection fraction (LVEF) is a pathological condition characterized by subjective and objective symptoms. These symptoms appear in patients with preserved LV function, when ejection fraction is ≥ 50%.

Chronic heart failure with preserved left ventricle ejection fraction occurs relatively often among patients aged > 65 years and is diagnosed in at least > 50% of the population. HFpEF increases the risks of hospitalization and mortality. After the first hospitalization, the 5-year risk mortality rate was approximately 35%. Moreover, the risk of rehospitalization was similar to that in patients with decreased LV function.

In accordance with the Erwan Donal, in general, HFpEF is spread among 2% of the population of Western European countries and is diagnosed in at least 54% of subjects (an average of 40–71%). The majority of these patients were elderly women. Regarding the population between 25 and 49 years, the rate between males and females is about 0:1; however, in population over 80 years old, the rate is 4-6%:8-10%, respectively [1].

In accordance with a trial performed by Amil M, Shah et al., several basic echocardiographic parameters confirmed the presence of HFpEF. This trial was based on the PARAGON-HF trial results (angiotensin-neprilysin inhibition in heart failure with preserved ejection fraction), which was held in 2019-2020.

Amil M, Shah reviewed the following parameters: left ventricle ejection fraction (LVEF), left ventricle hypertrophy (LVH), size and volume of left atrium, lateral and septal tissue Doppler parameters of mitral annulus and E/e` ratio, and tricuspid annular plane systolic excursion (TAPSE). After analysis, the author concluded that increasing LV mass, elevation in E/e` ratio, and dilatation of LA (LA volume and LAVi) might be considered

the best markers for confirming HFpEF and the best predictors for further hospitalization and mortality risk [2]. Nevertheless, it should be emphasized that LA volume and LAVi parameters did not reveal sufficient prognostic and diagnostic value in other similar trials.

RV dysfunction, regardless of its exact cause, always negatively affects the course of patients` primary disease and prognosis. The mortality rate was significantly increased in patients with LVEF < 30%. RV contractility function is an important prognostic marker also in patients with IHD if LVEF < 40% [3].

The right ventricular ejection fraction (RVEF) is defined as the contractility function of the RV and the pre/post load forced to that cavity. Hence, all those conditions that impact the above-mentioned parameters might deteriorate the RV function and might provide the RV diastolic and systolic dysfunction [3].

RV dysfunction is a common finding in patients with HFpEF. Based on the available data, it varied from 4 to 48% [4]. Thomas M. Gorter attentively discussed this issue in his trial. The author reviewed all echo parameters in detail that were used during the clinical trial to evaluate RV function [4]. For example, the following parameters were calculated: tricuspid annular plane systolic excursion (TAPSE), fractional area change (FAC), lateral tricuspid annulus peak systolic velocity (S`), right ventricle end-diastolic volume (RVEDV), pulmonary artery systolic pressure (PASP), and mean pulmonary artery pressure (MPAP). Based on these parameters, the author concluded that TASPE and FAC should be considered the main echocardiographic parameters for the assessment of RV function, and a meaningful relationship is fixed between these two markers [4].

Several echocardiographic parameters are used for evaluating RV systolic functions, mainly RV performance index (RV RIMP), tricuspid annular plane systolic excursion (TAPSE), myocardial acceleration during isovolumic contraction (RV IVA), fractional area change (FAC), RV three-dimensional ejection fraction (3D RVEF), lateral tricuspid annulus peak systolic velocity (S`), RV strain index. TAPSE, FAC, and S` are used frequently among listed parameters for assessing the RV systolic function [5].

Single and unique parameters that directly uncover RV involvement in patients with HFpEF are currently difficult to determine. For instance, an RV FAC < 45%, which is considered an important parameter for the assessment of RV systolic function, is rarely met in patients with HFrEF rather than in patients with HFpEF. Based on other clinical trials, RV systolic and diastolic strains are the best markers for evaluating RV function. As for TAPSE as a separate marker for RV function assessment, no significant information was obtained using that one parameter individually in HFpEF patients: its reduction was clinically significant in 20% cases only; meanwhile in patients with HFrEF, reduction of TAPSE was important in approximately 46% of cases, respectively [6].

Measures and volume of heart cavities might be considered as important indirect echocardiographic indicators of RV dysfunction in patients with HFpEF, especially LA measures and volume; meanwhile, LA size and volume might be the norm in a third of patients [7]. Size of LA was declared as a certain prognostic marker in the I-PRESERVE Trial (Irbesartan in Patients with Heart Failure and Preserved Ejection Fraction). Nevertheless, the LA volume did not reveal any prognostic significance in the same trial. A similar result was found in the Spironolactone for Heart Failure with Preserved Ejection Fraction (TOPCAT) trial when the longitudinal size of LA (and not its volume) was detected as a prognostically important marker. Moreover, in the CHARM trial (Candesartan in Heart Failure), LA size did not reveal any prognostic significance in further mortality rates [7].

RIMP is defined as the active performance index of the right ventricle. In other words, it defines the connection between the periods needed for blood accumulation in the RV and its release.

Calculating the RIMP, we assumed receiving information about both the systolic and diastolic functions of the RV. Moreover, we might evaluate the correlation between RIMP and other parameters of RV function, such as TAPSE, FAC, and S`.

TAPSE and FAC mostly provide information about the longitudinal movement of the RV walls and its global contractile function. These parameters are almost completely reduced when RV contractile function deteriorates. Nevertheless, lots of clinical trials describe a weird situation when, when RV contractile function is declined, but those parameters that describe its longitudinal strain are in norm (namely, TASPE, FAC and S`) [8]. Consequently, the scientists principally paid attention to RIMP as a marker for evaluating RV global contractile function because, in general, RIMP might provide information regarding both RV systolic and diastolic functions simultaneously [8].

RIMP might also be calculated for evaluation of RV global contractile function when tricuspid regurgitation maximal velocity is not adequately reachable, for example, in cases of eccentric tricuspid jet and severe RV dysfunction. In those situations, the calculation of RIMP is quite acceptable.

It should be foreseen that TAPSE and S` values might be impacted by a certain problem in the pericardial cavity. For instance, pericardial effusion in post-CABG patients. Hence, we should expect that RIMP is a more specific parameter for evaluating RV contractile function rather than TAPSE or S`. Paradoxical movement of IVS that is frequently met among the post-CABG patients might also impact TAPSE and S` value. That phenomenon disrupts the normal structure of RV, and despite the preserved contractile function, it impacts FAC and TAPSE parameters. Hence, TAPSE and FAC might be in false ranges. That phenomenon also proves that RV global contractile function is better to be assessed using RIMP rather than TAPSE or FAC [8].

Hezzy Shmueli reviewed data from the patients and concluded that univariate markers for a high mortality rate in patients with pulmonary embolism (PE) are the following: Pulmonary Accelerating Time, PVAT < 81 msec, Stroke Volume, SV < 44 cc, and RIMP > 0.42. The sensitivity of RIMP was at least 75%, and its specificity was about 74% (P = 0.05). Meanwhile, sPAP, TR Velocity, and FAC did not reveal any significant diagnostic value regarding measures and volume of the right cavities [9]. In

conclusion, the author supposed that RIMP might be considered as an important and separate echocardiographic indicator of mortality in patients with PE [9].

Yasunobu Hayabuchi also reviewed some obstacles that might impact the RV RIMP. The author pointed out the phenomenon called pseudo-normalization in patients with RV infarct. That might increase RV end-diastolic pressure and pressure in pulmonary arteries; hence, it might impact IVCT in general. Hence, the author suggested paying great attention to the RIMP calculation in the appropriate population of patients [10].

Nese Dursunoğlu also wrote about obstacles and problems in the calculation of RV RIMP in his article. The author observed the patients with sleep apnea syndrome. The author concluded finally that diastolic dysfunction of RV was observed in patients with moderate/severe apnea (AHI ≧15). Higher RV RIMP was detected in that group also and was not met among the patients with mild apnea syndrome (AHI: 5–14) and among the control patients (AHI < 5). Hence, Nese Dursunoğlu concluded that sleep apnea syndrome and its especially severe impacts on RV systolic/diastolic function and on RV RIMP, respectively [11].

Another attractive correlation was detected by Ioulia Grapsa. She observed 93 patients who developed pulmonary hypertension for various reasons. The author wrote that RV RIMP is slightly correlated with TR regurgitation jet velocity; however, it is more correlated with the severity of pulmonary regurgitation and the eccentricity index. Additionally, a slight connection was observed between RV RIMP and RV acceleration time [12]. It was an interesting finding because, in general, the lower the RVOT/PV acceleration time is, the higher the pulmonary hypertension and the more visible the RV deterioration is.

Enrico Vizzardi focused his attention on TAPSE as the easiest reachable marker. Meanwhile, he pointed out that several obstacles might impact TAPSE values, including myocardial movement and compliance and volume overload of heart cavities. Hence, TAPSE usually roughly and imprecisely reflects the RV function and might be frequently overestimated. As for RIMP, lots of barriers might be neglected while calculating the RIMP parameters rather than TAPSE. Thus, RIMP usually reflects RV function more predictively and adequately [13].

In conclusion, we attempted to estimate the RV systolic and diastolic functions using almost all echocardiographic parameters and values that are available nowadays. Our attention was paid basically to the tissue Doppler of the RV and RVOT. We evaluated the following echo parameters: TAPSE, RIMP, TAPSE/sPAP ratio, FAC, and RV S`. Our objection was to better delineate that the most valuable and specific echo parameter that might assist in RV assessment among the patients suffered from HFpEF.

Materials and Methods.

Characteristics of the study population:

A prospective single-center study was conducted at David Aghmashenebeli University of Georgia (SDASU) and the Cardiology Department of the Clinic Jerarsi. The data was collected from January 2024 through July 2024. 26 patients with a diagnosis of HFpEF were examined. That diagnosis was confirmed based on 1. subjective and objective symptoms for HFpEF; 2. assessment of risk factors; 3. assessment of H2FPEF score; and 4. evaluation of the level of NT-proBNP. We avoid including those patients in the trial who had the conditions that directly impacted RV functions: COPD and bronchial asthma, pulmonary emphysema, sleep apnea syndrome, pulmonary embolism, and CTEPH. Additionally, patients with pathological conditions that might have impacted the NT-proBNP level were not chosen for the trial: myocarditis, hypertrophic cardiomyopathy, pericardial disease, severe anemia, severe renal disease, and liver insufficiency. Other exclusion criteria were the following: refusal to sign the informed consent, subjects with decreased LV ejection fraction below 50%, normal value of Pro-BNP regardless of the presence of symptoms of chronic heart failure, patients with severe acquired or any kind of congenital heart valvular diseases, patients who had any major adverse cardiac event (MACE) three months prior to being involved in this trial, including coronary revascularization (PCI of CABG), patients with operated heart valves, patients with active cancer, patients with active viral hepatitis, and patients with unsatisfied ultrasound window.

The following potential patients were considered to be involved in this trial: over 30 years old male or female subjects, patients who sign the informed consent form, ≥ 3 subjective or objective symptoms of chronic heart failure based on 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure, ≥ 1 supportive risk factor for development of HFpEF based on 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure, H2FPEF score score ≥ 3, Pro-BNP level ≥ 220 pg/ml in patients with sinus rhythm and ≥ 660 pg/ml in patients with atrial fibrillation, preserved LV ejection fraction ≥ 50%.

This trial and its ethical aspects were reviewed by the scientific board of David Aghmashenebeli University of Georgia (SDASU). All materials, including patients` informed consent and patients` facing materials (HFpEF ultrasound criteria checklist, HFpEF symptoms checklist, concomitant treatment checklist and list for the comorbidities, NYHA heart failure checklist), were discussed and approved by the scientific board of the above-mentioned university.

Those patients who applied for the outpatient department of the clinic Jerarsi with the symptoms of heart failure were enrolled in our trial. All those patients were consented based on Good Clinical Practice (GCP) standards. The subjects were adequately informed about trial design. They were provided with the detailed information regarding expected laboratory and instrumental examinations. All the questions arising from the potential subjects were answered. Finally, all suitable patients signed the trial-related consent form. Original documents are now stored among the medical sources for each subject.

All comorbidities and concomitant conditions were evaluated based on medical documents that were provided by the consented subjects on the day of examination. The certified copies of all medical sources are now stored among the medical sources for each subject.

Medical treatment prescribed for each subject was attentively evaluated. We confirm that almost all subjects enrolled in our trial were treated based on guideline-directed medical therapy

(GDMT) for HFpEF. Among the 26 subjects, beta-blockers were prescribed in 23 patients (88.4%), angiotensin II receptor blockers/ACE inhibitors were prescribed in 26 patients (100%), loop diuretics were prescribed in 22 patients (84.6%), thiazide diuretics were prescribed in 12 patients (46.2%), antiplatelet drugs were prescribed in 12 patients (46.2%), anticoagulants (NOACs) were prescribed in 17 patients (65.4%), and SGLT2 inhibitors were prescribed in 12 patients (46.2%). We did not interfere in the basic treatment regime for either subject because it was not the aim and objective of our subjects (Figure 1).

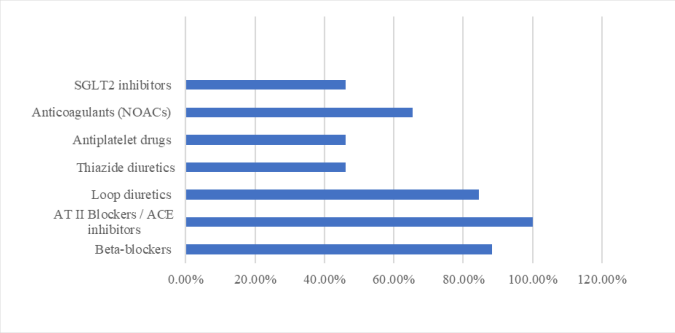

Figure 1. *Guideline-directed medical therapy (GDMT) for HFpEF enrolled in this trial.*

All patients were divided into two separate groups: those with normal sinus rhythm and those with atrial fibrillation.

All enrolled patients were provided with the preprinted questionnaires, created by the investigator based on 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure and approved by the scientific board of SDASU. Those questionnaires contained an HFpEF symptoms checklist, a concomitant treatment checklist, a list for the comorbidities, and a NYHA heart failure checklist.

Demographic aspects were reviewed for all patients in both groups, including gender, age, weight, height, and BMI. Patients` medical conditions, treatments, and ECG evaluations were assessed.

For all patients, a detailed heart ultrasound examination was done. This examination was performed at the cardiology department of the Jerarsi clinic using the heart ultrasound machine MINDRAY Resona I9. Cardiac measurements were performed based on the 2015 guideline of the American Society of Echocardiography and the European Association of Cardiovascular: Recommendations for Cardiac Chamber Quantification by Echocardiography in Adults. Right ventricle ultrasound findings were evaluated based on the 2010 guideline of the American Society of Echocardiography, endorsed by the European Association of Echocardiography: Echocardiographic Assessment of the Right Heart in Adults, Echocardiographic Assessment of the Right Heart in Adults: A Practical Guideline from the British Society of Echocardiography (2020), and additional scientific materials and articles related to echo evaluation of the right ventricle. Diastolic dysfunction echo parameters were assessed based on the 2016 guideline of the American Society of Echocardiography and the European Association of Cardiovascular Imaging: Recommendations for the Evaluation of Left Ventricular Diastolic Function by Echocardiography. LV was studied using a 17-segment model. For assessment of diastolic function, the following parameters were assessed: mitral PW Doppler, tissue Doppler, DT, IVRT, LA volume, LAVi, and TR velocity. The main attention was paid to right cavities, especially RV. The following aspects were studied: RV linear measurements, RV volume, FAC, TAPSE, TDI RV S`, RIMP, and Eccentricity Index (EI). Normal ranges for the essential parameters were the following: FAC < 35%, RIMP > 0.54, TAPSE < 20 mm, RV S` < 10, and EI < 1.

Normal ranges for RV linear and volume measurements were the following: RV basal size 25-41 mm, RV middle size 19-35 mm, RV longitudinal size 59-83 mm, proximal RVOT size 21-35 mm, distal RVOT size 17-27 mm. RV end-systolic volume 10-44 ml in males and 8-36 ml in females; RV end-diastolic volume 35-87 ml in males and 32-74 ml in females; RV lateral wall thickness < 5 mm.

Pulmonary hypertension was measured with the TTE approach using the following parameters: systolic pulmonary pressure (sPAP), mean pulmonary pressure (mPAP), tricuspid regurgitation maximal velocity (TR Vmax), pulmonary acceleration time (PVAT), and TAPSE/sPAP ratio. The normal ranges for all those parameters were the following: SPAP < 25 mmHg, mPAP < 20 mmHg, TR Vmax < 2.8 m/sec, PVAT < 130 msec, and TAPSE/PASP < 0.36.

Required laboratory analyses, including pro-BNP and ECG examinations, were obtained at the Clinic Jerarsi. All certified and signed copies are now stored among the medical sources of each patient.

After receiving all data, the H2FpEF score checklist was completed. The following data was entered there: heavy (2 points), hypertensive (1 point), atrial fibrillation (3 points), pulmonary hypertension (1 point), elder > 60 (1 point), and LV filling pressure (1 point). The highest point that was received by the enrolled patient was 9 points, and the lowest was 4 points.

A HFpEF ultrasound and laboratory confirmation checklist created based on 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure and approved by the scientific board of SDASU was completed for each patient. All patients received the 5 and more points, and therefore, HFpEF was fully confirmed. None of the subjects needed to make additional diastolic stress-test examinations. The completed and signed checklists are now stored among the medical sources of each patient.

Statistical Analysis.

Echocardiographic parameters of the right ventricle were evaluated separately in male and female patients and in patients with sinus rhythm and atrial fibrillation. For proving the zero hypothesis, the independent-samples Mann-Whitney U test was used. Correlative analyses were held using the Pearson correlation test for identification of relationships between ultrasound parameters of RV systolic and diastolic findings and levels of pro-BNP, SPAP/PASP ratio, PVAT, TR Vel, and NYHA HF class. During statistical processing, when $P < 0.05$, the data were considered reliable, and if $P > 0.05$, the statistical data were considered unreliable.

Results.

Among 26 patients included in this trial, 21 subjects were female (80.8%), and 5 subjects were male (19.2%).

The first group with normal sinus rhythm contained 12 patients, and the second one with atrial fibrillation contained 14 subjects. The ratio was 1:1.28.

The minimal age of the investigated patients was 52, and the maximal age was 91. Hence, the average age appeared to be 79.

Clinical findings:

In patients with HFpEF in the sinus rhythm group, the most frequent clinical symptoms were the following: dyspnea (100%), decrease in physical tolerability (100%), fatigue and decrease of performance (100%), peripheral edema (100%), and murmur while heart auscultation (91.6%). In patients with atrial fibrillation, the same observation uncovered the following frequent subjective and objective symptoms: dyspnea (100%), decrease in physical tolerability (100%), fatigue and decrease of performance (100%), peripheral edema (100%), palpitation (100%), murmur while heart auscultation (100%), dizziness (78.5%), night paroxysmal dyspnea (57.1%), and wheezing (57.1%) (Figure 2).

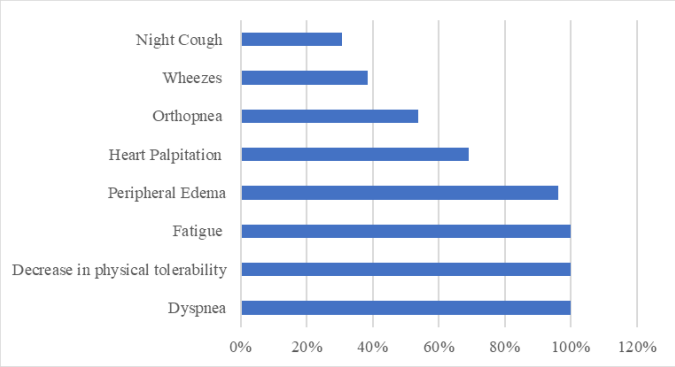

Figure 2. *The most frequent symptoms among all patients are involved in this trial.*

The severity of heart failure was studied based on the NYHA classification of HF. Hence, in patients with sinus rhythm, NYHA I class was met in one subject (8.3%), NYHA II was met in 6 patients (50%), NYHA III was revealed in 5 patients (41.6%), and NYHA IV was fixed in 0% of the investigated population. On the contrary, in the atrial fibrillation group, NYHA I class was met in 0% of subjects, NYHA II was met in 5 subjects (35.7%), NYHA III was fixed in 6 patients (42.9%), and NYHA IV was detected in 3 subjects (21.4%).

Concomitant illnesses that might have impacted the development of HFpEF were observed attentively also, and the following results were uncovered: in patients with sinus rhythm, the most frequent conditions were arterial hypertension (100%), acquired heart valvular disease (91.6%), coronary artery disease (41.6%), and anemia (25%). In subjects with atrial fibrillation, the results were distributed as follows: arterial hypertension (100%), acquired heart valvular disease (100%), arrhythmia (100%), and other concomitant conditions, including chronic kidney disease (50%) and coronary artery disease (35.7%) (Figure 3).

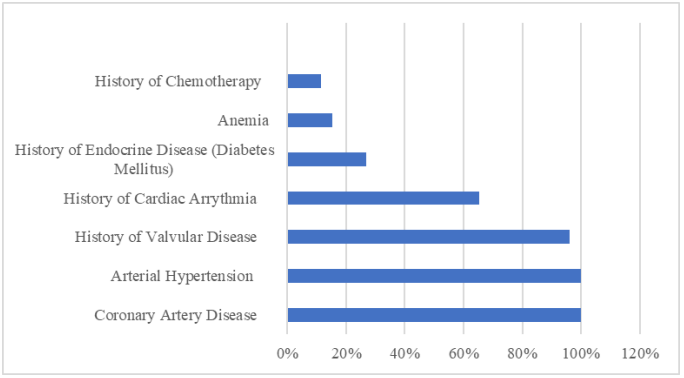

Figure 3. *The most frequent comorbidities among all patients are included in this trial.*

Laboratory findings:

Laboratory tests were evaluated with caution. Those results assisted in the establishing of HFpEF as well as in the diagnostic approach of any concomitant condition that might have influenced the development of HFpEF. The main attention was paid to NT-proBNP (pg/ml), troponin (pg/ml), creatinine (µmol/L), etc. NT-proBNP was an important link in the diagnostic approach of HFpEF. The most elevated NT-proBNP that was met in patients with sinus rhythm was 7671.9 pg/ml (diagnostic cutoff for HFpEF is > 220 pg/ml), and in patients with atrial fibrillation the same result was 19099 pg/ml (diagnostic cutoff for HFpEF is > 660 pg/ml).

Echocardiographic findings:

After reviewing the results received from 26 investigated subjects, some significant questions were tried to be answered. Basically, the distribution of HFpEF in patients with sinus rhythm and atrial fibrillation was sought while keeping in mind that FAC < 35%, RIMP > 0.54, and TAPSE < 20. Those parameters were declared as echo findings of RV dysfunction. Using the independent-samples Mann-Whitney U test, we uncovered that FAC, RIMP, and TAPSE were not significantly different in male and female subjects in both groups despite their gender affiliation (P > .05) (Table 1).

Table 1. *Distribution of echocardiographic parameters of right ventricle dysfunction in male and female patients.*

Group Statistics					
	Patient` gender Male	N	Mean	Std. Deviation	Std. Error Mean
FAC %	Female	21	49.78	10.273	2.242
	Male	5	43.91	10.133	4.532
TAPSE (mm)	Female	21	17.95	3.383	.738
	Male	5	17.80	2.168	.970
RIMP	Female	21	.6852	.15753	.03438
	Male	5	.6000	.19391	.08672

Independent-Samples Mann-Whitney U Test was used in the assessment of the most predictive parameter (FAC, TAPSE, RIMP) for RV dysfunction in patients with sinus rhythm and atrial fibrillation, regardless of gender affiliation. FAC was the main heterogeneous parameter that distinguished the patients with sinus rhythm and atrial fibrillation (P < .05). Other

parameters, such as TAPSE and RIMP, did not emerge with the same differences. The P value for TAPSE was 0.131, and for RIMP it was 0.860, respectively (Table 2).

Table 2. *Distribution of RV disfunction echocardiographic parameters in patients with sinus rhythm and atrial fibrillation.*

Group Statistics					
	AF	N	Mean	Std. Deviation	Std. Error Mean
FAC %	Atrial fibrillation	14	44.09	7.774	2.078
	Sinus rhythm	12	53.98	10.631	3.069
TAPSE (mm)	Atrial fibrillation	14	17.00	3.038	.812
	Sinus rhythm	12	19.00	3.045	.879
RIMP	Atrial fibrillation	14	.6607	.19277	.05152
	Sinus rhythm	12	.6783	.13176	.03804

Since FAC < 35%, RIMP > 0.54, TAPSE < 20, and S` < 10 are the principal parameters that characterized the RV dysfunction, interestingly, this criterion was frequently fixed in RV-deteriorated patients to describe both RV systolic and diastolic dysfunction simultaneously. Based on the statistical analyses, RIMP was the main parameter pointing to the presence of RV dysfunction: 19 patients (86.4%), then S` < 10: 8 patients (36.4%); changing of TAPSE was revealed in 4 patients (18.2%), and finally, FAC that was fixed in 3 patients (13.6%). Hence, RIMP was the principal echocardiographic parameter that gave a clue for systolic and diastolic RV dysfunction despite patients` cardiac rhythm (Table 3).

Table 3. *The frequency of RV dysfunction echocardiographic parameters in patients with sinus rhythm and trial fibrillation.*

$parameters Frequencies				
		Responses		Percent of Cases
		N	Percent	
$parametersa	Fac_Var	3	8.8%	13.6%
	Rimp_var	19	55.9%	86.4%
	Tapse_Var	4	11.8%	18.2%
	TDI_S'_Var	8	23.5%	36.4%
Total		34	100.0%	154.5%
a. Dichotomy group tabulated at value 1.				

During our investigation, we were trying to seek any relation between the level of Pro-BNP and the frequency of echocardiographic parameters of RV deterioration separately in both groups. That question was asked independently as well for each echo marker of RV dysfunction. Pearson correlation was used for that statistical analysis. We did not find any statistical clue in the correlation between FAC and degree of elevation of pro-BNP either in patients with sinus rhythm or with atrial fibrillation (P > .05) (Table 4).

We did not find any statistical correlation between RIMP and degree of pro-BNP elevation, either in patients with sinus rhythm or atrial fibrillation (P > .05) (Table 5).

The same answer was uncovered while investigating the correlation between TAPSE and elevation of pro-BNP—no correlation at all (P > .05) (Table 6).

During our study, we were analysing the presence of any statistical correlation between the ultrasound parameters of pulmonary hypertension and RIMP. RIMP, itself, was chosen because it was better to delineate the RV systolic and diastolic dysfunction simultaneously. Correlation analysis was performed using the Pearson correlation test.

Table 4. *Colleralion of FAC with degree of pro-BNP elevation in patients with sinus rhythm and atrial fibrillation.*

Correlations				
AF			NT-proBNP (pg/ml)	FAC %
Sinus rhythm	NT-proBNP (pg/ml)	Pearson Correlation	1	-.097
		Sig. (2-tailed)		.763
		N	12	12
	FAC %	Pearson Correlation	-.097	1
		Sig. (2-tailed)	.763	
		N	12	12
Atrial fibrillation	NT-proBNP (pg/ml)	Pearson Correlation	1	-.370
		Sig. (2-tailed)		.213
		N	13	13
	FAC %	Pearson Correlation	-.370	1
		Sig. (2-tailed)	.213	
		N	13	14

Table 5. *Colleralion of RIMP with degree of pro-BNP elevation in patients with sinus rhythm and atrial fibrillation.*

Correlations				
AF			NT-proBNP (pg/ml)	RIMP
Sinus rhythm	NT-proBNP (pg/ml)	Pearson Correlation	1	.117
		Sig. (2-tailed)		.718
		N	12	12
	RIMP	Pearson Correlation	.117	1
		Sig. (2-tailed)	.718	
		N	12	12
Atrial fibrillation	NT-proBNP (pg/ml)	Pearson Correlation	1	.212
		Sig. (2-tailed)		.487
		N	13	13
	RIMP	Pearson Correlation	.212	1
		Sig. (2-tailed)	.487	
		N	13	14

Since the normal range of sPAP (RVSP) was < 25 mmHg and mPAP < 20 mmHg, we questioned whether any relation between the pulmonary hypertension and RIMP existed if we considered that the RIMP cutoff was > 0.54. Finally, we received the result about the absence of any statistical correlation between sPAP/mPAP and pulmonary hypertension and RIMP (P > .05) (Table 7).

Table 6. *Colleralion of TAPSE with degree of pro-BNP elevation in patients with sinus rhythm and atrial fibrillation.*

Correlations				
AF			NT-proBNP (pg/ml)	TAPSE (mm)
Sinus rhythm	NT-proBNP (pg/ml)	Pearson Correlation	1	.348
		Sig. (2-tailed)		.267
		N	12	12
	TAPSE (mm)	Pearson Correlation	.348	1
		Sig. (2-tailed)	.267	
		N	12	12
Atrial fibrillation	NT-proBNP (pg/ml)	Pearson Correlation	1	-.021
		Sig. (2-tailed)		.945
		N	13	13
	TAPSE (mm)	Pearson Correlation	-.021	1
		Sig. (2-tailed)	.945	
		N	13	14

Table 7. *Correlation between sPAP/mPAP and RIMP in patients with sinus rhythm and atrial fibrillation.*

Correlations				
		RIMP	RVSP	mPAP
RIMP	Pearson Correlation	1	-.045	-.047
	Sig. (2-tailed)		.828	.819
	N	26	26	26
RVSP	Pearson Correlation	-.045	1	1.000**
	Sig. (2-tailed)	.828		.000
	N	26	26	26
mPAP	Pearson Correlation	-.047	1.000**	1
	Sig. (2-tailed)	.819	.000	
	N	26	26	26
**. Correlation is significant at the 0.01 level (2-tailed).				

Table 8. *Correlation between TAPSE/PASP and RIMP in patients with sinus rhythm and atrial fibrillation.*

Tapse_pasp * Rimp_var Crosstabulation					
			Rimp_var		Total
			No	Yes	
Tapse_pasp	No	Count	5	16	21
		Expected Count	5.7	15.3	21.0
		% within Tapse_pasp	23.8%	76.2%	100.0%
	Yes	Count	2	3	5
		Expected Count	1.3	3.7	5.0
		% within Tapse_pasp	40.0%	60.0%	100.0%
Total		Count	7	19	26
		Expected Count	7.0	19.0	26.0
		% within Tapse_pasp	26.9%	73.1%	100.0%

Since the cutoff for RIMP is > 0.54, the correlation between that value and the TAPSE/PASP ratio was also investigated. TAPSE/PASP ratio is one of the newest parameters distinguishing pulmonary hypertension. We were interested in the possible relation of those findings in situations when the TAPSE/PASP ratio cutoff was < 0.36 mm/mmHg. Finally, we uncovered no plausible correlation at all (P > .05) (Table 8).

PVAT < 130 msec and TR Velocity > 2.8 m/sec were also examined as secondary clues of pulmonary hypertension. In our trial, the correlation between PVAT value and TR velocity on the one hand and RIMP (cutoff > 0.54) on the other hand was surveyed. That correlation was not found out (P > .05) (Tables 9 and 10).

Finally, we were trying to evaluate any correlation between the class of heart failure and echo parameters of RV dysfunction (FAC, TAPSE, RIMP). We were interested in whether the severity of RV deterioration described by any of its echo parameters was worsening or not concurrently in patients with a high NYHA class of HF. Statistical analyses did not uncover any plausible relation between those two points (P > .05) (Tables 11-14).

Discussion.

Chronic heart failure with preserved LV function attracts scientists` attention nowadays. Its frequency and spreading, primary and secondary hospitalization, and mortality rate observed in patients with HFpEF tend to gradually increase. Negative dynamics in hypostatization and mortality rate are

Table 9. *Correlation between RIMP and PVAT in patients with sinus rhythm and atrial fibrillation.*

Correlations			
		PVAT (msec)	RIMP
PVAT (msec)	Pearson Correlation	1	.033
	Sig. (2-tailed)		.871
	N	26	26
RIMP	Pearson Correlation	.033	1
	Sig. (2-tailed)	.871	
	N	26	26

Table 10. *Correlation between RIMP and TR Velocity in patients with sinus rhythm and atrial fibrillation.*

Correlations			
		RIMP	TR vel (m/sec)
RIMP	Pearson Correlation	1	-.049
	Sig. (2-tailed)		.813
	N	26	26
TR vel (m/sec)	Pearson Correlation	-.049	1
	Sig. (2-tailed)	.813	
	N	26	26

Table 11. *The relation between echo parameters of RV dysfunction and HF NYHA I class in patients with sinus rhythm and atrial fibrillation.*

Group Statistics					
	NYHA I	N	Mean	Std. Deviation	Std. Error Mean
FAC %	No	25	48.32	10.384	2.077
	Yes	1	57.00	.	.
RIMP	No	25	.6660	.16718	.03344
	Yes	1	.7400	.	.
TAPSE (mm)	No	25	17.84	3.184	.637
	Yes	1	20.00	.	.

Table 12. *Relation between echo parameters of RV dysfunction and HF NYHA II class in patients with sinus rhythm and atrial fibrillation.*

Group Statistics					
	NYHA II	N	Mean	Std. Deviation	Std. Error Mean
FAC %	No	15	48.21	8.635	2.229
	Yes	11	49.26	12.688	3.825
RIMP	No	15	.6853	.18369	.04743
	Yes	11	.6464	.13930	.04200
TAPSE (mm)	No	15	17.67	3.155	.815
	Yes	11	18.27	3.259	.982

Table 13. *Relation between echo parameters of RV dysfunction and HF NYHA III class in patients with sinus rhythm and atrial fibrillation.*

Group Statistics					
	NYHA III	N	Mean	Std. Deviation	Std. Error Mean
FAC %	No	15	49.27	11.898	3.072
	Yes	11	47.81	8.156	2.459
RIMP	No	15	.6587	.15574	.04021
	Yes	11	.6827	.18243	.05501
TAPSE (mm)	No	15	17.53	3.583	.925
	Yes	11	18.45	2.505	.755

Table 14. *The relation between echo parameters of RV dysfunction and HF NYHA IV class in patients with sinus rhythm and atrial fibrillation.*

Group Statistics					
	NYHA IV	N	Mean	Std. Deviation	Std. Error Mean
FAC %	No	23	48.90	10.346	2.157
	Yes	3	46.72	12.104	6.988
RIMP	No	23	.6678	.15661	.03266
	Yes	3	.6767	.26102	.15070
TAPSE (mm)	No	23	18.43	2.793	.582
	Yes	3	14.00	3.464	2.000

especially evident in patients with HFpEF for whom reduced RV function is diagnosed simultaneously.

No gold standard for echocardiographic evaluation of RV function in patients with HFpEF exists today. Despite lots of echo parameters, none of them might fluently provide us with adequate answers regarding RV function. All those parameters might be impacted by a number of obstacles and barriers.

We tried to estimate the RV function using almost all those echo parameters that are suggested in the literature. Special interest was paid to tissue Doppler of the RV and RVOT; we observed RIMP, TAPSE/SPAP ratio, FAC, TDI S', etc. Finally, we assumed we would find out those echo markers that would assist in describing RV systolic and diastolic function adequately in patients with HFpEF.

In conclusion, we were seeking any specific echocardiographic parameter for better delineation of the RV dysfunction in patients with HFpEF, despite gender and cardiac rhythm. After analysis, RIMP became uncovered to be the better clue for evaluation of both systolic and diastolic decoration of RV function.

Conclusion.

Based on the results, HFpEF is especially spread among relatively older female patients: 21 subjects, including patients, were female with an average age of 79 years.

We uncovered those main supporting factors that impact the development of HFpEF, basically overweight and obesity. That condition is especially fixed among female subjects also.

We uncovered that arterial hypertension was met in 100% of examined patients in both groups. Almost 100% of frequency was met regarding heart-acquired valvular disease in sinus rhythm patients. Not surprisingly, the presence of arrhythmia was confirmed by all subjects in the atrial fibrillation group. Additionally, we discovered that anemia and chronic renal insufficiency were the most frequent noncardiac disorders met among both types of subjects.

NT-proBNP (pg/ml), which was the main diagnostic laboratory marker for HFpEF, was evaluated in all patients. It should be mentioned that elevation of NT-proBNP occurred among all subjects regardless of their gender, age, and concomitant conditions.

Important deviations from the normal ranges for TAPSE and FAC did not occur in patients with sinus rhythms or atrial fibrillation, regardless of the symptoms of heart failure and their severity. For example, the highest score of TAPSE in sinus rhythm patients was 26 mm, and the lower range was 15 mm. average value was 19 mm. The most frequent TAPSE range we met was 20 mm (25%) (σ: 2.92). If we consider the cutoff for TAPSE: < 20 mm, we can conclude that this parameter does not have to be used separately for the better description of RV functions in patients with sinus rhythm. Relatively different results occurred while examining TAPSE in patients with atrial fibrillation. The highest level of TAPSE was 22 mm, and the lowest was 10 mm. Hence, the average TAPSE value was 17 mm The frequent range that occurred among AFiB subjects was 15 mm–3 patients (21.4%), 16 mm–3 patients (21.4%), and 20 mm–patients (21.4%) (σ: 2.93). Therefore, TAPSE is relatively decreased in patients with atrial fibrillation and might better point out the problem regarding the right ventricle.

If we consider FAC < 35% as a cutoff, we will receive the drastically contrasting answers in both populations. In patients with sinus rhythm, the highest level of FAC was 66%, and the lower value was 32%. The average mean value was 53.98%; the basic FAC parameter in that group was 57%—3 patients (25%) (σ: 10.18). As for the patients involved in the atrial fibrillation group, the highest FAC was 58%, the lowest was 29%, and the average mean value was 44.1%; the basic FAC parameter in that group was 50% of 2 patients (25%) (σ: 7.49). So, we can conclude that FAC basically was not deviated from the normal cutoff in either group. Therefore, FAC should not be considered an important echo parameter for evaluation of RV function in patients with HFpEF, regardless of cardiac rhythm. Interestingly, FAC was plausibly different among men and female subjects that was detected by the independent-samples Mann-Whitney U test: Std. Error Mean among females: 2.242 and among men: 4.532.

If we discuss RIMP and its cutoff > 0.54, we received the following results in patients with sinus rhythm: the highest value of RIMP was 0.89, and the lowest value was 0.51. The average mean parameter was 0.60. RIMP > 54 occurred in 10 patients totally (83.3%). In atrial fibrillation subjects, the highest RIMP value was 0.95, and the lowest was 0.41. The average mean value was 0.66. RIMP result > 0.54 detected among 8

subjects (64.3%). Hence, we can clearly see that RIMP was frequency deviated from its normal range in patients regardless of their gender and cardiac rhythm. Therefore, RIMP might be used for a better description of RV function in HFpEF patients. Additionally, RIMP might give us the full information about both RV systolic and diastolic functions, respectively.

It should be emphasized that statistically plausible differences between RIMP and TAPSE among male and female subjects were not detected using the independent-samples Mann-Whitney U test: for RIMP, Std. Error Mean for female subjects was .03438, and for male subjects, it was .08672; for TAPSE, Std. Error Mean for female subjects was .738, and for male subjects, it was .970.

We assumed that RV function might have been significantly deteriorated in parallel with moderate and severe elevation of BNP. Nevertheless, correlative analyses did occur for this relation for neither RIMP, TAPSE, nor FAC in either group of patients. It is well documented in the tables # 4, 5, and 6 above. Hence, we received the negative results and conclude that the BNP lever does not impact RIMP, TAPSE, or FAC at all.

We were also interested in the possible correlation of RIMP with the severity of pulmonary hypertension. We investigated the non-invasive echo parameters of pulmonary hypertension, such as sPAP, mPAP, PVAT, and the TAPSE/SPAP ratio, separately in patients with sinus rhythm and atrial fibrillation. Pearson correlation was used for evaluating any link between RIMP and PH echo parameters.

However, we did not find any clue that PH might have an influence on the results of RIMP for the patient regardless of the cardiac rhythm. It was documented in the tables # 7, 8, and 9 above.

Limitations.

We investigated the limited number of subjects suffering from HFpEF, mainly women.

Those patients were treated with different classes of drugs, and that treatment was not standardized by the single scheme. HFpEF treatment medications, which are suggested nowadays by the modern European and American guidelines, were not prescribed for all the subjects, including SGLT2 inhibitors.

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